Jean-Jacques Greif

Einstein Writes a Letter

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My dear Peggy,

In Europe, where I was raised, I wouldn't begin such a letter with your first name, much less with what seems to be a nickname. I would write "My dear Miss Jones," or "My dear Miss Smith." In America, of course, "anything goes," as you say. Actually, I don't know your last name, so how could I use it? I don't know what honest first name turns into the nickname "Peggy," either. I must say that I don't understand how Americans make up their nicknames. John, which seems short enough to me, becomes Jack. William doesn't become Will, but Bill. Charles turns into Chuck. I looked for female first names that begin with the syllable "Peg," but I found none, except maybe David Copperfield's friend Peggoty.

* * *

Yesterday, I was eating lunch in the University's Cafeteria. They serve these silly American meatballs. I don't know why they call them "hamburgers." I had a colleague from Hamburg, once. He was a real Hamburger, but certainly not a meatball.

The place was quite full. You came and sat at my table. You recognized me right away. Everybody recognizes me. One hundred and fifty million Americans know that professor Einstein lives in Princeton. You stared at me. You had one of these hamburgers in your hand, but you seemed to hesitate before biting into it.

"Are you proud of yourself?" you asked suddenly. "You killed millions of people with your atomic bomb, and now the Russians got one, too, and I bet they'll blow up the whole planet soon enough… Let me tell you something: you should have stayed home on the day you went and invented that stupid bomb!"

"It's not my bomb, miss."

I hate it when people say "your bomb." I wanted to tell you that I never killed anybody, that the people who should have stayed home were the ones who voted for Hitler in 1933, that… But you took your hamburger and moved to another table. Some of your fellow students approved your outburst.

"Well said, Peggy!"

That's when I heard your name. You seemed to be no more than twenty years old. You looked like most of the American girls I see in the university, with blonde curls and the nice round cheeks of a milk drinker.

This kind of thing happens all the time. Can't help it, I guess. I felt sorry for you and also for myself, relieved that you had moved away, but also slightly frustrated because I hadn't answered properly. I didn't sleep well. This morning, I decided I would write a kind of letter to you. I need to explain a few things – to justify myself, and perhaps to apologize. I'd like you to understand me and, if you still believe I have committed a crime, to forgive me.

Whether I'll give you the letter (supposing I can recognize you) is something I'll have to decide later.

* * *

You'll probably see the next millennium, my dear Peggy. As for me, I grew up at the end of the previous century. I was born on March 14, 1879 in Ulm, a small town located in Swabia, a province in Southern Germany. I do not remember anything about Ulm, because my parents moved to Munich, capital of Bavaria, one year after my birth.

When I was a child, Bavaria, a peaceful and beautiful land, was falling under the spell of war-loving Prussia. The Prussian chancellor, Bismarck, had united the separate States of the former German empire in 1871 by attacking and defeating France. In school, my comrades played at war in the courtyard and dreamt of becoming officers in the army. I refused to take part in their brutal games. I was a quiet and thoughtful boy. I once saw a military parade with my parents. "When I grow up," I told them, "I won't be like these poor fellows."

I loved to visit my father's factory. Maybe I should say "workshop," as there were not that many workers. They made electrical machinery. While my uncle Jakob was engineer in chief, my father took care of the sales. I think that my father lacked the spirit and the talent of a born businessman. We had left Ulm because the company he had founded there had failed.

The electrical devices fascinated me. Axles and blades rotated as if they were obeying some kind of magic. I asked my uncle, who could invent these wonders, to explain them to me.

"Uncle, how does electricity set things in motion?"

"Well, let's see… The motor contains a magnetic part. When electrical power comes near a magnet, the magnet moves."

"Yes, but where does the electrical power comes from?"

"We make it with a machine called a dynamo. Actually, I invented a new kind of dynamo. We founded this company to build it."

"You tell me that the dynamo produces electricity, but I would like to know how."

"Oh, that's quite simple. Whenever you rotate a magnet near a copper wire, electrical power begins to run along the wire."

"So you move a magnet to make electricity, then you use your electricity to move a magnet. You're running around, aren't you?"

"In a way, yes… I mean, not at all. You'll understand this later. They'll explain it to you in school."

Magnets had been puzzling me for a long time. When I was four or five years old and pinned in my bed with some illness, my father had offered me a pocket compass. I remember playing with it for hours. I could hardly believe my own eyes: the needle moved by itself! Whichever way you turned the compass, the needle always came back to its starting position, as if controlled by hidden forces. I loved to look at things. I hoped to understand the world I belonged to. I thought that I would unravel the secrets of objects, plants and animals if I examined them carefully and used my brain.

Until I was three years old, I spoke little. I didn't want to mishandle language like a baby. I would repeat the sentences I heard, mouthing them silently. When I was seven or eight years old, I still often moved my lips while I prepared a sentence, then said it aloud with a tiny time lag. My parents wondered whether I was retarded in some way.

I distrusted adults. I felt it was useless to ask them questions like all the other children did. Their answers were condescending, vague or just stupid. Most of the time, they knew nothing. I asked my father anyway.

"Why does the needle of the compass always return to the same position?"

"Because the needle points to the North. You know North, South, East and West? The sun rises in the east and sets in the West."

"Why does it point to the North?"

"The needle is a magnet. Magnets point to the North."

"The magnet knows where the North is?"

"Magnets are attracted by iron. There are great amounts of iron neat the North Pole."

"How does it turn? If I want to move something, I push it. Who pushes the needle? Or does it have tiny legs like a bug?"

"This is called magnetism. You'll study it in school."

When he showed me his electrical gadgets, my uncle mentioned magnets too. They didn't move by themselves, like the compass needle, but were pushed by electricity. This mysterious electricity, what was it? A kind of invisible fluid… My uncle knew how to create electricity with his dynamo, he could measure its intensity and power with meters, but he couldn't tell me what it was made of really.

* * *

My father and uncle pretended that I would be given the keys to all the mysteries in school. I was quite disappointed. The master insisted on teaching me the alphabet and the multiplication table, which I already knew. When I asked him how iron attracted magnets, he answered it was too difficult a question for a boy my age. He didn't know the answer, obviously. He didn't care about the wonders of the universe. He was happy when we marched like soldiers and sang patriotic anthems.

The school was Catholic, like most schools in Bavaria. The other boys said their prayers: "Our Father in Heaven…" There were seventy boys in our class. I was the only one who kept silent. My parents had explained to me that I wasn't a Catholic. I studied catechism with the others, so I could have prayed, but I found this Father in Heaven business rather strange. Since the master knew more than me, or pretended he did, I asked him about it.

"When you pray, you talk to God as if he could hear you."

"Of course he hears us."

"He lives in the sky?"

"That's right."

"In the sky, I see the sun, the moon, the stars. I don't see God."

"He is invisible, so you can't see him."

"Invisible like electricity?"

"Well, maybe that's a good way to put it… You don't see electricity, but it is very powerful. This is true of God, too."

"Electricity is powerful, but when I talk to it, I don't expect an answer. Your God doesn't answer either. I think it's useless to talk to him."

My parents had told me our ancestors were Jewish. They believed in a unique God, whereas Catholics address prayers to God, Jesus, the Holy Virgin and all the saints in Heaven. The Jews have a church called a synagogue. They rest on Saturday rather than Sunday. My parents didn't go to the synagogue. "We won't waste our time with these old superstitions," they said. While my grandfather was named after a Jewish patriarch, Abraham, I guess he wasn't too fond of the old superstitions already, so he gave my father a German name, Hermann. If my parents had followed tradition, they would have named me Abraham, like my grandfather. They tried not to stray too far and named me Albert.

The only Jewish primary school in Munich had just closed for lack of pupils. My parents didn't have much of a choice when they enrolled me in a Catholic school. The Jews considered that their children would have to live with the other Bavarians anyway, so it made sense to begin as soon as possible.

I knew I was different from the other boys, since I didn't pray with them. One day, the religion teacher brought a long nail in class and said: "With such a nail did the Jews nail Jesus onto the cross."

* * *

After losing my time in school, I went home. My mother, who was a good piano player and loved music, wanted me to study the violin. Herr[1] Schmied, my teacher, gave me precise instructions.

"Bend your fingers slightly when you hold the bow. Your little finger too."

"What happens if I don't bend them?"

"The sound isn't as full."

"I don't hear any difference."

"You should believe me. I have been playing the violin for forty years. Before me, thousands of violin players have bent their fingers for centuries."

He reminded me of my schoolteacher. They think they know everything. I told my mother the violin lessons bored me.

"I don't like music."

"You shouldn't give up. You'll get to love it by and by."

My sister Maja[2] was born two years after me. She obeyed her teachers and other adults without a hint of revolt. I tried to convince her she was wrong.

"You have a brain."

"Yes, Albert."

"You can think by yourself."

"Yes, Albert."

"So then why do you accept that papa, mama and your teachers decide everything in your place?"

"They know better."

"Of course not. Nobody knows better than you do. Say, do you think I know better than you?"

"Yes, Albert."

"So you'll obey me?"

"Yes, Albert."

"Then I order you to disobey me."

"Yes, Albert."

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[1] Mr.

[2] Pronounced : "Maya".

As she wasn't stupid, she understood she had got herself entangled in a paradox. She laughed loud and long. She was the only girl I knew, and also my only friend.

I mean, she was the only friend my age, as I considered my uncle Jakob a true friend. He lived in our home. Having neither wife nor child, he took me to the zoo or circus. While my teachers pretended I had to learn what I already knew or didn't want to know, my uncle guessed what could be of interest to me and tried to satisfy my curiosity.

"Do you see this ape, Albert? Well, you know, our ancestors were apes like this one."

"My grandfather Abraham too?"

"Papa? He may have looked like him slightly… I mean our remote ancestors, who lived millions and millions years ago. Yes, apes are our relatives. Actually, all animals are cousins."

"We are animals?"

"That's right. The great English scientist Darwin proved it."

"Do you believe that animals think like we do?"

"Why not? This ape might be wondering whether you're going to give him a banana. It's a pity he can't talk."

"It seems to me that if he doesn't talk, then he doesn't think."

"Let's see… Deaf-mute people don't talk. They do think, though, I'm sure you'll agree about that."

"The ape isn't deaf."

"Indeed, my dear Albert. He may have learned the German language by listening to the zoo's visitors. I bet he heard quite an amount of utter foolishness. He thinks like you and me, this dear ape, but we'll never know, because he doesn't speak.

"Hey, you ape, I brought a banana for you! See, uncle Jakob? If you were right, if he understood us, he would hold out his hand…"

"This poor ape just arrived from Africa, probably, so he hasn't had time to learn our language yet."

"You should come every day and give him lessons, uncle Jakob!"

* * *

I finished my primary studies and entered the Luitpold high school. If the elementary school masters seemed to me like drill sergeants, the high school teachers were like lieutenants. We had to learn lots of useless stuff: battle dates, Latin grammar rules, long lists of Greek verbs, mathematical formulas and theorems. My teachers were influencing my life in a negative way, turning me into an enemy of history, Latin, Greek and mathematics.

I was lucky that uncle Jakob opposed his strong magic to their evil charms, at least as far as mathematics were concerned.

"Forget this stupid teacher, Albert. Believe me, mathematics are wonderful! I hate to think that these fools want you to learn and repeat theorems like a parrot. What matters is to understand the purpose of theorems. Do you know who invented geometry?"

"The Greeks."

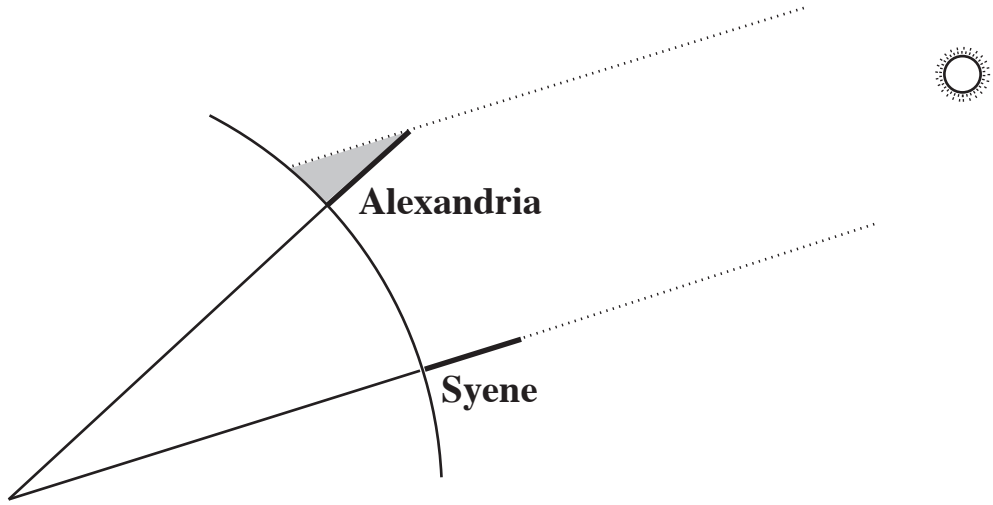
"And why did they invent it?"

"To torture poor school children."

"That's what I thought when I was your age, too… They invented it because they needed it. When a father left a field to his sons, they wanted to measure it and divide it in equal parts. The Greeks and the Romans used the same word for geometry and surveying. This is still true in French. Do you know what? With their geometry, the Greeks measured the circumference of the earth!"

"They knew the earth was round?"

"Of course. When a ship sails toward the horizon, her hull vanishes first, then her mast. The Greeks understood that the only way to explain this vanishing act was to consider the earth was curved. Now let me tell you about Eratosthenes, a scientist who lived in Alexandria two centuries before Christ. A traveler told him of a strange thing that happened near the city of Syene[3], in the South of Egypt. On the day of the summer solstice, at noon, a vertical stick loses its shadow altogether and the sun lights the bottom of a well."



"It means the city is located on the Tropic of Cancer."

[3] Known today as Aswan.

"You're quite clever already! Eratosthenes knew nothing about the Tropic of Cancer, but he measured the shadow of a vertical stick on the day of the summer solstice at noon in his own city, Alexandria. Knowing the length of the shadow and the length of the stick, he found the angle between the stick and the sun rays: 7.2 degrees. Because the Syene stick points exactly toward the sun, this is also the angle between the two sticks – and the difference between the latitudes of Alexandria and Syene. You know that a full circle is 360 degrees. What proportion of the full circle does 7.2 degrees represent?"

"One fiftieth."

"Good. All he had to do, now, was to measure the distance between Alexandria and Syene."

"You need a very long piece of string."

"Wait… Have you heard of the great library in Alexandria?"

"I know only my school library."

"The library in Alexandria was much bigger. Eratosthenes was the librarian. He couldn't leave his office, you know, and draw a piece of string across five hundred miles. He just asked a caravan leader how long it took him to ride his camel to Syene. This isn't as precise as you might wish. Eratosthenes found that the distance between Alexandria and Syene was something like 5,000 "stadia" (a Greek unit of length). He multiplied this number by fifty to evaluate the length of a meridian: 250,000 stadia. Historians do not agree on the exact value of the stadium. This length could be 24,000 miles, or 28,000."

"This way of measuring makes sense only if Syene and Alexandria sit on the same meridian."

"Hey, I think you're right… I had never thought about it. Say, Albert, you're a real wizard! He came very close to the actual length, anyway. It is 25,000 miles, as you certainly know."

I thought of Eratosthenes drawing geometrical figures in the sand, or on a papyrus, then driving his stick into the ground in Alexandria. His figures let him represent the earth he imagined in his mind. Dear miss Peggy, I hope you admire his amazing intelligence as much as I do. As soon as he heard of a shadowless stick, he understood he could compute the earth's circumference. Twenty centuries later, the people who measured the length of the meridian confirmed his results.

The Greek scientists were human beings like you and me, who used their brains to crack Nature's secrets. My uncle also told me the story of Aristarchus of Samos.

"After looking at the planets and stars in the sky, he suggested that the earth rotated around itself in twenty-four hours and around the sun in a year. This got him into the same troubles as Copernicus and Galileo much later: he was accused of insulting the gods."

"They jailed him?"

"I don't know. I guess the priests' hostility didn't bother him as much as his colleagues' objections. They said it was obviously impossible. If the earth rotated, a spot on its surface would move 24,000 miles or so in 24 hours, or 1,000 miles per hour. This crazy speed should set furious winds into motion, provoke storms and typhoons. A leaf would fall five hundred yards away from its tree. What do you think about that?"

"Er… Whatever is to be found on the earth, or just above it, moves along with it, doesn't it?"

"It seems obvious to us. Galileo explained it clearly. I wonder why Aristarchus's opponents didn't understand it."

My uncle Jakob gave me a modern version of Euclid's *Elements*, which I called "my little geometry Bible." It was one of my favorite books. There I discovered the theorem of Pythagoras. Euclid demonstrates the theorem in a very clever manner. When I was eleven or twelve, I worked hard to find my own demonstration. I still try to remember various demonstrations of the theorem now and then, as you might do with your favorite poems. A good mathematical demonstration has a special kind of beauty or harmony that rejoices the mind.

Don't worry. I won't bother you with the clumsy demonstration I found as a teenager, nor with Euclid's clever one. I mention this great theorem because it played an important part in my life. To obtain the first important result in my famous theory of relativity, all you have to do is apply the theorem of Pythagoras to the movement of a light ray.

* * *

My uncle considered my high school teachers moved too slowly. He said I was advanced enough to study algebra.

"Algebra is fun. You're looking for a small unknown animal that you name *x*. When you find it, you hurry up and catch it, then you give it a name for good."

* * *

When I was twelve or so, my parents invited a medical student named Max Talmud, brother of a doctor we knew, to have lunch with us every Thursday. This is similar to an old Jewish custom, which consists in inviting a poor student to share the Sabbath dinner. Max soon discovered that I liked physics and mathematics, but that I was

frustrated in the Luitpold high school, where we studied mainly Greek and Latin. He brought me science books and encyclopedias, and also books of mathematical problems. I would solve a problem during the week and show him my answers on the next Thursday. After a few months, he told me he couldn't go on.

"You're progressing too fast, Albert. I can't follow you anymore."

"We could study philosophy."

"People usually wait until the last years of high school to begin the study of philosophy, but why not… Nature gave you a quick mind. What do you know about philosophy?"

"I have read Kant's *Critique of Pure Reason*."

"Then you've overtaken me in this field too! I've tried to read Kant, but I don't understand a single word of it. Albert, you're a true genius."

I'm sure you know, miss Peggy, that I have often been called a genius later in my life. I don't deny it—I'm a genius. I wasn't especially talented as a child, though, except maybe for building amazingly high houses of cards. I'll tell you what I believe: every human being is born a genius. Children soar like eagles until their parents and teachers clip their wings. As for me, I refused to let my teachers stiffle my curiosity by filling up my head with useless stuff. That's why the spark of genius I received at birth stayed alive. It seemed obvious to me that school was shaping robots who would serve the State without thinking. The whole system was a fraud. At that time, I began to be wary of people who chose the side of power and authority. I've never changed my mind about this subject.

I wonder what would have happened if I had remained in high school until graduation. I might have overcome the crisis of youth and turned into a standard student. Obviously, my father hoped I would study engineering and follow him at the head of Einstein & Co. Alas, the company was floundering. For many years, it had been quite successful. It made arc lamps, dynamos, electric meters, circuit-breakers, cables. It had specialized in urban electrification. After installing electric street lights in a suburb of Munich, my father and uncle invested lots of money in a bigger project: they tried to win a huge contract for lighting the whole city of Munich. The city counselors chose a Nuremberg company. It was said they didn't want to award such an important commission to a "Jewish" firm, even though it meant preferring an outside company to a local one.

Einstein & Co was too much in debt to survive. Some of my mother's relatives lived in Italy. They had helped the company win contracts with Italian cities. My father and my uncle decided to build a new factory in Pavia, near Milan. They moved to Milan

with my mother and Maja in 1894. I was fifteen. They left me in a Munich boarding house, because I was supposed to pass my final exam at Luitpold high school a few months later. This final exam, called *Abitur*, is very important in Germany. You can't enter university without your *Abitur*.

I didn't like the people in the boarding house any more than my schoolmates or teachers. I missed my talks with Maja. My violin provided my only consolation. As my mother had predicted long ago, I had learned to love music. I had discovered that Bach's pieces have the same kind of strong magnificent structure as Euclid's most beautiful theorems. I also admired Mozart's grace and Schubert's melancholy, but I often found the music of the nineteenth century superficial and clumsily built.

As time went by, I felt I was wasting my youth. While I had to obey morons, my parents were picking up oranges and singing barcaroles under Italy's luminous sky. I decided to join them. I couldn't just flee, because the headmaster of Luitpold high school would send the police after me. After asking my friend Max Talmud for advice, I consulted his brother the doctor.

"Did Max explain my situation? I want to leave school for medical reasons."

"Yes, he told me about you. He says you're some kind of genius. Your teachers must seem worthless to you… I can prescribe a six-month suspension for nervous exhaustion."

"That would be perfect. Six months is just right."

"Now I have to warn you that you're taking a risk. Suppose that some day you want to become a university teacher. If they discover you suffered a nervous breakdown when you were fifteen, they'll probably refuse to give you the job."

"I understand… Listen, why don't you give me the medical certificate, and then I'll see whether I use it or not."

What was I to do? I talked to my math teacher. He also wrote a certificate, stating I was too far ahead in mathematics to stay in high school and thus had to enter university as soon as possible, even without an *Abitur*. Now I had two certificates. While I was wondering which one I'd better use, the headmaster took the decision for me—he expelled me from school because I "disturbed the class."

I didn't feel I was disturbing the class. I certainly didn't intend to. I sat quietly in my corner, thinking about various subjects. I did refuse to learn stuff by heart, as I found it a useless custom. Maybe they were upset that I never really tried to climb a rope or kick a ball during sport sessions. When we marched in step, going to the stadium or elsewhere, I kept losing my step. This may have disturbed the class, or at least the staff. In the end, the Greek teacher gave me a convincing reason: "Your mere

presence undermines the class's respect for me." I failed to respect my elders! I didn't obey orders. I talked back. If the other pupils decided to imitate me, the card house of German authority would tumble down. The German army wouldn't march in step anymore and the great German empire would be torn to pieces by its enemies.

I bought a ticket and boarded the first southbound train. I was humming: "I'm free! I'm free!" and laughing like a madman. I decided I'd never return to Germany. I was fed up with wearing a uniform, marching in step, shouting *Jawohl, mein Herr*[4] while banging my heels. They called it education, but their real aim was to train kids for military service.

My parents and my sister were glad to see me, of course, but didn't understand what had happened. I was dropping out of school six months before graduation! I had been expelled! What would become of me? I eased their worry by showing them the math teacher's certificate. I had progressed faster than the rest of the class, that was all.

But then I brought up another painful matter. I told them I wanted to give up the German nationality. My father found this rather puzzling.

"It's not a thing you can decide on a whim, Albert. Think about your future. Maybe someday you'll want to work for a German company, or teach in a German university."

"They're already dreaming of the next war against France, all of them. They'll force me to become a soldier and shoot at poor guys labeled *enemies*. I don't know them, I don't care about them, I don't see why I should consider them my enemies."

As I had not reached the age when you're allowed to take your own decisions, my father was supposed to act as my stand-in and inform the Germans that I had been one of them long enough. He didn't hurry. He hoped I would change my mind. He sent the letter eventually, so that I became a stateless person at the beginning of 1896.

You despise me because you believe I have invented this awful atomic bomb, miss Peggy. If you hate the bomb as much as you pretend, why don't you give up the American nationality? After all, your country did drop the bomb on Hiroshima.

* * *

My father still expected me to become an electrical engineer.

"There are very good schools outside Germany. You could receive a first-class training in Switzerland, for example in the Zurich Polytechnikum. They speak German there."

"Engineers are needed to build new machines, no doubt, but I'm not sure this would be a good profession for me. I've watched uncle Jakob. He is very skillful. He handles

[4] Yes, sir.

the tools even better than trained workers. I feel very clumsy when I compare myself to him."

It seemed obvious to me that intellectual endeavors attracted me more than manual work.

"You can choose to study theoretical subjects in the Polytechnikum," my father said. "You don't even need the certificate of your math teacher, you know. All you have to do is pass an exam that's open to everybody."

I had left Germany at the very end of 1894. The next Polytechnikum exam was to take place in September, 1895. This left me plenty of time to visit the monuments in Milan and Pavia and to explore the colorful Italian countryside. The Italians have invented so many kinds of pasta that you need to be quite good at mathematics to count them. I loved to stop in a village inn and try a new kind. Sometimes, people in the village were celebrating their saint's day by singing and dancing. Often, they were singing and dancing although there was no holiday to celebrate, as if their happiness was just overflowing. I looked at schoolchildren in the streets. Never did they march in step like soldiers! In Italy, I enjoyed life more than ever before or afterward. For months, I didn't worry about anything.

I hiked to Genoa, a harbor on the Mediterranean sea. Jakob Koch, who was my mother's brother, lived there. I had the strong legs of a sixteen-year old boy and never got tired. The distance is the same as between Princeton and New York City: sixty miles or so. While I chewed an ear of wheat and shouted *Buongiorno* to the peasants working in their fields, I wondered about my future life. Engineer? Successor to the honorable Hermann Einstein? Italian? Swiss?

I slept in cheap hotels. The birds' *bel canto* woke me up at dawn. On the way back from Genoa to Pavia, as the weather was warm and dry, I slept under the stars for the first time in my life. I felt overwhelmed by the night sky's width and depth, amazed when I looked at the millions of twinkling dots and thought of them as so many exploding suns. Even though science was rushing forward, the universe remained mostly a mystery. So many things hadn't been discovered yet. I didn't want to build machines as the heir to Hermann Einstein. I wanted to wrestle the word's secrets as the heir to Eratosthenes, Galileo and Newton.

Lying on my back in an Italian meadow, I tried to imagine the fantastic journey of a light ray. Born millions or billions of years ago in the hot blaze of a remote star, it started on its way fearlessly. Straight ahead! It traveled freely, without meeting any obstacle, before ending its long life at the back of my eye! While it was whizzing across

space, dinosaurs, mammoths and human beings were appearing and vanishing on our tiny planet…

Let's suppose an ape, having learned the German language, is actually thinking in his cage in the Munich zoo. Can he see himself flying through the universe like a ray of light? Does he understand that our sun is just another small star? I admired the power of my mind to roam the paths of imaginary landscapes.

We knew so little about light. It is the fount of life, though. Without light, there would be neither blooming trees nor thinking apes on the earth. While I couldn't hope to discover the meaning of life, I could at least try to decipher the mystery of light. How does the star create this radiation that flows continuously like a river? Why does the wire of Edison's light-bulb begin to shine when an electric current heats it? For thousands of years, blacksmiths have laid pieces of iron on embers. The gray metal turns red, which means it is emitting red light. Where does this light come from? Was it hidden inside the iron?

I had learned little in high school, but I had read lots of books. Scientists in the 17th century, seeing that light bounced upon a mirror like a ping-pong ball, supposed it was made of tiny grains. Then experiments showed that light was actually similar to a wave[5]. For a familiar example of a wave, miss Peggy, please consider sound. My vocal cords or my violin's string create a vibration. Molecules of air move back and forth. The vibrating molecules set other molecules in movement, which set more molecules in movement, and so on. In the end, the vibration is transmitted all the way to your eardrums. Single air molecules don't move much. What moves—using air as a support or medium—is what we call the "sound wave." If you ask me what this sound wave is made of exactly, I'd answer "energy."

In the middle of the 19th century, a Scottish scientist, James Maxwell, wrote mathematical formulas that described the light waves quite well. If light was a wave, then a medium similar to air was vibrating and carrying the energy across space. As there is no air between the stars, it was thought that space was filled up with an invisible fluid called "ether."

While science was exploring all the nooks and crannies of Nature and giving a description of the Universe that seemed almost complete, nobody had been able to describe this invisible ether in a satisfying way, or even to prove that it existed. The very year I was born, an American physicist, Albert Michelson, set up a very clever experiment with simple mirrors[6]. He expected to show that the earth moved through

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[5] See "Bits and Pieces," at the end of the book.
[6] See "Bits and Pieces."

the ether. He failed. He tried again and failed again. This was somewhat unsettling. The experiment seemed to prove that the earth didn't budge, or ether didn't exist. But then how could the light wave move across space without a support? "It does move, though!" I thought—lying on my back with the light rays raining into my eyes. There had to be an explanation.

I wondered whether human beings would build spaceships some day and fly to the stars. Could such a spaceship reach the speed of light?

I imagined I was riding a ray of light. In real life, this is quite impossible, but nothing prevented me from doing it in my mind. Miss Peggy, if you throw a pebble into the water, ripples appear and spread out. This is a wave, too. Molecules of water are moving up and down. The expanding wave is carrying this movement or vibration outward. Now imagine that a bee is flying just above the crest of the wave front. What does it see? A small motionless hill of water. For the flying bee, there is no wave, no vibration. If I rode a ray of light, I would be like that bee. I would see no vibration. Light would stand still. If I tried to look at myself in a mirror, I would see nothing, as if I had become a vampire. This didn't make sense. Experiments by many physicists during the 19th century had shown that light always travels at the same very high speed. The Michelson experiments confirmed it. Light won't stand still.

The laws of physics allowed me, at least in theory, to ride a ray of light, but what I saw contradicted these same laws of physics.

* * *

I took the entrance exam of the Zurich Polytechnikum in September, 1895. While the minimum age for candidates was eighteen, I was only sixteen and a half. The headmaster gave me a special permission when I showed him the laudatory certificate of Luitpold's math teacher.

I knew this exam meant a lot for my parents. My father had never been able to attend university, because its doors (as well as many other doors) had been closed to Jewish citizens until 1869.

I received perfect marks in mathematics, but I hadn't bothered studying botanics and the French language. Thus—well—in a word, I failed. My mother, who had come to Zurich with me, was quite disappointed. As for me, I felt a kind of relief. Fate was winking at me: I wouldn't become an electrical engineer, after all, and build machines that people didn't really need.

My math score impressed the headmaster, though.

"We are sorry to let you go, Herr Einstein. Our professor of physics, Herr Weber, thought you might attend his class as a free student. I suggest something else. You

could spend a year in the Aarau cantonal school, where you would polish your humanities, then you'd take the exam again."

Do you know where Aarau is, miss Peggy? Well, on the very first page of the dictionary!

The Greek and Latin teacher, Herr Winteler, invited me to live in his own home. Being a romantic young man, I fell in love with one of his three daughters, Marie. He also had four sons. I felt so happy there that I called the professor and his wife Papa and Mama.

Switzerland is a blessed country, my dear Peggy. For centuries, it has been an island of peace and democracy in the middle of an ocean of tyranny and war. The cantonal school teachers didn't pretend they were army officers. They listened to us, talked to us, never tried to force their prejudices on us, but helped us expand our abilities.

The city of Aarau rested its old walls in the bosom of a green valley. When the sun shined, Herr Tuchschmid, our physics teacher, gave his course on mountain paths.

"This is just what the philosopher Aristotle did in his famous Academy," he told us. "Walking frees and stimulates the mind. What's more, in case I don't teach you anything of interest, you may still see a gentian or a bearded vulture and draw a nice picture in your scrapbook."

"I once hiked from Milano to Genoa, Herr Tuchschmid. I did think a lot during my journey. Maybe I should walk to Vladivostok to heat my brain and cook some new ideas."

At the end of the school year, in June, 1896, I took the Polytechnikum exam again and I was admitted. I spent my summer vacations in Pavia, then I came back to Switzerland with my sister Maja. I had praised the pleasant pedagogy of the Aarau school so highly that she decided to train as an elementary school teacher there. As for myself, I rented a room in Zurich near the Polytechnikum.

During the next four years, I studied mathematics, physics, astrophysics, astronomy, geology, philosophy, anthropology, economy. Since I intended to become an intellectual—rather than manual—worker, mathematics should have appealed to me. They did, but not as much as physics. There were too many kinds of mathematics. They were spread too wide. Why would I choose one kind rather than another? The evolution of modern mathematics seemed arbitrary to me. Physics, on the other hand, had one clear purpose: to describe and understand nature. Besides, although I didn't want to become an engineer, I liked to play with the machines in the physics lab.

In a world-famous institution like the Polytechnikum, the teachers couldn't be as easy-going and friendly as in Aarau. I found most of them awfully stiff and slow.

Science was rushing ahead too fast for these solemn gentlemen. The physics teachers, Herr Weber and Herr Pernet, weren't ready to enter the 20th century. They didn't teach the physics of Maxwell, but knew only Newton.

As I hate to waste my time and endure useless strain, I studied the subjects I favored by reading books in the joyful public room of Café Odeon—while old goats expounded outdated science in the stern halls of the Polytechnikum. My friend Grossman attended the class and let me study his notes. The teachers took offense at my absence. They blamed me officially for "lack of application." They also pretended (I had heard the same thing in Luitpold high school) that I was haughty and impertinent. It seems I had flaunted my remarkable insolence by saying "Herr Weber" instead of "Herr Professor." That was quite possible. I didn't even notice this kind of distinction. And still don't.

The students, my comrades, interested me more than the teachers. They came from the farthest corners of Europe. We were young and careless. We hiked in the Alps. We slept in mountain farms with the cows! I learned to maneuver a sailboat on the lake of Zurich. All the physicists love sailing, as you need to balance the force applied by the wind to the sails with the reaction of the water on the keel and rudder blade.

Miss Peggy, you are a living proof that Princeton university welcomes students of both sexes. In 1896, this was unheard of in most European universities (as well as in most American ones, I think). The Zurich Polytechnikum may have had a somewhat stiff staff, but it was a very progressive institution in other ways: several young ladies studied and hiked with us. One of them, Mileva Maric, also played the piano. We played sonatas by Mozart and Beethoven together—she at the keyboard, me on my violin. She was born in a Serbian province of Hungary.

After four years, in August, 1900, I graduated. The final exams weren't too difficult—once I overcame my tendency to rebel against studying mandatory subjects. All my comrades graduated too, except Mileva.

Like other universities, the Polytechnikum enrolled as paid assistants the graduate students who looked forward to a career in research and teaching. Thus, Grossmann, my best friend, became an assistant in the math department. One of the two physics teachers should have offered me a position. Neither of them did. They intended to punish me, I guess. *So you want to follow your own rules, Herr Einstein? Why don't you go to the South Pole? Nobody will bother you there.*

I felt awfully hurt and disappointed. I had already imagined a quiet life in Zurich with Mileva. We would have played music every evening. I would have sailed on the lake every Sunday…

* * *

I spent the end of the summer in Italy, as I usually did. My sister Maja came from Aarau. She was engaged to Paul Winteler, one of the sons of the Greek and Latin teacher. I told my parents about Mileva Maric.

"Where does she come from, exactly?" my mother asked.

"She is born in Hungary, but her parents are Serbs."

"Serbs? I guess they're not Jewish."

"Er, I don't think they are."

"Well, you can't expect all the female students in the Polytechnikum to be Jewish. It doesn't matter, anyway."

I felt it did matter, actually. Paul Winteler wasn't Jewish either, but my parents didn't seem to care. Maybe they thought that a Jewish mother was needed to raise children properly. They wondered whether a student of physics could become a good housewife.

The Pavia factory had failed. It had prospered for a while. Then, Italian companies had started making electrical equipment. When cities decided to switch to electricity for their lighting, they preferred to deal with Italian businessmen than with foreigners. My uncle Jakob had given up and become an employee in a Vienna factory. My father had tried to launch a new company in Milan. He worked hard at keeping it afloat, but his worries had affected his health. As I couldn't expect his financial support, I had to find a job as soon as possible. I sent letters to many professors, asking them whether they needed an assistant. Some answered no. The others answered nothing.

I spent a few weeks in the Zurich observatory as an intern, in order to get a residency certificate. I needed this piece of paper to conclude a long process: I had requested the Swiss nationality one year earlier. The Swiss Federal authorities were very careful before granting citizenship. I had to swear that I wasn't a drunkard and that no member of my family was suffering from syphilis. The police investigated. They even sent a detective to Milan. He checked I hadn't made up my whole story, I guess. At last, in February, 1901, I became a Swiss citizen. I was lucky: I escaped compulsory military service, which lasted three months, because I was found to have flat feet.

During my internship in the observatory, I sent a short article to *Annalen der Physik*, the top German review: "Conclusions on the phenomenon of capillarity, by Albert Einstein." Capillarity is what pushes sap and melted tallow up trees and candles' wicks. It was a nearly worthless article, I must say, built on shaky ideas, but you can imagine how proud I was to see my name, for the first time, in this famous review.

I hoped universities and labs would consider my application, now that I was a Swiss citizen with his name in *Annalen der Physik*, instead of a stateless nobody. I sent letters

everywhere, but I received only one offer, in May, 1901. A math teacher in a technical school in Winterthur had been called away for a two-month military training period. I was to replace him. I would have preferred a real job, but I didn't have a choice. I was quite delighted, anyway, when I thought I would soon earn my first salary.

Having fond memories of my hike between Pavia and Genoa, I decided to walk across the Alps from Milan to Coire, in the South of Switzerland, then to take a train to Zurich and Winterthur. The road climbed low hills covered with blooming orchards and green fields, followed the bank of lake Cuomo, crossed the sleepy Swiss city of Lugano, then wound its way between gigantic mountains. The peaks were so high that I felt I was shrinking and would soon vanish.

I made a great discovery: that hiking on mountain paths stimulates the mind even better than walking in the plain. The number of subjects worth thinking about was increasing every year, too. The world of physics was in turmoil. There were tense debates in several fields. Something had to happen soon.

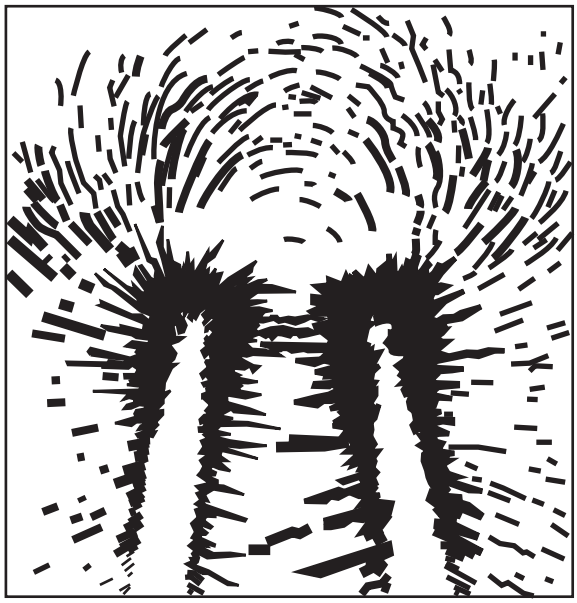
This wasn't my first mountain hike, since I had walked in the Alps often with my Polytechnikum comrades, but it was the first time I was hiking alone. I need solitude if I want to think hard. Indeed, the pleasure I feel when I talk to myself is detrimental to my relations with other human beings. I wore strong hiking shoes I had bought in Zurich, a thick woolen shirt, a pair of comfortable corduroy pants, a waxed cotton cape that could protect me against the worst mountain storm. Although I followed a well-trodden path, I hadn't forgotten to bring a compass. A low cloud may wrap the mountain in a dense mist, a snowstorm may fall out of nowhere even in May or June. Without a compass, you risk running circles and getting utterly lost. This wasn't the compass my father had offered me long ago, of course. What had become of it? I smiled when I thought that neither my father nor my uncle had been able to explain why the needle pointed toward the North. They said a large mass of iron, close to the North Pole, attracted it. How could a mass of iron act on a needle thousands of miles away?

I had bought a portrait of Faraday in a curiosity shop. I've always felt close to this English physicist, who lived one century before me. His father was a blacksmith. Faraday went to elementary school, where he learned to read and write. When he was fourteen, he was an apprentice in a bookbinding shop. As he was binding the "E" tome of the *Encyclopedia Britannica*, he happened to read the article about electricity. He found it so startling that he began to look for textbooks on physics and science. A few years later, to encourage him, his boss offered him a ticket to a series of talks by the famous scientist Davy. Now Davy had promised a book to a publisher, but he had just burned his eyes in a chemistry experiment. Or was it his right hand? Well, the poor

man couldn't write. Someone said: "There's this young fellow sitting in the first row at your conferences, who jots down everything you say. You could use his notes for your book." So then Davy took Faraday as a secretary and assistant. When Davy died, Faraday replaced him as the head of the laboratory.

Faraday showed that moving a magnet near a copper wire creates an electric current. This means he invented the modern generator. Before he did, small quantities of electricity were created by chemical means, in batteries. Faraday also invented the electric motor, which is just an inverted generator: electricity moves a magnet.

He made an experiment that you have certainly seen in school, miss Peggy, if you've studied a little physics. You hold a sheet of paper covered with iron shavings above a magnet. When you shake the sheet, the tiny pieces of iron move and turn so as to settle along lines showing what we call the "magnetic field."[7]



At every point of a field line, there is a force that can move an iron shaving. Faraday replaced action at a distance, which was hard to explain, by a local force. "As if the magnet sent invisible tentacles across space," he said. This way of thinking changed physics forever. My great theory, General Relativity (in 1901, I had no idea I would change physics forever myself) replaces another action at a distance, Newton's law of gravity, with a "gravitational field" present everywhere in space. I owe much to Faraday. If he had gone to university and studied Newton's physics, he might not have invented his quirky tentacles—which his colleagues made fun of at first.

[7] A similar field surrounds an electric circuit. Thus, its proper name is "electromagnetic field."

So we know why the needle points to the North: because a magnetic field exists on the earth. Where is the magnet that creates this field? What do you think, my dear Peggy? Maybe at the center of our planet. The rotating mass of its molten iron core acts like a huge magnet[8].

A Scottish physicist, Maxwell, found equations for the electromagnetic field's local forces. Now, if you move the magnet or electric circuit that creates the field, the forces will change. Maxwell imagined vibrating magnets or electric circuits. The field lines vibrate and ripple like water after you've thrown a pebble. Maxwell didn't have the tools to test his theory, but a German physicist, Hertz, created such "electromagnetic waves" at the end of the 19th century. We call them "Hertzian waves." They bring radio and TV programs in your home, you know. They move at the speed of light. As a fact, light is also made of electromagnetic waves.

* * *

When I came to a village, I bought a loaf of rye bread, a goat cheese, a few apples. Then I looked for a pleasant clearing in a wood, or a flat rock near a mountain stream, and I halted there to eat my lunch. Good shoes, bread, cheese, sun rays—I didn't need anything more to feel perfectly happy. At the same time, I knew that my happiness didn't matter in the general scheme of things. Here I was, a tiny speck of life, not much bigger than an ant, crawling upon the coarse skin of a small planet. Nearly nothing.

Strangely, though, the mind of this insignificant ant was so large that it could contain the whole world! The tall peaks, the wild forests, the clouds that drifted in the sky like fluffy foam, the other planets, the remotest stars… What I couldn't see, I imagined.

The Earth's electromagnetic field surrounded me. Since our planet was a gigantic oscillating magnet, it probably emitted Hertzian waves. All the stars were likely to emit Hertzian waves on top of light waves. These waves vibrated everywhere around me, but they remained invisible. Today, miss Peggy, human beings emit lots of Hertzian waves that transmit sounds and pictures. In 1901, Guglielmo Marconi had just sent the very first Morse code radio signals. Wilhelm Röntgen had discovered other invisible waves and named them X rays. Henri Becquerel had noticed that uranium ore emitted a strange radiation.

I would have liked to perceive these invisible waves in the same manner I saw the sunlight dancing among the trees and playing with the stream's water, to feel their pulsation as I felt the pleasant warmth of the sun on my skin. Well, although I didn't see the magnetic field, I could show it existed by pulling my compass out of my pocket.

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[8] This was confirmed only recently. The field fluctuates and disappears every few million years or so. Compass needles can then point South.

We knew how to measure the power of X rays and the radioactivity of uranium. What totally escaped our grasp was the ether that was supposed to carry all these waves.

An Irish physicist, Fitzgerald, and his Dutch colleague, Lorentz, had suggested that material bodies, including the Earth, "contracted" or shrank when they moved. This explained why our instruments couldn't measure the variation of the speed of light that should have resulted from the movement of the Earth relative to the ether: the instruments shrank with everything else. A clever but arbitrary theory, created for the sole purpose of allowing results that didn't make sense otherwise.

* * *

I wore a warm blue sweater that my mother had knitted years ago. As the path rose higher, the air became colder and its pressure decreased. This meant simply that there were fewer molecules around. After thinking about the mysteries of the infinitely great, I turned my mind's eye toward the invisible springs of the infinitesimal. Most scientists agreed that matter was made of tiny bits of stuff. Just think a minute, miss Peggy: can you imagine dividing matter forever? Since the 17th century, these elementary bits of matter were called corpuscles, particles or molecules.

I had become a student at Zurich University at the same time as at the Polytechnikum, in order to get a doctorate of physics. I studied gas molecules. When you bring energy to a room by heating it, the air molecules move faster, so that more of them hit the walls every second. We say the pressure increases. We can measure it with an instrument called a manometer. Our microscopes aren't powerful enough to let us see the molecules, but we know how to calculate their speed and their size. That is, the physicists act *as if* molecules existed. At least I did, to write several articles and prepare my doctoral thesis. The skeptics said: "Your molecules don't exist. They are just words in a theory." This was precisely what I liked about physics. Molecules are a word in a theory, like Hertzian waves, but it doesn't mean they don't exist.

I often thought about Eratosthenes, who drew a round Earth in the sand. He supposed the earth was a globe. This was a word in a theory—a hypothesis that fit his observations. In the same manner, molecules were a satisfying hypothesis.

Is a molecule the smallest bit of matter? In the 19th century, it was found that water was composed of hydrogen and oxygen. Thus, you can divide a water molecule into several parts. Democritus, a scientist who lived five centuries before Christ, called *Atomos*, which means "can't be cut," the smallest bits of matter. We say a water molecule is made of hydrogen and oxygen "atoms." Toward the end of the 19th century, Lorentz, the Dutch physicist, and J. J. Thompson, an English scientist, showed

that our "atom" could actually be cut. It contains smaller particles, called "electrons," which carry electric power.

Electricity seems to flow continuously, but it doesn't. It is produced by the movement of small particles. In 1900, the German physicist Max Planck put forward a bold hypothesis. Since matter is discontinuous, the energy it emits—for example, when you heat a piece of metal, or when a vibrating electric circuit sends Hertzian waves—is also discontinuous. Max Planck called this elementary bit of energy a "quantum."

* * *

What can I tell you about Winterthur? I spent thirty hours a week teaching descriptive geometry and I studied physics during my free time. Then a former Polytechnikum comrade found a job for me in a boarding school in Schaffhausen, north of Zurich, as the personal teacher of an English pupil. I was rather unhappy when I discovered that the owner of the school gave me only one tenth of what my student's parents paid for his tuition. The owner wasn't satisfied with me either. He found me too lax. He was quite different from the congenial Aarau teachers.

I was saved from gloom and doom by my friend Marcel Grossmann, or rather his father, who recommended me to Herr Haller, director of the Swiss Patent Office in Bern. This office, founded a dozen years earlier, was looking for employees "with a thorough university education in mechanical-technical and physical directions." This sounded just like me, didn't it? I wrote to Herr Haller in December, 1901. He received me in March, 1902.

"See, young man. Here's what a patent request looks like. These pages contain a detailed description of the invention, and we also have a working prototype. What do you think of this one?"

"Er… It is a photographic camera, obviously. The written description isn't clear…"

"This is what makes the job arduous. With experience, you'll understand the most tangled texts. Here, the inventor doesn't request a patent for the camera, but for the plate-changing system."

Herr Grossmann's recommendation was potent and Herr Haller was lenient. He signed me in as "technical expert third class," with an annual salary of 3,500 Swiss francs. I was to start on June 23, 1902.

My first pay day was more than three months away. I had barely enough money to rent a small room under a roof and eat bread and cheese, like a desperate character in a naturalistic novel. I published an ad in a Bern newspaper: *Albert Einstein, graduate of the Zurich Polytechnikum , private lessons in physics and mathematics, 3 francs per hour, free trial lesson."* A Rumanian young man, Maurice Solovine, rang my door.

"I'm studying philosophy in the university. I would like to understand modern physics so I can have an up-to-date vision of nature."

"An excellent idea, no doubt. I liked philosophy myself when I studied it in high school, but I thought that it gave a very vague and arbitrary description of reality, so I chose to become a physicist."

My student was two years younger than me. Like Herr Tuchschmid, my teacher in Aarau, I often gave my lessons outside. We left Bern on Sunday morning and hiked to the lake of Thun, more than fifteen miles away. We walked most of the day, but I only charged for a one-hour lesson. Then we took a train back home. Two former Polytechnikum students, Conrad Habicht and Michelangelo Besso, soon joined us. We called our small circle "The Olympia Academy." We wondered whether atoms existed, whether the Earth moved relative to the ether, whether the speed of light was constant. I had met Michelangelo Besso in a private concert in Zurich. At first, he had thought I was a professional violinist, which was quite flattering. We had become such good friends that I had introduced him to the Winteler family, with the result that he was engaged to Anna, the eldest daughter of Mama and Papa.

In October, 1902, I went to Milan, where my real papa was dying. He was only fifty-five years old. The terrible hardships and frustrations he had suffered trying to sell power generators to Italian cities had worn him out. He had never been able to repay the capital he had borrowed from his cousin Rudolf Einstein, his brother in law Caesar Koch and other members of the family. He had been ill for years already. "Marry her and be happy," he told me in a feeble rasping whisper. When he felt the end coming, he asked all the people in the room to leave, as he wanted to die alone.

Soon after my father's death, my mother came to live with Maja in Aarau. Later, Maja went to Berlin to study medieval French. My mother then moved in with her sister Fanny, near Stuttgart.

* * *

My dear Peggy, I hope to convince you I am neither a monster nor a mass murderer. As I don't want you to accuse me of lying by omission, I'll tell you something very few people know…

If you like fairy tales, you certainly expect me to marry Mileva and live happily ever after. This didn't happen. Our marriage came to a lousy ending because it had a messy beginning. I'm sure you've noticed, by now, that I scorned Society's conventions and preferred to follow my own rules. I convinced Mileva to spend a night with me, now and then, in Winterthur and Schaffhausen. It was a kind of secret marriage. As a consequence of my having skipped biology classes at the Polytechnikum, however

(supposing the teacher described the actual mechanics of reproduction, which is far from a sure thing), Mileva became pregnant toward the end of summer, 1901. We were so ignorant, both of us, that several months passed before we noticed anything. We knew there were means of interrupting a pregnancy, but we didn't know how to proceed. We didn't want to marry just when my father was dying. My mother hated Mileva without knowing her. She cried loudly whenever I mentioned her. She had even written a letter to Mileva's parents, telling them the Einstein family would never welcome their daughter.

Mileva went back to Hungary. A baby girl, Lieserl, came into this world in May, 1902. When I received the letter (written by Mileva's father, as she was probably too weak) announcing the birth of my daughter, I was overjoyed. I wrote to Mileva right away:

"Is she healthy? Does she cry properly? What are her eyes like? Which one of us does she more resemble? Who is giving her milk? Is she hungry? She must be completely bald. I love her so much and don't even know her yet! Couldn't you have a photograph made of her when you've regained your health? Is she looking at things yet? Now you can make observations. I'd like to make a Lieserl myself someday. It must be fascinating! She's certainly able to cry already, but won't know how to laugh until much later. Therein lies a profound truth. When you feel better, you'll have to draw a portrait of her!"

But then, I thought about Switzerland. It was (and still is, I'm afraid) a very conservative country. I couldn't register the child, born out of wedlock, just when I was entering the Federal administration. They would have expelled me right away. Mileva's parents found an adoptive family in Belgrade for our little Lieserl, so that I didn't even see her. We had to promise that we would never try to find her.

It was a very painful turn of events, of course. I felt terribly guilty, because I had forced my views, or should I say my parents' views, on Mileva.

I could solve a differential equation better than tackle a problem in real life. On the one hand, I was beginning to understand that Mileva was a good friend, like Marcel Grossmann or Michelangelo Besso, but that I didn't feel toward her the noble passion called *love*. On the other hand, a kind of blurry conception of honor compelled me to marry her as a way of making amends for the harm I had inflicted. I would have considered myself a scoundrel if I had left her just after asking her to give up our baby.

We got married on January 6, 1903 in Bern. We celebrated by dining in a good restaurant with our two witnesses, Maurice Solovine and Conrad Habicht. I had found a new apartment, slightly larger than my room under the roof.

Mileva had spent more than one year in Hungary. She had returned a different person. She spoke little and never smiled. I thought childbirth had depressed her. Her character had always been somewhat sullen and distrustful. It was now more so. She had never told me much about her childhood. She had suffered a form of tuberculosis that had bent her joints or something, so that she limped slightly.

Hans-Albert was born ten months after our wedding, as if to replace Lieserl.

* * *

In the patent office, I received vegetable mashers, player pianos, self-winding watches. I had to study technical drawings, mock-ups, prototypes, operation manuals, then accept the good inventions and reject the bad ones—those that somebody else had already patented, those that didn't work as advertised, those that pretended to change lead into gold or work forever without any fuel. People invented all kinds of electrical devices that reminded me of my father's factory or relied on Maxwell's equation to emit Hertzian waves. I could see right away what the thing was all about, so that after a while I left the vegetable mashers to my colleagues and became an expert of avant-garde technology.

I spent most of my time editing the inventors' written descriptions of their gadgets. They were obscure, full of technical and logical errors. I can say I learned how to write clearly—and maybe also think clearly—by editing hundreds of patent requests in Bern. Herr Haller taught me to be a sharp critic.

"When you look at a patent application," he said, "you should consider that anything the inventor says is wrong."

Michelangelo Besso, whom I recommended warmly to Herr Haller, became my colleague at the office. He found an apartment close to mine, so that we often walked home together after work. The Olympia Academy still met on a lake shore or mountain path during the week-end, in my home on week-day evenings. On March 14, 1904, Maurice Solovine, Conrad Habicht and Michelangelo Besso came to my home.

"I brought a bottle of Asti Spumante, our Italian champagne."

"Here is some caviar. I hope you like it, Albert."

"I don't even know what it is."

"Fish eggs. In Rumania, we eat the stuff when there is an important celebration."

"I remember reading in some Russian novel that some character ate some. It is supposed to be very refined and expensive. You see, Albert, your friends haven't forgotten your birthday."

"My birthday? It this March 14?"

"He didn't even know. A real absent-minded professor."

"Bah, it is just another day. The Earth goes on rotating. Do you think the planets and stars notice my birthday?"

"Listen to him! Just another day… You're twenty-five. A quarter of a century."

"I won't deny that twenty-five is one fourth of one hundred. Now let's open our Academy meeting."

"Not before we've opened the wine bottle and the can of caviar!"

"My friends, I consider this a very special day indeed. Not because it marks twenty-five years of my presence on Earth, but because I'm going to expound a discovery of the highest importance. I think I'm beginning to understand what's wrong with modern physics. It's not much, you'll see. Just a tiny word, a little "or" in Newton's first law of motion… Mileva, the child is crying."

"Hey, I'm interested, too. I'll take care of the baby and be back. Wait for me!"

"Here, Albert, try this caviar."

"Thanks, Maurice. Do you remember Newton's first law? I told you about it last year."

"Er, I remember you told me about it, but don't ask me what it is!"

"It was just a nightmare. I put him back to sleep."

"You know I've been racking my mind for years about the speed of light and the movement of the Earth relative to ether. I've decided to go over these questions *ab nihilo*, without any preconception. Do we really understand the words we're using? To begin with, let's get rid of ether. We've supposed it existed because we needed it to explain the movement of light waves, but we don't know what it is. I hope you agree with me."

"It's an invisible fluid."

"Not as tasty as this Asti Spumante, I'd say."

"Since no one had ever found a trace of its existence, let's forget about it. We'd better spend some time examining the other words. Do we know what speed is? What about movement?"

"Of course we know. What a strange question!"

"Right now, Conrad, are you moving?"

"My dear Albert, now that I'm sitting in this comfortable armchair, I intend to stay there during the next hour."

"Are you motionless? Is your speed zero?"

"Yes, that's right."

"You do turn around the Earth's axis and around the sun, don't you?"

"Ah, I see what you mean. I'm moving very fast, actually."

"Be careful not to fall from your comfortable armchair, Conrad!"

"At least, you're motionless relative to the Earth. Would you agree with that statement?"

"I'm as motionless as can be."

"Are you really sure?"

"Well, yes, I mean…"

"Please imagine now that you wake up after a short nap. You know, sometimes, when we wake up, we feel slightly confused about where and when. I'll suppose this room is a sleeping-car in a train. Please think carefully, Conrad. Can you tell me, when you wake up, whether the train is moving or not?"

"If it moves, it is noisy. Also, I can look through the window and see the landscape speeding by."

"Good remarks. I suppose the train moves slowly, noiselessly, without jumping and shaking, and that the curtains are lowered."

"I get it. I can imagine a situation where I can't tell whether the train is moving or not."

"Right. There is no difference. If you're inside a train moving at constant speed on a straight track (we physicists call this "uniform motion" and say the train is "an inertial system"), you are not aware of your movement relative to the Earth. It is as if the train didn't move. When you walk at three miles per hour inside the train, you feel you're walking at three miles per hour, even if the train is moving at thirty miles per hour. You countryman Galileo, my dear Michele, was the first to notice that the sentence: "this stone doesn't move" is meaningless if you don't add: "relative to the boat" or "relative to the Earth." In physics, a movement is always *relative to something*.

Maurice Solovine, who hadn't studied physics, was contorting his face like a fellow following a difficult conference. Suddenly, he smiled.

"Now I think I remember that lesson last year, Albert. Before coming to Newton, you talked about Galileo and his theory. Wait… The theory of relation, is that it?"

"Relativity! You certainly remember the example he gave. Bales of wool are tied in the hold of a ship. A merchant in Venice says: 'They came from Cyprus to Venice.' But when someone asks the ship's captain whether they moved, he answers: 'They didn't budge. They were tied tight.' And Galileo adds: 'If a mouse jumps from one bale to another, that's a big move for him. He knows nothing about Cyprus and Venice.' The movement of an object is always *relative to a system of reference*. The bales do not move if you take the ship as the system of reference, but they do if you take the Earth."

"There was an aquarium full of fish, right?"

"Galileo asks you to imagine an aquarium in the hold. If the ship is accelerating, the fish are attracted toward the back of the aquarium. If it is slowing down, they are attracted toward the front. You've noticed this when you travel in a train or a car, of course. Now comes the important fact: if the ship moves at a constant speed in a straight line, the fish swim around without feeling any effect of the ship's movement. They live their fishy life inside the aquarium, as if it was motionless relative to the Earth."

"Albert! Albert! Talking about fish… You ate all the caviar! How did you like it?"

"I ate all of it? Are you sure? Er, I liked it, obviously, otherwise I wouldn't have gobbled it. I'm not such a great expert about food. This is what happens when you offer refined fare to a boor. He is unable to appreciate it. Say, where was I?"

"Fish live their fishy life until Galileo eats them without even noticing."

"Ah, yes. A movement relative to a ship in a state of uniform motion is similar to what it would be if the ship was motionless in a harbor. Galileo imagined a man doing long jumps inside the cabin. He jumps the same length whether the ship is moored to the wharf or sailing at sea. Galileo also imagined a pierced bucket and a bottle under the hole. Water drips into the bottle whatever the speed of the ship, as long as it is constant. In the 17th century, people didn't go very fast and had never really thought about speed. Thus, to explain precisely what he meant by 'uniform motion,' Galileo had to invent the modern idea of speed ('instant speed[9]'). He also invented what we call 'inertia': an object in a state of uniform motion keeps the same speed and direction as long as nothing interferes, or as long as 'no force applies to it.'"

Maurice Solovine's smile widened.

"This is Newton's first law of motion, which you taught me last year. It all came back to me while you were talking."

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[9] What you read on the speedometer of your car.

"Newton's first law includes a few more words: 'A body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.'"

"Remember, Albert? We had a heated discussion about my bicycle. I said that when I reach cruising speed, the damn thing doesn't keep moving forward forever. I have to apply some force on the pedals. You said I reasoned like Aristotle."

"Yes, the Greeks thought that things were lazy and seeked rest. Aristotle's mental system of reference was his own body. We do want to stop when we run! Galileo and Newton understood that was slows your bicycle down and stops it is the force of friction. Objects are indeed so very lazy that they won't modify their state of motion unless something forces them to. Now I'm coming to this small 'or' I told you about. In his first law, Newton says 'in its state of rest *or* of uniform motion.' He backpedals relative to Galileo, who stated that there was no difference between 'rest' and 'uniform motion.' For Galileo, immobility doesn't exist. For Newton, it does. What about you, my friends? What do you think? Are there any motionless objects in the universe?"

"The sun?"

"The sun is an ordinary star in the Milky Way. It moves like the other stars. Newton was careful not to consider the sun at rest. The map of the night sky had changed already since antiquity, so he knew the stars moved. This motion of the stars bothered him. He needed an absolute system of reference so he could define uniform motion. For lack of a better way, he decided that the universe itself, the stars' container, was motionless because that's how God created it. He said that God, at least, knew whether a thing was at rest or moved. You'll admit that 'God only knows' may be a fruitful formula for philosophy, but looks rather out of place in a theory of physics."

"Ether is the absolute system of reference!"

"Right, Mileva. You've seen through the desperate attempt by the physicists to replace Newton's God. Ether represents what's at rest in the universe. Except it doesn't exist. You remember what I said: we'll forget about it…"

"There is no absolute space?"

"No. Everything is relative! Let me tell you now what I think of Michelson's experiment. It is obvious that Michelson can move and play billiards in his lab like the fish in Galileo's aquarium, because the lab is an inertial system."

"Fish playing billards? Please!"

"Hey, wait, Albert… The aquarium was supposed to be in a state of uniform motion. Michelson tried to measure the motion of the Earth, which is not uniform."

"Look at the wine in your glass, Michele. It is as motionless as you might wish. If it contained a small fish, the creature wouldn't be pushed in any direction by an acceleration. We can consider the Earth an inertial system for any local experiment that doesn't last too long. The Earth's rotation does affect sea currents, hurricanes and such things."

"Foucault's pendulum?"

"A clever experiment that renders the Earth's rotation visible, but you've got to wait quite a while. That's why I said 'that doesn't last too long." Now listen carefully. According to Galileo, Michelson can play billiards and accomplish any short-lasting *mechanical* experiment in his lab without worrying about the lab's movement. I pretend that if he tries *electromagnetic and optical* experiments, the lab's movement won't affect them either. I extend Galileo's relativity to electromagnetism. I assert that all the laws of physics, including the laws of optics, should be considered relative to the lab. If a lamp emits light in the lab, the speed of the light is the same in all directions. The movement of the Earth doesn't influence that light. Thus, Michelson's experiment has to fail."

"If ether doesn't exist, I admit that the light emitted by a lamp in a lab and reflected by mirrors keeps the same speed. But what about the light coming from a star? Its speed could change according to the star's movement relative to us."

"This is my second assertion: the speed of light is always the same. I suggest we consider it the only absolute value in space. Ether doesn't exist, absolute space doesn't exist, but light always moves at the same speed. Everything else is relative. Do you understand what it means?"

"Well, you just said it, Albert. An object's speed is relative, except if the object is a ray of light."

"Yes, but let me ask you something, my friends. How do you add speeds in this new system? In Galileo's relativity, if I walk at two miles per hour inside a train moving at thirty miles per hour, my speed relative to the Earth is twenty-eight or thirty-two miles per hour, depending on my direction. I don't want this rule to apply to the speed of light, since it has to stay the same. I need a new way of adding speeds. This is a simple matter, actually, if you accept the contraction of Fitzgerald-Lorentz: an object that moves very fast is flattened."

"I heard you call it an arbitrary theory."

"Lorentz imagines that atoms, which we know nothing about, are physically flattened by speed. My vision is very different. I think that when speeds get close to the speed of light, space itself is modified, as well as time and the relationship between

space and time. An object may seem flattened, but it is not actually flattened in a physical sense. In my theory, the effect is reciprocal. An object belonging to system A seems flattened to an observer in system B, but an object belonging to system B seems contracted in the same manner to an observer in system A. Time in system A seems to run slower to an observer in system B, and vice-versa."

"My head is spinning, and not only because of Michelangelo's wine. You modify space first, then time too! What is this expression about the valiant Swabian?"

"The valiant Swabian is not afraid. It comes from a poem."

"Well, you're not afraid, that's for sure."

"You don't know our Albert, my dear Maurice. Already in the Polytechnikum, he had the strangest ideas. He imagined he was riding a ray of light!"

"In Newton's universe, we can reach and exceed the speed of light. In my universe, which is the actual one we inhabit, you can't do that."

"I don't know whether time accelerates or slows down, but it is already three in the morning. I think we could close this session of our Olympia Academy."

"Really? But I haven't explained why time runs slower."

"Let's keep some for the next session, Albert."

"Are you coming with me, Conrad? If we walk fast enough, space will contract and we'll be home before we've even started!"

* * *

Miss Peggy, I'll now write the formula that stands at the center of my theory. As I told you when I mentioned the little geometry book I loved as a child, this formula is based on Pythagoras's theorem[10]

$$\frac{d'}{d} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

This looks like gibberish to you, I'm sure. It lets you compute the contraction of distances in a laboratory moving at speed *v* relative to a system of reference. *d* is the distance as measured by an observer inside the lab, *d'* the distance measured by an observer at rest in the system of reference. *c* is the speed of light.

A similar formula lets you compute the dilatation of time.

When the speed *v* is much lower than the speed of light, the value of $\frac{v^2}{c^2}$ is close to zero and both observers measure the same distance. Then we don't notice the

[10] The "Fitzgerald-Lorentz contraction" uses the same formula. See "Bits and Pieces."

contraction of space and the dilatation of time. It means that Newton's mechanics work fine. You don't shrink like Alice in Wonderland when you run very fast or fly in an airplane, miss Peggy, and your watch keeps good time. Things begin to go strange when an object moves at one fourth the speed of light relative to another object or system. This has been verified with particles like electrons, which can reach very high speeds in big machines called cyclotrons.

My theory also applies to an object's mass: it increases with speed. Electrons can take it, as far as I know, but I'm not so sure about you and I. Any increase in the mass of our atoms would bring disaster, I'm afraid.

A few weeks ago, a young man came and sat at my table in the cafeteria, just like you did, miss Peggy. I must say he was nicer than you. Instead of insulting me and moving to another table, he began a conversation quite politely.

"Professor Einstein, may I ask you a question?"

"Of course."

"Are you sure we can't go faster than light?"

"Quite sure. The speed of light is an absolute limit."

"What would happen if we tried to go faster?"

"Long before we'd reach the speed of light, our mass would increase so much that we'd need enormous quantities of energy to go on accelerating. In the end we'd need an infinite quantity of energy. Only light, which has no mass at all, can move at the speed of light."

"What about time travel? Do you think we'll be able to visit the past and the future?"

"I'm sorry, but I have to answer no once again. Time travel is impossible."

"But I've read a science-fiction novel where a guy travelling in outer space doesn't age as fast as his children, who stayed on Earth, because of the theory of relativity. Time slows down or something. When he returns to Earth, he's younger than his children."

"Younger than his children? This would be a very awkward situation. Well, it is true that if you travel to distant stars and come back, you won't age as much as if you stay on Earth. I wouldn't expect to count the difference in years, though. More like a few minutes.[11]"

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[11] This is known as "Langevin's paradox." Luke Skywalker goes to planet Dagoba. When he comes back home, Princess Leia has been dead for centuries! In the "Special Theory of Relativity," time seems to go slower for Luke as measured by Leia, but the effect is reciprocal: time goes slower for Leia as measured by Luke. Langevin's paradox is a consequence of "General Relativity." It involves acceleration: Luke has to accelerate to reach a very high speed, then he brakes hard to land on Dagoba, etc. People who spend weeks in the Space Station gain a few seconds.

"In another novel, the hero travels in time and must help his parents meet each other. If they don't meet, he may vanish all of a sudden. Poof! Do you understand?"

"I understand quite well. Writers imagine what they like in their novels. While books may describe spaceships that go to remote galaxies by exceeding the speed of light or by taking a shortcut through hyperspace (whatever that is), reality has all kinds of rules and laws and restrictions… I'll tell you something, young man. The theory of relativity has changed the way we deal with very tiny things like atoms and very big things like stars and galaxies. It doesn't affect our daily life. We do not live in Einstein's strange universe, but in Newton's sensible solar suburbs.

* * *

In June, 1905, the review *Annalen der Physik* published the article I wrote to introduce my new theory. Much later, I became so famous that several authors wrote my biography without waiting for the end of my life. They all apply the same Latin expression to the year 1905: *Annus mirabilis*, which means "miracle year." This is actually a flattering reference to a previous miracle year, when Newton moved to a country home outside London to avoid the plague and made all his great discoveries.

My June article was already the fourth I published in *Annalen der Physik*. in 1905.

In the first one, *A new Determination of Molecular Dimensions*, I deduced the size of sugar molecules dissolved in water by measuring the viscosity of the solution. The article was a shorter version of my university thesis. I had given up my first idea, which was to write a thesis about gas molecules, because everybody else did it.

As I knew that many physicists were reluctant to believe in the actual existence of molecules, I gave another proof in my second article, *On the Movement, Demanded by Molecular-Kinetic Theory, of Particles Suspended in Liquids at Rest*. This is not a very elegant title. As the great physicist Boltzmann said, "I leave elegance to tailors and bootmakers." The subject of my article was "Brownian movement," a phenomenon discovered by a Scottish botanist, Brown, in the early 19th century. Looking at pollen particles suspended in water through a microscope, he had seen that they never stopped moving. I looked at Brownian movement through a microscope myself. The particles were indeed swimming to and fro like small fish, without ever getting tired. I found it fascinating, but also quite funny. I thought of all these crazy inventors who pretended they had mastered perpetual motion. If Nature requested a patent for Brownian movement, I would have to admit that it had invented perpetual motion… Why do the particles never cease moving? The reason is quite obvious. Every grain of pollen is similar to a tiny soccer ball. As soon as it comes close to a molecule, it receives a kick that sends it elsewhere! When you measure the pressure of a gas or the viscosity of a

sugar solution, you get numbers that describe the molecules in an indirect and abstract manner. But when you look at the Brownian movement though a microscope, you perceive the molecules with your senses. While you don't actually see them, the nautical ballet of the pollen is a kind of amplified echo of their vibration. I gave equations for the relationship between the average course of the particles and the number of water molecules in a given volume. A few years later, when I was already famous, a French scientist set up an experiment that verified my equations.

In my third article, *A Heuristic*[12] *Viewpoint Concerning the Generation and Transformation of Light*, I expanded the hypothesis introduced by Max Planck in 1900 about "quanta" of energy. He had supposed that the atoms of a hot metal emitted energy in discontinuous bursts he called quanta. He thought the emitting was discontinuous, but light was nevertheless a continuous wave. Imagine that you fill up your bathtub by using a one-quart measuring cup, miss Peggy. It would take you a long time! This is a discontinuous process, but the water becomes a continuous mass in the tub. Thus, you can draw water with a smaller cup, or even a thimble. What I asserted is that the water stays in quarts inside the tub. You can't draw out a thimble or a cup of water, but only a quart. Or, back to light: it is emitted as quanta, it stays as quanta, it is made of quanta! Light is discontinuous, just as Newton thought. The particles of light, called "photons," do carry their own wave—which is what makes interferences possible. I suggested in my article that my hypothesis could be checked by experiments on the "photoelectric effect," discovered by Hertz and J. J. Thompson at the end of the 19th century. Light moves electrons and produces electricity when it falls on certain atoms. The experiments were made about ten years after my article was published. They are not easy. You need to count the number of electrons released when you vary the light's intensity and color. If you own a recent camera, miss Peggy, it may include a light meter that uses the photoelectric effect to measure the quantity of light.

* * *

Today, everybody knows I have discovered the "Theory of Relativity." My famous June, 1905 article had a very different title, though: *On the Electrodynamics of Moving Bodies*. The word "relativity" had just been invented by Henri Poincaré, a great French scientist, to describe Galileo's theory of moving bodies. In order to extend Galileo's theory to the movement of light, I had modified our ideas of time and space. At the end of my article, I thanked another Italian fellow, Michelangelo Besso—who helped me refine my thought when we walked home together in the evening.

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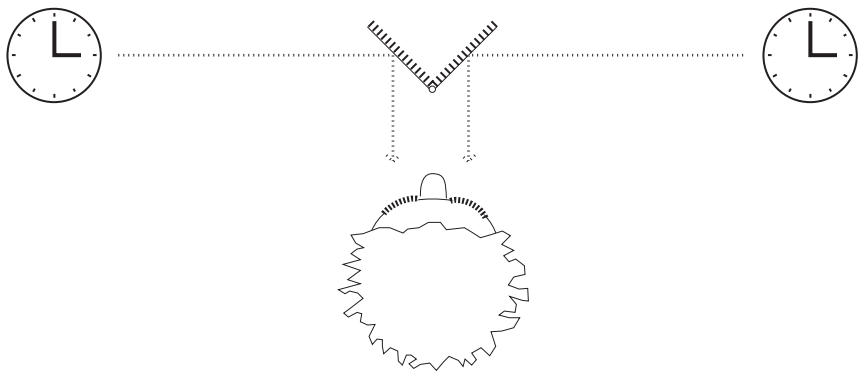
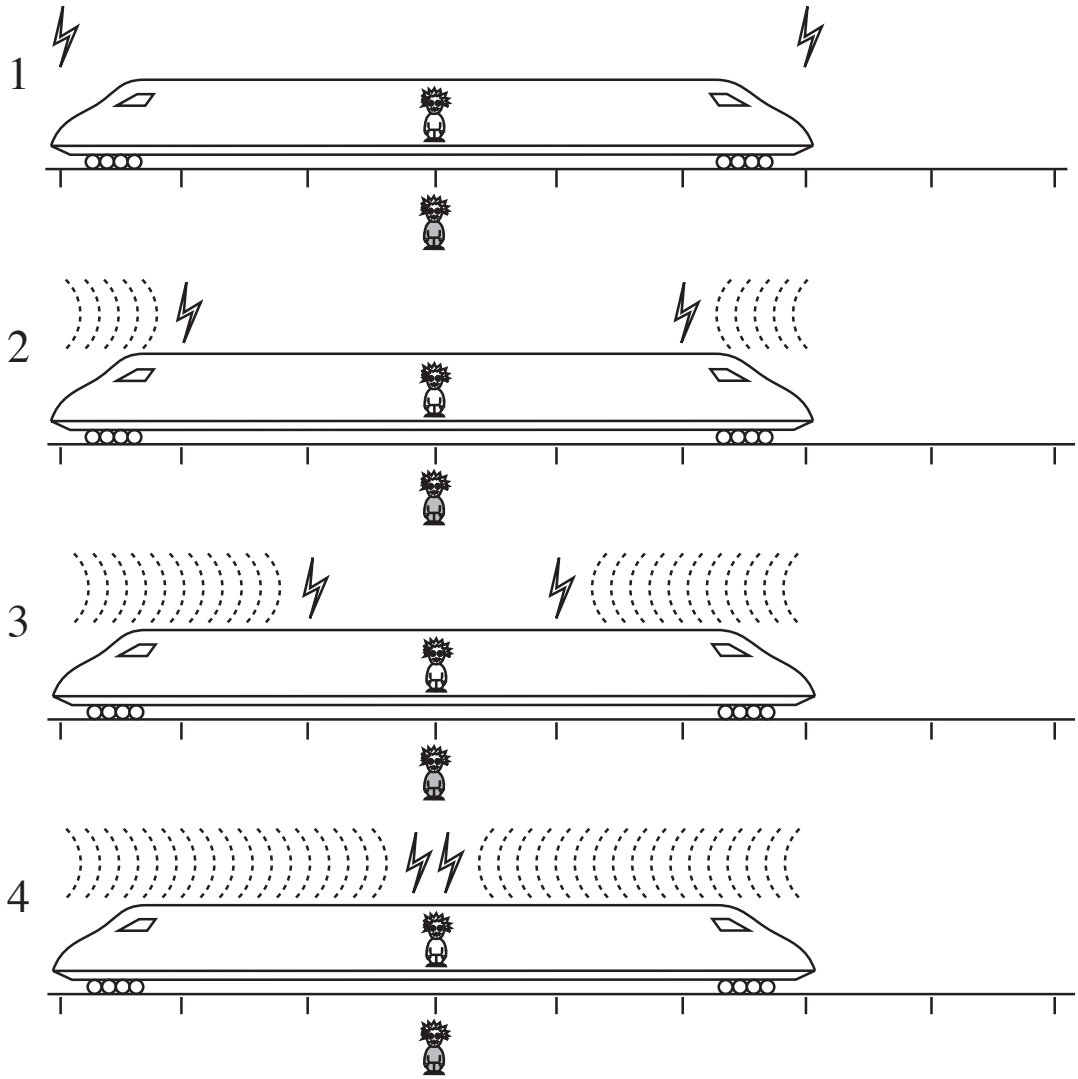
12 "Stimulating interest as a means of furthering investigation" (according to Webster's unabridged dictionary).

I thought that the readers of the article, being professional physicists, wouldn't find the shortening of distances too surprising, as it seemed similar to Fitzgerald-Lorentz's contraction, but I was afraid they'd balk at the dilatation of time. I decided to face that question head on. I began my article with a reflection on our notion of time. When we talk of measuring the time that elapsed between two events, we don't notice that we actually talk of *simultaneousness*. We pull our watch out of our pocket (people didn't wear wristwatches at the time) and say: "The train arrives here at seven." What we mean is: "The train's arrival and the small hand of my watch pointing to the number seven are simultaneous events." How do we know? A light ray coming from the train and a light ray coming from the watch might hit our eye at the same time. Hey, but isn't the train farther from our eye than the watch? The train's light ray takes a longer time to reach our eye, which means the two events are *not* simultaneous.

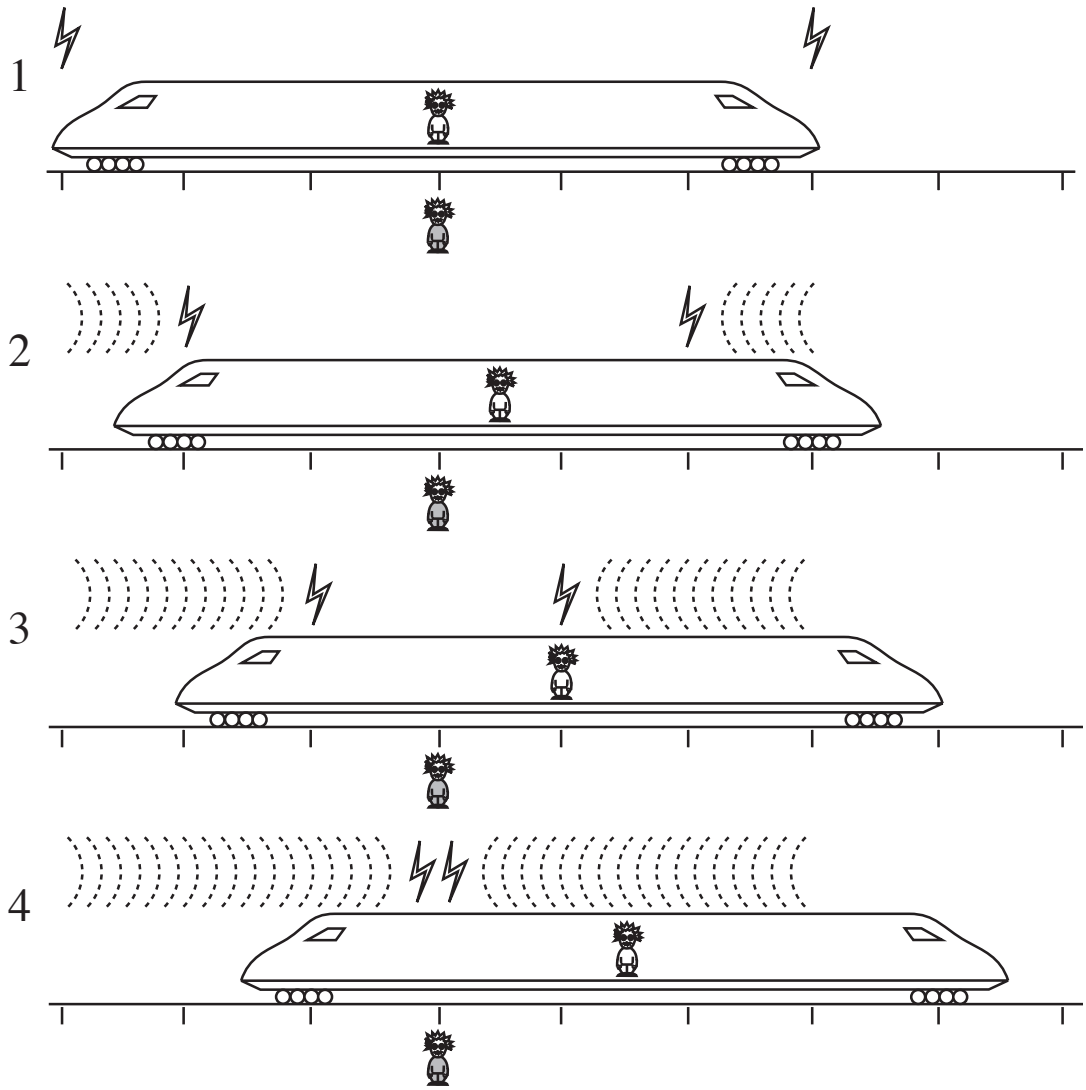
I introduced a simple tool, made of a double mirror. With this tool, I can position myself halfway between two clocks, for example, and check that their arms point at the same numbers simultaneously—that is, I can synchronize the clocks.



Now in this example, the observer doesn't move relative to the clocks. What if he does? Let's imagine two observers. One in a very fast train, the other on the ground.



Let's first consider a stopped train. Instead of the small hand pointing to a number, a rather fuzzy event, I'll use flashes of lightning as my "events." One observer stands in the very center of the train, the other one just outside. Using double-mirrors, they perceive the two flashes at the same time and they both call them simultaneous. Notice that I've drawn graduations on the rail. You can see that the light moves one graduation ahead from one picture to the next.



Now the train is moving at half the speed of light—half a graduation from one picture to the next. In picture 1, the two flashes occur. In picture 2, nobody has seen anything yet. In picture 3, the inside observer sees the first flash. In picture 4, the outside observer sees the same thing as before: two simultaneous flashes of light. Ha, but the inside observer has still seen only one flash. For him, the flashes are not simultaneous at all.

This experiment shows that simultaneousness is a relative notion. Events can be simultaneous in a system of reference, but not simultaneous in another system. As our way of measuring time relies on simultaneousness, it means the measure of time is relative.

* * *

After my new theory of space, time and moving bodies was published in *Annalen der Physik*, I went to Novi Sad, in the South of Hungary. Today, this city is part of Yougoslavia. Mileva wanted her husband and two-year old son to meet her parents. While I hadn't talked much (so I've been told) before the age of three, our Hansi was already quite a magpie. His grandparents worshiped him right away like a god. They didn't like me as much as my son, I'm afraid. They thought I could have found a better-paying and more prestigious job than third-class technical expert in the patent office. I was a Polytechnikum graduate, after all.

We spent a few days on the Adriatic sea. I rented a boat and went sailing with Hansi and Mileva.

Sailing has always stimulated my mind somehow. I wrote a letter to my friend Conrad Habicht.

"I have thought of yet another consequence of the electrodynamic paper. By combining the relativity principle with Maxwell's equations, I can show that the mass of a body is a direct measure of the energy it contains. You could say that light transfers mass. You know that radium emits great quantities of radioactive energy. If my hypothesis is true, then there should be a noticeable diminution of radium's mass. The idea is amusing and enticing, but whether the Almighty is just laughing at me—that I can't know."

As soon as I came back from my vacations, I sent a short article on that subject to *Annalen der Physik*. Its title was *Is the Inertia of a Body Dependent on its Energy Content?* The formula that links a body's mass and its energy content is very simple:

$$E = mc^2$$

This small post-scriptum to my theory explains the mysterious phenomenon of radioactivity. Becquerel, Pierre and Marie Curie wondered where the energy emitted by uranium and radium salts came from. I gave the answer: the salts lose weight by and by, as a very tiny proportion of their mass turns into radiation. Since the square of the speed of light is a very high number, a very small mass becomes a huge quantity of energy. This is altogether different from what happens when you burn something, which is a plain chemical reaction. The sun has been shining for billions of years because its enormous mass turns slowly into energy. If it burned like coal, it would be consumed entirely in fifteen hundred years.

Miss Peggy, it is a fact that this terrible crime you consider me guilty of, the bombing of Hiroshima and Nagasaki, is a consequence of my amusing and enticing

idea. Please consider, however, that the equivalence of mass and energy is a law of nature. I didn't invent it. If anybody did, it is the Good Lord. I just discovered it a few months or years before somebody else.

I went back to the patent office. I didn't become the famous Professor Einstein all of a sudden. The following summer, a young German physicist, Max von Laue, came to Bern in order to meet me. He found the patent office and asked for me. They told him I'd come right away. When I entered the waiting room, he didn't stand up, because he expected the author of the *Annalen der Physik* articles to look like a dignified Herr Professor, not like a young man wearing a short-sleeved shirt and sandals. He worked in Max Planck's Berlin laboratory. He said that my articles had impressed everybody. Max Planck himself had quoted and commented them during a public conference. As the inventor of quanta, Max Planck had read my article about the discontinuous nature of light very carefully.

"You know, Herr Einstein, the old man doesn't agree with you at all. The energy is emitted as quanta, but we have no proof that it stays discontinuous. All the experiments show that light behaves like a wave, not like a stream of particles."

"Then we'll have to do new experiments. Have you read my other article, about the electrodynamics of moving bodies?"

"Yes, but I'm not sure I understand it. It seems more metaphysical than physical to me."

"You've seen that I suggest we abolish ether, anyway. Without ether, light can't be a standard wave. If you admit that a star spits billions of tiny light grains that fall into your eye and into mine, then everything becomes crystal clear."

He told me people read my articles in Würzburg, Göttingen, Breslau, and as far as Cracow. Professor Witkowski had told Professor Loria: "A new Copernicus[13]!"

* * *

After a while, Max von Laue and the other physicists ceased to find my ideas metaphysical, philosophical or poetical. It didn't follow that they accepted them. For years, I wrote articles to answer objections put forward by the great professors of that time. I should say: the great professors of the 19th century. Lorentz, for example, was fifty-five years old in 1905. The Nobel prize had crowned his career in 1902[14]. He wrote to me, I answered. Exchanging letters with this great man, whom I had always admired, brought me a feeling of intense satisfaction. It was useful, too, as it helped

[13] Copernicus lived in Cracow.

[14] Nobel, a Swedish businessman who invented dynamite and earned lots of money, created this prize in his will. He died in 1897. Röntgen received the first physics prize, in 1901, for his discovery of X rays. After Lorentz, the 1903 prize went to Becquerel, Pierre and Marie Curie.

me consolidate my theory. I tried to convince him he should give up his flattened atoms. Objects didn't contract, but space itself became different at high speed.

Many scientists called my theory false, foolish, absurd and so on. Some grumpy fellows objected to my person. How could a twenty-six year old civil servant dare suggest a new vision of reality—right under the (wrinkled) noses of famous professors who had spent their whole lives trying to resolve the contradictions of modern physics? They were willing to accept the new theory, but they denied I was its father. They said I had stolen the ideas from Lorentz and Poincaré.

The Swiss newspapers got wind of these controversies. They didn't display my photograph on the first page, as they did later, but published ironical articles in the national section.

"A YOUNG SWISS PHYSICIST PRETENDS TIME IS ELASTIC!
DON'T BE SURPRISED IF YOUR WATCH LOSES TIME WHEN YOU TRAVEL ON A TRAIN!
The excentric theory of a Patent Office employee."

* * *

While many physicists didn't even bother to refute my theory, an outsider restated it in a very clever way. Herr Minkowski had been my mathematics teacher at the Polytechnikum. He used to say I was "a lazy dog who doesn't give a damn about mathematics." He now taught math in Germany, in the great Göttingen university. Something in my theory of relativity struck him at once : I treated time and space in the same manner. In 1907, he suggested that time be considered a fourth dimension of space. He used the expression "space-time continuum," but everybody just says "space-time."

The fourth dimension appears as ict, where i is an imaginary number whose square is -1, so that the squared length of a space-time vector is $x^2 + y^2 + z^2 - c^2t^2$. Although I may understand this formula better than you do, miss Peggy, I found it rather strange at first. I had discovered that space and time were relative, but they were still real. The high mysteries of mathematics can arouse a feeling of awe in a non-mathematician. It seemed to me that Göttingen's crazy algebraists were hijacking my theory and turning it into an abstraction that I didn't recognize. I wondered whether they wanted to move knowledge forward or simply to impress the physicists. Then, by and by, I admitted that I didn't have a choice—I had to study modern mathematics to widen the range of my theory. This would have been easier if Minkowski, who could have helped me, hadn't died suddenly, in January, 1909, of acute appendicitis. He was only forty-four years old.

He had been my most zealous propagandist. He was said to be obsessed by the theory of relativity. Moved by his enthusiasm, by the commotion my theory had provoked in the world of physics, the Swiss authorities eventually found out about me. These poor authorities felt foolish when they had to acknowledge that the famous Albert Einstein was a second-rate employee in a federal office in Bern. In any civilized country, a scientist whose ideas were admired and attacked by the luminaries of his profession would have been a tenured university teacher. The authorities certainly knew that some eminent Swiss professors didn't teach the forty-year old Maxwell equations yet. By giving me my due, Switzerland could move to the vanguard of science in one swell shot.

Thus, the authorities decided I was to enter university. Professor Kleiner, who had supervised my doctorate thesis in Zurich, was willing to take me as his assistant. Ah, but this was against the rules. In Switzerland, you don't go around breaking the rules. I couldn't become an assistant unless I climbed the ladder like anybody else, beginning as a *Privatdozent* or "private tutor." It didn't make sense. It meant giving private lessons to university students, with no salary except what they'd be willing to offer me. A *Privatdozent* earns so little money that he needs a regular job. I couldn't leave the patent office, so I had to request a *Privatdozent* position in Bern university rather than Zurich. I still laugh when I think about it (I didn't laugh at the time): the physics teacher in Bern, a stupid old mummy, refused my application. Seventeen published articles and my Zurich PhD weren't enough. He had never heard about me, obviously. He wanted "a new project." I felt so angry that I was ready to give up Bern university and Zurich university. Mileva kept me in line.

"Think about your future. You must take care of your family."

"I didn't request this great honor. Professor Kleiner asked me, and now there's trouble. Forget about it."

"Give them your next article. Call it your new project."

I followed this wise advice and became a *Privatdozent*. Three persons listened to my first course: Michelangelo Besso and two of his friends. During the second semester, a real student joined them. For various reasons, my three friends stopped attending my lessons, so that I had only one student. I explained relativity to him in my home, or on mountain paths.

* * *

The patent office knew nothing about my growing fame. What impressed them was my writing a university thesis and becoming "Herr Doktor Einstein." They promoted me to second-class expert and raised my salary to 4,500 Swiss francs. We moved to a

slightly larger apartment. Mileva always complained about our living conditions. We moved seven times in the seven years we spent in Bern.

Hansi was growing up. I built a small cable-car for him, including a working electric motor. He loved mechanical toys. Although I tried to have him learn the piano, nothing came out of it. The power of music didn't seem to affect him.

My sister Maja lived in Paris for a while, then came back to Switzerland to get a Ph.D. in Zurich university. The subject of her thesis was medieval French. She married Paul Winteler and they settled in Luzern.

* * *

Whereas in the German-speaking half of Switzerland I was a lowly teacher with a single student, the French half considered me a top-notch scientist. The university of Geneva had been founded three hundred and fifty years before by Calvin. They decided to celebrate this anniversary with solemn ceremonies and included me in a batch of people who were to receive *honoris causa*[15] diplomas. The letter they sent me was covered with ornery characters and failed to get to the point in the first paragraph, so I thought it was some kind of publicity. It looked like they were trying to sell me expensive Burgundy or Champagne wine. I crumbled it and threw it into my wastebasket with my equation-covered sheets of paper.

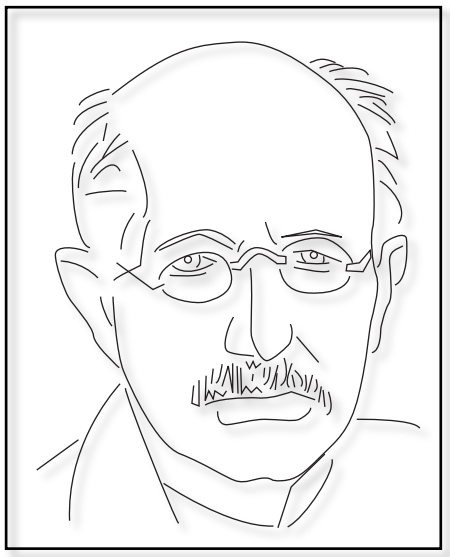
Mileva complained all the time because she found me messy. I never tidied my desk, she said. I lost all kinds of things, I didn't help her. I can't deny I often drifted somewhere in the clouds or beyond the moon.

The university of Geneva wrote another letter and sent it to my student, who happened to be a graduate of the university. As I liked to make fun of him, he played a little practical joke on me. He said I was invited to a celebration in Geneva and gave me the train tickets, without telling me anything about the honorary doctorate. There were maybe a hundred meritorious scientists marching in the streets of Geneva, all in black academic robes and mortars—except one, Herr Doktor Einstein, who wore his old tweed jacket and his straw hat. After listening to many boring speeches, I ate like a pig at the biggest banquet I have attended in my whole life. Calvin, who lived on bread and water, was certainly turning in his grave.

A few months later, in September, 1909, I was invited to my very first physics conference in Salzburg, Austria. I met Max Planck at last. We had exchanged letters for years. The great man praised me so much that I felt quite embarrassed and blushed like a shy maiden. He seemed somewhat surprised when he first saw me, although Max von Laue had certainly told him what to expect. You won't offend me if you compare

[15] Honorary.

me to a scarecrow, miss Peggy. I am not too careful about the way I cover my body. I refuse to carry tons of luggage when I travel. For example, I find socks useless, so I wear a pair only when it freezes. Once or twice a year, some special official event compels me to wear a tie. Otherwise, I don't see why I should squeeze my neck with this ridiculous silk ribbon. Max Planck, on the other hand, wore a stern gray suit made by a stern gray Prussian tailor. He was tall and stood straight. Thick hair grew under his nose and on both sides of his head, but none on top. His wire-rimmed glasses seemed to enhance the boring power of his gaze. His eyes saw a lot and helped him understand things instantly.



He gave my theory its common name. I guess he got tired of saying "Electrodynamics of moving bodies." He called my theory "Einstein's relativity" to distinguish it from Galileo's relativity. Later on, when a larger public heard about "relativity," people used the word in fields outside physics, for instance politics or history. They credited me with an obvious truism: "Everything is relative, as Einstein says." This may be true in politics and sociology, but certainly not in my theory, since the speed of light is absolute. What my theory really asserts is that the laws of physics do not change when you switch from an inertial system to another. You might as well call it "the theory of invariance."

In Salzburg I met Max Born, who became a good friend. He had been the assistant of poor Minkowski in Göttingen. He asked me lots of questions, since he had to introduce Minkowski's mathematical formulation of my theory during a plenary meeting. As for myself, I gave a conference about "The Nature and Constitution of Radiation." I suggested that light and other radiations possessed a double personality.

"Many experiments show light behaving in a way consistent with Newton's corpuscle hypothesis. Other experiments can't be explained unless light is considered a wave. I think that the next step for theoretical physics will be to combine the corpuscle and the wave models. We'll need to change our vision of nature."

Max Planck had initiated the return of the corpuscle hypothesis, but he still refused to follow me.

"Our present ideas of physical reality are the result of three centuries of work by the best minds in many countries," he said. "We can't forsake these ideas without very strong reasons. Any talk of change is premature."

I went on with my conference. I suggested we try to see the particle and the wave character of energy quanta as two faces of a medal, in the same manner that, according to my equation, a body's energy and its mass are two aspects of the same reality. The older physicists frowned at what they considered wild ramblings, but my younger colleagues, for example Arnold Sommerfeld and Lise Meitner, seemed entranced and enthusiastic.

* * *

The top European scientists had discussed my theories more than anything else at the Salzburg convention. I was becoming a "star," as you Americans say. My lowly situation in Bern didn't fit with my growing fame.

One year earlier, professor Kleiner had convinced the authorities that theoretical physics should be taught in Zurich university. He meant to give me the job, but it appeared I didn't have the proper qualifications. His own assistant, Friedrich Adler, whom I knew well, had become a physics student in the university at the time I entered the Polytechnikum. Since he hadn't lost years in a musty office, he was first in line for the new position. The authorities wouldn't let a newcomer become a *Herr Professor* when there was an old university hand around. If you ignored the law and broke the rules, anarchy would engulf Switzerland. Besides, Friedrich Adler wasn't just anybody. His father, Viktor Adler, was the leader of the Austrian social-democrats. He had just won a measure of democracy for the citizens of the Austrian empire and had been chosen as the head of the Socialist International. Most members of the university's board were socialist… Quite a tangled affair. Mileva, who was pregnant, wasn't keen on moving to Zurich.

"Hansi has good friends in school. He is learning to read. He'll soon have to share his parents with a baby brother or sister. He doesn't need another disturbance in his life."

"Let them pick up Adler. I don't care. I didn't apply for this job."

"You'd earn more money, though."

"But not at all. I'd say less. I wouldn't be a full tenured professor, but what they call 'extraordinary' professor. What's more, the patent office is willing to give me a raise to keep me. I'm quite a top-rate patent clerk, you know. It seems they hadn't noticed until today."

"A big raise?"

"A reasonable Swiss raise. I'm much too young to become a first-class expert. This would be unheard of."

"If you won't earn more in Zurich, then it's not worth it. The rent would cost twice as much over there."

The university of Zurich hesitated for one full year before offering me the job. Friedrich Adler had made a scene in front of the board.

"Come on! I hope you won't promote me to professor when you could choose a man like Einstein! As physicists, we don't play in the same league. This is a unique occasion to raise the level of our university."

Friedrich Adler had a fiery character. His father had sent him to Switzerland so he wouldn't get involved in Austrian politics, but Friedrich hadn't promised he'd dedicate his life to physics. After he refused to become professor of theoretical physics, the board found another candidate—a Swiss professor who promptly withdrew from the race, too, by dying of tuberculosis. Then they turned to me, half-heartedly. They offered a ridiculous stipend. I protested and refused. They accepted to match my salary at the patent office: 4,500 francs per year. Well, I could hardly go on refusing. They were creating the position for me, after all.

My new colleagues knew so little about theoretical physics that they had never heard of me. A new chair of physics was founded for an unknown employee of a minor federal office, who hadn't bothered to climb past the first rung of the academic ladder. They knew I was a privatdozent, but they didn't know I had only one student! What really amazed them is that the famous Herr Professor Nernst of Berlin and the no less famous Herr Professor Sommerfeld of Munich came to Zurich especially to meet Herr Einstein.

* * *

Life was so expensive in Zurich that we had to sublet part of our home to students. Mileva was angry. She scolded me for all kinds of reasons, or without any reason.

"You were supposed to bring Hansi back from school."

"Gosh, that's true. I'll go right away."

"You were to get him at two o'clock, but now it is five. I can't count on you."

"Five o'clock? Where is my watch? He's going to worry."

"He came home long ago. Mrs. Müller brought him back. I felt quite embarrassed."

"Who is Mrs. Müller?"

"Our neighbor. You don't even know our neighbors. I had to lie to her. I told her you didn't feel well. She found Hansi crying in front of the school at three o'clock. I wonder what she thinks of us. Parents who forget their own child!"

"He could come home by himself. It's not so far."

"Are you kidding? He's only seven. He can't cross the street. It is very dangerous, with these new automobiles."

I had offered Hansi a small sailing-boat. I sometimes took him to the lake of Zurich. There, he sailed his boat in a special basin where other children played with their own boats. One day, when we came back from the lake, Mileva screamed at me.

"What happened? The child is all wet!"

"Hey, I hadn't noticed. Is it raining? I guess not, since I'm dry."

"How did you drench yourself so, Hansi?"

"I fell into the basin."

"My God! He fell into the basin and you, Albert, didn't notice anything!"

"I must have been thinking. It is not very deep, anyway."

"The great scientist was thinking! Maybe you should think a little less about your physics and a little more about your son."

We lived in the same building as Friedrich Adler, near the Zurichberg, and we became the best friends in the world. Hansi is now forty-seven years old, miss Peggy. A few weeks ago, he told me he had been in love with Assinka Adler, Friedrich's daughter, who was his age, but I don't remember her. I don't even remember that Friedrich Adler was married.

Our second son, Eduard, was born in July, 1910.

* * *

In March, 1911, we moved again. I accepted a position as full professor in Prague's German University. I had remained only eighteen months in Zurich. I wasn't unhappy there. I liked the lake and the mountains. The university was small and nobody cared about theoretical physics, so I could count my students on the fingers of my hands, or even sometimes of one hand. This allowed me to give my courses in a café or on the banks of the lake. I brought them to my home for tea, even though Mileva complained that I never asked for her permission.

Ah, but the German University in Prague was a famous institution. The great scientist Ernst Mach, who was still alive but very old, had long taught there. As he had

studied sound, his name had been given to the unit of sound speed[16]. In one of his books, he criticized Newton's absolute space and time. This shaped my own thoughts, in a way. He also had original ideas about mass. Under his influence, the university had reached a high level in scientific matters. What attracted me, actually, was the vast library. I felt I was moving from a village to a big city. Mileva didn't object to my plan. A full professor earned twice more than an extraordinary one. In Prague, we would live in a large apartment and be able to employ a maid. Hansi rejoiced because we would have electrical lights. In Bern, we used oil lamps, in Zurich gaslight.

The board of the Prague university had more common sense than the Swiss cowards in Zurich. They inquired about me. Max Planck recommended me warmly: "If Einstein's theory should prove to be correct, as I expect it will, he will be considered the Copernicus of the twentieth century." They wanted me to join the faculty as soon as possible. Things turned messy, though, and the whole project came close to failure. In those times, Prague belonged to the Austrian empire. The representative of the Imperial ministry of education brought in his own candidate, Herr Jaumann, who didn't believe in atoms but happened to be Austrian and catholic. While both sides were ready to fight a long battle, Herr Jaumann withdrew his candidacy: "I'll have nothing to do with a university that is fascinated by so-called modernity while being blind to real established merit." Then, the representative of the Imperial ministry noticed that I never mentioned my religion in official papers. Without a religion, I couldn't swear allegiance to the emperor—a necessary step on the way to professorship. I had to go to Vienna and explain to some fool in the ministry that I considered myself Jewish, even though I seldom entered a synagogue. "Mosaic," the fool wrote in my file.

To swear allegiance and become an imperial civil servant, I had to request the Austrian nationality. They let me keep my Swiss citizenship. For years, I had lived without a nationality. Now I had two.

As soon as we settled in Prague, I discovered that nationality and religion played a primary part in public life there. Out of one hundred inhabitants of the city, ninety-five were Czech. They had their own university. The Germans and the German-speaking Jews were facing the Czech majority together. The Germans hated it. "*Ach Gott*, we have to ally ourselves with these damn Jews !" Antisemitism was increasing. Being caught between the Germans and the Czechs wasn't a comfortable position for the Jews. Many of them became interested in Zionism, a new movement that had the strangest idea: Jews would move to Palestine and become happy peasants there.

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[16] The speed of sound depends on the pressure of the air. It is something like 700 miles per hour. A plane is said to fly at Mach 2 if its speed is twice the speed of sound, etc.

My Jewish colleagues introduced me to Zionist circles. I met the writers Max Brod and Franz Kafka. Whereas Max Brod never became as famous as his friend Kafka, he is the only writer I know who wrote a novel about physics. Its heroes are the great astronomer Tycho Brahe and his student Kepler, who lived in Prague. People said that Brod based the character of Kepler on me. The novel's Kepler doesn't seem to feel any emotions, as he is devoting his whole life to science. I didn't find this supposed portrait very flattering.

The Prague Zionists were friendly enough, but their wonderful Palestine didn't attract me. I couldn't go to some god-forsaken place and work alone, as I used to do. If I wanted to extend my theory, I needed mathematics and mathematicians.

* * *

Miss Peggy, the theory of relativity can be compared to a house with two floors. The first floor is the so-called "special" relativity, which I described in my 1905 article. It concerns physical phenomenons that take place in "inertial systems" moving at constant speed in a straight line. Such a theoretical system doesn't exist in our universe. A laboratory located on the earth, for example, turns around the axis of the earth and around the sun, so it doesn't move in a straight line. Neither does an object that I throw as fast as I can: it follows a parabola and falls on the ground after a while because of the earth's attraction. The second floor of my house, "general" relativity, had to take the Earth's attraction into account, as well as the Sun's attraction and other forces of gravitation.

In 1907, I wrote an article about what I called "the principle of equivalence." I was climbing the first step of the long staircase that leads to the second floor of my house.

It all began in my office in the patent bureau. I remember it as if it had happened yesterday. I was sitting near the window, not doing much, day-dreaming, looking at the birds and the clouds outside… A man was repairing a roof across the street. Gosh, I thought, this is not a job for me. I'd be scared stiff. Now he's sitting and eating his bread and sausage. What if his apple rolls down the roof and he tries to catch it? I saw myself falling from the roof. I had read *Alice in Wonderland* to Hansi recently. I was falling, and the apple was falling too, and I noticed something obvious but amazing. As the apple and I were falling at the same speed, it was not moving relative to me and thus I could catch it easily. It didn't push my hand downward as usual. It felt as if it weighed nothing at all. Of course, I could see the windows of the buildings rushing by me, so I knew I was falling. If this hadn't been a day-dream, I would have worried more than Alice. In less than a second I was going to be as flat as a pancake!

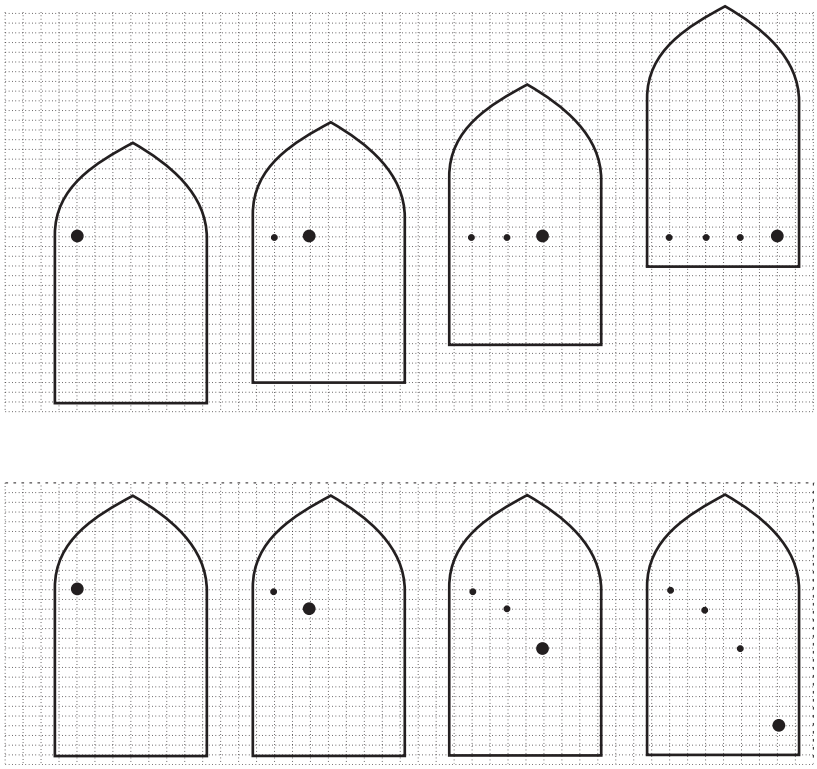
I imagined a slightly different day-dream, or what I called a "thought experiment." I was falling in the same manner, and the apple was falling too, but we were inside a lift. Its cable was broken, I guess. Now I didn't see any rushing windows. There was no way I could know whether I was actually falling. It felt more like floating or flying. My hair danced around my head like the tentacles of an octopus. The apple was suspended in mid-air. If I took my pipe out of my pocket, it floated too. Everything inside the lift seemed utterly weightless. I began to laugh. I had just discovered that gravitation isn't an absolute phenomenon, but a relative one. If I took the lift as a reference system, there were no forces acting on me and there was no acceleration.

Then I moved my lift (known by physicists as "Einstein's lift") into empty space, far away from the Earth and Sun. I was still floating! My pipe and apple too! Someday, miss Peggy, we'll build spaceships. Imagine a brave astronaut floating freely inside the cabin. When he wakes up in the morning, he can't tell whether he is inside a falling lift or a spaceship.

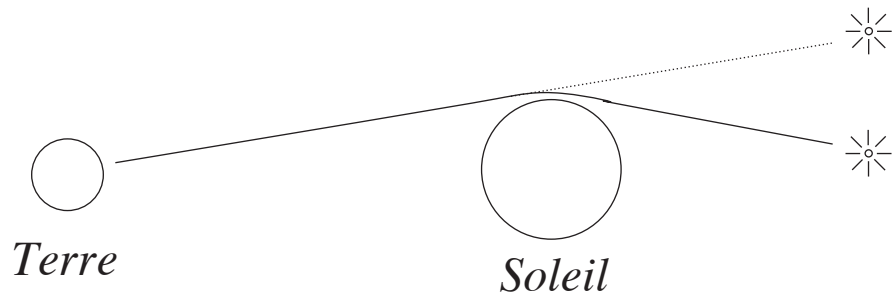
I imagined a strange event. An angel was holding the lift's cable, up there in space, and pulling with increasing strength. Today, I could add to the lift one of those rocket engines the Germans experimented with at the end of the war. If I light the rocket engine, the lift accelerates. I stop floating. I am thrown toward the floor like Galileo's fish toward the back of the aquarium. All the objects floating in the cabin "fall" toward the floor. The astronaut who wakes up during a phase of acceleration doesn't know why he is falling on the cabin's floor. Is it because the spaceship is accelerating? Or because it has landed on some planet that attracts apples and other stuff, like the Earth? My mental experiment shows that the two situations are *equivalent*.

In 1911, I published a new article about Einstein's lift. I asked a simple question: what happens when a light ray crosses the spaceship? This particular lift or spaceship has portholes, otherwise light couldn't go across it. Adding portholes doesn't cost me anything. In thought experiments, you can do what you want. I may suppose that I follow a single particle of light. It enters through an upper porthole on the left. As the spaceship is accelerating, its "floor" is moving toward the light particle, which exits through a lower porthole on the right.

The upper series of pictures below shows what an outside observer sees (if the lift has a glass wall). The light particle moves on a straight line from left to right. The lift is accelerating upward. The lower series of pictures is seen by an inside observer. The particle moves faster and faster toward the floor of the spaceship, just like an object falling to the ground on the Earth. The inside observer sees a light ray that doesn't follow a straight line, but a parabola!



My principle of equivalence says that light behaves in the same manner in relation with an accelerated system or a planet that attracts apples. This means that light falls toward the Earth. Light rays appear to follow straight lines because our planet has a small mass and a low power of attraction. What about the Sun? I wrote in my article that we should be able to measure the very slight bending of light rays near the Sun. The angle is less than a "second." There are 3,600 seconds in a degree and 360 degrees in a full circle. Imagine looking at a dime standing four miles away! Because of that tiny angle, a star located behind the sun becomes visible—but the only time we can actually see it is during a total eclipse, otherwise the light of the sun is much too strong.



One of my Prague students happened to meet Freundlich, a famous German astronomer, in Berlin. He talked to him about my hypothesis. Freundlich wrote to me

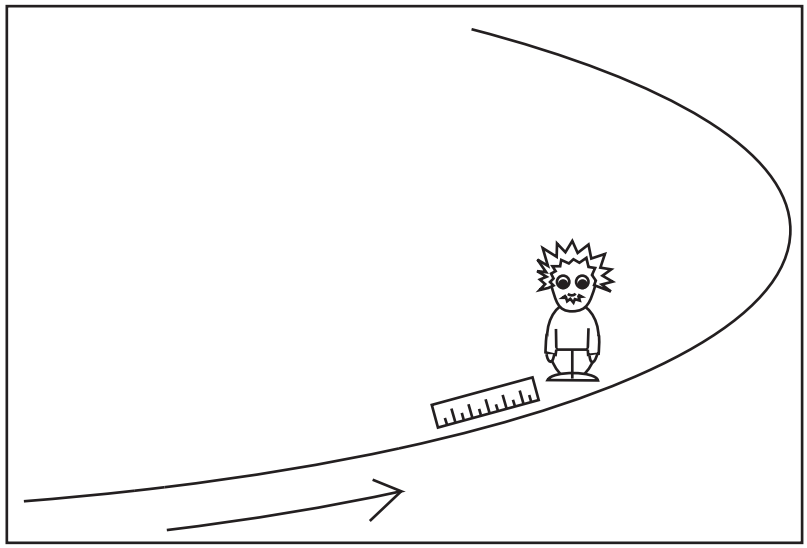
that he would try to verify it. As eclipses are not frequent, he thought of measuring the light's deviation near the planet Jupiter. The angle was one hundred times smaller than near the Sun, so Freundlich didn't see anything.

My principle of equivalence had brought me halfway between the first and second floor of my house. To go on climbing toward general relativity, I needed to take a closer look at gravitation. I couldn't accept the force of gravitation that Newton had described, because it wasn't compatible with special relativity. Nothing prevented Newton's force from accelerating things forever. An object could go faster and faster and eventually move faster than light—which I had shown was impossible. Besides, Newton's gravitation seemed to act without any delay, whereas I refused instant action at a distance. I considered that the speed of light was a limit for the action of forces, too.

I was still working within the boundaries of Newton's theory. Newton himself believed that light could fall, since he thought it was made of particles that were lighter than cannonballs, but not weightless. Galileo had dropped cannonballs and marbles from the leaning tower in Pisa to prove that they would reach the ground together. If bodies fall at the same speed whatever their mass, even weightless particles could fall. An English scientist, Henry Cavendish (1731-1810), understood that we can't see light falling on the Earth, because our planet is too small, but that the huge mass of the Sun may attract a light ray visibly. He computed the angle of deflection in 1784: 0.85 seconds. A German physicist, Georg Von Soldner (1776-1833) had the same idea in 1801. He even suggested we measure the angle during a solar eclipse. I knew nothing of these forgotten predecessors. I found about Von Soldner when professor Lenard (I'll tell you more about him later, miss Peggy) "discovered" him around 1921.

My bent or curved light ray followed the shortest path between the star and my eye, since nothing can go faster than light. In so-called Euclidian geometry, which we learn in school, the shortest path between two points is always a straight line. I was beginning to perceive what lay ahead: I would have to tweak the very geometry of space.

I thought of another mental experiment. A huge disk is turning very fast. An observer is measuring distances with a ruler.



He measures the circumference of the disk. As the ruler is very short compared to the circumference, we can consider it moves on a straight line. It contracts because of the high speed, so the length of the circumference is greater than if the disk wasn't turning. Now the observer measures the radius of the disk. The ruler doesn't contract in that direction, so in the end the observer finds a circumference longer than $2\pi R$. Once again, our result differs from what we'd get in Euclidian geometry.

Special relativity's inertial systems move in a straight line at constant speed. When a system doesn't move in this manner, it undergoes acceleration. Thus, a rotating disk is considered an accelerated system. Because of my principle of equivalence, we know we would get the same inflated circumference if we replaced the forces of acceleration by the forces of gravitation. This is the beginning of my great discovery: gravitation modifies the geometry of space.[17]

I remembered, oh so vaguely, that some mathematicians had imagined non-Euclidian geometries a century or more ago. I knew almost nothing about these strange geometries, but I needed them to invent general relativity. I was somewhat angry at myself. Professor Minkowski was right when he called me a lazy dog. I should have attended his courses!

I studied the book that Max von Laue had written about professor Minkowski's presentation of special relativity. I read articles of mathematical physics by Sommerfeld. I talked to George Pick, who taught mathematics in the German

[17] A technical note. In this example, acceleration (or gravitation) increases when you move away from the center of the disk. This kind of gravitational field doesn't exist in Nature. Gravitation decreases when you move away from the center of the earth. In our universe, as we'll see later, the circumference of the circle would be lower than $2\pi R$, not higher.

university. He said that two Italians, Ricci and Levi-Civita, had just perfected the very set of tools I needed, called "absolute differential calculus."

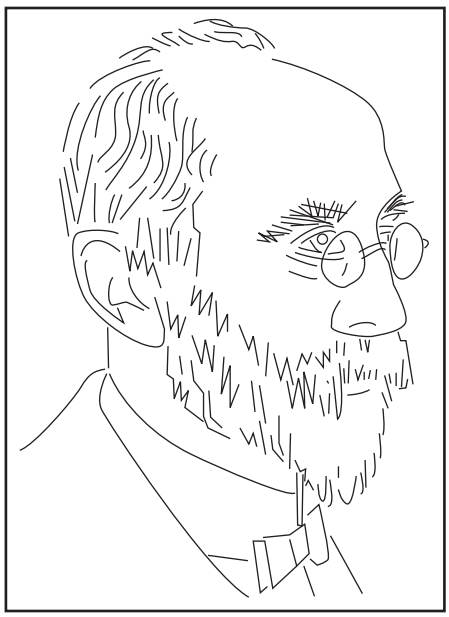
I notice that I haven't mentioned my dear violin for a long time. George Pick was quite a good violinist. Two of his friends joined us to play string quartets by Mozart and Beethoven twice a week. I also played sonatas for piano and violin with the sister-in-law of one of my colleagues. She was an old piano teacher. If I made the slightest little mistake, she insisted we start the whole piece again. Quite a dragon!

* * *

You'll think me restless, miss Peggy. I stayed only eight months in Prague. I was a full professor, I earned a good salary, but I liked neither my colleagues nor my students. They didn't care about modern physics. They lacked curiosity. After wasting my time with them, I had to spend hours filling forms in triplicate for the Austrian imperial bureaucracy. Mileva was unhappy, too. On top of what she found wrong with life in general, or maybe mainly with her husband, she felt uncomfortable amidst Prague's religious and political tensions.

Well, I guess I might have remained longer in Prague if I hadn't been offered better jobs elsewhere. The board of Utrecht university, in Holland, sent me a first proposition, which I refused, then a second and better proposition, which I found rather tempting.

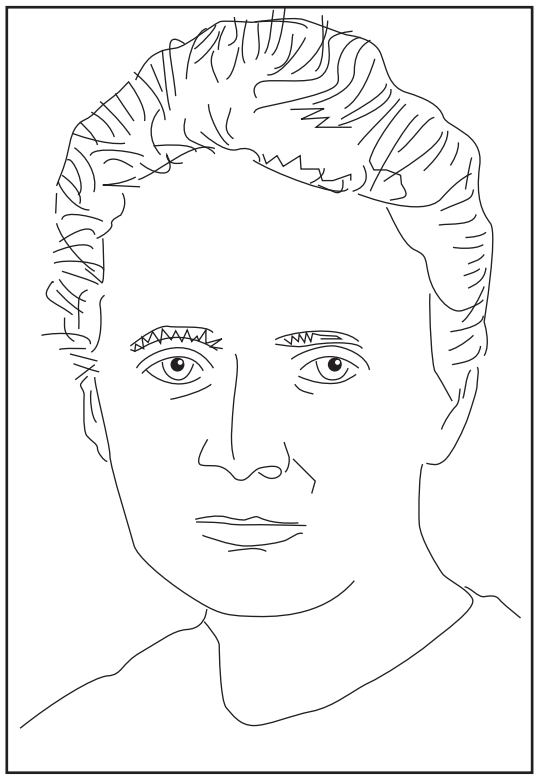
In Holland resided the great Hendrik Lorentz, whom I called my master. I saw him for the first time in 1911. I spent a few days with him in Leyden, his city. I had exchanged so many letters with him that I considered him an old friend. With his gray beard and solemn eyes, he looked like a warm and wise grandfather.



We went together to Brussels, in Belgium. Ernest Solvay, a Belgian industrialist, was financing what he called *Le Conseil de physique Solvay*, a gathering of the eighteen greatest scientists in Europe. He had asked Walther Nernst to choose the scientists. I was quite flattered that he included me in the lot. Although the public at large had not heard of me yet, I was already well known in the scientific community.

Lorentz presided the meeting. He was a perfect president. He spoke German and French fluently and treated all his colleagues with the sweetest courtesy.

I met Marie Curie—who had just received her second Nobel prize. She was a small nervous woman, whose face brightened when she spoke of her dear radium and polonium. The dear radium had burned her skin, though. She rubbed the tingling tips of her fingers constantly.



I also met Henri Poincaré, Paul Langevin, Jean Perrin, Ernest Rutherford. I was glad to see Max Planck, Nernst, Sommerfeld, and other German and Austrian physicists who had attended the Salzburg conference. The scientists who were meeting me for the first time stared at me as if I had just arrived from another planet. Some accepted my ideas, others didn't. Poincaré and Lorentz, who had come closer to special relativity than anybody else, stuck to 19th-century science. They just couldn't admit that ether didn't exist.

Right in the middle of the conference, we learned that a ridiculous scandal was shaking Paris. The newspapers accused Marie Curie, who had been a widow since 1906, of seducing Paul Langevin, a married man and father of four children. Didn't she flee with him to Brussels, pretending that some unknown science-crazed millionaire had invited them? As Marie Curie was born in Poland, the far-right newspapers remarked that foreigners weren't to be trusted. They wondered whether she wasn't secretly Jewish. Poor Pierre Curie had been crushed by a heavy cart as he was crossing the rue Dauphine absent-mindedly. The journalists insinuated that he had discovered his wife's infidelity and had committed suicide.

You should have seen Paul Langevin and Marie Curie! They certainly didn't look like lovers, much less scheming lovers. They told us they worked together every day in Paris. Becoming intimate would have been easy. They didn't need to go to another country. Paul Langevin and his wife had grown apart long ago. He had filed for divorce. Madame Langevin was trying to get a more favorable divorce settlement by accusing her husband of adultery.

Today, miss Peggy, I am seventy years old. If you hadn't moved to another table in the cafeteria, we could have talked together. I bet you would have found me rather childish. Good scientists spend their lives asking questions like children. Their naive curiosity lets them soar to the far reaches of knowledge. Once they're lost amidst numbers and galaxies, though, they lose sight of the rough wheelings and dealings of society. Marie Curie and Paul Langevin didn't know how to face the scandal, which cruel journalists pumped up every day. They felt guilty, as if they had indeed committed a crime. It was a pity that the situation couldn't be described with numbers and equations. The best minds in the world would have worked on it and found a solution in no time!

* * *

During my stay in Brussels, the university of Utrecht sent me a new proposition. The salary was so high that I wondered whether I hadn't made a mistake converting the Dutch guilders into Swiss francs. At the same time, Lorentz himself invited me to consider replacing him in Leyden, as he was soon going to retire.

In the end, I accepted another offer. I went back to Zurich… Mileva, who loved that city, was delighted. I liked Zurich, too. I was still a Swiss citizen, anyway. I didn't return to the university, but to the Polytechnikum, which had just become a regular university and was creating a chair of mathematical physics for me. Good old Polytechnikum! The authorities no doubt remembered me as the rascal who had insulted professor Weber by calling him *Herr Weber* instead of *Herr Professor*. The

authorities had refused to offer me a job on my graduation. I wondered whether they had changed their minds or were playing nice reluctantly. My comrade Marcel Grossmann, who taught mathematics and headed the department of fundamental research, had spoken vigorously in my favor. Marie Curie had sent a very laudatory letter of recommendation, calling me the leader of a new generation of physicists. Henri Poincaré had sent one, too. He said I had so many brilliant ideas that at least some of them would prove true and useful. He still couldn't accept special relativity, but when I read his generous letter I felt he was anointing me as his successor. He died soon afterwards.

While the authorities were writing a contract slowly and carefully, in the Swiss manner, I found new offers in my mailbox every week: from Columbia university in New York, from Vienna, from Berlin. I preferred the Polytechnikum. To sail on the lake of Zurich again! To walk on the mountain trails! My little Hansi asked me every day: "When are we going home, Dad?"

Nernst and Planck invited me to Berlin. They wanted to show me the university and the lakes (somebody had told them I loved sailing). I didn't stay in a hotel, but in the home of my aunt Fanny, my mother's sister. She had moved to Berlin recently, leaving my mother in Stuttgart. Fanny had a daughter, Elsa, whom I hadn't seen for ages. Elsa was divorced and lived with her two daughters, Ilse and Margot, in the same building as Fanny. Family dinners were fun. They reminded me of my childhood. I couldn't help comparing my cousin and my wife. Elsa was blond, placid and pleasant. Her warm smile went straight to my heart. Mileva was dark, stern, moody, full of anger. As she had failed to become a physicist, my success made her jealous. Elsa was proud of her cousin the famous *Herr Professor*.

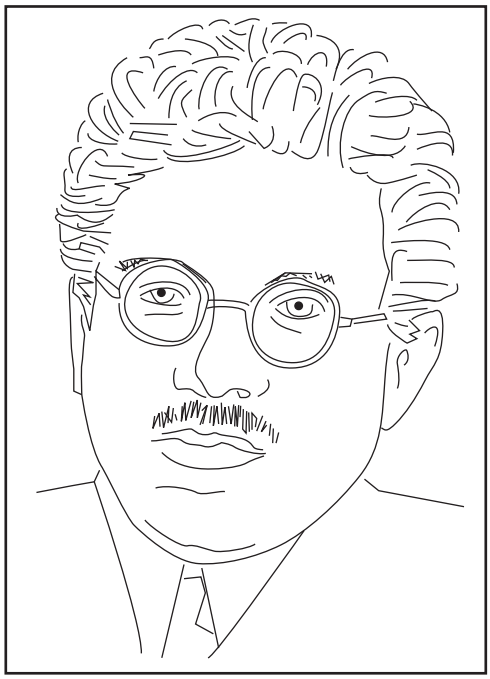
* * *

The people in Prague didn't expect me to leave so soon. Journalists made up explanations, as usual. My backward colleagues had rejected me, they said. The Imperial administration had mistreated me because I was Jewish—and besides, it favored Vienna over Prague. I wrote to the university's dean that he shouldn't mind these silly rumors. I had been perfectly happy in Prague, but I had promised the Zurich authorities I would come back if they offered me satisfactory conditions.

Just before leaving Prague, I met a man who became one of my closest friends, Paul Ehrenfest. Born in Vienna, he had taught in Saint-Petersburg. I hadn't been "mistreated as a Jew," but he had. He had left his job after a sudden burst of Russian antisemitism. He came to Prague as a candidate to replace me, but he refused to declare that he "observed the rites of the Mosaic religion," as I had done.

"I am a free-thinker," he told me.

"It doesn't make sense. Do you want your children to starve? Once you are a *Herr Professor*, nobody will check whether you go to the synagogue."



He lived in my home with his wife and four children while he was in Prague. We had long talks about physics. We found that we disagreed about relativity, then we found that we agreed after all. We played Brahms's third violin sonata together. Tatiana, his wife, was a Russian physicist.

Instead of replacing me in Prague, Ehrenfest replaced Lorentz in Leyden. I visited him several times there. I don't know whether I am as insensitive as Max Brod's Kepler. I do admit that I tend to keep my intercourse with my fellow human beings to a minimum—but the friendship that linked me to Paul Ehrenfest was born in a few hours and never waned.

He wasn't my only friend either. In Zurich, my comrade Marcel Grossmann was waiting for me. He became my private mathematics tutor. He taught me the geometry of Riemann[18] and some other complex tools I needed to perfect a model of space-time. In 1913, we published an article about general relativity together. I felt I was moving ahead, but I hadn't reached my goal yet. All the cards were laid on the table, but I wasn't sure which way to order them.

[18] Important German mathematician (1826-1866). He invented a non-Euclidian geometry.

I also saw Friedrich Adler again. He still hadn't decided whether he was a physicist or a politician.

"So what about you big theory?" he asked me.

"Nature shows us only the tip of the lion's tail. I'm quite confident there's a lion at the end of the tail, even if he's much too big for us to see him in his full splendor. I can just hope to be a flea exploring his fur."

* * *

The whole world wanted me to give lectures and attend conferences. In March, 1913, the *Société Française de Physique* invited me to Paris. Mileva came with me. We both looked forward to visiting the capital of France. Marie Curie took care of us. As the French government wanted to honor the only person in the world who had received two Nobel prizes, it was building the *Institut du Radium* for her. Today, it is called *La Fondation Curie*. Her daughter Irène Joliot-Curie does her research there.

In 1913, Irène was only fifteen years old. She knew a lot about physics already. When we went to the top of the Eiffel tower with her mother and her sister, Eve (who was nine years old, like my Hansi), she showed she had read my articles.

"I hope the cable doesn't break. I'd hate to experiment an Einstein lift, even with its inventor!"

"We should have taken the staircase, miss Irène."

"This would be fine with me, but tough for Maman."

"My daughter is right, monsieur Einstein. You're young and strong and used to climbing the Swiss mountains. For an old woman like me, it's impossible."

"As your emperor Napoléon said, 'Impossible is not a French word.' Why don't you come visit me in Zurich next summer, madame Curie? You'll see that there is no age limit for hiking in the Alps."

We spoke French. I had studied this language in school in Munich. Irène found my accent funny and laughed at my mistakes.

Marie Curie accepted my invitation. She came with her daughters in July, 1913. As I earned the highest possible Swiss university salary, I lived in a large house and there was room enough for her to stay with us. We went hiking every day. She walked fast. In Paris, the burden of her work and obligations weighed heavily on her shoulders, but she wasn't that old—forty-three years only.

We talked at length about physics.

"Do you remember Rutherford, monsieur Einstein ? You met him in the Solvay conference."

"A tall Englishman, yes."

"He comes from New Zealand, but he does work in England. He experiments with great skill. He was the first to analyze the rays of radioactivity."

"He found more than electromagnetic radiations, right? Some rays are electrons expelled at great speed, others helium atoms."

"He suggested the atom be compared to a solar system, with negatively charged electrons rotating like planets around a heavy nucleus, charged positively."

"Ehrenfest told me about this. It seems a fellow in Denmark or someplace refuses this hypothesis."

"Niels Bohr, in Copenhagen. He studied with Max Planck and also with Rutherford. He says a planet-like electron constitutes a small electrical circuit that has to emit electromagnetic waves. Thus, it loses energy, shortens its orbit and crashes on the nucleus very soon. According to him, there are stable or 'preferred' orbits corresponding to various levels of energy. When an atom absorbs a quantum of light, an electron jumps from its orbit to a higher one. When the electron returns to a lower level, the atom emits a quantum of light."

"This is a clever idea. Very clever. Wonderful! A quantum model of the atom!"

"Sommerfeld is working in the same direction."

"Arnold Sommerfeld, in Munich? I wish I had time to study quanta some more. General relativity is taking all my time. There are so many things to discover… Be careful not to slip, madame Curie."

"I'm glad I followed your advice and took a cane. This glacier is amazing."

"It is melting in the sun. That's why water is running along the path. We couldn't walk on the glacier itself unless we were tied with ropes. Look, here, and also there: these are very deep crevasses. They develop because the glacier is breaking as it moves forward. We're such meaningless cogs in the magnificent mechanisms of Nature! At least we can try to understand them."

"Tell me, monsieur Einstein, what is the name of that snowy peak over there?"

"Well, I don't know."

"Really? As a Swiss citizen, you should know your mountains."

"It is the Woolf's Tooth, Maman."

"Miss Irène knows more than I do."

"I've seen the Alps in France. All the peaks are called the Woolf's Tooth or the Dog's Tooth."

* * *

Other important visitors knocked on my door during that same summer of 1913. Max Planck and Walther Nernst came all the way from Berlin to see me. The first one

tall and gaunt, as serious as the Pope; the second one short and round, radiating a contagious good mood. These two giants of German science brought a tempting invitation.

"We've been admiring certain American research institutes for a long time, Herr Einstein. Since 1911, we've worked on creating such an institute in Germany."

"What kind of institute?"

"Pure research. What Steinmetz does in the labs of the General Electric company in the United States. A similar project is planned in England."

"And our friend madame Curie just opened her *Institut du Radium*."

"Some of the biggest banks and companies are backing our project. We're already building a laboratory of chemistry, to be headed by Fritz Haber, in Berlin. A physics lab will be next."

"The emperor accepted to sponsor our institute, so we've named it the *Kaiser Wilhelm Society for the Advancement of Science*."

"Excellent. Whatever may help science move forward is excellent. But you haven't told me the reason of your visit, gentlemen."

"We'd like you be the director of the physics institute, Herr Einstein. You'd receive a professor's pay, but you wouldn't have to teach, since the purpose is pure research."

"Moreover, the Prussian Academy of Science is ready to offer you Van't Hoff's seat."

"Van't Hoff[19] is dead?"

"He died two years ago. They didn't replace him, because he had a special position in the Academy, which entitled him to a high pension. They couldn't pick up just anybody."

"The Academy would add the pension to your salary, so that you'd earn 12,000 marks per month."

"This is, hmm, unexpected. As you know, I came back from Prague last summer. I'm afraid my Swiss friends might feel offended if I leaved after just a year. Well, obviously, I can't compare the level of physics… Much higher in Berlin, of course. Much higher. I wouldn't have to teach anymore, which is a good thing, certainly… You should let me think about it for a while."

"You're a fast thinker."

"We'll go visit the lake of Zug tomorrow. This is our summer vacation, after all."

"Why don't you give us an answer when we come back?"

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[19] He received the very first Nobel prize for chemistry, in 1901.

"Tell you what, gentlemen. I'll wait for you at the railway station. If I refuse, I'll stick a white rose in my lapel. A red rose will mean yes."

Berlin was the world capital of science. An emperor lived in a palace there somewhere, but as far as physics was concerned, they offered me to be the king. Did I need more money? Well, there's nothing wrong with honestly earned money. I figured the *kolossal* salary would let me give my sons the best possible education. In a way, my dear Peggy, I was trying to justify a decision that my subconscious mind had already taken. I knew perfectly well what some rich parents did with their marks or dollars: they offered glitzy gifts to their children in place of attention and affection. How long would I go on living with Mileva and my sons? I couldn't stand her anymore. If she still felt any love, she hid it carefully. The world's mounting admiration for me seemed to feed her contempt.

I bet you've guessed what attracted me to Berlin, miss Peggy, even more than glory and a big pot of gold. I had been exchanging secret letters with my cousin Elsa ever since my visit. She wrote to me at the Polytechnikum.

I bought a red rose for Elsa's blue eyes.

* * *

Last visitor during that long summer: in September, Freundlich the astronomer. He had just married. "Believe me, darling," he had told his bride, "while Zurich isn't as famous as Venice as a honeymoon destination, it is just as romantic." I waited for them at the railway station. He recognized me, having seen my photograph in the newspaper, but he seemed to wonder whether this Swiss peasant, wearing a handkerchief on his head instead of a hat, was really the famous professor Einstein.

He still hoped to prove that the sun could bend a light ray.

"An eclipse is going to take place in Crimea next year. The Berlin Observatory administration won't spend money for what they consider a big joke, but they let me take an unpaid vacation. I'll have to finance the whole expedition. We use lots of heavy expensive equipment. Cameras that take pictures through a telescope, super-sensitive photographic plates, special tripods."

"I'll write to Max Planck. He was here last month. He knows many people in Germany. If he doesn't find enough rich backers, I'll break my piggy bank. I guess I can find two or three thousand marks."

"I'm quite sure I'll measure a deflection, you know. We'll amaze the world, Herr Einstein! The Observatory fools will gnash their teeth and rent their clothes!"

"My dear Freundlich, frau Freundlich, please come with me to Frauenfeld. I have to give a talk about general relativity there."

In Frauenfeld, I invited them to have lunch in a typical Swiss inn with Grossmann and Otto Stern—my young assistant in Prague, who had followed me to Zurich. When the bill came, I discovered I didn't have a cent on me.

"Can you lend me a hundred francs, Stern? My offer to finance the expedition still holds, Freundlich!"

The Krupp iron works financed the expedition eventually, so I kept my savings.

* * *

The Prussian Science Academy elected me in November, 1913. In February, 1914, having taught three semesters altogether in the Polytechnikum, I prepared to move once again. My colleagues gave a small party for me. I walked home with Marcel Grossmann.

"Are you happy, Albert?"

"I'm glad I'll spend all my time on research, but I feel uneasy at the prospect of living in Germany."

"You were born there, weren't you?"

"That's why I feel uneasy. I came to Switzerland because I loathed Germany and Germans. They are stiff and intolerant. They distrust people who won't join the crowd. They reject new ideas. They wear blinkers like horses, you know."

"They're expecting you like the Messiah."

"This worries me too. They're buying the golden goose, but I don't know whether I'll be able to lay eggs. I hope I won't be tempted to publish bad articles just to feel I deserve my salary. At least, when I was teaching, I felt useful. I'll become an academician without any obligation, a kind of living mummy. I'm looking forward to this tough job."

My sister, Maja, now lived in Luzern with her husband. My mother had moved in with them. I went there to say goodbye. My mother glowed with pride. Who would have thought that her son would ever belong to an Academy?

On April 6, 1914, I moved to Berlin with Mileva and the boys. My name was stuck on the door of a huge office in the Prussian Academy building, on the *Unter den Linden* avenue.

Administrators of the *Kaiser Wilhelm Society for the Advancement of Science* often came to see me. They were laying the foundations of the Physics Institute. They wanted to know how to design the labs.

"What do you need for your own use, Herr Professor?"

"Paper and pencils, which I'll bring myself, and a large paper basket to throw away all my junk."

Even today, miss Peggy, I never leave home without taking a notepad and a pencil. I jot down the ideas that flow through my mind when I stroll around. Otherwise, they fly away.

I saw Freundlich nearly every day to help him prepare his expedition. As I was having dinner in his homme one evening, I pushed my plate without thinking and wrote some equations on the embroidered tablecloth. I guess I had left my notepad in my coat pocket. A friend told me he met Frau Freundlich recently. She's sorry she washed the tablecloth. If she had kept it, it would be worth millions today!

* * *

On June 28, 1914, a Serbian student murdered the heir to the Austrian empire in Sarajevo. Since I was floating beyond the sun looking for hidden stars, I knew nothing of events taking place in some remote corner of our tiny planet. Mileva did hear the gunshots, though.

"You can't go on playing with your equations and telescopes as if nothing had happened."

"What happened?"

"Total war will engulf Europe pretty soon. We must go back to Switzerland right away."

"Total war? Back to Switzerland? I am giving my first talk to the Academy tomorrow!"

"Don't you read the papers? The Austrians want their police to start an inquiry in Belgrade about the shooting. Serbia can't accept such a flouting of its sovereignty, obviously, so it will refuse. The Austrians will enter Serbia anyway. This means war."

"One more war in the Balkans, maybe. I don't see how it could lead to total war in Europe. Most countries just don't care."

"I care. I'm a Serb."

"Come on, you're Swiss. You were not even born in Serbia, but in Hungary."

"The Austrians and the Hungarians will persecute their Serbian minorities even more. Russia and France are allied with Serbia, Germany with Austria. I don't feel safe here."

"Nobody will attack you."

"The Germans despise all the Slavs. I hate them. I'm returning to Switzerland. You do what you want. Put on your fancy uniform and go to your Academy. You told me that you renounced the German nationality because your countrymen were obsessed with war. It doesn't seem to bother you anymore."

On July 2nd, I put on my fancy uniform and went to the Academy. Decrepit oldsters who knew everything about Java spiders or the Quechua language listened to me politely—or slept as if I was singing a lullaby. I thanked them for electing me. I talked about my work. A theoretical physics hypothesis remains a kind of mind game, I told them, until someone proves, by performing practical experiments, that it does describe reality. "Nature is an inflexible and unfriendly judge. It never says *yes*. In the best case, it says *maybe*, and most of the time simply *no*. A Berlin astronomer will travel to Crimea before the end of the month in order to prove my theory. Then we'll see whether light accepts to follow the path I imagined."

Mileva and I signed a separation agreement on July 24. Michelangelo Besso came to Berlin and helped her move back to Zurich. They took a train on July 29. I felt relieved. A quiet empty home was what I needed to work day and night on general relativity. Hansi was eleven, Eduard was four. I loved them, but I found them too noisy. They shouted, they fought, they cried. If I tried to interfere, things went from bad to worse. I lost hours exchanging bitter recriminations with Mileva. A dark angry mood seemed to poison the air in my home as well as all over Europe. I felt lucky that I could find consolation in stars and equations.

In a poem by Heinrich Heine that German children learn in school, two French grenadiers walk across Germany after spending many years in a Russian jail. They hear that the enemy has vanquished France and captured Napoléon. They want to die. One of them says he can't, because his wife and children are waiting for him in France. The other one shouts his despair.

Was schert mich Weib, was schert mich Kind…
Der Kaiser, der Kaiser gefangen !
What do I care about wife, about child…
The emperor, the emperor captured!

I could have shouted too.

What do I care about wife, about child…
The universe, the universe waiting for me!

I was approaching the great mystery. I felt a kind of bliss when I thought I would soon get a glimpse of the Good Lord's original design for the universe.

I went to the railway station with Besso, Mileva and the children. When the train vanished in the distance, I don't know what came over me, I began to cry.

* * *

Mileva was right. On August 1st, Germany declared war on Russia (which had declared war on Austria because Austria had declared war on Serbia—what a mess).

The Russians arrested my poor Freundlich and seized his expensive Carl Zeiss equipment. Cameras? Telescopes? The man was a spy, no doubt. He saw the eclipse from his prison cell. They exchanged him for some Russian prisoners, so he came back to Berlin at the beginning of September. I was glad to see him alive, but sorry I had to wait until the next eclipse to know whether nature was willing to answer *maybe*.

* * *

Although I had noticed since I was a child that the Germans liked to march in uniform and dreamt of conquering the world, I did expect my colleagues, my fellow scientists, to use their brains and choose peace over war. Alas, miss Peggy! Otto Stern, my assistant, volunteered to fight on the Eastern front. My friend Max Born went to work in an army lab. The great Nernst himself began to look for new ways of manufacturing high explosives. Max Planck encouraged his students to go and risk their lives. "Having exhausted its remarkable patience, Germany had no other choice but to draw its sword against the fetid spring of perfidy."

The most ferocious of them all was Fritz Haber, who headed the chemistry institute of the *Kaiser Wilhelm Society for the Advancement of Science*. He was born a Jew, but he had converted and become a Protestant to erase any doubt he wasn't a real Prussian. He wore a monocle. His face was marked with scars—a stupid custom of the students in imperial Germany. "See, I fought duels to protect my honor," the scars said. Haber decided his institute would serve his country. "I work for mankind in peace time, for the fatherland in war time," he said. At first he studied high explosives, like Nernst. His assistant gave his life to the fatherland without leaving the lab, when he discovered a new kind of dynamite so sensitive that it blew up right there and then. Haber then thought of using gas to asphyxiate the enemy. He invented the terrible mustard gas, which killed thousands of people. When the emperor rewarded him by naming him a captain in the army, tears of joy ran along his scars.

Ninety-three intellectuals—writers, painters, theater directors, but also Wilhelm Röntgen, Max Planck, Walther Nernst, Fritz Haber and most of my Berlin colleagues—signed an *Appeal to the Civilized World* declaring that Germany was defending the legacy of Goethe, Kant and Beethoven, whereas France and England had allied themselves to Russia and were driving Negroes and wild Mongolian hordes against the white race. How could these great thinkers sign such crap? Was I the only sane human being left in Germany? How sad! I did find a kindred soul after a while: Georg Nicolai, a famous doctor, whom the emperor himself had consulted for his heart. We wrote an *Appeal to Europeans* to counter the ninety-three warmongers. We noted that our continent was shrinking, as new means of transmitting information and faster ways of

carrying goods and people were invented. Culture now jumped over borders, blurring differences. Europe was facing an easy choice. It could either advance toward unity, peace and prosperity—or get bogged in a hopeless war opposing brother to brother in such a way that nobody would win but everybody would lose. We suggested that educated men bypass narrow-minded politicians and create an international organization with the aim of uniting Europe. The first step on the way to this *League of Europeans* was simple: they just had to sign our manifesto.

Two people signed.

I joined a new pacifist party, the *Union for a New Fatherland*. Its influence seemed close to nil, but the authorities noticed its existence—they banned it.

I felt somewhat angry that my colleagues were trying to invent new techniques for killing as many people as possible. I wrote bitter letters to Paul Ehrenfest in Leyden. "Europe has gone crazy and provoked an incredible catastrophe. We belong to such a stupid animal species! This 'free will' we're so proud of is really a joke. Obviously, men have always needed some idiotic illusion that they could use as a pretext for war. Yesterday, it was religion, today it is the State. As a true believer in internationalism, I feel disgusted and quite lonely. I dream of a quiet island where mild and moderate people could live in peace. In such a place, I would accept to become an ardent patriot."

In September, 1915, I went to Switzerland to see my sons (and my wife).

I had sent a letter to the great French pacifist writer Romain Rolland, to inform him of the founding of the *Union for a New Fatherland*. He invited me to visit him in Vevey, on the lake of Geneva. I told him what I thought of the Germans. I had forgotten how pleasant it is to talk without being afraid of someone denouncing you to the police. I would have liked to stay in Switzerland, but I couldn't. My work on my theory had progressed very slowly, but now I felt ready to conclude. I hoped to explain my theory to the academy in a couple of months. On the way to Switzerland, I had stopped in Göttingen and talked to David Hilbert, the best mathematician in the world, about general relativity. Besides, I needed the salary I earned in Germany, which I sent almost entirely to Mileva.

* * *

My dear Peggy, I'm sure you are complaining that I talk too much about my work and not enough about my personal life. This is not due to my modesty or bashfulness, but to a temporary suspension of my personal life in 1915. Because of my obsession with the universe, I stopped caring about myself. I worked so hard that I forgot to eat. When I began to fall asleep on my equation-covered notebook, I went to bed. A cleaning lady came every morning. She swept away the dust in the living-room, but I

didn't allow her inside my office. She washed my shirts. She cooked a soup with a few antique potatoes and shriveled turnips. "What with this war, there's scant anything in the market," she said. I had become as skinny as an Indian fakir. Romain Rolland's cook was more resourceful. She baked a plump chicken stuffed with nuts and mushrooms, then an old-fashioned apple pie, so that I fell asleep in the train that took me back to Zurich.

I dreamt I had decided to play the violin in front of the Academy—instead of expounding my theory of general relativity, which wasn't ready yet. Gosh, I was so clumsy that I just couldn't button the stiff collar of my Academy uniform. I was late. I was trying to gather the sheets of the score, which were spread on my desk and covered with equations. As I was closing my door, a terrible feeling of loss and fright overwhelmed me. My violin! Where was it? I remembered suddenly that I had played the violin on the shore of the lake for Romain Rolland. I ran toward the beach. Yes, the violin was there, by the water… I was going to grab it, but a vicious wave stole it right under my nose. Then something amazing took place: the lake began to whirl and eddy, as if it was going to drain into a hole, like water in a huge sink! I had not noticed how small this lake was. More like the basin where Hansi used to play with his toy sailboat. My violin was describing circles around the basin. The water turned and churned, without vanishing. A large hole shone at the center of the basin.

When I arrived in Zurich, I understood that all my equations were false. I had chosen a wrong path with Marcel Grossmann three years earlier. I saw the dear Grossman in Zurich. "With our equations, the apple wouldn't fall on Newton's head," I told him. "I'll start again as soon as I'm back in Berlin."

* * *

I worked so hard on the ten equations of general relativity that I retain very few memories of the fall of 1915, even though it was the time of my greatest triumph. I exchanged technical letters with David Hilbert, the mathematician. When I became fully confident that my equations described the deep structure of the universe, I felt palpitations and a kind of dilatation of my breast. During several days, I went through a state of euphoria that was almost painful. The unique beauty of my theory dazzled me. I was drunk with joy.

On November 25, 1915, I told the academy that I was updating Newton's view of the world. This bit of news wasn't amazing enough, I guess. The old fellows fell asleep as soon as I started writing equations on the blackboard. At least I had no trouble buttoning my stiff collar.

I wrote an article and sent it to *Annalen der Physik*, which published it as a stand-alone fifty-page booklet in 1916. It didn't make as much a splash as my 1905 articles. People were more preoccupied by war than by the shape of space. My colleagues were perfecting bombs, airplanes, submarines. Those who made the effort to read the booklet thought I was giving a new mathematical description of the universe, no closer to reality than Minkowski's imaginary time. Max Born and Freundlich understood my theory quite well, though. Both of them published simplified versions for physicists who were not familiar with the tricky math involved.

As soon as I stopped working, I discovered I was totally exhausted. I found it depressing that men were killing each other instead of admiring the magnificent harmony of nature. I became aware that my stomach hurt. This had begun months before, actually, but I had focused my strength on the equations so thoroughly that I had ignored the pain. I thought it might be a cancer. I was going to die happy, in my thirty-eighth year, having reached my great goal.

Dr Rosenheim, a friend of Freundlich, found what was wrong with my stomach: I ate too little and too seldom. He weighed me. I had lost fifty-five pounds without noticing.

I became a regular dinner guest in the homes of my aunt and of Elsa. They did their best to find some food in spite of the naval blockade.

* * *

I went back to Zurich in March, 1916. I told Mileva that our marriage was over. She cried. She said I was behaving like a coward. She refused to consider divorce. Michelangelo Besso, our common friend, tried in vain to reconcile us.

"Don't be selfish, Albert. Think about your sons. You're two smart adults, Mileva and you. You should be able to compromise."

"She's smart, that's why we're in trouble. I'm fed up with her tricks and her recriminations. Now that I live alone, I feel I have escaped gloom and become younger."

"She's very unhappy."

"She lives in a beautiful city, far from the war, with two wonderful boys. She's as free as a lark. What's more, she stands in the halo of hurt innocence."

Michelangelo and another friend, Dr. Zangger, represented me in Zurich. They found schools for my sons. They wrote to me when Mileva needed money. She fell ill. I felt partly responsible for her illness. "I won't bother her about the divorce anymore," I wrote to Besso. At first, Zangger thought she might suffer from tuberculosis. It wasn't this terrible illness after all, so she got better by and by.

* * *

My former schoolmate Friedrich Adler, my neighbor in Zurich, had returned to Austria at the beginning of the war. I have told you about his fiery character, miss Peggy. In 1916, he murdered the Austrian prime minister because he couldn't stand his constant calls to arms. He hoped the empire would withdraw from the alliance with Germany and stop fighting. While in jail waiting for his trial and probable death sentence, he wrote a thick treatise to demonstrate that the theory of relativity was a sham. I received a letter from his father containing a copy of the treatise. "It would help us tremendously if you could read it and give us your opinion as an expert, dear Herr Professor. Our honorable judges know nothing about relativity, of course. If they don't trust you, who could they trust? This treatise proves that my poor son is insane, obviously. He was insane when he shot the prime minister. They should let him out of jail. He belongs to a psychiatric ward."

The treatise was silly and much too long, but not crazier than the junk written by respected professors against my theory. Besides, Friedrich had justified his gesture without any trace of insanity during his trial. Most of the young people in Austria admired him. What would I gain by declaring him insane? I would offend him and lose his friendship.

I was lucky. While I was wondering what to do, his father struck a deal with the authorities. The judges condemned Friedrich to death, but the last emperor paroled him and he was sentenced to jail for life.

* * *

The following summer, I left Germany again to visit Ehrenfest in Leyden and Lorentz in Haarlem. There was no fighting near Holland, which lay hundreds of miles north of the front and trenches. All I had to do was change trains at the border, provided I could show a piece of paper called a safe-conduct. I thought I would get it easily, being an Academy member. Well, the war-crazed bureaucracy balked. I had to ask Lorentz for an official invitation. I went several times to the Swiss embassy. I needed certificates proving I was indeed a naturalized Swiss citizen.

I was looking forward to meeting Paul Ehrenfest again. Of all the physicists I knew, he was the one I felt closest to. I imagined I would tour the stars with this good companion, far from the stupid war that rented Europe. I was confident he had been able to maintain a scientist's equanimity, like me, by observing the indifference of mother nature. I had forgotten that I was a better physicist than psychologist… Ehrenfest didn't care about the stars. He was deeply distressed—as if stuck in the mud of current events. He had gained weight and looked ten years older. He was scared.

"We're seeing the triumph of barbary, Albert. Think of our children… What kind of a world are they going to live in?"

"Let's hope this war cures people of their nationalistic fever. Our children will grow up in a new, peaceful and united Europe."

I loved his wife and their four children. I told you about his wife, miss Peggy: she was a Russian physicist he had met in Saint-Petersburg. She was a warm and generous person, who held him above the bottomless pit of depression. To change the subject of our conversation, she asked me about my work.

"Are you still reshaping the universe, Albert?"

"I've bent it and twisted it as if I was Jupiter himself."

"Really? Don't hurt it too much! You don't look like a brute…"

"I brought the article that tells it all."

"Paul can understand your article, but I ceased to follow the latest discoveries when the children were born. Since I'm lucky enough to have the inventor in my home, I hope he's going to explain everything to me."

"Hmm, where shall I begin? You know that the shortest path between two points is a straight line. Well, this isn't always true for a ray of light. Sometimes, the shortest path is curved."

"I remember something you told me long ago: light is made of vibrating particles. Does the vibrating prevent the particles from running straight?"

"Nice idea, Tatiana—except nature chose otherwise. The light corpuscles don't lurch about like drunkards on a straight road. They follow the road quite carefully, but the road itself isn't straight."

Paul couldn't help noticing I had just said something strange.

"Space is curved?"

"Yes. Its structure isn't described by Euclid's geometry, but by Riemann's."

"Hey, you two, stop using your coded lingo. What's this Roman geometry?"

"Forgive me, Tatiana. You know the geometry of old Euclid. A straight line goes all the way to infinity. Two parallel straight lines never meet. If you consider a point outside a straight line, you can draw one straight line parallel to the first one through point. One, only one. One of Euclid's theorems says that the sum of the three angles in a triangle is always equal to 180 degrees."

"Although I have forgotten a lot, I remember that."

"We draw the figures of this Euclidian geometry on a sheet of paper that stands for a boundless plane. We use a system of coordinates made of two axes to locate points on the plane. To know where a point is located, we need two numbers."

"Its coordinates, x and y."

"Right. So we say the plane has two dimensions. As you know, our familiar space has three dimensions."

"Paul told me four. He says it's your great discovery."

"Time can be considered a fourth dimension, indeed. Let's forget it for the time being. Let's even forget the third dimension and go back to our sheet of paper. Tell me something, Tatiana. Can you imagine yourself as some kind of a flat creature?"

"Like the Queen of Hearts in Alice? All right."

"Yes, this is a good example. As a flat person, you live within two dimensions and know nothing about a third dimension. You've studied straight lines and triangles and the rest of Euclid's geometry. Now, let's suppose you're lying on the ground, on a straight road going north, without any mountains or seas to interrupt it. You begin drawing a straight line with a flat pencil of some sort. Do you agree that you'll reach the North Pole, eventually?"

"Am I gliding on the road? It will take me a long time before I reach the Pole."

"As this is an imaginary mental experiment, it doesn't matter. Now start again from home, but follow a road at a right angle with the first one, let's say eastward. In our mental experiment, you've got a flat watch and a flat compass. So you notice something strange about the moment—which we can call 'noon'—when light comes exactly from the south. When you start, the small hand of your watch points to the number twelve at noon. After a few weeks, let's say, the small hand points to eleven at noon. Where are you?"

"In Germany, I guess."

"Yes. You continue moving eastward. Please stop drawing the line on the road when the small hand of your watch points to the number six at noon. What proportion of a trip around the globe have you accomplished?"

"Let me think… One fourth?"

"Good. Where are you now?"

"Somewhere in Russia. Siberia?"

"All right. Now turn north and draw a new straight line at a right angle. It is parallel to the very first one, isn't it?"

"Wait. I'm drawing all this in my mind. Lines number one and three are at a right angle to line number two, so they're parallel to each other."

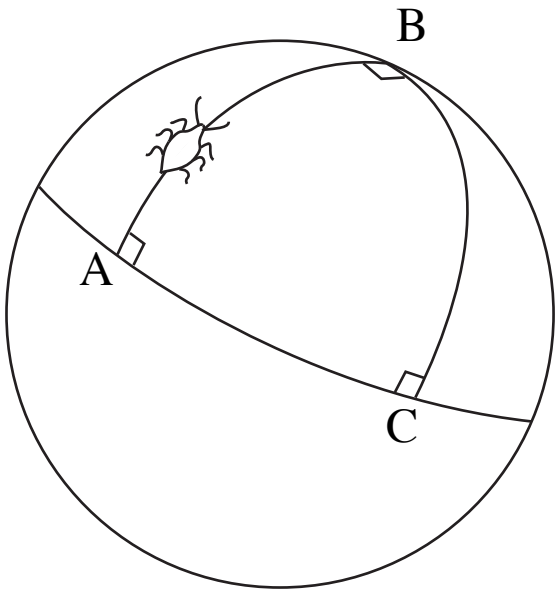
"You're going north again, so you'll reach the North Pole again."

"I'm afraid I'll be the worse for wear and tear. Also, I'm not allowed to wear a coat."

"Do you know what? You've drawn two parallel lines that meet at the North Pole. In Euclid's geometry, parallels never meet. A space where two parallels meet is non-Euclidian. When your two straight lines meet at the Pole, can you tell me their angle?"

"You're cruel, Albert. You question me as if I was passing an exam."

"You're at the North Pole. One meridian is coming from Holland, another one from Siberia. Imagine you cut an orange into four parts. I'll draw a picture."



"I've become a bug, all of a sudden?"

"One of those flat bugs, you know. Drawing the Queen of hearts is too difficult. What about the angle?"

"Ninety degrees."

"Exactly. You've drawn a triangle with three angles measuring ninety degrees each. Their sum doesn't add to 180 degrees, but to 270."

"Yes, but the Earth is not a flat plane. Your so-called straight lines are circles. You're playing games with me."

"The surface of the Earth is a two-dimension space, though. You locate any spot on the Earth with two coordinates, its longitude and latitude. What we can say about this particular two-dimension space is that it is not flat like a plane, but curved."

"A curved two-dimension space… I see what you mean."

"Note that locally, on a sheet of paper, even if it is quite a large sheet of paper, or on the length of road that the bug or the Queen of hearts would cover in one hour, we can consider the space as flat. A short portion of a meridian doesn't differ from a straight line. The Queen and the bug can't discover that the space is curved by using

their senses or their simple flat tools. They have to do a complex experiment, like going all the way to the Pole to draw a gigantic triangle, and even then they'll be able to imagine the actual shape of space only if they use their brains and their scientific knowledge. Do you know who discovered that the Earth was round?"

"Some Greek, I guess. "

"The Greeks certainly knew it. Who was the first one? Maybe some fisherman sees that the hull of a boat vanishes under the horizon before its mast… What does this mean? Hey, the Earth's apparent two-dimension surface is actually the skin of a three-dimension volume! The fisherman can understand this because he has seen a sphere, or at least an orange. He lives in three dimensions, so he is familiar with two-dimension surfaces and three-dimension volumes. Not so the Queen and the bug, of course. They've never seen a sphere."

"Nor an orange."

"All they have is some figures and numbers on a piece of paper. They can say that the surface is curved. They can use words like 'sphere' and 'third dimension,' but they can't really imagine the three-dimension space because their flat senses don't let them apprehend a sphere."

"I think I understand. Later on, I'm sure I won't understand anymore, otherwise I would be Einstein."

"Einstein himself had a hard time understanding space. I followed a wrong path with Grossman in Zurich. Riemann's geometry is tricky."

"Oh, Riemann… I thought you said 'Roman' at first. He was a mathematician in the 19th century, right?"

"He invented a non-Euclidian geometry where parallels meet, which nobody needed at the time. We can consider the surface of the Earth a non-Euclidian two-dimension space, curved in the third dimension. Riemann studied non-Euclidian spaces with more dimensions. Our three-dimension space seems Euclidian or 'flat.' A straight line, or a ray of light, can go all the way to infinity…"

"Don't expect me to say yes or no. I understand that you want to curve space, even if I don't really know what you mean."

"I'll begin with another example. Imagine you're at the North Pole. A glaring whiteness surrounds you…"

"Am I flat again?"

"As flat as a flounder. Now go one mile south."

"South is everywhere, so I can start in any direction."

"You could have a one-mile long piece of string. Or maybe you glide at a regular speed, so you can use your watch. When you reach one mile, you draw a cross on the ground."

"On the snow."

"Go back to the Pole, then rotate one degree and start again: go one mile and draw a cross. Do it again and again, until you're back at the very first line. How many crosses have you drawn in the snow?"

"Three hundred and sixty."

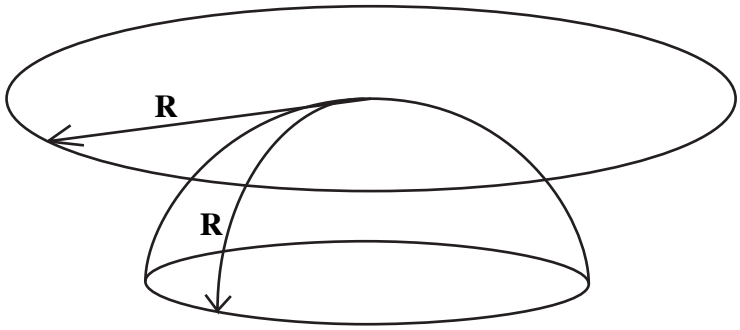
"Now please use your imagination to draw a circle going through all the crosses. How long is its circumference?"

"The radius is one mile. The circumference, $2\pi R$… 6.3 miles or so."

"No, tell me the exact length.

"Well, 2π miles."

"Are you sure?"



"Wait… Yes, I see. The length would be 2π miles if the Earth was flat. The circle actually defines a segment of a sphere. Its length is smaller than 2π miles."

"Indeed. Less than a fifth of an inch smaller for a one-mile radius. So you've proved once again that your two-dimension space was curved. Do you understand why I asked you to do this second experiment?"

"It is quite similar to the first one. Where you had a kind of curved triangle, you now have a curved radius."

"This second experiment is easier to reproduce in a three-dimension space. You're now a regular three-dimension human being. Imagine you're somewhere in deep space, far from any star or planet. You still have your one-mile long piece of string. You start from a certain point P in space. You go one mile away and you leave some kind of marker, let's say a pin head. Then you go back to P, rotate one degree and so on. If you try all the directions, you'll leave lots of pin heads at one mile of point P."

"More than a hundred thousand pin heads, I think."

"They define a sphere with a radius of one mile. Can you tell me the value of its surface?"

"If I haven't forgotten my high school math, $4\pi R^2$, or 4π square miles."

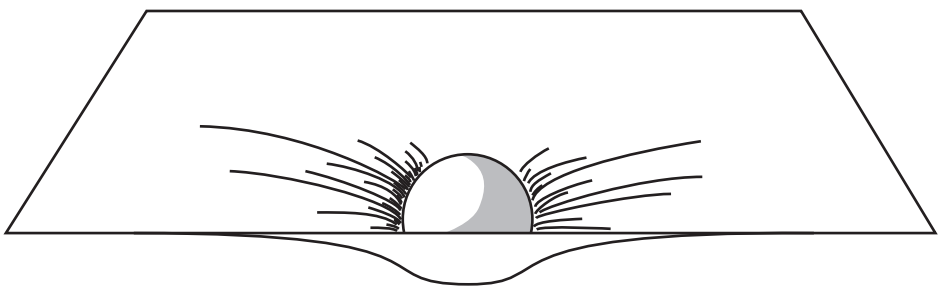
"This result is correct in a three-dimension Euclidian space. Do you remember what happened when you were a flat creature? By doing clever experiments and using your knowledge of mathematics, you discovered that you flat space was curved—but you couldn't feel the curvature of space with your limited senses. Now you're a normal woman again, living in a three-dimension space. Your limited senses won't let you know whether this space is curved into the fourth dimension, but you can measure the surface of the sphere defined by your pin heads. If the surface's value is 4π square miles, then the space is Euclidian or 'flat.' If the value is smaller than 4π, then we can say the space is 'curved,' by analogy with our two-dimension example. You can't feel or even imagine this curvature, but you're able to prove it and measure it because you're a clever being."

"I admit that space can be either 'flat' or 'curved.' What I don't understand is why it matters at all. What difference does it make? What's the point of all this?"

"Haven't you guessed? The curvature of space is what we call 'gravitation.' I'll try to describe my new space by going back to two dimensions. Imagine a piece of cotton, let's say a bedsheet, stretched on a horizontal wooden frame. Now, to curve this two-dimension space, let's deposit something heavy, like a billiard or croquet ball, on the sheet. The ball depresses the sheet. Maybe the sheet should be made of rubber. Then you would have a nice depression."

"I've gone to a circus with my children. We've seen acrobats jump on an elastic sheet. They call it a trampoline."

"That's a good name. So please consider in your mind your depressed trampoline. As we're back in our two-dimension fantasy, you're the Queen of Hearts. Let me try to draw the trampoline."



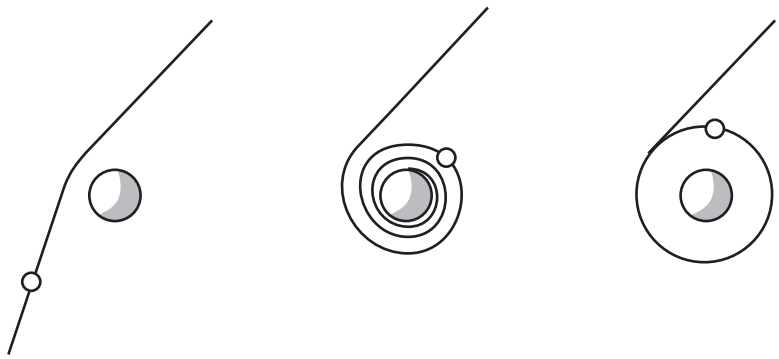
"That ball has three dimensions. A heavy disk would be better."

"Very good remark. Actually, you don't need to know what depresses the sheet. In our mind experiment, it's a disk. If we want to experiment with a real trampoline, a ball works better. I guess we would also replace the gliding Queen of Hearts with a rolling marble. Whether you're a playing card or a marble, you can follow a straight line at a constant speed as long as you're far from the depression. If it so happens that you are gliding toward the center of the depression, you'll feel by and by that you're accelerating and falling… If you're not gliding in the direction of the depression, but sideways, you won't be able to keep gliding along a straight line. There is no straight line inside the rim of the depression. There, the shortest path between two points follows a circle. The depression will bend your trajectory. If your initial speed is high, you'll climb out of the hole. What will your trajectory look like ?"

"A kind of bent straight line, I suppose."

"What if your initial speed is low ?"

"I'll follow a kind of spiral curve that will bring me closer and closer to the center until I hit the ball."



"Of course, if your speed is neither too high nor too low, you'll describe a circle around the center without escaping the depression or falling into it. What you need to understand is that you're not 'attracted' by the billiard ball. You don't know anything about this ball. All you know is that your speed is increasing or changing direction because of the shape of space. Think of a mountain stream. It follows a path toward the sea, but you wouldn't say that the sea is 'attracting' it."

"You're saying that the Earth is not attracting the apple and the moon?"

"Newton himself found it hard to believe that the Earth could 'attract' the moon, which is so distant. The Earth's mass is curving space. In my theory, space is flat—or Euclidian—when there is no massive object around. Any massive object curves space into the fourth dimension. The moon doesn't know anything about the distant Earth. It follows its path right there and then, like a train on a track. The path is circular. It is the

shortest possible path, what we call a geodesic[20]. Newton's gravitation was a force active at great distances. My gravitation is a local effect due to the geometry of space. I use the expression 'gravitational field,' by analogy with a magnetic field."

"You haven't answered my question yet. What difference does it make? Does it change anything to see a gravitational field where Newton saw an attraction between distant bodies?"

"Yes, it does. When I started working on general relativity, I found that gravitation and acceleration were equivalent. As a consequence of this equivalence, a very massive object should bend a light ray. An astronomer, Freundlich, went to Crimea in 1914. He hoped to measure the deviation of a light ray by the sun during an eclipse."

"Paul told me about it. The Russians thought he was a spy and threw him into jail."

"I felt sorry for him at the time, but actually it was a lucky accident. The angle I had computed within the frame of Newtonian physics and Euclidian geometry was wrong. If I take the curvature of space into account and work with Riemanian geometry, the angle is twice bigger[21]. We can't feel the curvature of space with our senses, but we can measure it in this manner."

"So Freundlich should try again. I guess he'll have to wait for the end of the war."

Paul seemed lost in his dark broodings, but he was paying attention.

"When the war is over, there won't be anybody left to go and watch eclipses."

"I don't really need an eclipse. There are other differences between Newton's theory and mine. More than one century ago, two French astronomers, Arago and Le Verrier, noticed that the planet Mercury was deviating from its Newtonian orbit over the centuries. This planet is closer to the huge mass of the sun than the others, so it is affected by a higher curvature of space. My theory predicts its exact orbit. In general relativity, a mass also modifies time. Thus, the mass of the sun should decrease the frequency of its light very slightly[22]."

"I tried to follow you, Albert. My brain is boiling and I am exhausted. You know what you should do now?"

"What should I do, my dear Tatiana?"

"Play a Mozart sonata with Paul."

"A wonderful idea. You're a wise woman. Paul is quite lucky."

* * *

[20] Shortest path between two points.
[21] Approximately 1.75 second of arc.
[22] The shift of the spectrum toward the red is so small that we can't measure it. A shift due to a similar effect was observed in 1960 between the top and the bottom of a building in Harvard. The top was sixty feet farther from the mass of the earth than the bottom.

A few days later, I went to Haarlem, where Lorentz had retired. Holland is a small country, so the train ride lasted only thirty minutes. Lorentz was waiting for me at the station. A pleasant feeling warmed my heart when I saw his tall figure on the platform. My old master's beard was as white as snow now. We walked across town toward his home. We talked about the war.

"Men speed forward on the road of technical and scientific progress, my dear Einstein, but there is no such thing as moral progress."

"They are bloodthirsty beasts. Technical progress turns them into more efficient killers. As soon as they invent a flying machine, they use it to drop bombs from above. Militarism is an illness. An epidemic is ravaging Europe. Science has become a weapon controlled by murderers. You know that Haber brewed these poisonous gases that kill thousands of soldiers at random… Before the war, Germany was proud of having the best chemists and physicists in the world. Now they are inventing new ways of giving death, inspired by industrial methods. I wonder where they'll stop."

"Have you heard of Dr. Freud?"

"He is Austrian, isn't he? He invented psychoanalysis. I know nothing about it."

"I have read several of his books since I have retired. While you're changing our way of considering space and time, he is renewing our idea of the human soul. Men may be animals, but they can learn and decide to control their instincts. On the one hand, some people exploit the work of the scientists to invent deadly weapons. On the other hand, we can hope that modern psychology will teach us how not to use these new weapons."

After lunch, Lorentz and I went to his library. He sat behind his desk, I sat in front of him. He offered me a cigar.

"So? Are you done?"

"I've brought the article…"

As he knew more mathematics than Tatiana, I explained the finer details of my theory to him: the "tensorial" equation linking the curvature of space to the mass and energy of an object, and so on. He took notes with a pen that he dipped into a golden inkstand. Now and then, he muttered: "Yes, I see" or "nice touch," like a teacher encouraging a student. Having described the new costume I had designed and cut for space and gravitation, I stopped speaking. I smoked my cigar in silence while Lorentz checked the equations. I told myself that I had worked well: the costume fitted to perfection. Many parts of the universe seemed to wear very shabby dresses by comparison. I would have to overhaul the whole rigmarole. I knew how to compute the curvature of space near a star, but I needed to study the general curvature of the

universe due to the cumulative mass of all the stars. Why didn't the stars fall upon one another? Where did the stars come from? Massive matter curves space and slows time. If there were no stars, there would be neither space nor time. A ray of light doesn't go straight to infinity. There is no infinity. Someday, men will travel to the planets and maybe to the stars. This strange stuff that I have discovered will belong to their daily lives and they'll find it quite obvious.

I twisted a strand of my hair, as I always do when I'm thinking hard. Maja, my sister, used to joke about that habit. She said I had inherited it from my Jewish ancestors, who let long curls grow on both sides of their face. When I lived with Mileva, she'd cut my hair. I hate to waste my time at the hairdresser's. I was sure my cousin Elsa knew how to cut a man's hair. Women always know how to do it.

How long had I been lost in my meditation, twisting my hair and chewing a cold cigar? I raised my head and saw Lorentz. Tears filled his eyes. I thought about Minkowski. On his death bed, his last words (or so I was told): "I hate to die so soon, without knowing where the theory of relativity will lead us." The theory was now complete, but the universe remained as mysterious as ever.

* * *

In Leyden, Ehrenfest introduced me to Willem de Sitter, who taught astronomy in the university. Like all astronomers, he dreamt of finding whether the sun really bent light rays, as my theory predicted.

"Alas, Herr Einstein, the university of Leyden is too poor to go and photograph the next eclipse, and let's not forget there's a war going on."

"When and where does the next eclipse take place?"

"In May 1919, a perfect total eclipse will be visible from several inhabited lands: in Africa and in the north of Brazil. If you don't object, I'll send your article to the *Royal Astronomical Society*, in London. These gentlemen should be able to finance an expedition."

"I certainly won't object. The English physicists don't receive *Annalen der Physik*. anymore, I guess. I can't even send mail to France or England."

In this manner, my article landed on the desk of Arthur Eddington, secretary of the *Royal Astronomical Society*, teacher of astronomy in Cambridge. It so happened that he belonged to the Quaker sect, which preaches universal friendship and pacifism. Although my article came from Germany, he didn't throw it away. I don't know whether English scientists signed bellicose petitions like their German counterparts, but some of them accused Eddington of "favoring German science" because he

translated my article into English. He was utterly convinced that my theory was true. He talked to his boss, the president of the *Royal Astronomical Society*.

"De Sitter, the Dutch fellow who sent me the article, says we should set up an expedition. I think we don't need to send ships across the ocean and spend a fortune just to prove something that's quite obvious."

"This new theory may be obvious to you, Eddington. It isn't to me. I'm sure everybody would appreciate observations confirming the hypothesis. You know, I've talked to someone in the war department about it. They accept to consider you'll be serving your country by sailing to Africa and Brazil. Otherwise, they'd gladly send you to jail with Bertrand Russell and the other pacifists."

Miss Peggy, you know that the Earth travels around the Sun. This means that the stars hidden behind the Sun change during the year. The eclipse's date, May 29th, was very propitious: the Sun would be moving across a group of stars called Hyades, which we know especially well.

Once they have decided something, the English never give up. While a war was raging, while German submarines were prowling under the waves, they began preparing a double expedition to the Gulf of Guinea and Brazil.

* * *

In the meantime, I had gone back to Berlin. My stomach was protesting again: "Leave your stupid stars alone and take care of me," it said. I felt awfully tired. Dr Rosenheim sent me to one of his colleagues, who thought I might have gallstones, unless perhaps something was wrong with my liver.

"You need rest, Herr Professor. This is the best cure, no doubt. In such cases, we also advise taking the waters."

"I prefer the first cure, Herr Doktor. Doesn't cost anything. If I wanted to go and take the waters, not only would I have to find money, but I would need to acquire a sufficient amount of superstition first, in order to believe that the money wouldn't be wasted."

I went to Switzerland. After stopping in Stuttgart to see my mother, I stayed for a while with my sister and her husband in Lucerne. Then I spent a fortnight with my sons in a mountain village. Hansi was thirteen, Eduard seven. I sent seven thousand marks per year to Michelangelo Besso for their education and for Mileva's needs, as well as six hundred marks to my mother. This amounted to more than half of what I earned. My salary had been reduced steeply, as the *Kaiser Wilhelm Society for the Advancement of Science* had been put to sleep because of the war. I definitely needed to save money. Back in Berlin, I moved to 5, Haberlandstrasse, the very building where

my cousin Elsa lived. A tiny apartment had become available. As the rent was low and Elsa fed me my daily gruel, I didn't have to go and beg in the street.

I wasn't in want, so what happened all of a sudden? Money began to pour. In 1917, some of the big companies that were sponsoring the *Kaiser Wilhelm Society for the Advancement of Science* complained that the funds they had earmarked for the physics institute were sleeping in the bank. Since we couldn't decently build new labs for theoretical physics, an apparently useless science, while most German people were hungry, we decided the institute, born officially on October 1st, 1917, would be located in my tiny apartment! I had enough money to enroll Ilse, one of Elsa's daughters, as the institute's secretary, and to bankroll Freundlich's research.

Elsa was a very careful and helpful woman. Her character was the opposite of Mileva's. She was quite different from me, too. She brought me what I lacked. I don't mean only clean shirts and tasty dishes. Her qualities made up for my flaws.

She was glad to have me near at hand. She praised me to Philip Frank, my successor in Prague, who came for a visit.

"I needed a talented physicist like our Albertle. In these times we have to buy food in all kinds of cans, often foreign made, rusted, bent, and without the key necessary to open them. But there hasn't been a single one yet that our Albertle has failed to vanquish."

The one drawback of becoming close to her was that she always wanted to jiggle my furniture and my books to remove the dust.

"Why do you want to put away the dust? It will come back anyway."

"I don't meddle with your physics, so let me take care of the housecleaning in my own way."

"This reminds me of a joke."

"What joke?"

"My father always told jokes about Rothschild. A shnorrer[23] knocks on Rothschild's door. When the butler opens the door, the shnorrer shouts that he wants to see Rothschild right away. He shouts and screams and makes such a frightful din that Rothschild comes down from his office. The great banker gives a few coins to the shnorrer to get rid of him. 'My friend,' he says, 'I find your method rather crude and unpleasant. Let me tell you that if you had asked for some money politely, I would have given you much more.' The shnorrer smiles. 'Listen, your honor. I don't give you any advice about the best way to invest your capital, so don't try to teach me my profession.'"

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[23] A beggar, who lives from the charity of others.

What with the Prussian Academy sessions and my silly uniform and everybody calling me Herr Professor and even Your Honor, my own profession impressed Elsa so much that she accepted to grant me a great favor: she promised never to enter the room I used as an office.

* * *

I published two new articles in 1917. In the first one, I looked into Niels Bohr's quantic model of the atom. When an atom absorbs a quantum of energy, an electron climbs to a higher level. The atom is like a pregnant woman. It can't keep its fat belly forever. The electron will climb down sooner or later and the atom will then emit a quantum of energy. I predicted that by feeding the atom more energy than it could absorb, we could control the energy it would emit[24].

I remarked that the expression "sooner or later" wasn't very rigorous. We hadn't found the exact mechanism of the emission yet, so its timing seemed to obey a random law. In my view, there was no place for randomness in physics. I spent many years thinking about that question, miss Peggy. I haven't found the answer yet.

The second article revived an old science: cosmology, the study of the whole universe. It had been sleeping for centuries. We knew almost nothing about the universe. We saw lots of stars out there, but nobody knew whether their number was finite or infinite. Some astronomers imagined a finite number of stars gathered like a sort of island in the middle of an infinite space. General relativity said this was impossible, as space was now linked to matter intimately. An infinite number of stars wasn't possible either, since their infinite mass would have created infinite gravitation forces. There was only one possibility: a finite number of stars in a finite universe. Space is curved locally—a little near a light star, a lot near a heavy star. It also has a general curvature due to the total mass of the universe. I mentioned a familiar two-dimension example in my article: our good old Earth, with its local hills and mountains and its general curvature as a globe. Because of its general curvature, the universe closes on itself. Like the surface of the Earth, it is finite but has neither rim nor center. It is not easy to imagine such a universe, but I found my hypothesis pleasant and rather harmonious. What do you think, miss Peggy?

I tried to apply the equations of general relativity to this new cosmology. As observations and data were lacking, I had to rely on guesswork. I must say that I made several mistakes. I estimated the size of the universe to one hundred million light-years, whereas we now consider it at least one hundred times larger. My equations seemed to call for an expanding or shrinking universe, but the ancient Egyptians and Babylonians

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[24] This article described the laser, which was perfected well after Einstein's death.

had already described most of the stars we see today, which I took as a proof of the universe's stability. I introduced a "cosmological constant" to counter the destabilizing effect of my equations. As soon as the article was published, de Sitter, the astronomer I had met in Leyde, showed that my cosmological constant wasn't necessary. Soon afterward, a Russian mathematician, Alexander Friedmann, found a simple way to apply the equations to the cosmos. In his solution, the curvature of space was decreasing—or the universe expanding. To use the analogy of the Earth once more, you have to imagine that you're inflating our globe like a balloon; all the cities are moving away from each other.

* * *

My silly belly was still bothering me. Dr Ehrmann, a stomach specialist, used an X-ray machine to look right through my old creaky corpse. He didn't see any gallstones, but a duodenal ulcer. I spent the first few months of the year 1918 in my bed. Dr Ehrmann was a good man, who became my friend, but I doubted that X-rays could actually detect gallstones or ulcers. I told Ehrmann that I didn't consider medicine an exact science.

"The only diagnosis I accept to believe is the one that you make *post mortem*."

I wasn't forty yet, but illness had pushed me across the threshold that separates youth from ripe age. My hair had become quite gray.

I began a divorce procedure. What a waste of paper! I went to the post office several times a week to send or retrieve registered letters. Michelangelo Besso acted as go-between. Mileva, pretending she had helped me, claimed a share of my income. I couldn't refuse, since she had to raise the children. Where would the money come from? The expected defeat of Germany cast a shadow on the future of the *Kaiser Wilhelm Society for the Advancement of Science*. The universities of Leyden and Zurich knew it and tried to lure me away. They were willing to pay me even if I stayed in Berlin, as long as they could add the name of the famous professor Einstein to their roster. I hesitated. It seemed wrong to earn money without working. At the same time, well-informed people told me I would soon receive the Nobel Prize. I promised Mileva I'd put the prize money—a huge sum—in a Swiss bank. The interest would constitute her pension.

My Dutch friends sent me good news: Eddington, the Englishman, was preparing the expeditions that would look for bent light rays during the 1919 eclipse.

On November 4th, 1918, the sailors of the Baltic fleet rebelled and demanded the end of the war. Factory workers throughout Germany soon joined them. The emperor fled to Holland. A republic was proclaimed. The war ended on November 11th.

Nothing now stood in the way of the English expeditions. I was convinced that Eddington would see the bent rays. It couldn't be otherwise.

I hoped the various countries of Europe would reconcile after the awful slaughter. As I hadn't been very successful with my pacifist ideas during the war, I had stopped meddling in politics. Besides, I was exploring the fourth dimension. Now that the war and my exploration were over, I climbed down from my ivory tower. I was glad I had seen German militarism crushed forever (or so I thought). I went to meetings of the *Union for a New Fatherland*, which had survived underground after being banned. I sent a petition to the heads of State who were meeting in Versailles, near Paris, to sign a peace treaty: "Please don't design a peace that will give birth to a new war!" They didn't listen to me. The sanctions they forced onto the German people were so harsh that hunger and misery spread over the land, building up hidden resentment.

I refused to become an absentee professor in Leyden and Zurich, but I accepted to give conferences. I went to Zurich in February, 1919. I was to explain special and general relativity in my good old Polytechnikum. So many people wanted to listen to me that the authorities decided to sell tickets, which was really unheard of.

Here I am, trying to enter the conference hall.

"Where is your ticket?" the guard asks.

"I don't have a ticket."

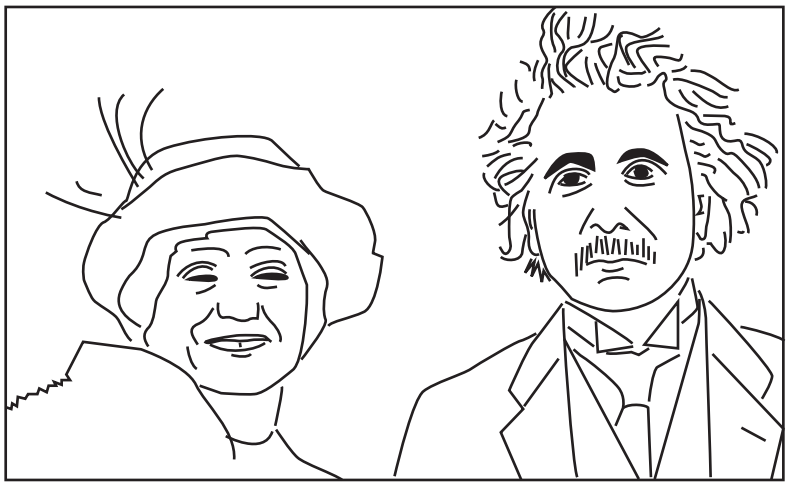
"If you haven't bought a ticket, you can't come in!"

At the end of my conference, some students asked me to talk about quantum theory. "I'm not sure I understand the latest developments," I told them. "You'd better consult a specialist." I had played a leading part in the launching of quantum theory, but it was moving in a direction that I couldn't accept. My colleagues were discovering, as I had done, that particles sometimes seemed to act in a random manner. The youngest physicists were willing to consider chance a normal component of particle behavior. It found that impossible. I thought the theory wasn't complete.

While I was in Zurich, the cantonal court divorced us. Our lawyers had provided an official reason—my adultery. As I had committed this terrible crime (and confessed), I deserved to be punished. The judge ordered me not to marry again for two years.

I traveled to Zurich again in May for my next conference. People now knew that, after one or two feeble introductory jokes, I wrote equations and Greek letters on the blackboard for hours. The conference room was almost empty. The authorities and I agreed to put an end to the series of lectures.

As soon as I was back in Berlin, I married Elsa. I didn't have to go to Switzerland again, so there was no risk I'd be jailed for disobeying the cantonal judge.



I exchanged my small apartment for an attic located just above Elsa's apartment. There I moved my office, which still doubled as the headquarters of the *Kaiser Wilhelm Institute for Physics*. I found a place on the wall, between my bookshelves, to hang my pictures of Newton and Faraday.

Elsa was three years older than me. She left me alone as a physicist, so I accepted a few things she required of me as a husband. I combed my hair now and then. I began using a toothbrush, although I considered this gadget perfectly useless. I let her sew my hanging buttons and torn hems, and wash my shirts more often than I thought necessary.

* * *

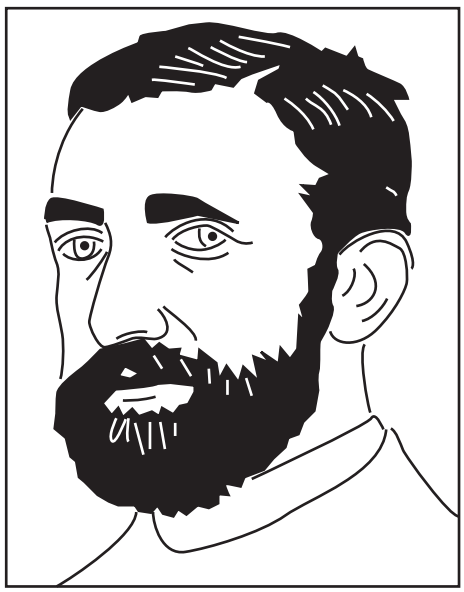
The small world of physics was entering a period of turmoil. Dignified professors were as jittery and feverish as molecules in a heated gas. According to a rumor, the victorious countries demanded that Walther Nernst and Fritz Haber be captured and handed over, so they could be judged as war criminals. Meanwhile, the Nobel committee gave the 1918 chemistry prize to Haber. While it rewarded his technique for extracting fertilizers from thin air rather than his invention of high explosives and deadly gases, it did seem somewhat questionable. The Solvay conference announced that its first post-war meeting would take place in April, 1921. Lorentz wrote to me.

"We haven't invited the Germans, because their presence in Brussels right now would arouse painful feelings. However, we haven't said that this policy applies to all Germans. The door is open for you. Let us hope that the others will be allowed to return in the future too."

I had neither signed the manifesto of the ninety-three intellectuals, nor perfected deadly gases. The secretary of the Solvay conference declared I could be invited because my nationality was "undefined." Somebody told me they knew I was German,

but had decided to consider me "international" so I could join them. I don't know whether I felt German, international or undefined, but I refused to go to Brussels without my colleagues.

I became the target of attacks by stupid people on both sides of the border. When Marie Curie and Paul Langevin invited me to Paris, a French professor protested: "Do we really need to invite the citizens of neutral nations who have spent the entire war in Germany?" Among my dear colleagues, some still thought that only Germany could "save the White race." They considered me a traitor. I had not only rejected my nationality when a teenager, but also supported the enemy by calling for peace. The leader of those racist scientists was Philipp Lenard, a good physicist, who had received the Nobel prize in 1905 for his research on cathode rays.



Lenard believed that nationality played a vital part in physics as in everything else. You may have learned in high school, miss Peggy, that the unit of electrical intensity is called "ampère." In his Heidelberg university lab, Lenard called it "weber," to avoid the disgusting French name. He pretended to distinguish a "German" science, deep and true; a "French" science, which stayed superficial because it relied too much on reason; an "Anglo-American" science, too practical and businesslike to find significant results; and a fake "Jewish" science, vicious and dangerous, which muddled minds by twisting space and distending time.

This baloney worried me. Ehrenfest had told me about venomous antisemitism in Russia, but I hadn't expected such medieval prejudices to be revived in Germany. Miss Peggy, I guess you are not studying physics, otherwise you would know I haven't

invented the atomic bomb. Perhaps you're studying history. In that case, you know that troubled times followed the first world war in Germany. Far-right and far-left groups fought a kind of civil war. The rightists complained that Jewish refugees coming from Eastern Europe were invading Germany. Rightist army officers murdered Rosa Luxemburg, a leftist leader who happened to be Polish and Jewish.

In 1917, after the Russian revolution, the Soviets had asked for peace. They considered that a war started by the czar, opposing the capitalists, didn't concern them. German propaganda called the end of the war on the Eastern front a great victory and promised that the Western enemies would also be vanquished soon. The generals and the politicians certainly knew they were losing the war in the West, but they didn't say anything about it. So when the end came all of a sudden, the people were quite surprised. As a workers' strike had played a part, the rightists suspected a Bolshevik and Jewish plot. Now it is true that many Jews, in Russia and elsewhere, believed in communism's promise of equality. Trotsky, number two in the Soviet regime, was Jewish. He announced that the revolution would spread to the whole Earth. The rightists said this proved the Jews were plotting to dominate the world.

A Zionist leader, Kurt Blumenfeld, requested my support.

"The Jews won't be safe until they have their own country."

"You want to change our Jewish intellectuals into peasants! Moreover, the Turks won't let you settle over there."

"The English have expelled the Turks from most of the Middle East during the war. Lord Balfour, the British minister of foreign affairs, declared that the Jews had a right to a homeland in Palestine."

Actually, the Zionist project didn't seem as foolish to me as when Max Brod and others had tried to convince me of its worth in Prague. Before the war, I didn't even feel Jewish. I never entered a synagogue. Mileva was orthodox when I married her, then had converted to Catholicism with the boys during a trip in Austria. I certainly knew more about the catholic religion, which I had been taught in school in Munich, than about the Jewish one. My friend Michalangelo Besso, who belonged to an old Italian Jewish family, used to tell me I was making a mistake: "You're Jewish, Alberto. This is not something you can ignore and forget. You shouldn't, anyway."

Do you know what, miss Peggy? I can thank the antisemites. They forced me to recognize my Jewishness, which I now consider an important part of myself. When Lenard attacked "Jewish science," he meant me. The antisemites didn't wait long before mentioning me by name.

I didn't feel threatened yet. I could count on the friendship and assistance of Max Planck, the grand old man of German science. Although he had signed the manifesto of the ninety-three, everybody considered him an upright and exemplary person. The most famous universities offered me big amounts of money. I was tempted several times, but I refused because I didn't want to betray Max Planck and my other German colleagues just when the world was shunning them. "True German science needs you, Einstein," Max Planck said. Also, I hated to imagine Lenard and his clique rejoicing because I was gone.

* * *

On September 27th, 1919, I received a telegram from Lorentz.

Eddington found deviation. According to preliminary results, between one and two seconds of arc.

When a postman delivered the telegram, I was talking to a young woman who worked with Haber. I handed the piece of paper to her.

"Look, this might interest you."

"But, Herr Professor, this is fantastic! The theory is confirmed! You must be the happiest of men. This is the grandest day in your life!"

"Well, I knew the theory was true."

"So what would you have said if the telegram had brought news of failure?"

"In that case, I would have been sorry for the Good Lord. The theory is really true!"

I went to Holland so I could get more details.

On May 29th, the day of the eclipse, Eddington had set his special telescopes, coronoscopes and cameras on Principe, a Portuguese island in the gulf of Guinea. Davidson, his colleague, was ready to tackle the same experiment in Brazil. On Principe, the sky was gray, but the clouds parted just before the end of the eclipse. An assistant changed the photographic plates as fast as possible. Another removed a screen he held in front of the lens, measuring exposure length with a metronome. Because of the clouds, only nine photographs out of sixteen could be analyzed. On one of them, five stars were quite visible.

The Brazilians barely knew that the war in Europe was over. They were surprised to see that a tremendous English expedition intended to check the theories of a German scientist. The observations were to take place in a remote and wild region. The peasants who lived there admired the strange machines pointing toward the sky. "Please use your magic wands to call the gods," they asked the astronomers. "Tell them to send some rain. Even the very oldest people don't remember a dry spell that long. Soon, there won't be any more water in the rivers and we'll die of thirst." I don't know how

the astronomers did it, but it rained for a whole week. The people were delighted, the astronomers were crestfallen. In the end, the gods granted them a few minutes without rain during the eclipse, so they were able to take seven photographs. They had to stay another two months to photograph the Hyades stars at night, in order to establish a reference picture and compare the angles.

The astronomers in Greenwich and Cambridge spent months comparing the eclipse pictures and the night pictures. The deflection of the light rays appeared on the plates as a tiny shift of the stars—less than a thousandth of an inch. Measuring the shift with a micrometer confirmed my predictions.

On October 25th, 1919, the Dutch Royal Academy invited me to Amsterdam. Lorentz announced that the English expedition had confirmed my theory. This wasn't official news yet, so the report of the session didn't mention it.

At last, on November 6th, Eddington told the British *Royal Society* that the Sun did bend a ray of light. The angle was 1.75 second, as predicted by general relativity. They told me that you could feel the same kind of silent tension in the public as when Othello prepares to kill Desdemona. All the princes and lords of English science were there. J. J. Thompson, president of the *Royal Society* and Newton's heir, made a speech.

"This is the most important result since Newton's day, and it is fitting that it should be announced at a meeting of the Society so closely connected with him… The result is one the highest achievements of human thought."

The next day, newspapers spread the news around the globe. Suddenly, I wasn't "professor Einstein" anymore, but "the famous professor Einstein, whose theory of relativity has knocked over our conception of the universe." A mere eclipse had given weight to my theory, which had ceased to be a vague mathematical abstraction. Not only did people compare me to Newton, as J. J. Thompson had done, but also to Euclid, Aristotle, Copernic, Darwin. Journalists and photographers kept a vigil in front of my door. After the war's terrible bloodshed, the public longed for new outlooks. Seen from the stars, the miserable conflicts that shook our planet didn't seem so important.

Fame, the ultimate dream of so many men and women, crowned me all of a sudden. I wrote to my mother: "Good news. The English expeditions did prove the deflection of light rays." I thought she'd enjoy my success more than I did. If I had hoped that fame makes you happy, I would have been disappointed. I felt just the same as the day before. My stomach still hurt like hell.

Max Planck complimented me. "So once more you've linked beauty, reality and truth. You told me several times that you didn't doubt the validity of the theory, but

this expedition is a good thing nevertheless. Unbelievers do have to accept proven facts, after all."

The whole world sent me invitations. I received so much mail that I threw most of the letters away without opening them. The newspapers published sensational articles that I found closer to science fiction than to physics. They asked stupid questions: "If space comes to an end, could Mr. Einstein please tell us what lies beyond it?" Max Born, Freundlich and Eddington published good books. Several other authors published not so good books. *The Times* of London, considering that nobody knew my theory better than I did, asked me to explain it.

At the beginning of my article, I thanked England. While the war was still raging, it had set up expeditions to check theories completed and published in the country of its enemies. This proved that bridges were not broken between the scientific communities and that a reconciliation between the nations was possible.

I hope the technical part of my article was clear enough for the readers of *The Times*. I gave a short history of physics, from Galileo to Newton and from Maxwell to Lorentz. I showed we couldn't accept a fixed speed for light without changing our ideas about space and time. I described the non-Euclidian space of general relativity. I concluded with a joke: "By an application of the theory of relativity to the taste of readers, today in Germany I am called a German man of science, and in England I am represented as a Swiss Jew. If I come to be regarded as a *bête noire* [to be hated] the descriptions will be reversed, and I shall become a Swiss Jew for the Germans and a German man of science for the English." Could I know I was actually predicting the future?

I wasn't the only person who joked about my theory. Physicists and other people had lots of fun with its quirky features. Eddington told his students in Cambridge that if he were traveling at 150,000 miles per second, his height would shrink from six feet to three feet. J. J. Thompson advised the teachers of mathematics to give their courses on the sixth floor, since space becomes more Euclidian when you move away from the center of the Earth. The scientific magazines were full of comical poems about Einstein and his theories. Here's my favorite one:

There was a young lady called Bright
Whose speed was much faster than light
She went out one day
In a relative way
And came back the previous night.

I knew I had become really famous when Ehrenfest, at whose home I spent a few weeks in 1920, told me I had become a character in Jewish jokes, just like Rothschild.

He told me the following story:

An old Jew is quite proud of his grandson, a college student.

"Tell me," he asks him, "who is this Einstein, about him all the newspapers are talking? And what is this relativity business?"

"Dr. Einstein is the greatest living scientist, grandpa. And relativity—well, it ain't easy. I'll try to explain it to you… If a man's sweetheart is sitting on his knees, an hour feels like a minute. On the other hand, if the man sits on a hot stove, a minute feels like an hour. That's the theory of relativity."

The grandfather finds this strange. He thinks it over, mumbles in his beard, then turns toward his grandson: "Now tell me… From this your Einstein makes a living?"

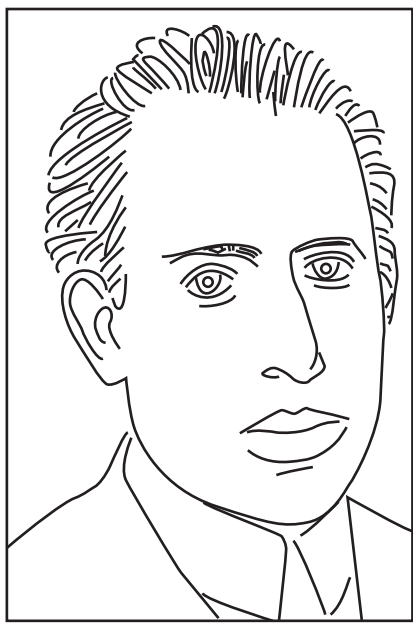
Elsa cut my hair now and then, but I forgot to comb it. The cartoonists loved to draw in the popular press a scientist with wild hair and thick mustache. In one of the cartoons, a young woman asked this ink Einstein what his profession was.

"I study physics."

"Really? But you're old! I stopped studying physics when I was eighteen!"

The mark was losing its value fast. I gave conferences all over Europe to earn real money and send it to Mileva. This real money couldn't transit through Germany, where it would have vanished into thin air. Ehrenfest became my secret banker. We communicated in code. "The new salts have arrived," he wrote to me. "The *Au* ions concentration is 6,7 x 10^3." *Au* is the chemical symbol for gold. He had received 6,700 florins, which he sent to Mileva in Zurich!

One of my trips took me to Denmark. There I met Niels Bohr, one of the physicists who pushed quantum theory beyond what I considered decent borders.



He looked like a huge and childish Scandinavian peasant, with both feet set solidly on the ground.

"Come on, Bohr, you seem to own a good mind and lots of common sense. How can you accept these crazy ideas? Atoms that act as if they had a free will… A reality that we won't ever be able to know and understand fully…"

"You're a theoricist, Einstein. You build a theory as simple and harmonious as possible, then you check that it does describe reality. I start from reality. I observe and experiment. If what I find doesn't make sense, so be it!"

In spite of our differing ideas, we became good friends.

My trips doubled as vacations. After working night and day for years, I was entitled to some rest. Besides, I considered that I promoted reconciliation.

My enemies criticized my "internationalism." They wasted ink and paper to publish stupid slanders about me. "Einstein goes abroad and shakes hands with people who starve Germany. Although he renounced his nationality as a teenager and refused to support Germany during the war, he pretends to represent German science. He tries to impress the masses with his bogus theories, which failed to convince most serious scientists."

A "Society of German Scientists for the Preservation of a Pure Science"—founded by people who worked in labs but knew too little physics to understand my articles—attacked the theory of relativity in public meetings. This Jewish and Bolshevik theory pretended to replace real honest German science…

I was still young and foolish. I wrote an article in a popular Berlin daily to defend my theory. "You shouldn't stoop to answer this scum," my friends said. I even attended an "anti-relativity" conference with my friend Max von Laue. I stood up and tried to correct an orator's obvious lie, but the crowd shouted and booed me to silence. Several rightist groups, including the future nazi party, held booths in the hall. They handed antisemitic leaflets and recruited loafers.

This made me rather nervous. Elsa was worried.

"Think about your health, Albertle. Your digestive tract is in shambles, the doctor said. I don't like those circles under your eyes."

"I woke up one morning and I had become the most famous Jew in Germany. I attract the hate of the antisemites like a lightning rod. I have never desired nor decided to become famous. I find the price to pay slightly too high…"

"This turmoil will settle down by and by. Don't worry."

"I hope you're right, Elsa. But you could as well be wrong. Maybe I should go to Leyden and play Mozart sonatas with Paul. I've also received a proposition from the

university of Cambridge. I would work with Rutherford. He isn't very fond of me, but he is a fantastic experimenter."

"You forget that you don't speak English."

"I'll learn. You'll learn too. They say England is a beautiful country."

Arnold Sommerfeld, who had just become president of the Society of German Physicists, begged me "not to desert." He said that all the important physicists supported me, except Lenard. Then Max Planck asked me whether I wanted to punish the real German physicists for the despicable slanders of mock scientists. Intellectuals like the writer Stefan Zweig and the theater director Max Reinhardt wrote articles to express their solidarity.

A journalist interviewed me.

"Are you going to leave Germany?"

"If I left, would that be surprising? I feel like a man lying in a magnificent bed, but plagued by bedbugs. I haven't decided anything yet, I must say. Let's wait and see."

I remained in Berlin, after all. The German republic was young and fragile. If people of good will let it down, what would become of it? My fame put me in a position to help my human brothers by praising democracy and peace. I couldn't forfeit my duty.

I went to a lake most afternoons and sailed, hoping to restore my serene mood. In the evening, I played the violin with friends. When I performed some Bach or Beethoven piece, I couldn't curse all the Germans anymore.

* * *

I gave a conference in Prague. I saw Philipp Frank, who had taken over my job in the German university. He had just married. As he hadn't found an apartment yet, he lived with his young wife in his university office—that is, my former office. They let me sleep in that strange bedroom and moved next door into a chemistry lab. I slept very well, actually.

Before the war, Prague belonged to Austria and the German minority held the reins of power. Now that Czechoslovakia had been created, the Germans were considered second-class citizens. Their newspapers announced my visit on their front page, glorifying "the German race that has produced a man like Einstein." I didn't want to hold the flag for the supposed superiority of Germany. I didn't want to represent the supposed Jewish race either. I just wanted to be Albert Einstein.

I gave a first conference in front of a crowd who asked me wacky question about light and time, then a second conference in front of the university professors, who asked the same questions. Then the mayor or whoever invited me to a cocktail party where I

was to meet the so-called important people. They asked me to make a speech. I thought I had spoken enough already.

"I'm sure it will be more pleasant and easier to understand if I play a piece for you on my violin."

The next day, some students came to see me in the office. One of them said he had been hoping to meet me for a long time.

"Herr Professor, I have studied your equation . Look at this picture… I have found a way to use the energy contained within the atom to produce a new kind of explosive. Much more powerful than dynamite! We need to discuss it."

"I don't want to discuss such a thing. Your equations and pictures are foolish. It doesn't make sense at all."

There's something I need to tell you about my wonderful formula, miss Peggy. Lenard thought it might become useful someday. He also imagined amazing high explosives, I guess. So, in a book he wrote, he distinguished it from the "fake and vicious Jewish science" of relativity. He attributed its invention to Hasenöhrl, an Austrian physicist who had studied "radiation pressure." I had met Hasenöhrl. He admired me sincerely. He couldn't protest against this erroneous attribution, alas, as he had been killed during the war.

From Prague I went to Vienna. The young Austrian republic had declared an amnesty and Friedrich Adler was free. I was glad to see him again, of course. Later, he became a great socialist leader.

I gave the usual lectures. I was staying at the home of a physicist. His wife found it surprising that I traveled with a small bag containing a pair of pants and a shirt.

– Haven't you forgotten anything, Herr Einstein ?

– Call me Albert. Well, I don't think so.

– You don't have any socks.

– I don't believe in socks.

– No slippers.

– Who needs slippers?

– No toiletries?

– Oh, you're right… I forgot them!

In any case, when I carried too much luggage, I left most of it abroad. Elsa laughed about it when I came back home.

"You're lucky your head is screwed tightly on your shoulders, otherwise you would have left it over there…"

The wife of the Vienna physicist ironed my spare pants before the conference, but I forgot all about it and spoke to the students in my wrinkled pants.

* * *

My mother was terminally ill with cancer. She was sixty-two. I convinced her to come to Berlin with my sister Maja. I tried to find the best doctors, but she died after three months.

I talked about it with Hedwig, the wife of my friend Max Born, who had lost her own mother recently. "One feels right into one's bones what ties of blood mean. I saw my poor mother in torturing agony. There is no consolation. We all have to bear such heavy blows, for they are an inescapable part of life."

* * *

Do you remember I mentioned Kurt Blumenfeld, a Zionist leader, miss Peggy? I saw him again.

"I'm still opposed to nationalism in all its shapes," I told him, "but I'm beginning to understand that Zionism may be necessary. Let me know if can make myself useful to the cause, now that I've become a famous Jew."

Most German Jews disliked Zionism. They considered themselves good German citizens "of Jewish confession." They tried to ignore antisemitism or even declared it was a normal reaction, what with all these uncouth Jews from Eastern Europe invading Germany. Did they hope to earn the respect of the so-called "Aryans" by despising their own Jewish brothers? I told Blumenfeld what I thought about their cowardice.

"A German Jew who works for the Jewish people and for the Jewish homeland in Palestine doesn't cease to be German any more than a Jew who becomes a Christian and changes his name ceases to be a Jew."

Actually, the very definition of "Jewish" puzzled me. You could feel Jewish, as I did, without observing religious rites. We were neither a race nor a nation, but a kind of social community sharing traditions. One thing was obvious: we existed in the eyes of the others.

The president of the World Zionist Organization, Chaim Weizmann, was a Russian-born chemist who had taken the English nationality. During the war, he had contributed to the English war effort by perfecting new explosives, just like Haber in Germany. To thank him for his help, Lord Balfour had offered a homeland to the Jews in his famous declaration. Blumenfeld told me that Weizmann was preparing a great American tour and wondered whether I might accept to go along. He hoped to convince the American

Jews to finance the settling of Jews in Palestine, and also the founding of a "Hebrew University" in Jerusalem. I hesitated before giving an answer.

"I'm neither an orator nor a politician. He doesn't want me for my abilities, but only for my name. Its publicity value is so high that a substantial effect is expected among the rich tribal companions in Dollaria."

"Don't play down your abilities, Herr Professor. As a scientist, you can explain to the Americans that we need a world-class university in Jerusalem."

While I hadn't decided anything yet, Fritz Haber entered my office in the Academy.

"To the whole world you are today the most important German Jew, Einstein. If you fraternize just now with the British and their friends, people in this country will see it as evidence of the Jews' disloyalty. Many Jews went to war and gave their life because they considered it their duty. Their heroism hasn't suppressed antisemitism, but it has reduced its intensity. Do you wish to wipe out this gain by your behavior? You would hurt the career of many Jews in the universities and elsewhere, as well as your own."

"Dear Haber! Far more is involved than an act of loyalty or disloyalty. The very future of our Jewish tribe is at stake. The creation of a Jewish university fills me with particular joy, as I've seen recently so many cases of splendid young Jews being treated harshly by German universities."

Whenever I saw Haber, I thought about these deadly gases he had brewed. His visit helped me make up my mind. I told Blumenfeld I was ready to go.

I exchanged letters now and then with my former student Maurice Solovine, who had settled in Paris. I wrote to him before sailing. "I am not so keen about this trip to America. The Zionists are bringing me as bait to fish dollars from the deep pockets of the American Jews. I'd be glad to let you go in my place if it were possible. You know I don't have a patriotic fiber in me. I hope that the Jews, because of the small size and weakness of the colony in Palestine, will escape the madness of power."

I sailed on March 21st, 1921 on the *Rotterdam* with Elsa, Blumenfeld, Chaim Weizmann and his wife. Weizmann had a jolly mujik's head (a mujik is a Russian peasant, miss Peggy), with a mustache and a goatee like Lenin.

I was somewhat surprised to discover we were traveling first-class.

"I thought you would have bought third-class tickets, Herr Weizmann. The purpose of our trip is to gather some funds, isn't it? So we should try to save money rather than spend it."

"Bah. To such a situation, mathematics don't apply. You know nothing about politics, Einstein. We're the official delegation of the Zionist Organization. If we

traveled third-class, the American Jews would see us as shnorrers and give us bread crumbs."

When we entered New York harbor, a motor launch came along our ship. A battalion of journalists and cameramen climbed aboard and rushed at me. I didn't understand right away why they were running and where to. Me? Why me? This was quite unexpected. Even before they had caught their breath, they were asking me to explain the theory of relativity in fifty words for the American public. I had been asked that sort of question before. The American journalists were only faster than their European colleagues. They went straight to the point. I knew what to answer.

"Let me give you a condensed and maybe whimsical reply. Before, it was believed that if all material things vanished from the universe, time and space would remain. According to my new theory of relativity, time and space disappear with material things."

This explanation satisfied them. They turned toward Elsa.

"Do you understand your husband's theory, Mrs. Einstein?"

"Oh no, but it doesn't prevent me from being happy."

They asked the same question from Frau Weizmann, who gave a clever answer.

"Professor Einstein explained his theory to me every day during the crossing, so now I am fully convinced that he understands it."

Some of them found her the most fascinating person in our party : she was a woman, she was a doctor and, above all, she smoked!

A huge crowd was waiting for us on the dock. The mayor of New York himself stood on a wooden platform to welcome me. I wore my old coat and my everyday clothes. I carried my pipe in one hand and my violin in the other one. The journalists wrote that I looked like an artist. I've always thought there was a kind of kinship, actually. When I invent a theory to explain new observations or to simplify older theories, it seems to me that something like an artistic passion is moving me. This is similar, maybe, to what attracts a composer to music. The scientist and the artist are people who try to overcome the limitations of human nature.

At least the crowd impressed Elsa.

"Look, Albertle, all these people came for you."

"Well, they receive a victorious boxer with still greater enthusiasm."

A fifty-year old man with a familiar face was waiting for me in the hall of our hotel.

"Hey! Hey! Max Talmud! What a pleasant surprise! How long has it been? Twenty years?"

"My name is Talmey now. I have taken the American nationality."

"I wouldn't be here if you hadn't offered me all these scientific books when I was a child!"

I attended noisy Zionist meetings with Weizmann. I let him talk and talk, but it was obvious that the public was more interested in my silent self. I was told they saw me as the archetypal wandering Jew, as the dreaming aloof intellectual lost in his books. The meeting halls were always full, the public applauded with plenty of zest, but our tour didn't bring in as much money as Weizmann had expected.

I also gave conferences about relativity in universities and elsewhere. I spoke German while an interpreter translated my words into English. They often introduced me as a Swiss scientist, because the Germans, being former "enemy aliens", were not welcome. The students were not as serious as their European counterparts. They laughed loudly when I made a mess of wiping the blackboard or couldn't find my glasses.

In the university of Princeton, someone told me of a professor who had built a fancy machine and pretended to prove that the Michelson experiment was mistaken. All the newspapers quoted my comment: "Subtle is the Good Lord, but malicious he is not." The Princeton people liked this sentence so much that they engraved it on the wall somewhere.

We spent nearly three months in the United States. The president of the country, Mr. Harding, welcomed me to the White House as if I was an official representative of the whole Jewish people. I wondered whether I deserved such an honor. The newspapers called me "the new Christopher Columbus of science, sailing on the strange seas of the mind." Your countrymen are sometimes excessive, miss Peggy, but I found them younger and livelier than the Europeans. I also noticed that women were freer and more fun in the United States than in Europe.

Looking at the American Jews, who came from all the countries in Eastern Europe and had kept their ancestral traditions, I felt, for the first time in my life, that I was really meeting the Jewish people.

I shared the front page of the newspapers with Thomas Edison, the famous inventor, who had just criticized higher education, saying it failed to teach anything really useful. Whoever applied for a job in his company had to answer a bunch of "practical questions," then got a position according to the results of this special exam, without any consideration of diplomas or previous experience[25]. The journalists, who loved a good quarrel, asked me to answer Edison's questionnaire.

"Here's the first question, Mr. Einstein… What is the speed of sound?"

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[25] But no Jew needed apply.

"I don't know. I don't see the point in burdening my memory with information that I can find easily in books."

This trip would have exhausted me if Elsa hadn't served as my manager. She kept the journalists at bay, telling them I needed to rest. She checked the food I was offered, because of my stomach's weakness. She forced me to change into clean clothes before official receptions. Weizmann admired her, or maybe felt jealous.

"Your Elsa takes good care of you."

"Bah, when women are at home, they take care of their furniture. Always moving and dusting it. When we're traveling, I am the only furniture around, so my wife can't help fussing and messing with me all day."

* * *

On the way back, we stopped in England. Freundlich—the astronomer—happened to be visiting his mother, who was English. I enrolled him as my interpreter, since he knew the language. I met English Zionists, lords, Oxford and Cambridge students, J. J. Thompson and many other scientists—including Eddington, the man who made me famous. The Royal Astronomical Society had awarded me its prestigious Gold Medal, but at the last minute it noticed that I lived in Berlin and decided to change its royal astronomical mind. For the first time in thirty years, there was no medal. They did give it to me a few years later.

The prime minister, Lloyd George, also found out about my German ties and failed to attend a grand formal dinner given in my honor. They sat me next to the archbishop of Canterbury, who was the most prominent person there.

"I tried to read several books on the subject of relativity," he told me, "but they have driven me to what I would call a state of intellectual desperation. May I ask you, Mr. Einstein, what effect relativity would have on religion?"

"None at all. Relativity is a purely scientific matter and has nothing to do with religion. I think physics helps us understand the world, but doesn't show us the path we should follow as human beings. This is religion's role. It gives meaning to our life. It pretends to know this meaning through divine revelation, but I believe we owe it to the strong personalities who founded and developed the various religions."

I went to Westminster Abbey with Eddington. I wanted to deposit some flowers on Newton's tomb.

I even had lunch at the Rothschilds. They laughed heartily when I told them the joke of the shnorrer.

All the newspapers agreed that my trip could be considered an encouraging first step toward reconciliation between England and Germany.

* * *

Paul Langevin, whom I had met and befriended at the Solvay conference, shared my pacifist outlook. In 1922, he invited to me to give a lecture in Paris. He wrote that he had obtained an official authorization from Paul Painlevé, a mathematician who had been minister of war and prime minister of France. I thought it was too risky and told him I had to refuse, although I would have loved to see him and dear Mrs. Curie again. France and Germany were still enemies at heart. The word *reconciliation* could be uttered in England or America, not in France. Some enlightened intellectuals would welcome me, but what about the rest of the French people? What would the Germans say? Then I happened to meet Walther Rathenau and asked him for advice. I knew him through common friends. He was a remarkable man. He had revamped the German economy during the war (which had extended the butchery by at least one more year, actually). Now he was minister for foreign affairs, and also the highest-ranking Jew in the German State. After consulting the other ministers, he advised me to accept.

As Paul Langevin worried about my safety, he found a "secret" apartment for me. I gave my address to Maurice Solovine, but he was supposed to keep it strictly for himself. The Paris train goes from Berlin to Cologne, then crosses Belgium. Paul Langevin and Charles Nordmann, an astronomer who had written a book about me, "Einstein and the Universe," came all the way to the border between France and Belgium. They were quite surprised to find me in a second-class car. Charles Nordmann described me in a high-brow Paris review: "Einstein is tall, with broad shoulders and a slightly bent back. His head—the head in which a new vision of the world was born—instantly attracts attention. It is round, with an unusually high and wide forehead. A small mustache, dark and very short, adorns a sensual mouth, very red, rather big, with its corners betraying a permanent slight smile. His deep eyes' thoughtful expression seems distant, as if it was trying to grasp the whole universe. Black gray-flecked unkempt hair falls in a tangle of curls on his neck and ears. The general impression is that of a stunning, youthful, very romantic man, irresistibly reminiscent of the young Beethoven."

A crowd of journalists and photographers was waiting for us at the train station, where we arrived around midnight. I didn't want to talk to them. Langevin was afraid some nationalist hoodlums might be hiding among them. So we found a side door and escaped into the subway.

I gave my lecture on March, 31st at the Collège de France, then again a few days later in the Sorbonne. Henri Bergson, Paul Painlevé, Marie Curie and many other famous Parisians attended. I did my best to speak French.

The "reconciliation" half of my visit wasn't as successful as the relativity half. The *Société Française de Physique* simply refused to welcome me. The *Académie des Sciences* hesitated. When thirty members said they'd boycott my lecture because Germany hadn't joined the League of Nations yet, it was canceled. Several newspapers defended me: "If he had invented a cure for tuberculosis or cancer, would the thirty gentlemen take the medicine or would they wait for Germany to join the League of Nations?"

To celebrate my visit, an American living in Paris offered a five-thousand dollar award for the best explanation of my theory in three thousand words or less. Paul Langevin found this story quite funny.

"He can't find jurors to grade the answers, because all the physicists in Europe are trying their hands at it."

"Except me. I would never be able to do such a thing."

A sixty-year old Irishman won the award.

Before leaving France, I wanted to look at the battlefields of the Great War. For miles and miles, there was just no more landscape. Villages that had been built with love centuries ago had vanished. Fire and brimstone had erased the green hopefulness of life, leaving behind a black desert petrified by the despair of death. I was so shocked that I shivered uncontrollably. I turned toward Paul.

"This is worse than anything I had imagined. Terrible. Awful. All the students in Germany, all the students in Europe, should be brought here to see how ugly war really is."

The French, who love to eat, had already built a restaurant in the ruins of Rheims. We had lunch there. Two French officers sitting at a nearby table recognized me. When we left, they stood up and bowed politely. This gave me some hope.

* * *

Back in Berlin, I found an invitation by some students in Zurich. I needed rest and wanted to return to physics, so I sent them the following letter: "As an old Zurich boy, I was pleased no end by your invitation, but I desperately need peace and quiet. What I could say on the subject of physics is so well-known everywhere by now that even the birds on the rooftops can whistle it. Please don't say, 'He went to Paris but didn't come to us.' I have accepted the Paris invitation to promote international ideals, devotion to which is now more necessary than ever. Of course, there is no need of reconciliation in the case of my own countrymen, who have always retained their sobriety, equanimity and toleration."

On June 11th, I spoke at a meeting of the main German pacifist organization. I called for the unification of Europe. I suggested that children learn foreign languages in school so they could communicate with people in other countries. I accepted to become a member of the *International Committee for Intellectual Cooperation*, a branch of the League of Nations—the ancestor of what is now called Unesco.

On June 24th, two young far right militants shot Walter Rathenau in his car. They hated him for being Jewish, for signing a treaty with the Soviet Union, for displaying "Jewish servility" toward Germany's former enemies (which meant he was trying to talk to them). Another Jewish minister had just escaped an attack. It was said that the antisemites had condemned me to death as well. One of the far-right madmen offered a reward for my murder. He was fined ten dollars or so.

The government decreed one day of national mourning for Rathenau's death. Schools and universities were closed, but Lenard gave his course at Heidelberg university as if nothing had happened. Some factory workers entered the university and grabbed him. The police saved him just as they were going to throw him into the river.

How had we reached such a level of violence? I was disgusted. I wanted to give up all my national and international public roles, leave Berlin, become a private citizen again in Switzerland or Holland and resume my research in physics. Marie Curie, whom I had convinced to join the *International Committee for Intellectual Cooperation*, asked me not to resign from this new institution. "They need you," she wrote. "Germany needs you too. You can't leave it to the barbarians."

I couldn't make up my mind. To leave or not to leave? I had moved many times, I had never felt a special bond to any corner of the earth, but now it seemed that age kept me in place. Miss Peggy, I would have gained ten years if I had left in 1922. I was waiting for fate to send me some kind of signal.

Fate sent me an invitation, which let me postpone my decision. A Japanese publisher offered me a nice lump of money for a series of lectures. I would at least put some distance between this awful mess and me—and also, escape would-be killers for the time being.

At the last minute, Max von Laue asked me to cancel my trip.

"Some Swedish colleagues let me understand that, hmm, a pleasant event could take place in November, that would make it necessary for you to be there in December."

"I have accepted the Japanese publisher's offer. In a few days, I'll be sailing on the high seas and I'll stop worrying about the Berlin chaos. Then I'll discover the Far East. Please tell your Swedish friends to wait another year."

So I was to receive the 1921 Nobel prize. I couldn't decently complain. I didn't rejoice either. Because nobody in the Swedish academy understood relativity, they had waited until the fall of 1922 to give me the prize for the preceding year. There was quite a tangled tale behind this. People had suggested my name for the prize as far back as 1910. Theoretical physics being still a new science, nobody knew anything about it outside Germany, England and France. A chemist had tried in vain to explain relativity to his Swedish academy colleagues. A biologist hadn't done any better. There wasn't a decent physicist in the academy, but there was at least one Lenard crony, who later became a personal friend of Hitler and Göring. This man declared that many first-rate scientists considered relativity a fraud. According to Nobel's will, the prize was supposed to reward useful or ground-breaking inventions and discoveries, not fuzzy theories that fed controversy. The secretary or what, who had consulted the former winners of the prize, said they called me the most important living physicist. Since I should have received the prize long ago, it would be a shame to wait any longer. They bickered so much that they missed the date for the 1921 prize. They settled on a compromise to avoid mentioning the fuzzy theory of relativity (which smacked of Jewish science, no doubt): they gave me the prize for my explanation of the photo-electric effect, part of my 1905 article about quanta. Lenard crowed as if he had won a great victory: the Swedish academy, by giving me the prize for something else, had recognized that relativity was worthless.

I would find no consolation in riches, since I had promised the prize money to Mileva.

We boarded a Japanese liner, the *Kitano Maru,* in Marseilles in October, 1922. We were to stop over in Port-Said, Colombo, Singapore, Hong-Kong and Shanghai, then reach Yokohama after six weeks at sea.

To face my enemies in Berlin, I had kept my willpower at a high level for months. Now that nobody threatened me anymore, I felt a sudden lack of energy and I fell ill. I didn't worry, because I recognized my old stomach troubles. The ship's doctor, Mr. Miyake, took good care of me. He knew our language: "We study medicine in German books," he told me.

I spent quiet days in my cabin. I kept a diary during my trip. Here's the first entry: "Marseilles. Bugs in the coffee."

I didn't go ashore in Port-Said. Elsa saw the pyramids without me.

"I don't remember what you told me, Albertle. They climbed on top of the great pyramid to measure the perimeter of the earth?"

"No. Eratosthenes calculated the perimeter of the earth by measuring the shadow of a stick. A few centuries before, Thales had also measured the shadow of a stick to calculate the height of the pyramid."

Rest and Dr. Miyake's prescription—or rather, diet—did me lots of good. I had packed a suitcase full of books and newspapers that I had been too busy to read in Berlin. Having read rigorous scientific articles for years (as well as not so rigorous but nevertheless logical patent submissions), I was amazed to discover that journalists were allowed to write without worrying about truth or plain common sense. As they knew nothing about physics, as they couldn't explain my theories, they had found a clever excuse for their laziness: no more than twelve people understood relativity, they said. What a joke! I knew more than a dozen physicists who could be called relativity specialists, and each of them had more than twelve students who understood the theory perfectly well.

It was said that when Eddington had returned from his trip to Brazil and told the Royal Society that the Sun did bend light rays, one of the members had come to him during the post-lecture cocktail.

"Say, Eddington, I've heard that three men only understand this Einstein's theory. You seem to be one of them, old chap."

"Well, I…"

"Don't be so modest, Eddington."

"It's not what you think. I was wondering who the third man could be."

As I felt much better, I went ashore in Colombo. Here's the entry in my diary: "We visited the city in tiny carts pulled by small trotting men. Frail-looking, but herculean strength. Bitterly ashamed to share responsibility for the terrible treatment accorded fellow human beings, but unable to do anything about it. They surround the foreign tourist and beg so movingly that they break one's heart." Colombo is the main city of Ceylon, which was then a British colony. The Englishmen I knew were quite civilized, so I wondered why they tolerated this degrading custom.

In another British town, Hong Kong, the local Jewish community invited me to a five o'clock tea. Most of these people came from Egypt or Syria. This unexpected meeting at the end of the world moved me deeply. From my diary: "Am now quite convinced that the Jewish race has more or less kept itself pure over the past centuries, as the Jews form the Euphrates and Tigris shores are very similar to ours. Strong sense of belonging together."

Between Hong Kong and Shanghai, a telegram confirmed that I had received the Nobel prize for the year 1921. The 1922 prize went to my Danish colleague, rival and

friend, Niels Bohr. A second telegram arrived a few days later: "Congratulations. I'm happy to get the prize too, but even happier that I didn't receive it before you! Niels Bohr."

When the ship entered Shanghai harbor, the choir of the German colony, which was waiting for us on the wharf, sang *Deutschland über Alles* in our honor. I found this bombastic welcome definitely unpleasant. I felt Swiss, all of a sudden.

I fell in love with Japan. Either because of the latitude and hygrometry, or because peasants and gardeners worked at it for centuries, nature seemed more beautiful there than anywhere else. The people seemed kinder, too. As you know, miss Peggy, they became ferocious and made war like all the others after all.

I gave lectures in front of attentive friendly audiences. There were more than two thousand people for my first lecture in Tokyo. Kaizosha, the publisher who had brought me over, had promised me high royalties. I soon understood that my revenue was but a small share of the general profit. The seats were as expensive as for a recital of the famous tenor Caruso. We didn't shortchange the public, though, as I lectured for hours. I mean, I spoke for ten minutes, then the interpreter spent half an hour translating my speech and answering questions. I wondered whether clever students criticized the translation, or whether the interpreter explained some of relativity's fine points. He was a competent physicist, named Jun Ishiwara, whom I had met before the war in Zurich. When he let a few questions get through, I always found them remarkably pertinent. I had known several Japanese students in Germany. I guess I tended to underestimate them because they seldom spoke proper German.

Jun Ishiwara told me that all the newspapers published poems about the speed of light and the fourth dimension, but that they had a hard time fitting my name, Ainshutainu, into their haiku.

I was invited to celebrate red maple leaves' day—or something—at the Imperial Palace. Kimono-wearing musicians played Japanese classical music, which I found rather strange. I prefer Bach and Mozart! I was introduced to the emperor and empress. All the courtiers and other guests wanted to shake my hand. I believe I eclipsed the emperor, even though he is a great-grandson of the Sun goddess.

Dr. Miyake, my doctor on the ship, invited me to a tea ceremony in his house. I had been told that I would have to take off my shoes, to keep the *tatami* mats clean. As I was afraid my bare feet might not be as clean as the *tatami*, I put on some socks. A Japanese home looks a little bigger than it is, because there is very little furniture—no tables, no chairs, no beds. The windows and the partitions between the rooms are made mostly of paper. The tea ceremony takes place in a special empty room, where the only

decoration is a very simple and tasteful "flower arrangement." The tea is green, frothy and quite bitter. Tiny cakes that look like sculptures are served with it. I found everything fascinating and wonderful, but my old knee and ankle joints kept protesting: "Hey, enough already with all this sitting and kneeling on the floor!"

I enjoyed the tea ceremony (even if my joints didn't). Meanwhile, I wasn't in Stockholm to attend another ceremony: the big Nobel bash. The Swedish academy was looking for me: "Where is Einstein? Whom are we going to give his medal to?" The German ambassador in Sweden: "To me, to me!" The Swiss ambassador, caught dozing: "Gee, what about me?" The Prussian academy sent a telegram saying I had to be German, since I belonged to the academy. They knew this was not a very convincing proof, so they looked for naturalization papers in the Berlin archives. They found all kinds of certificates allowing Herr Einstein to do this or get that "although he is Swiss." By that time, my medal was already in the German ambassador's pocket.

We left Japan at the end of the year 1922, having stayed there six weeks. On February 1st, 1923, we landed in Port-Said and took a train to Palestine. I was to cut a ribbon and declare the Hebrew University of Jerusalem open. The British High Commissioner, Sir Herbert Samuel, a well-read man who understood the general outline of my work, treated me like a head of state. They shot the canon for me, which I considered a little too much, and gave several official dinners. Elsa complained. "I am a simple German housewife. I like things to be cozy and comfortable and I feel unhappy in such a formal atmosphere. For you it is a different matter—you are a famous man. When you grab the wrong fork or whatever, they say you do so because you're a man of genius. In my case, however, it is attributed to a lack of culture."

We did find time to walk here and there in the streets. The joyful liveliness of the workers and peasants dispelled my worries: our Jewish intellectuals were succeeding in their new lives. They had built a magnificent new city in Tel Aviv. It seemed to me that a spirit of friendship was cementing the unity of the new country. The pioneers were dressed in a simple manner (I fit quite well in their midst), talked without any excessive formality, danced in the streets at the end of the shabbat.

The city of Jerusalem lived up to my expectations. I felt that the ghosts of a glorious and tragical past lived in the old cobblestones and walls. Some living ghosts disturbed me, though: the black-clad religious Jews who spent their days praying to God in front of the so-called wailing wall, rocking their bodies back and forth. What a waste of time! The best way to thank the Creator for the wonderful mind he gave us is to use it.

So I cut the ribbon. I inaugurated the university by pronouncing a Hebrew sentence I had learned phonetically. “There must be something wrong with my brain,” I then said in French. “Please don’t expect me to ever learn Hebrew…”

Everybody begged me to stay in Palestine rather than return to Berlin, where crazy murderers were waiting for me. My heart was willing, but my reason refused. Until today, miss Peggy, I’ve never gone back to Jerusalem.

* * *

I gave lectures in Spain and France, then went back to Berlin. I had been away for nearly six months. I hoped that the wounds of the war were healing, that the fanatics were calming down, that I would be able to resume my work without being bothered by stupid polemics and death threats.

I guess the newspapers sold more copies when they put me on the first page. They said I was back from a grand tour of the Soviet Union, where my communist friends had welcomed me warmly. Who made up these fake news? I suspected Lenard and his gang.

In July, 1923, I gave a lecture in Stockholm in front of the King, the academicians and other distinguished guests. This was a kind of atonement for missing the Nobel ceremony. On the way back, I stopped in Copenhagen and said hello to Niels Bohr. I also spent a few weeks in Kiel, on the Baltic sea, where the owner of the Anschütz company lent me a cottage on the beach and a sailboat every summer. I worked for him, actually. Ever since I had been a patent clerk in Bern, I earned a little money by giving expert advice on patents. The Anschütz company had consulted me because a certain American company seemed to make a gyroscope based on an Anschütz patent without paying the required royalties. On the one hand, I had given an opinion in Anschütz’s favor. On the other hand, I had found their gyroscope very primitive and suggested improvements, then invented a vastly superior gadget—a gyrocompass for submarines floating in mid-air with the help of a strong magnetic field. Anschütz sold it all over the world. My dollars went to my secret banker: my dear Ehrenfest.

At least once a year, I gave a lecture in Leyden university and played Mozart sonatas with Ehrenfest. I saw him in September, 1923. Back in Berlin, I was informed by the police that troubles were brewing again and they couldn’t protect me if I stayed in town. So I went back to Leyden. Two days after my arrival, on November 9th, 1923, Adolf Hitler tried to seize power in Munich in what history books call “the beer-hall putsch.” Although this putsch failed, I found the whole thing quite scary. Indeed, the police people told me that Hitler’s henchmen had intended to kill me, as well as several other famous Jews. While I had always thought that German brutality came from

Prussia and that southern provinces were quieter, Hitler had installed his headquarters in Munich, the very city where I had grown up.

Once more, I considered staying in Leyden. Once more, Max Planck sent me a pathetic letter: "Please think of all the people who love you and admire you here. Do not let us suffer because of the abject infamy of a pack of mad dogs whom we'll subdue eventually. You could at least keep your official residence in Berlin and give a lecture now and then." Once more, I went back to Berlin.

* * *

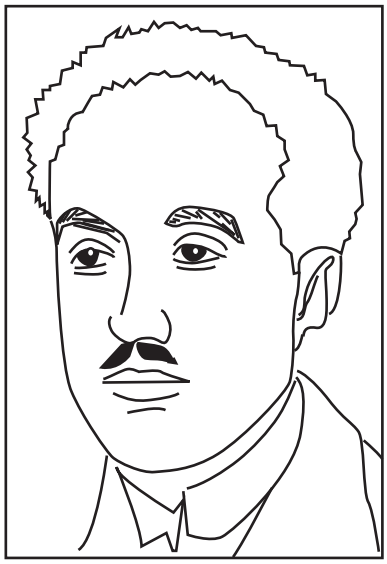
I remained in Berlin until 1933. Hitler spent a few months in jail. The mad dogs stopped barking for a while. Optimists thought they had learned the lesson and would never be heard of again. I don't know whether some lucid pessimists guessed that they were working discreetly on sharpening their fangs. At least they let me alone.

In one of its craziest attacks, the Lenard camp pretended that I had replaced the plain Aryan physical idea of *force*, invented by Newton, by the vicious Jewish notion of *field*. I had indeed replaced the force of gravitation by the gravitational field. Every bit of matter is surrounded by such a field. But where does the matter actually end? Where does the field begin? Is there a difference? Maybe you think that matter is weighty, whereas a field isn't, miss Peggy. Well, let me remind you that mass can be changed into energy, and vice-versa. It would be very satisfying if matter could be shown to be some kind of extremely concentrated field. Then a single unified field theory could describe the whole universe. I have spent more than thirty years looking for that theory.

You may have heard, miss Peggy, that I failed in my quest. There are two theories today. General relativity applies to galaxies and other huge masses that shape the vastness of space. The theory of quanta tells us how tiny particles behave. The two theories refuse to merge. The theory of quanta was my own unruly child, in a way. It went its own way, laughing at its old father.

Maurice de Broglie[26], a French physicist whom I had met at the first Solvay conference, had a younger brother, Louis, who studied medieval history. When he came back to Paris, Maurice told his brother about relativity and about my prediction that we would have to find a way of seeing light as a wave and a weightless particle at the same time. All this fascinated him so much that he dropped history and started studying physics.

[26] This is pronounced something like Broy or Broil.



In 1924, Louis de Broglie wrote his doctoral thesis and gave it to Paul Langevin. He extended my hypothesis to massive particles, for example electrons. Like light, they could act as interfering waves in certain circumstances. This thesis was so remarkable that Paul Langevin sent it to me. "I think he has raised a corner of the big veil," I wrote back to Paul. The Nobel committee gave the prize to Louis de Broglie in 1929. The Nobel prize doesn't often reward a doctoral thesis.

These new "material waves" or "de Broglie waves" fascinated my young colleagues. Erwin Schrödinger, an Austrian physicist, wrote their equation—a very important first step for a new branch of physics that he called "wave mechanics."

Erwin Schrödinger and Max Born

We knew how these waves behaved. We appreciated one of de Broglie's and Schrödinger's magic tricks, which turned "stationary waves" into the preferred orbits of Niels Bohr's atom. There remained a basic question we couldn't answer about these waves: what kind of creature were they? What vibrated or oscillated exactly? My good friend Max Born suggested a strange answer. What oscillates, he said, is the probability that the electron be found at a certain place. The material waves became probability waves. This wild theory went far beyond a mere new branch of physics. It created a whole new kind of science. Wave mechanics were already stale. Max Born gave the new theory a new name: "Quantum mechanics."

Until then, physics had allowed us to make precise predictions. With Newton's mechanics, we could say where a cannonball would fall. The new physics wanted us to weave some luck or randomness into our predictions. Democritus knew it already: "Everything that exists in the Universe is the fruit of chance and necessity," he said.

Max Born and I exchanged letters about his mind-blowing hypothesis. "My dear Einstein, do you remember what you told me about light quanta? That you now saw them as mostly material particles, with a whiff of wave that could be compared to a ghost. After our conversation, I applied your idea of a ghostly wave to the Schrödinger equation and this led me directly to my theory."

Scientists are often more inventive and productive when young. I was forty-seven years old. I had become the grand old man of physics without noticing the passage of time. Max Born—who was only three years younger than me, actually—tried to convince me that I was the father or grandfather of his theory, hoping maybe that I would give it my blessing. I sent him a perplexed answer. "My dear Max, quantum mechanics certainly calls for a great deal of respect. But an inner voice tells me we're not there yet. Although the theory offers a lot, it doesn't bring us much closer to the Old Man's secret. As for myself, I am convinced that he doesn't play dice."

This letter became quite famous, at least in the small world of physics. I seemed to refuse the evolution of science. Niels Bohr gave me some playful advice: "Don't try to tell God what to do, Einstein!"

I had always thought that the purpose of science was to make things clear. Now it was making them fuzzy. A young German physicist, Werner Heisenberg, added a layer of mystery. According to what he called the *uncertainty principle*, we can't know everything about a particle. For example, we can know the exact location of an electron or its exact speed, but not both.

Reality was vanishing like the Cheshire cat under our very eyes. An enigmatic smile floated in mid-air. These young fellows didn't mind giving up the very principle of causality, which says that the same cause always produces the same effect. Do you play billiards, miss Peggy? If you hit the ball under a certain angle and with a certain force, classical physics lets you know you where it will be and how fast it will be going after so many seconds. In quantum physics, you can only say: "There's a sixty percent chance that the ball will be here and a forty percent chance it will be there." Thus, a same cause doesn't produce the same effect every time. Particles (and billiard balls) were turning into elusive ghosts.

I often talked things over with Max Born.

"With your theory, Max, Nature doesn't act in a rational manner anymore. How could I accept that?"

"It acts rationally at our level, but what happens at the atom's level follows other rules. Imagine a huge insurance company. It can compute its profit and losses and next year's budget. If you single out an insured man, though, he lives in complete uncertainty."

"If we knew every parameter of this man's life, we could predict his future. We're unable to predict a particle's future because we haven't found what laws it obeys. We'll find them someday, I'm sure. We'll get rid of probabilities. When we have an explanation so simple that a child understands it, everybody will be relieved. I'm looking for that explanation."

"You still think you can study nature's laws objectively. It is impossible, Albert. Science is subjective. You are not a spectator looking at a theater show, you're an actor belonging in the show. You can't describe reality, but only its interaction with the instruments you observe it with. We'll never get rid of statistics and probabilities. Uncertainty lies at the very heart of matter."

"This is not physics, this is metaphysics! I believe that the world exists objectively and we can know it."

"You started all this with your 1905 article, when you suggested that light was a wave and a particle at the same time."

"It was an idle speculation… I didn't think anybody would take it seriously."

"Your stubborn belief in the universe's objective existence resembles an act of faith. When you said that God didn't play dice, I thought you meant nature. Now I wonder whether you don't actually mean God."

"Whoever studies physics seriously has to conclude that a rational and harmonious mind, vastly superior to ours, manifests itself in the laws of the universe. What's

obvious, of course, is that this superior mind doesn't care about our miserable lives and doesn't look over our shoulders to check our every action. In other words, morals may play a primary role in our life, but it has nothing to do with God."

* * *

I knew how to dispel all this quantum nonsense: I just had to hatch a good unified field theory. Well, I wasn't hatching anything. I guess I didn't work as much, or as intensely, as when I was twenty years old. A large proportion of my time was taken with other activities. This was convenient, in a way, as it gave me an excuse for my failure.

I received as much mail and as many visitors as a government minister. The whole world knew Einstein's address: 5, Haberlandstrasse in Berlin. Elsa helped me turn away unwanted visitors. Her daughter, Ilse, took care of reading and throwing away the mail. I was becoming another Rothschild. Not only a character in Jewish jokes, like him, but also a target for *shnorrer*. One of them asked me to finance an archeological expedition in Africa, another needed my money to develop a marvelous invention that would change the world. I received more plans for absurd inventions than when I worked as a patent clerk: a new flying machine, an automatic pickax for extracting coal, a bed so restful that you could sleep two hours per night and be perfectly healthy. Young ladies sent me marriage propositions. I was offered a fortune for declaring I used a certain shaving lotion. Adepts of spiritualism begged me to come and turn tables with them, because the theory of relativity obviously confirmed their ravings. I had shown that the world wasn't what it seemed to be, so it could contain ectoplasms and poltergeists, couldn't it?

Since I wasn't as rich as Rothschild, I didn't give my lose change to the crazy inventors, but I always tried to help students who knocked on my door. Leopold Infeld, who became my assistant in Princeton in 1936, told me he had seen me in Berlin twelve years earlier.

"Mrs. Einstein gave me a very friendly welcome. I was arriving from Cracow, where I had been a student. I waited for you in a room full of furniture and trinkets."

"There was too much stuff. I told Elsa, but she hated to throw things away."

"You were talking with the education minister of China."

"That's possible. They came to me from everywhere. China, India, Argentina. They invited me to their countries. I did go to Argentina, actually."

"I felt somewhat flustered. You walked the Chinese minister to the door, then you let me enter your office. You wore an old dressing gown."

"Elsa wanted me to put on a suit when I received visitors. Women don't know how to keep things simple."

"I told you I couldn't go on studying in Cracow, because of growing antisemitism. You said there were antisemites in Berlin too. You wanted to help me by writing a letter of recommendation to Max Planck, but you couldn't find a blank sheet of paper—although there was a mountain of paper on your desk. I laughed and you laughed. The memory of your warm laugh often comforted me when life turned sour."

* * *

I didn't spend all my days at home gabbing with visitors. I went out to attend the Academy's sessions and to take care of the Kaiser Wilhelm Institute for Physics. Every Thursday afternoon, I went to the university, where advanced graduate students were giving lectures. I liked to listen, they liked me to comment or criticize. Max von Laue supervised another kind of advanced class, where university professors described new discoveries to physicists who worked in industry and could create useful inventions. There I used to meet Max Planck, Walther Nernst, Fritz Haber, Lise Meitner and others.

I sailed on the lakes around Berlin. I played music and listened to concerts. I became friends with the violinist Fritz Kreisler and the pianist Arthur Schnabel. I often visited Ehrenfest in Holland. Until 1928, I also called on Lorentz, but my dear old mentor died that year.

I knew no greater pleasure than spending a week or two with the Ehrenfest. Tatiana was a wonderful hostess. I could stay in bed as long as I wanted, eat bread and aged Gouda cheese at any time of the day, go everywhere barefoot. I loved to swim in the sea with the Ehrenfest children, play some music with Paul, talk about physics and other subjects while smoking a pipe in the warm light of the setting sun. One of the living-room walls doubled as a visitors' book: all the guests signed their names on it. This was an old Russian custom, Tatiana said. My signature could be seen right in the middle of the wall, as it was one of the earliest ones.

One day, Paul woke me up as I was napping after lunch.

"Albert, Albert, the queen just called on the phone!"

"The queen? What queen?"

"Wilhelmina, the queen of Holland. She's in Leyden with her husband and the queen mother. She's inviting us to a party tonight."

"Party? All right. Now I think I'll sleep a little more."

"Hmm. There's no formal dress in your tiny bag, obviously."

"Even in Berlin I don't own a formal dress. When I need one, I rent it."

"I don't think we can rent one in Leyden. I'll ask Tatiana what to do."

Tatiana phoned to all the teachers in the university, except the dwarves and the giants. She found a tail coat to my size, more or less. When we came to the party, she burst out laughing.

"Why are you laughing, Tatiana? What's so funny?"

"Albert, you've forgotten to put on your socks."

"You know I never wear any. I hope the queen will forgive me."

The queen just shook my hand. I thought I was free to drink some champagne in a corner with Paul and Tatiana, but a shrill voice called us.

"Hey, you scientists, come here right away! You can shake hands with an old lady, too. Don't you try to escape!"

It was the queen mother. She was sweet and didn't even ask me to explain relativity.

* * *

As I had accepted to go to Argentina, I spent the beginning or 1925 at sea and in South America. I discovered a magnificent continent, a true Eden—but I should never have gone there, miss Peggy. I wasted months explaining relativity yet again in dozens of cities and universities, as well as soliciting rich Jews like a *shnorrer* for the Hebrew University of Jerusalem. I was so tired when I came back that I canceled another trip, planned for the end of the year, which might have changed my life. Robert Millikan, a physicist who had proved very cleverly that light was indeed made of particles, and Edwin Hubble, the great astronomer, had assembled a first-rate team in the Caltech university, located in Pasadena. They invited me to join them.

I now think that if I had gone to Pasadena in 1925, I would have settled in California. Most of the scientists in Caltech worked on relativity. I did meet them in 1930. It was too late. By then, I was stuck in my hopeless search for the unified field and unable to steer my life onto the right path. Fate smiled at me when I was young, then laughed at me.

In Germany, only Freundlich still cared about relativity. He had never overcome his resentment over the failed mission in Crimea. Being a stubborn man, he went to the South Pacific to look at an eclipse of the sun. He photographed many more stars than Eddington and removed any lingering doubt about the deviation of light rays by the sun.

He built a new observatory in the Potsdam university campus. The telescope was on top of a sixty-foot tower, which everybody called "the Einstein tower." The architect, Erich Mendelsohn, had relied on the properties of concrete to design a very modern shape. The students joked that its rounded geometry was non-euclidian. Many tourists came to look at it. My enemies blamed me for this tower, as if I had conceived it myself.

Its "Jewish" shape, they said, offended German good taste and proved I wanted to destroy ancient German traditions. While I was certainly willing to discard some of the ancient German traditions, I didn't like "my" tower at all. I have always been fond of classical architecture and art, miss Peggy. Freundlich and Mendelsohn had never consulted me about the tower, anyway.

* * *

I went to Kiel in the summer to sail—and improve my gyrocompass. I also took patents on a silent refrigerator I perfected with a young Hungarian physicist, Leo Szilard. He had called on me to ask my opinion about some clever relativity ideas and we had become friends. He was a short chubby fellow who wore wrinkled clothes and kept losing his comb, so that most of the time his hair looked even wilder than mine. I had been shocked when an entire family had died because the gas of their refrigerator had escaped. We replaced the gas by liquid sodium, which we moved around with an electromagnetic system. The AEG company bought our patents, but didn't go ahead with our fridge. Sodium is as dangerous as gas, actually. Besides, other people invented refrigerators that used non-toxic gases[27].

* * *

My trip to Argentina had really exhausted me. In 1927, I felt a sharp pain on the left side when I rowed to bring the boat back on a windless day. I didn't have time to see a doctor, as I went to Belgium right away to attend the Solvay conference for the first time since the war. We were to talk about quantum mechanics, the only topic that interested the physicists just then. We all stayed in the same hotel. I ate breakfast with Niels Bohr and the young fellows: Wolfgang Pauli, Werner Heisenberg, Paul Dirac.

I have told you about Bohr and Heisenberg already, miss Peggy. Pauli followed my footsteps: he was born in Germany but taught in Zurich's Polytechnikum. He was a strange man. You never knew what he thought. He had discovered how electrons divide up the space around the atom's nucleus. Two electrons with the same characteristics, including a new quality called "spin," can't be in the same location. This "Pauli exclusion principle" explains why different atoms, like carbon and iron, are, well, different; how they interact in chemical reactions to make water, salt and big foolish creatures like you and me; and also, why they can't go through each other although they are mostly made of empty space.

Paul Dirac was English. He had written a beautiful "relativistic" equation for high energy electrons. He was amazed when he found two solutions for his equation. One

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[27] Einstein and Szilard's system is still being considered now and then to cool nuclear reactors.

was our good old electron, which carries a negative electric charge. The other one was a positive electron. Nobody believed this could exist. One year after Dirac first mentioned it, though, someone found it in cosmic rays coming from deep space and named it "positron." It was the first example of what we call "anti-matter."

Pauli and Dirac

Lorentz chaired the conference. He was seventy-four years old. This was one year before his death. He asked me to open the proceedings.

"Please give us the latest news about quantum physics, professor Einstein."

"I'm sorry, Herr Professor. I do not feel competent enough. I had no part in the most recent discoveries. There are two reasons: the first is that things move too fast for me; the second is that I do not approve of the purely statistical interpretation upon which these new theories are based."

My colleagues seemed rather disappointed. As I had played a decisive part in the birth of the quantum hypothesis, they expected me to contribute to the current research. Well, there was no way I could accept some of the wilder lectures. For example, they discussed the famous 19th century experiment by Young—he sent light through two slits and obtained interferences, which proved that light was a wave. In quantum mechanics, light is made of particles called photons. How do you explain the interferences? Heisenberg and the others pretended that a single photon or electron will "spread" and go through both slits, then interfere with itself—but only if nobody is

around. The bashful creature stops doing it as soon as you observe it. This defies common sense, obviously.

I kept silent during the lectures, but I couldn't help bantering and joking with my young friends during the dinner. My jolly mood and a glass of wine or two heated my brain or something. Suddenly, I saw a clear objection to the uncertainty principle or some other pillar of the quantum theory. All the young physicists had been Bohr's students in Copenhagen. While they listened politely to my objection, Bohr stopped eating his chocolate mousse and frowned. Ehrenfest told me he knocked on his door at one in the morning. "Just a word, Paul…" He stayed two hours. He came to breakfast with red eyes above dark shadows. He pulled his notebook from his pocket.

"Listen, Albert…"

He refuted my objection. I improvised new comments. During the morning lecture, the young Turks exchanged messages on bits of paper, then sent me notebook pages covered with graphs and equations. Even though I considered that quantum theory didn't fully describe reality, I had to admit that it worked. Often my objections had a philosophical flavor.

"Even when we use the most abstract mathematical tools, we want to describe the real world. A good theory should let us predict what happens in this real world."

"At the atom's level, there is no objective reality," Heisenberg answered. "We can't observe the atom with our senses. We must accept to limit our knowledge to a series of equations, a kind of mathematical map, without expecting to nail down any 'real' world."

Paul Ehrenfest was sad to see me standing on the shore and refusing to sail along on the stream of science.

"What a topsy-turvy situation, Albert! You're opposing the quantum theory exactly in the same manner your enemies were rejecting the theory of relativity."

Maybe he was right. Heisenberg told me a story about the theory of relativity.

"I attended one of your lectures in Leipzig in 1922. When I entered the hall, a Lenard follower gave me a leaflet saying that your theory was a hodge-podge of silly speculations, that it would have petered out long ago if Jewish newspapers hadn't chosen to use it as a battering ram against German genius. I barely knew your theory, but I thought it was probably right. Otherwise, Lenard wouldn't have used irrational arguments against it. He would have built a plain scientific refutation."

Although I disagreed with these young scientists, I admired them. As a former Nobel laureate, I was allowed to recommend candidates for the prize. I recommended Louis de Broglie, then Werner Heisenberg and Erwin Schrödinger[28].

* * *

In March, 1928, I spent a few weeks in Zuos, a Swiss mountain resort. I was supposed to rest, but I couldn't say no when some people suggested I give a lecture and play the violin for students of a new Davos school. The poor kids were residing in the Alps because they suffered from tuberculosis. Then I accepted a generous amount of money to give my opinion about a patent in a Leipzig court. On the way back, I took a train from Leipzig to Stuttgart, then another train from Stuttgart to Zurich, then a bus from Zurich to Zuos. In the end, I started climbing a steep snowy path to reach my chalet. I was carrying a heavy suitcase, because I had bought some books in Leipzig. All of a sudden, my legs gave up. "This is as far as we'll go," they said. I just couldn't move anymore. I felt life ebbing from my body. "So this is it," I thought. Well, it wasn't. Dr. Zangger came from Zurich in the morning. You remember he was a friend who acted as my official representative (together with Michele Besso) in my relationship with Mileva and the boys. "He took great care of my corpse," I wrote to Michele. "I was close to croaking, which of course one can't put off forever." Zangger called a ambulance and reserved a special medical berth in a sleeping-car so I could be carried safely to Berlin.

There I called Dr. Plesch, who diagnosed a pericarditis[29]. I knew two famous doctors in Berlin: Dr. Ehrmann had treated my ulcer, Dr. Katzenstein was my sailing partner. They criticized my choice.

"How can you trust this Plesch with your health? He knows nothing."

"No doctor knows anything, as the human body is much too complex a system for our limited mind. Dr. Plesch gives wonderful dinners, where I've met all kinds of fascinating people."

"Precisely. He is more interested in society life than in medicine. I've heard that he rented the opera for a costume ball."

"He prescribed rest and a salt free diet. This can't hurt. He said I didn't exercise enough. I told him I played the violin. He said I should switch to the drums and the trumpet. So you see he is quite a good doctor after all."

I stayed three months in bed. Elsa went to Lübeck and rented a small house so I could regain some strength by walking on the beach and breathing the invigorating

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[28] De Broglie received the prize in 1929, Heisenberg and Schrödinger in 1933.
[29] Inflammation of the pericardium, a membrane enclosing the heart.

Baltic sea air. Elsa was active in a foundation that helped Jewish orphans. She asked the foundation's secretary, Rosa Dukas, whether she knew of a colleague who would take care of my mail and telephone calls while we were away. Rosa suggested Helen, her sister. Thus, a very shy young woman came to our home a few days before we left. I was lying in my bed, reading a book. She entered my bedroom. I could see she felt rather uneasy, so I stretched my hand and joked.

"Here lies an old corpse, miss."

She laughed. She was so pleasant and efficient that she is still my secretary today.

I have fond memories of the months I spent on the Baltic sea. I found that I didn't miss the Berlin pandemonium, the lectures, the visitors, the dinners in town. Sitting in a comfortable deck-chair, I admired the birds' perfect flight, the waves' unceasing jitterbug, the clouds' vain endeavors to hide the sun. I felt that contemplating nature would help me understand it better.

* * *

From my deck-chair, I canceled a trip to Geneva, where I was supposed to attend a meeting of the *International Committee for Intellectual Cooperation*. I used to go there every year in July. I loved to meet Marie Curie, Lorentz and other friends who belonged to the Committee. We tried to help scientists in various countries overcome political and economic hurdles. Besides, I belonged to a group trying to set up an international meteorological office.

In 1928, I was still a true pacifist. I thought the Committee could help ensure a better understanding between nations. All we had to do was improve education and schooling all over the world. I believed we could remove nationalism from school programs. I was very naive, miss Peggy

At that time, to a journalist who interviewed me, I said: "If a new war breaks out, whatever its cause, I'll refuse to participate, even in an indirect manner, and I'll try to convince my friends to take the same stand." Later, I changed my mind.

The Committee didn't do much anyway. Neither did the League of Nations. It spurned Germany until 1926. Your great country never joined it, miss Peggy.

Giving up another responsibility, I resigned from the board of the Hebrew University. I had attended a board meeting in Munich. Chaim Weizmann was chairman. An American Jew, Judah Magnes, headed the university in Jerusalem. Chemistry and biology institutes had been built already. Magnes had no academic experience. He was very bossy and took stupid decisions, but he escaped our control because the rich American Jews who financed the university supported him. I had

thought we were trying to create the best university in the world. The American Jews just wanted to gain prestige by sending their idle sons as teachers there.

In 1929, when I felt better at last, I went to an international Zionist congress in Zurich. I saw Mileva and my sons. Hansi was a student in the Polytechnikum, Eduard in medical school. My relations with the Zionists were ambivalent. I found them too nationalistic. I suspected they wanted to evict the Arabs from Palestine. As they received plenty of money from America, they could buy land and exploit the Arab peasants. When the Arabs protested or revolted, they treated them harshly instead of trying to understand them. Yes, but Hitler had left jail long ago and his Nazi party was becoming stronger and nastier. Zionism was necessary. It seemed that German Jews might need a shelter pretty soon.

* * *

During my long stay by the sea, I designed a new geometry, halfway between Euclid's and Riemann's. I believed I had found a path leading to my grail—the unified field. "Not only do I feel much better," I wrote to Dr. Zangger, "but I am blessing my illness, which gave me time to lay a wonderful egg in the area of general relativity. Whether the bird hatching from it will be healthy is still in the lap of the gods."

Elsa wrote to one of her friends in Berlin: "My husband is very happy. He solved the problem which he had been working on for years. Now he has realized his life's dream." The news reached *The New York Times* somehow. EINSTEIN ON VERGE OF GREAT DISCOVERY, the headline said.

I came back home at the end of 1928. As I was still too weak to speak on front of the Academy, Max Planck presented my theory in January, 1929. The journalists couldn't understand my equations, but this didn't prevent them from honoring me with the front page: EINSTEIN SOLVES RIDDLE OF UNIVERSE! I was foolish enough to give an interview to an English journalist and brag: "Now, but only now, we know that the same force moves electrons around the nuclei of atoms, moves the Earth in its annual course around the Sun, and brings to us the light and heat which makes life possible on this planet." This was quite premature. We still don't know, miss Peggy.

My colleagues were wondering whether I had lost my mind. Heisenberg, Dirac and Pauli were famous for their harsh tongues, but Pauli was the best (or the worst) by far. He shouted *Falsch* in a unique way when somebody said something false. When a student gave a worthless answer to a question, he crushed him by saying: "This is not even false!" He sent me a virulent letter: "Should I congratulate you or express my condolences? You're giving up your own interpretation of the deflection of light by the Sun and the precession of Mercury's perihelion. Are you trying to demolish the general

theory of relativity? Allow me to stick to that fine theory, even if you're betraying it. I bet that within a year, if not before, you'll give up your new geometry." He lost his bet: it took me two years to throw my failed attempt into the waste basket. I joked when I met him in 1932. "So you were right after all, you rascal!"

I changed the equations, I tried a fifth dimension[30], I worked for twenty years without reaching my grail.

* * *

Even for Einstein, time refused to slow down. On March 14, 1929, I reached the ripe old age of fifty. I received telegrams and gifts from at least three continents. The Sorbonne gave me an honorary degree, the Zionists planted an "Einstein grove" near Jerusalem. A German peasant sent me a pouch of tobacco with a note: "The amount is *relatively* small, but I gathered it myself in a good *field*."

I wasn't allowed to smoke more than one pipe a day, because of my frail heart.

"Smoking again?" Elsa would ask.

"It's the first one."

"I've seen you smoke another one this morning."

"All right, the second one."

"At least the fourth."

"Are you pretending to know mathematics better than I do?"

To escape the onslaught of journalists and photographers, I took refuge in Dr. Plesch's country house—or rather, palace. What with giving dinners and balls, he knew all the right people in Berlin, so he convinced City Hall to offer me the grandest gift: a house on one of the lakes so I could sail my own boat. When he came back from his first visit to City Hall, he said: "I had to explain to the mayor who you were. He has never heard of you." This was a bad omen, actually. People told the mayor who I was and City Hall found a small residence on the Havel river. It belonged to a large estate, with a castle and several outbuildings, which the City had purchased recently.

The newspapers published photographs of "Einstein's house." An orchard was blooming next to it, so it looked quite inviting. Elsa went to the Havel to check whether there was any work to be done before we could move in. When she came back, I saw a mischievous light in her eyes. She laughed.

"Well, what about the house?" I asked her. "What happens? Is it rotten? What's so funny?"

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[30] He explored an idea put forward by two young physicists. Extra dimensions are back in vogue today, as part of "superstring" theories.

"The house looks even better than in the pictures. The photographer forgot to show the tenants, that's all."

"Tenants?"

"Unpleasant people, too. The former owners of the castle. Told me I had no business there. When they sold the castle, they retained a ten-year lease on the residence."

City Hall apologized for the mistake. The newspapers joked about incompetent employees. City Hall found a piece of land near a lake. There was no tenant because there was no house. City Hall supposed I was rich enough to build my own villa. I wanted no villa. A man who doesn't wear any socks will sleep in a wooden shack. Let's say a big shack, because Elsa wanted a kitchen and a bathroom. Now, some other unpleasant people appeared on the scene: neighbors. It seemed that no building was allowed on the land, as it would have spoiled their view of the lake. We could buy a tent and camp on our land.

The adventure was funny at first, but we were not laughing anymore. City Hall found a piece of land that was quite far from the water, but close to a busy and noisy tram terminal. In the end, City Hall suggested I find the land myself. Some people who read about all this in the paper sent us pictures of a perfect plot, one third of an acre between a wood and a lake in the village of Caputh, near Potsdam. They were willing to sell it for 20,000 marks. I fell in love with the place right away. A young architect whom someone had recommended drew plans for a simple wooden house in the modern Bauhaus[31] style.

Now City Hall had to find the money to buy the land. This wasn't as easy as donating a City property. The City Council had to decide—and vote—whether to withdraw 20,000 marks from the land acquisition funds (or something) "to honor Prof. Einstein on the occasion of his fiftieth birthday." I was told that the nationalist and nazi councilors asked whether I really deserved such a gift. After a fiery debate, the decision was postponed until the next session of the Council.

Well-informed friends told me that the bureaucrats who had chosen a leased residence, then a land that couldn't be built upon, and so on, knew what they were doing from the beginning. They were neither incompetent nor stupid, just nazi already.

I wrote to the mayor: "My dear Mr. Mayor, I thank you for the friendly intentions of the City Council. Human life is short, however, while the authorities work very slowly. Now my birthday is already past and I decline the gift."

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[31] Architecture school founded in 1919 in Weimar. It influenced most of the great architects of the 20th century.

I bought the Caputh plot with my savings. The young architect built the house. He insisted on installing the epitome of modern luxury: central heating and taps with hot water. My friends, who were more generous than City Hall, offered me a magnificent boat, with mahogany fittings and even a toilet—the *Tümmler* or Porpoise. We enjoyed our house and boat so much that we settled in Caputh and seldom returned to the hustle and bustle of the city. In a way, I owed my happiness to those stupid city councilors and employees. Without them, I would never have thought of building a house by a lake.

Elsa and I both had our own bedroom. Mine was also my office. There was a bedroom for our maid and two more for guests. Our country house lacked a telephone line, which protected us against unwanted guests. Elsa's daughters came often. My sons also came, and even my sister Maja.

The great Indian poet and mystic Rabindranath Tagore, who was visiting Europe, wanted to meet me. He stayed a few days, and needed the two guest rooms, because two assistants or secretaries were following him everywhere. They wrote everything he said, so that a magazine published a conversation we had at night, walking on the shore of the lake—although I don't know how the secretaries could write in the dark and I'm not sure I said exactly what was published. I was looking at the sky, which resembled a black silk curtain embroidered with silver stars.

"We know nothing, Mr. Tagore. We're still in kindergarten."

"Do you think we'll know more someday? Shall we ever probe the secret?"

"Maybe we'll know a little more than we do. But the real nature of things, that we shall never know. Never."

"What we don't know, does it actually exist? I think that truth and beauty, for example, do not exist outside our conscience of them."

"I agree as far as beauty is concerned, but I do believe in truth. This means I am more religious than you are! I believe that the Pythagorean theorem states something that is true, more or less, and would remain so even if man ceased to exist."

As I was supposed to know more about the universe than most people, I received all kinds of inquiries concerning my good friend, the creator of the whole shebang. A New York rabbi wrote to me that a Boston cardinal had attacked the theory of relativity: "It befogs speculation, producing universal doubt about God and his Creation, cloaking the ghastly apparition of atheism." In order to answer the cardinal, the rabbi asked me a simple question: "Do you believe in God?" I sent him the following telegram: "I

believe in Spinoza's God[32], who reveals himself in the orderly harmony of what exists, not in a God who concerns himself with fates and actions of human beings."

I spent hours sweating on my equations, then I spent hours sailing on the lake. The water rippled in the wind and changed color as it reflected the clouds. I has passed the age for discovering new things and reached the age for meditating.

* * *

Miss Peggy, I'm sure you noticed that Elsa and I were not sleeping in the same room. After a few years of intimacy, we had become friends rather than lovers. The institution of marriage pretends to change a flash of passion into a lasting fire, but this can't be. Being a famous and admired person, I attracted women in spite of myself. Toni Mendel, a very rich, handsome and merry widow, tried to seduce me. I was too weak to resist her. Let me amend a sentence I wrote above: I had passed the age for working day and night and reached the age for having some fun! Also, it happened that her lakeshore country estate was close enough for me to just sail there. Quite convenient. Later, I sailed with Estella K., then with Margarete L. I considered I was just following the laws of nature. What could Elsa do, except shrug and bear it? She hated Margarete, I must say, because she was very young, blond and pretty—what Jews call a *shiksa*.

* * *

In May, 1929, I went to Leyden to give my annual lecture in the university and see the dear Ehrenfest family. As Holland is close to Belgium, I spent a few days in Antwerp with my uncle Caesar Koch—my mother's brother. Queen Elizabeth of Belgium, having heard I was visiting her country, invited me to the royal palace near Brussels. When I got out of the Brussels railway station, the royal chauffeur didn't recognize me. I didn't look like his idea of a famous professor, I guess. I entered a café and asked whether I could use their phone. I talked to the operator in my best French.

"Hallo, mamoiselle? I want to queen Elizabeth speak!"

The people in the café gawked at this tramp, carrying a small bag and a violin case, who pretended to speak to their queen.

Elizabeth was a Bavarian princess. She had grown up in Munich at the same time as I, more or less, and played the violin too. We had both rejected our Bavarian roots. I had given up my German nationality when I was fifteen. The queen had firmly taken her adoptive country's side during the war, which had made her immensely popular.

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[32] Spinoza was a Jewish philosopher who lived in Holland in the 17th century. He rejected a personal God but believed that there is something divine in Nature and the mystery of existence. The rabbis, who found his ideas sacrilegious, excluded him from the Jewish community.

We played Bach's double violin concerto, then drank some tea in the garden while I tried to explain relativity. I stayed for dinner. We ate spinach and eggs. The queen was vegetarian and liked simple things. There were no servants, actually, so we helped ourselves. King Albert was away on some official trip. Back in Berlin, I received photographs that a courtier had taken when we played the concerto, with a letter from the king saying how sorry he was that he hadn't enjoyed the pleasure of meeting me. The queen had added a sentence: "I'll never forget that you came down from your peak of knowledge and gave me a tiny glimpse into your ingenious theory."

As long as I lived in Europe, that is, during the next four years, I always played some violin with the queen after my annual lecture in Leyden. Afterward, I wrote to her regularly. But I never sent her a letter as long as this one, miss Peggy!

* * *

While we were trying to understand tiny invisible particles and wondering whether God played dice with them, astronomers were changing our ideas about the vastness of his creation. Looking through the new giant telescope of Mount Wilson, in California, Edwin Hubble discovered that the milky way wasn't the whole universe, as was believed, but a small provincial bunch of stars. When he examined white stains that had been considered clouds of gas until then, he found other galaxies[33] everywhere. Some were located at a great distance. Studying the color of a star's light lets us know whether it is coming toward us or moving away. Hubble observed that all the galaxies were moving away from the Milky Way. The farther they are, the faster they recede. This confirmed Alexander Friedmann's expanding universe hypothesis. Do you remember my analogy, miss Peggy? The universe can be compared to an Earth painted on a balloon. If you inflate the balloon, all the cities move away from each other.

Abbé Lemaître, a young Belgian priest who was studying astronomy in Boston (not the first astronomer wearing a cassock: think of Copernic), applied plain common sense to this expanding universe. Tomorrow, it will be larger than today. This means that yesterday, it was smaller. Last week, smaller yet. Abbé Lemaître went backward in time and saw the universe shrink and shrink in his mind's eye until it was no bigger than a "primeval atom" or "cosmic egg"—containing enough energy, however, to expand into the gigantic universe we know. I find it rather ironic that a priest should discover a physical explanation of the world's creation or, if you prefer, genesis. Later, my friend George Gamow described the actual physical reactions that may have happened at the beginning of everything. His colleague Fred Hoyle, by way of joking about Gamow's hypothesis (which competed with his own), called it the *Big Bang*.

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[33] This word means "milky way" in Latin.

Now that the universe was officially expanding, I didn't need my cosmological constant anymore. I was glad to discard what I considered one of my biggest mistakes[34].

* * *

The chairman of Caltech's board called on me in Berlin. Robert Millikan, Edwin Hubble and Richard Tolman (a teacher of mathematical physics who had just evaluated the size of the universe) invited me to come and talk shop. A businessman was offering to finance my trip, a two-month stay and a good salary.

I accepted immediately. While I was sloshing in the swamp of my research, the teams in Pasadena and Mount Wilson were rushing ahead. If I had been more lucid, I would also have understood that my stay in Berlin was coming to an end. The nazi influence was spreading like a plague, but I didn't pay attention. Not yet.

America was looking forward to my new visit. People over there didn't consider me an expert about tensorial equations or patents, but about religion. The New York Times had published my answer to the rabbi who wanted to know if I believed in God, then my conversation with Rabindranath Tagore. Now they asked me to write an article about *Science and Religion*. I distinguished three stages of religious development. At first, among primitive people, a religion of fear. Later, a moral religion. Among the most advanced contemporary men, a cosmic religious sense that needs neither dogmas nor a God made in man's image. This feeling of cosmic harmony, of the miraculous order that manifests itself in nature, is the strongest and noblest mainspring of scientific research, so that the only deeply religious people in our materialistic age are the earnest men of research. We do not try to communicate with a God we know nothing about, but spend our life studying his creation, amazed by what we observe and discover.

I had simply and honestly expressed my beliefs. Several progressive rabbis approved me, but some New York Times readers protested because their newspaper had published a text they considered subversive, anti-religious and thus anti-American.

I fulfilled some European obligations before crossing the ocean. I attended the 1930 Solvay conference (where I was confident I had at last refuted quantum mechanics, until Bohr refuted my refutation, as usual), I played some music with queen Elizabeth of Belgium (and met her husband, Albert), then went to Zurich because the Polytechnikum insisted on giving me a honorary doctorate.

Hansi didn't live at home any more. He had married a woman nine years his elder—without my blessing, I must say. I was conscious I mimicked my mother's intolerance

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[34] Einstein's cosmological constant is back in. It is needed to explain the universe's "inflation," or accelerated expansion.

of Mileva. But she was right, in a way, wasn't she? I learned I had just become a grandfather. The baby's name was Bernhard Caesar Einstein.

Eduard still studied medicine. He played the piano tolerably well and wrote tolerably good poems, but his mood tended to swing wildly. Dr. Zangger said there was nothing to worry about. His tone wasn't fully convincing, so I didn't believe him. Mileva was quite moody, of course. One of her sisters was crazy enough to be locked up somewhere.

On December 2nd, 1930, we boarded the *Belgenland* in Antwerp. This liner went all the way to California across the Panama canal. To the usual crowd of journalists, I addressed these parting words:

"Why don't you leave me alone, for a change? The world would certainly fare better if newspapers cared for thing that really matter instead of delving into people's private affairs and dealing with trifles. I hope you are not going to call me up in the middle of the ocean and ask me how I slept the night before."

The businessman's pockets were so deep that I traveled in a three-room apartment in first class. A steward stood near the door to answer my every beck and call. This excessive luxury and attention made me uncomfortable, but I did find the three rooms convenient. I worked every day with Walther Mayer, my assistant, a splendid mathematician—who certainly deserved a professorship, but didn't get it because he was a Jew. He grinded the equations while I took care of the deep thinking. I left my princely staterooms as seldom as possible, as all the passengers wanted to photograph me and get autographs.

I resumed my habit of keeping a diary on my trips. "Hate that dining-room," I wrote. "Feel odd with my peasant manners. Dressed negligently, even for the holy sacrament of dinner." Coming near New York: "Countless telegrams. The ship's radio operators must be sweating because of me. Wish I could stay aboard in New York. Hide in the purser's safe? The journalists would come and photograph the safe." In New York: "Worse than my most fantastic expectations. Well before we entered the harbor, when the pilot boarded the ship, swarms of reporters jumped aboard like pirates, as well as the German consul with his fat assistant. Photographers pounced on me like hungry wolves. The reporters asked amazingly stupid questions, to which I replied with cheap jokes. Had to define the fourth dimension in one word and relativity in one sentence. They seemed to love it."

In recent elections, six million people had voted for Hitler's party. The number of nazis in parliament had jumped from twelve to one hundred and seven. The journalists asked me about Hitler.

"I do not know Mr. Hitler personally. He's prospering on the empty stomach of Germany. As soon as economic conditions will improve, he will cease to count."

"Professor Einstein, professor Einstein! Is there a relationship between science and metaphysics?"

"Science itself is metaphysics!"

"Can religion bring peace to the world?"

"It hasn't so far. As for the future, I am no prophet. I believe your great country, my friends, with its wealth and power, could indeed destroy the dreadful tradition of military violence."

We stayed five days in New York. We went ashore every morning. The mayor and the president of Columbia university gave me the keys of the city, which made me an honorary New Yorker. I went to Riverside Church, near the Hudson river. I had been told I was represented on a stained-glass window, next to Socrates, Kant, Beethoven and other great men of the age.

"Am I the only living man in the series?" I asked the pastor.

"This is right, professor Einstein."

"Then I must be careful about what I say and do."

I gave a Zionist speech at the Madison Square Garden and a pacifist speech at the Ritz-Carlton hotel.

"Under the present system, any person can be compelled to commit murder in the name of his country. We must oppose military service. If only two percent of those called up declare that they will not serve and demand that international conflicts be settled in a peaceful manner, governments would be powerless."

Newspapers published this speech all over the world. I was told that many young Americans, in the streets and on university campuses, were wearing buttons with the words "Two percent." Everybody knew what it meant.

We stopped briefly in Cuba. From my diary: "Luxurious restaurants and clubs side by side with abject poverty, mainly affecting the colored people."

While the Suez canal was flat and rather boring, the Panama canal went over mountains by using locks as stairs. The captain showed us that, due to the twisted shape of the Panama isthmus, the sun rises on the Pacific ocean and sets on the Atlantic.

It seems the two oceans have different levels. Nobody knows why. We know as little about the Earth's geology, the oceanic currents, the submarine volcanoes, as about the birth of the stars. Scientists will be busy for centuries, I'm sure.

We reached San Diego on December 30th. A huge crowd was waiting for us. The city had prepared what you call a "parade," with brass bands and flower "floats" and

mermaids. Short-skirted girls were throwing canes into the air. I thought it was some kind of symbolic demonstration of gravitation, but I was told it was just for fun. The whole crazy feast lasted four hours.

"These Americans are like children," Elsa remarked.

"I have heard the Barnum circus has such a parade. I'm sure it is more amusing to see an elephant or a giraffe than an old scientist."

We settled in what I called "our gingerbread cottage" neat the Caltech campus in Pasadena. From my diary: "Here in Pasadena it is like Paradise. Always sunshine and clear air, gardens with palms and pepper trees. What strikes you at first is the superior technics and organization in this country. Objects of everyday use are stronger and more convenient than in Europe. The second thing that you notice is the joyful and positive attitude of the people, which can be seen by the way they smile in photographs. They are friendly, confident, optimistic."

We were not so far from Hollywood, so we visited the studios. I asked to meet Charlie Chaplin and we enjoyed the privilege of dining with him—although I didn't understand what he said and didn't know whether I could trust Elsa's translation. He invited us to the premiere of his latest film, *City Lights*. While the movies had been talking for more than a year, it was still silent. I cried when the girl recognized the tramp at the end, like all the other spectators.

The crowd in front of the movie theater applauded when we appeared. Charlie Chaplin said something to me, which Helen Dukas, who spoke better English than Elsa, translated:

"They're applauding me because they all understand me. They're applauding you because nobody understands you."

It is often said that comic actors are sad men. Charlie Chaplin wasn't as funny as his little tramp, but he was full of life and a pleasant companion. He did express some bitterness at the replacement of silent movies, which showcased his pantomime skill, by the talkies. Although he was ten years younger than me, he shared my feeling that our productive years were past. He was mistaken—he was still to make several wonderful films.

He had read the article I had written for the New York Times.

"I bet you didn't intend to shock the Americans, but you certainly did. Your ideas are too bold for them. Now they consider you a dangerous communist. Like me, my dear fellow! Just wait until you know them as well as I do. You'll discover they are sanctimonious and insidious bigots."

I was trying to go along without an interpreter, so I didn't understand everything he said. Besides, I had forgotten he was English, so I wondered why he criticized the Americans as if they were foreigners.

* * *

Edwin Hubble and his colleagues showed me reports of observations made with the giant telescope. It was obvious that Friedmann and Abbé Lemaître were right. The universe was expanding!

"I figure there are at least thirty million galaxies bigger than our Milky Way," Hubble said. "The remotest are moving away very fast—close to the speed of light."

The renewal of cosmology attracted many young astronomers, who built all their research on general relativity. They tried to answer very tough questions: How old is the universe? Will it go on expanding forever, or will it reverse its course and shrink to the size of an atom?

Professor Tolman drove us to mount Wilson, a few miles away, where the giant telescope was located. Hubble let me look through the eyepiece. Many more stars became visible than with the naked eye—billions and billions of stars whose light keeps flowing in all the directions. I couldn't imagine a remote corner of the universe where you didn't see all these stars. There are certainly large tracts of space without any matter, but not one millimeter without light. Everywhere, energy and fields curve space. Total emptiness doesn't exist.

"See this very shiny star?" Hubble asked me. "It is Sirius. It has a very dense companion star, which we can see only on photographs. Well, we have found a gravitational red shift in the spectrum of Sirius's companion. This confirms general relativity once more."

"This is good news. Except for Freundlich, who is still looking for a red shift in the sun's spectrum."

"The sun is too small. Say, have you read Gamow's article about the sun?"

"Who is Gamow?"

"A young Russian guy who works with Niels Bohr. He found how the sun can create its energy: a fusion reaction of the hydrogen nuclei."

"Turning into helium nuclei, of course. The loss of mass explains the energy. It was obvious, but nobody had thought about it. So little we know, so more we don't know yet…"

In the car going back to Pasadena, Tolman bragged to Elsa about his toy.

"Our 100-inch telescope is the biggest in the world. With it, we are going to establish and understand the structure of the universe."

"Bah, my husband doesn't need a telescope. He does that on the back of an old envelope!"

Caltech gave a grand formal dinner to honor the old Michelson and the old Einstein—and to offer two hundred rich sponsors the chance of seeing us in the flesh. I had already met Michelson in Chicago, during my fist visit in America. He was now seventy-eight years old and in poor health. I improvised a speech at the end of the dinner.

"I have come a long way, but the people I'm meeting tonight are not strangers. You have been my colleagues and comrades for many years. Dear Professor Michelson, when I was still a boy hardly three feet high, you uncovered a defect in the ether theory of light. Your wonderful experiments led Fitzgerald and Lorentz onto new paths. Without your work, the Special Theory of Relativity would today be scarcely more than an interesting speculation."

Michelson told me he was born in Poland and he was Jewish. His parents had moved to the States, when he was still a child, to escape persecution. He had been named Abraham, like my grandfather, before changing his name to Albert.

I also gave a speech for the students of Caltech. I asked them to keep concern for man as their chief objective. The result of our scientific work should be a blessing for mankind rather than a curse. "Don't turn men into slaves of the machine!" I advised them.

While still in Germany, I had written a foreword for a book by Upton Sinclair. As he lived in Los Angeles, I went to his home and we played some music together. He invited other writers to meet me and took me to a movie theater where we saw *All Quiet on the Western Front*, which was banned in Germany. Caltech's conservative scientists and sponsors couldn't accept a friend of such subversives as Sinclair and Chaplin in the faculty. My "socialist" speech to the students also unsettled them. It seems they had planned to offer me full tenure, in order to increase the prestige of their institution. Now they invited me to come and spend a month or two every winter. I found this good enough and accepted gladly.

I also disappointed some Zionists who gave a party for me, by suggesting that Jews should settle in some desert spot like Peru or Patagonia where they wouldn't disturb anybody. "We should look for a place without dangerous animals and poisonous snakes," I added.

We crossed the continent by train. We stopped over to see the Grand Canyon. Some Hopi Indians offered me a beautiful feather headdress and named me "The Great Relative."

Einstein writes a letter

I talked about peace in the Chicago railway station and about Palestine in a New York hall. Huge crowds applauded me in both places. People wanted to touch me and kiss my hands as if I was some kind of holy man. The papers called me “a prince of the mind” and “a Jewish saint.”

An American publisher wanted to fill my bank account with dollars, so I let him publish a text I had written ten years before or so. I tried to describe my character: “My sense of social justice contrasts strangely with my lack of any need to relate to individuals or groups. I am a lone traveler. I have never belonged to my country, to the circle of my friends, or even to my own family, with all my heart.” An often quoted sentence of mine is to be found in this text: “If someone can enjoy wearing an uniform and walking in step, then I despise him and consider he has received his brain by mistake, since his spinal cord would suffice.”

* * *

From a letter I wrote to Queen Elizabeth of Belgium when I was in Pasadena: “America is a country of contradictions and surprises, where one alternates between admiration and headshaking. I realize I am attached to the old Europe, with its problems and its pains, and am glad to return soon.”

From my diary at sea, after a storm that shook the ship like a baby’s rattle: “The ocean has a look of wrath that can’t be described. It is especially striking when the sun falls on it. I felt that the insignificant blob of molecules called Einstein was dissolved and merged into mother nature. Strangely, this made me happy.”

* * *

Soon after my return to Germany, I packed my bag again and went to Oxford, where I was to receive one more honorary doctorate and give some lectures. From my diary:

"Calm life in freezing monk's cell. Evening: solemn sacrament of the High Table with holy brotherhood in tails."

I enjoyed the calm life so much (despite the unheated room and the constant rain) that I accepted to become a "research student" of Christ Church college. The English people like to play games with words. They call their private schools "public," and an Oxford "research student" would be called "senior professor" anywhere else. I signed a five-year contract to give a month-long series of lectures every year. I promised I would learn English.

You might think I was taking on lots of different tasks, miss Peggy. Well, I'm sorry to say I had given up my optimistic ideas about Hitler fading away. The future looked bleak for Germany. How long would I be able to stay in my delightful Caputh house? I was ready to renounce my German nationality once more and become a wandering Jew. If only the English language weren't so tough! The words refused to stick in my old skull.

Lenard and his minions published a book of so-called refutations of relativity: *One hundred authors against Einstein*. Journalists asked me to comment.

"One author would be enough," I said, "if he put forward a solid proof against the theory."

I sailed to America in December, 1931 for my yearly Caltech session. I stopped keeping a diary when I was in Berlin, but I liked to write on the ship. "I've decided to become a migrating bird for the rest of my life. Seagulls fly along the ship as far as the Azores. These are my new colleagues, but God knows they are happier than me!"

The ship went directly to Panama without stopping over in New York. In Pasadena, I met de Sitter, the Dutch astronomer, who was visiting like me. We wrote a little thing together about the expansion of the universe. I found it hard to work, actually, under the palm trees. California held too many temptations. Helen Dukas showed me an article in a newspaper: "Professor Einstein attends all the society lunches and dinners, all the movie premieres, all the weddings and two divorces out of three."

I did find time to write letters and sign petitions concerning two obvious miscarriages of justice. Eight young black men had been condemned to death in Alabama for the alleged rape of two white women, although one of the women had testified that nothing had happened. Two labor activists, accused of detonating a bomb that had killed several people during a parade, were in jail for life in California. My Caltech friends were embarrassed. They would have liked to welcome me as a permanent colleague, but the millionaires who controlled the university's board refused to sponsor someone they considered a full-blooded communist. They didn't change

their minds when the eight black men and the two labor activists were declared innocent. Professors are not supposed to sully their moral authority by playing violent sports like politics. Obviously, our views about morals differed.

I enjoyed the palm trees and the parties so much that I was almost ready to sign a pledge to behave. Then I would have become "Einstein of Caltech," I guess. As you know, I became "Einstein of Princeton" instead. What happened? Abraham Flexner, a well-known education specialist, who had reformed colleges and medical schools in America, was touring the country with a project. Two very wealthy people in New Jersey, a brother and his sister, intended to finance a "haven for scholars," where a limited number of scientists would be paid to do pure research, without any bothersome teaching obligation. As Flexner wanted the future institute to be the best in the world (a typical American obsession), he visited the leading universities and asked teachers and administrators for advice. He was delighted to find me in Caltech and described the project at length. He spoke good German.

"What do you think, Herr Professor?"

"A fine idea. An informal organization is indeed better suited for pure research than a traditional university. The main drawback for scientists is not lack of money, but excess of bureaucracy."

I spent only two weeks in Berlin between California and Oxford. Old decrepit marshal von Hindenburg had been elected president of the country with eighteen million voices. Hitler had come in second with thirteen million.

Flexner included Oxford in his tour of famous universities just I as was residing there. We went for a walk on the perfect lawn of Christ Church college.

"We've decided to locate our Institute for Advanced Study in Princeton, Herr Professor."

"In the university?"

"It will be separate, but we'll be able to use the libraries and eat in the cafeteria and so on."

"This will make things easier, no doubt."

"Herr Professor, I would not presume to offer you a position in the new institute. I'm sure you already receive too many solicitations. Should you come to the conclusion that it could offer you an acceptable opportunity, however, then you would be welcome—on your own terms, of course."

* * *

Marshal von Hindenburg chose as chancellor (or prime minister) a far-right politician, von Papen, who declared martial law and dissolved the parliament. The

republic was dying. The newspapers attacked the Jews every day—and Einstein every other day.

I still wanted to believe in pacifism. The *International Committee for Intellectual Cooperation*, which hoped to deter violence with words, was encouraging "leaders of thought" to exchange letters about world peace. A first volume, entitled *A League of Minds*, had already been published. A gentleman working for the League of Nations came to my house in Caputh to talk about it.

"Would you accept to exchange letters with someone, professor Einstein? Whoever you like."

"Let me think… I could write to my friend Paul Langevin… About the history books, you know."

"What history books, professor?"

"The ones they use in classrooms in France and Germany. If they described events in the same way on both sides of the border, this would certainly decrease the risks of conflict."

The gentleman came again two days later.

"I am sorry, professor. I called Paris on the telephone. It seems Professor Langevin is traveling in China for the Committee."

"What do you think of Dr. Freud, then? I'd ask him whether psychoanalysis could help improve the education of children. Tamper their aggressive instincts, maybe. Dr. Freud thinks people kill each other because they hate their own father or something. I loved my poor papa, that's why I didn't kill anybody, I guess."

We had already exchanged letters. Dr. Freud had written to me in 1929, for my fiftieth birthday, that I was a happy man. I answered that he had looked under the skull of many people, but not inside mine, so how could he know whether I was happy? It turned out to be a misunderstanding. He meant I was lucky[35], since people who knew nothing about physics didn't dare contest my theories, whereas people who didn't have the faintest knowledge of psychology didn't hesitate to criticize psychoanalysis. In 1931, it was my turn to send him a letter for his seventy-fifth birthday. I told him that I didn't pretend I understood his writings, but I loved to read them. I admired their beauty and their clarity. Few people wrote German as well as he did, in my opinion.

I had met him once, in 1926. He was in Berlin to see his son. Common friends had invited both of us to dinner. Someone told me a comment he made after our meeting: "Einstein is quiet and courteous. He understands as much of psychology as I do of physics, so we had a very pleasant chat." Actually, I agreed with him that most of the

[35] The same word "glücklich," means happy and lucky.

workings of our mind are unconscious. My own ideas seem often to pop up from nowhere when I am daydreaming or playing the violin. I preferred to remain in the darkness of not having been analyzed, though. I was afraid it might kill the golden goose, in some way.

We both belonged to a very exclusive group. I don't mean unbelieving Jews, but the quaint quartet invented by people who say that Marx, Darwin, Freud and Einstein fathered modern thought.

I began my open letter to Dr. Freud with a question: "Is there any way of delivering mankind from the menace of war?" Then I mentioned an enigma that only an expert in the lore of human instincts could resolve: man seemed to harbor a lust for hatred and destruction. Was it possible to control a child's mental evolution so as to make him proof against this lust?

In his answer, Dr. Freud wrote that a drive toward hate, destruction and death did exist in the human psyche alongside a need for love. "These two urges are necessary and always go together. The aggressive or destructive instinct is needed to protect us, so we can't suppress it. Some say that in some remote corners of the earth, where nature brings forth abundantly whatever man desires, there flourish races whose lives go gently by, unknowing of aggression or constraint. I don't know whether I can believe that. I would like further details about these happy folks. Civilization and culture are the best safeguards against our urge to fight and kill, it seems to me. The main reason we should despise and avoid war is that it trips cultural progress. This progress is fragile, precious, dangerous maybe (because we risk turning our violence against ourselves), but it lets human beings develop what's best in them. To conclude in a hopeful but realist manner, I think that war might one day be ended through a combination of two factors: on the one hand, man's cultural disposition; on the other hand, a well-founded dread of the extreme violence of future wars."

His letter covered several pages. Its tone was dark, almost desperate. Reading it didn't brighten my own gloomy mood. Europe seemed ready to give up civilization and culture. It craved destruction and death once again. I resigned from the *International Committee for Intellectual Cooperation*. As if letters could cover the clang of arms! I was even beginning to wonder whether I would be able to remain a pacifist forever.

* * *

Many Jewish scientists were ready to leave Germany. Abraham Flexner went to the main universities and recruited the best of them for his new institute. "We're letting first-rate merchandise go at bargain prices," one the university presidents deplored.

Flexner came to visit me in September, 1932. Although it was a cold and rainy day, I was just wearing a light shirt.

"Aren't you cold, Herr Professor?" Flexner asked.

"I dress according to the season, not according to the weather. It's still summer, isn't it?"

"I have brought you a contract."

"I could spend half the year in America, I guess, for I have obligations in Oxford and Leyden. I'll keep my Berlin apartment and this little house, too, as I want to hope that things will improve eventually."

I had accepted Flexner's offer. The propaganda of the nazis and their allies was so pervasive that most of the people believed a "Jewish plot" threatened Germany. As I was the best-known Jew, the craziest among the nazis actually considered me the leader of the plot. Killing me would deal a severe blow to "International Jewry." A friendly journalist, who knew a well-informed general, told me of a real plot—against my own life.

Flexner had left a few blank lines in the contract.

"Tell me, Herr Professor, what would your conditions be?"

"Conditions? You mean salary? Well, I have noticed that things in America are rather expensive. What do you think of 3,000 dollars per year?"

"3,000? Are you sure?"

"Maybe we could live with less than that…"

"You couldn't live in the States with 3,000 dollars. Let me talk to Mrs. Einstein."

I guess that Elsa had gone to the hairdresser and bought sandwiches while I was giving lectures, so she knew the price of things in America. She agreed to a base salary of 10,000 dollars. Important expenses, for example my annual trip to Oxford and Leyden, would be taken care of. A separate position was offered to Mayer, my assistant. I must add that when I arrived in Princeton, the rich sponsors of the institute raised my salary to 15,000 dollars, because several other professors earned that much.

I wasn't going to Princeton right away, since I still had to honor my Caltech commitment. When we locked the door of our Caputh house and climbed into the taxi that was taking us to the railway station, I turned toward Elsa.

"Now is the time to take a last look. We'll never see it again."

"Is this some kind of premonition? You sound like a prophet, Albertle."

"We scientists know nothing about premonitions. I am considering probabilities. If Hitler topples Hindenburg, I bet he'll seize all properties belonging to the Jews."

We stopped over in Brussels so I could say hello to my friend the queen. She found a viola and a cello-player among her ladies-in-waiting (or whatever they're called).

"Let's play this Mozart quartet, Albert."

"All right. You take the first violin part, Elizabeth. Protocol says you come before me."

"Are you kidding, Albert? You come before everybody else. No false modesty, please."

The truth is, I've always liked to play second fiddle. All you have to do is follow the first violin. You can keep a free mind and listen to the music or dream. The queen preferred playing second violin for the same reasons, I suppose.

Then we ate braised endives.

"This is a typical Belgian vegetable," the queen said. "We also love mussels and fried potatoes. Tell me, Albert, what do they eat in America?"

"They eat fried potatoes, too. They call them French fries."

"Are you happy to go there?"

"I'm perfectly happy, but the Americans are not all happy about my coming. I had to talk to the consul in Berlin before he accepted to grant me a visa. A certain 'National Patriotic Council' called me a German bolshevist and warned the country against my pernicious influence. An upshoot of that group, the 'American Women's League,' said I was affiliated to more communist groups than Stalin himself. Besides, my theory was undermining church, state and science. They petitioned the State Department to bar me from entering the country. The consul wanted to know whether I was a communist. I told him it was none of his business. 'Is this the holy Inquisition?' I asked him[36]."

"So they don't understand your theory. But why do they call you a communist?"

"They dislike my pacifist speeches and an article about religion I gave the New York Times. The German antisemites also pretend I have stayed in the Soviet Union a few years ago."

"Did you ever go there?"

"Never. Whether the Soviet regime is communist or not, I don't like it. At the top, power-hungry individuals fight like dogs from purely personal motives. At the bottom, there are no more individuals and no more freedom of speech. What is life worth in such conditions? Let me tell you something: they hate my theory as much as the nazis. They say the proletariat doesn't need this speculative and obscure bourgeois science."

"The consul gave you a visa, after all, or you wouldn't be going to Antwerp."

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[36] Einstein did sign a statement that he wasn't a communist, which was found recently in declassified papers.

"I told him it would be quite funny if he didn't let me in. The whole world would be laughing at America. I also sent the newspapers a letter addressed to these leagued women. Wait a minute, I've got it somewhere… Aha, here: 'Never before have I been spurned so vigorously by the fair sex, or if it ever happened, then not by so many at a time. But aren't they right, those watchful women citizens? Why should one admit a person who devours hard-boiled capitalists with the same appetite and pleasure as the Minotaur in Crete devoured toothsome Greek virgins, and who moreover is mean enough to reject any kind of war, except the inevitable war with one's own wife? Listen therefore to your clever patriotic little women and remember that the Capitol of mighty Rome was once saved by the cackling of its faithful geese.'"

* * *

On January 30th, 1933, while I was studying the evolution of the universe with Tolman and Hubble on mount Wilson, von Hindenburg named a new chancellor: Adolf Hitler.

Less than a month later, the nazis burned the parliament, accused the communists of arson, declared a state of emergency and turned Germany into a totalitarian dictatorship. The newspapers attacked "Einstein the internationalist traitor," as well as Stefan Zweig, Thomas Mann and most artists and intellectuals.

I met Charlie Chaplin and Upton Sinclair again. I attended the big formal dinner that Caltech gave every year for me, or rather for the rich backers of the university who wanted to meet me. There I made a new friend, Leon Watters, a chemist who had founded an pharmaceutical company in New York. We became close later, when I lived in Princeton. He was Jewish and told good jokes. My English had improved so much that I could understand and appreciate them. But I didn't dare speak the language myself. If you had stayed at my table in the cafeteria, I couldn't have told you my story. I still speak slowly. I never know whether I'm using the right word. My accent is terrible. Writing is easier!

On March 10th, my last day in Pasadena, a woman journalist came to Caltech to interview me.

"I'd rather live in a country where civil liberty, tolerance, and equality of all citizens before the law prevail," I told her. "These conditions do not exist in Germany at the present time."

"Will you stay in the United States, professor?"

"I have to give lectures in Oxford and Leyden first. Then I'll spend six months in Princeton. I don't know where I'll establish my permanent home. In Switzerland, perhaps."

When she published her article, she added that I said goodbye to her, walked across the campus, stopped to talk to a colleague. Just then, the earth shook, but I didn't seem to notice. I guess my colleague was giving me the latest news about the cosmos or something. Besides, I had been walking on shaky ground for years. The "Long Beach earthquake," which was sending attenuated tremors to Pasadena, killed 166 people and wounded more than 5,000.

We crossed the United States by train. Once more, I spoke to Jewish organizations in Chicago. There I met the famous lawyer Clarence Darrow, who had defended John Scopes successfully. He was just another lawyer. What amazed me was the terrible crime that John Scopes had committed: he had taught Darwin's theory of evolution in Tennessee in 1925.

I lectured against war in New York City. I wasn't such a firm pacifist as before. I still extolled peace, but I didn't suggest that students refuse military service.

The German consul, whom I had known for a long time now, came to my hotel.

"You're German, Herr Professor, so you can go back to Berlin. Between you and me, though, I suggest you don't. They'll drag you through the streets by the hair."

While he was warning me, the nazis were already ransacking my Berlin apartment and my Caputh house! They wondered why they didn't find any arms, bombs, shortwave radio sets. I was the head of the Jewish plot, wasn't I?

When we arrived in Belgium, we heard the nazis were expelling all the Jews and "half-Jews" from the administration and universities. Bruno Walter, the musical director of the Berlin opera and one of our greatest conductors, had gone to Austria. Most other famous Jews were preparing to leave. Many Jews, not so famous maybe, stayed in Germany and died later in the camps. We can't blame them for hoping that good would vanquish evil. I didn't have a choice, so I didn't have to decide. The nazis had targeted me. It would have been very foolish to go back.

I went to the German consulate in Antwerp. I renounced my German nationality for the second time and resigned from the Prussian Academy. The nazis were furious. They were planning to cancel my citizenship and expel me from the Academy on April 1st to crown a "boycott of the Jews" day. The Academy published a motion saying that, since I licked the feet of Germany's enemies, it "didn't regret my resignation." Only my friend Max von Laue refused to sign the motion. Nernst, Planck and Haber kept mum.

A Berlin newspaper gave me the honor of a headline on its front page: *Good news from Einstein—he is not coming back!*

The city of Ulm, where I was born, had named a street after me when I had received the Nobel prize. Now this *Einsteinstrasse* became *Fichtestrasse*.

I was sad when I thought I would never see my Caputh house again, nor my dear Tümmler. When a light wind blew, wrinkles ran over the lake and the brave boat tried in vain to catch up with them.

When I travelled, I left my favorite violin at home and took a rougher instrument, which could stand sea salt and a tumble or two. The nazis had taken my old violin, I supposed. It wasn't a pricy Stradivarius, but a good and faithful friend, born in Bavaria a century ago or so. We got along pretty well, without exchanging a word.

While I didn't own anything valuable, I liked some of my books. The nazis threw my books, I mean the books I had written, into a bonfire in Berlin, together with works by better writers like Stefan Zweig, Marcel Proust and Thomas Mann. I guess they also burned my books, I mean the books that filled my library, in Caputh.

* * *

The mayor of Antwerp lent us a house. After a while, we settled near Ostend, in a seaside resort called Le Coq sur Mer. Elsa's daughters, whom the nazis would have loved to keep as hostages, had escaped the country with their husbands. They came to live with us. They brought good news: they had saved my papers.

"We put everything in a trunk."

"Where is that trunk now?"

"What a mess! There were papers everywhere, in Berlin and in Caputh."

"Did you find letters in a small black cabinet?"

"Oh, the letters from your girl friends? Of course."

"Letters from Michele Besso and Hedi Born, and my children, and many others."

"You met Dr. Bucky."

"Your doctor. What about him?"

"He's American, you know, so they leave him alone. He put the trunk in his big car and carried it to the French embassy. They sent it across the border in the diplomatic pouch or whatever. So I'd say it's in Paris right now."

"He invented a diaphragm for X-ray machines. Quite a clever piece of work. I helped him update the patent. His son gave me a toy."

"I remember. A yoyo!"

* * *

I wrote to Maurice Solovine, in Paris: "If you meet any academic refugee Jews from Germany, tell them to get in touch with me. I've thought of starting a university abroad

(in England?) for Jewish students and professors, so that we can at least do something for the most urgent needs, and create a kind of intellectual refuge."

Do you remember Leo Szilard, miss Peggy? A young Hungarian scientist. I patented a magnetic refrigerator with him. I heard that he was helping refugees in England. I wrote to him about my project. He came to Belgium. Just by looking at his hair, I could tell there had been lots of wind during the crossing.

"So you escaped to England, Szilard."

"I hid my money in my shoes."

"At least one hundred and fifty professors have left Germany already, and many more assistants and students. What do you think of my project?"

"Creating a new university from scratch is not realistic, Einstein. The refugees accept low salaries, you know, so the existing English universities are willing to give them jobs. We have founded an *Academic Assistance Council*, which finds positions for the refugees. Besides, your university for the Jews already exists in Jerusalem."

"Let them get jobs in England. The Hebrew university is controlled by American Jews who know exactly nothing about science."

"You'll soon become an American Jew yourself, won't you?"

"Every other semester only."

Instead of going with him to England, where I was supposed to give my Oxford lectures, I went to Zurich. I had received news that my younger son, Eduard, was ill. He had already spent some time in a psychiatric hospital in 1932. The doctors were not sure what was the matter. "Maybe a bout of depression after a love story gone wrong," they had ventured. Now they were talking of schizophrenia—which I kind of expected, as several members of Mileva's family were locked up in lunatic asylums. They tried shock therapy. It seemed to work, but then he went for a walk and got lost one block away from the hospital. "Better not to let him out anymore," the doctors said. "He'll be happy here." He was heavily sedated, so we didn't have a very fruitful conversation. I played some violin to him.

Soon after I arrived in Oxford, I attended a lecture by Rutherford. I felt rather depressed. If only I could have blamed unrequited love… Germany was sinking into a bottomless pit, my son had escaped to some obscure dreamland, I couldn't imagine my own future. When his talk was over, Rutherford called me to the rostrum. The public applauded me with such warm enthusiasm that I couldn't help laughing. Much better than shock therapy!

For the first time, I gave my lectures in English. I read my notes and spoke slowly. In England, I was still a pacifist—but when I came back to Belgium, I found that I was

following a new road and leaving pacifism behind. Eventually, I supported the research leading to the atom bomb. I wish I could explain my about-face, miss Peggy, since we're coming to what you're reproaching me. Words fail me at this critical moment in my story. I can neither express nor explain the feelings of dread and disarray provoked by the mad violence of the nazis. We had to resist, no doubt about it. Pacifism made sense just after world war I. If all the countries in Europe had become pacifist and buried their arms, the world would have avoided a second disaster. The time for pacifism ended in 1933.

Two young Belgian men had been arrested for refusing military service. Their lawyer asked me to intervene on their behalf. I was writing the draft of a letter to the lawyer when I received a telegram: "The husband of the second fiddle would like to see you on an urgent matter." This meant king Albert, of course. I went to Brussels. I told the king he shouldn't worry.

"I have long been an advocate for pacifism, but things have changed. The Belgian army can only be regarded as a means of defense, not an instrument of aggression. Considering the events in Germany, such defense forces are urgently needed. If anyone is to intervene in the case, it should not be a foreigner who enjoys your country's hospitality."

"We are delighted and honored to have you here, Albert. A man of your intellectual stature represents mankind rather than a single country. You can certainly intervene."

"You know, men who won't carry arms because of their religious or moral convictions should not be treated as criminals. Maybe they could help their country by working in mines or factories without pay. I'll write to the lawyer."

"Don't mention this conversation, please. As the sovereign, I am not supposed to meddle in politics."

I sent the following letter to the lawyer. "Until quite recently, we could assume that personal refusal of armed service was an effective way of fighting militarism. But today, a power in the heart of Europe, Germany, is obviously pushing toward war. This has created such a serious danger to other countries, especially Belgium and France, that they definitely need to strengthen their armies. Imagine Belgium occupied by present-day Germany! Things would be far worse than in 1914. I'll tell you candidly that if I was a Belgian citizen, I would not, in the present circumstances, refuse military service. Rather, I would enter such service cheerfully, in the belief that I would help save European civilization. This does not mean that I'm giving up the principles for which I used to stand. I hope a time will come when refusal of military service will once again be an effective method of serving the cause of human progress."

The lawyer sent the letter to the newspapers. The pacifist groups and parties were terribly disappointed. They were losing a world-famous spokesman. Romain Rolland declared that, after encouraging the conscientious objectors, I was betraying them. "It is easy to be a pacifist in time of peace, but authentic pacifists stay so when war threatens." He added that I was great as a scientist but not so great outside my own field, which was probably true. While his pacifism was absolute, mine was relative.

* * *

An English journalist and member of parliament, Mr. Locker-Lampson, whom I had met in Oxford a few years before, read the letter and came to see me.

"You're showing the proper spirit, professor. Eddington, Russell and their pacifist cronies are rather miffed, but I wish some of our politicos were as brave as you. Do you know what? You should come to London with me. You'll tell them who this Hitler really is."

I was always carrying my notebook in my pocket. I wrote "cronies", "miffed" and "politicos" between two equations. There are too many words in your language, miss Peggy. I despaired of ever learning them all.

I went to England with Locker-Lampson and met Winston Churchill, Lloyd George and other English "politicos." I wrote to Elsa: "Winston Churchill is an eminently clever man, and I am convinced these people are well prepared and will act resolutely and soon."

Lloyd George, who had been prime minister during the great war (Winston Churchill was his war minister), received me in his Surrey country home. When I signed the visitor's book, I wrote *ohne*—which means "without any"—on the line for my address. This *ohne* impressed Locker-Lampson so much that he made a big speech the next day in the House of Commons: "The most eminent men in the world have agreed that Einstein is the most eminent of them. Today, Einstein is without a home. The Huns have stolen his savings and even his violin." He introduced a bill to "promote English citizenship for Jewish refugees." Alas, the members of Parliament didn't vote this generous proposition because they were going on vacation or something, so that England didn't save the Jews of Europe.

I went back to my house behind the dunes in Le Coq sur Mer. One day, while I was grappling with the fourth dimension, hoping that it would at last cough up a few elementary particles, I heard some noise outside. The two policemen who stood in front of our door day and night had pinned a man to the sand. Elsa was shouting.

"No, no, this is professor Frank!"

They released him. I did recognize my successor in Prague. He was rather miffed! I was laughing so much that I could barely talk.

"How did you find this house, Frank?"

"What do you think? I just asked around."

"The people in the resort have strict orders not to reveal where I live. These two gentlemen are here to protect me."

"Please thank them for letting me live."

"The police told me the nazis are offering a reward of five thousand dollars for my murder. I didn't know I was worth so much! A journalist showed me an article denouncing me as the main enemy of the German State. There's a legend under my photograph: 'Not yet hanged.' A former nazi thug came last week. He wanted to sell me secrets for fifty thousand francs. What would I do with nazi secrets? He thought I had to be interested, as the leader of the plot against Germany."

"The German border is not so far. Their agents killed professor Lessing in Czechoslovakia recently. You should be careful."

"Bah, I'm going to Princeton in one month. Don't worry."

Elsa worried. She called Locker-Lampson on the phone and asked him to invite me again. She stayed in Belgium to prepare her trunks for our semester in Princeton.

Locker-Lampson was an eccentric adventurer in the British mold. He had been an airplane pilot and a tank driver during the war. He pretended that, being a friend of grand duke Nicholas, he had helped him kill Rasputin. The newspapers loved to publish his yarns. They wrote he had sent a submarine to pick me up in Belgium! What's true is that he hid me in a country house and enrolled strange sentries: two pretty secretaries armed with rifles.

"Whoever trespasses without a permit will get a bullet in the head," he told the journalists. They found me easily enough. Locker-Lampson brought some photographers, too, so that newspapers all over the planet published pictures of the sentries trying to look fierce.

Szilard, Rutherford and others were trying to develop the Academic Assistance Council. I accepted to attend a meeting and help them. I thought I would talk to a few professors and students, but Locker-Lampson said it would be a pity not to exploit what he called "my publicity value." He rented the Royal Albert Hall and advertised the meeting in the newspapers, so that I talked to a full house—more than ten thousand people. Rutherford, Churchill and several other luminaries were there, too. I read an English translation of a text I had written in German.

"How can we avoid a new disaster in Europe? How can we save mankind and its spiritual acquisitions, of which we are the heirs? I hope that, in the future, it will be said the freedom and honor of this continent were saved by its western nations. I trust England's traditions of justice and tolerance. I am going to spend a semester in America, then I'll return here and become a naturalized Englishman."

The public applauded warmly. I guess I got carried over. Locker-Lampson's looniness was rubbing off on me, maybe. I left my prepared text and improvised.

"Right now, I am living in solitude in a comfortable English country home. I must say I find the place quite stimulating for the creative mind. I have thought that young people who wish to think out scientific problems would benefit if they could be offered positions in isolated places like lighthouses…"

The people seemed to find this new Einstein idea a tad puzzling. I am sorry to report that nobody tried to invent a new theory in a lighthouse, as far as I know. Maybe I am the last ivory tower physicist, miss Peggy. Quantum mechanics is a collective construction. This atom bomb you hate so much (and I do too, believe me) was perfected by gigantic teams in Los Alamos and other places.

One last Locker-Lampson lark: a sculptor, Jacob Epstein, came to make a bust of me. I sat for several sessions lasting two hours each. Quite a job! He turned a lump of clay into a new Einstein, just as the Good Lord created Adam. Then he sculpted a stone bust which was exhibited in a London art gallery. It seems that someone came when the room was empty and tried to break it. Even in England, I had enemies. Some groups admired HItler, said that England should become his ally against the Soviets, and accused the Jews of plotting "to weaken the white race."

* * *

Two of my friends died while I was in England.

Fritz Haber could ignore the law barring the Jews from teaching in the university, because he had more war medals than a five-star general—beside being blond and scarred and a catholic convert. He chose to resign. "For more than forty years," he wrote to the new authorities, "I have selected my collaborators on the basis of their intelligence and character, not on the basis of their grandmother, and I am not willing to change, for the rest of my life, this method which I have found so good."

He came to England, where he discovered he wasn't welcome. Rutherford refused to meet him, because he didn't want to shake hand with the man who had invented chemical warfare. I was glad to see him, though.

"You shouldn't regret anything, Haber. Honest people have no place in Teutonia. Surely there is no future in working for an intelligentsia that lies on its belly before

common criminals and even, to some extent, sympathizes with them. You know, I am delighted that your former love for the blond beast has somewhat cooled off."

"What shall I do, Einstein? Where will I go? Perhaps you could recommend me for a position in your Hebrew University."

"Are you Jewish again? Who would have thought that my dear Haber would become a champion of the Jewish settlement in Palestine?"

I couldn't recommend him. My relationship with the Hebrew university was still quite chilly. Besides, I thought it needed fresh blood. I often advised young refugee graduates to go there. Haber was too old.

He went to Switzerland. Weizmann found a job for him in a private chemistry institute in Jerusalem, but he died in Basel without seeing the Promised Land. He was sixty-five.

Paul Ehrenfest committed suicide. He tried to shoot his young retarded son, too, but the child survived. He was depressed because of the hellish events in Germany and also, I think, because he had been stuck for years. "Scientists can't expect to find much after fifty," I used to tell him. "You have to accept it and help the young fellows." What a hard blow for Tatiana, I thought

* * *

I caught the *Westernland* in Southampton. Elsa, Helen Dukas and Walther Mayer were already aboard.

"See you in six months," I told my English friends. But I never returned to Europe, miss Peggy.

When we entered New York harbor, a launch came alongside the ship and took us directly to the New Jersey shore. Flexner was waiting for us there. He drove us to Princeton.

"This saves half a day, Herr Professor. The mayor was waiting for you on the pier with cheerleaders and a thousand journalists and photographers and the usual crowd of gawkers. They wanted to parade you to some hotel in Manhattan."

"The mayor? What are cheerleaders? Gawkers? They must be disappointed. I bet they're angry at me. Waiting in the rain, poor people. If I had known…"

"Don't worry. This is just politics. O'Brien needs to court the Jewish vote if he wants to be reelected. LaGuardia is way more popular right now."

"If I understand well, O'Brien is the current mayor and LaGuardia his rival. By sending the boat for me, you hurt Mr. O'Brien, so I guess you favor Mr. LaGuardia."

"I don't care one way or another. I live in New Jersey."

Flexner had reserved rooms for us in a small hotel, the Peacock Inn. While Elsa was checking that nothing was missing in her precious trunks, while the mayor of New York and an army of gawkers were still waiting for me on a Manhattan pier, I went down and explored Princeton. In a small pink and green store, I saw a waitress hand a student a triple ice-cream cone. I stepped in, pointed at the ice cream cone and at myself and gave the waitress a quarter.

"This one goes in my memory book," she said.

The student and the waitress stared at me as if I had been painted pink and green like the store. They recognized me because they had seen me in the film newsreels, so they probably thought I existed only on the movie screen.

I thought I'd go back to Europe after six months to honor my commitments in Oxford and Leyden. Well, I didn't. I've spent seventeen years in Princeton already. I like it here. This is a university town with lots of old trees, like Oxford. We found a pleasant house. I could walk to the Institute for Advanced Study, which was at first located in a corner of the university. Later, they erected a separate building. Flexner had recruited eighteen people—twelve "workers" and six "professors." Many of them were famous scientists, like the mathematicians Hermann Weyl and John von Neumann, but people called the new place "the Einstein Institute."

Most of my colleagues came from Europe, so we tended to speak German. I could understand and read English, but I was unable to ask my way in the street. In case of trouble, I would call the dean of the university, Mr. Eisenhart, who knew German. Once, a woman answered in English.

"Hello."

"Hello, miss. I would like speak to Mr. Dean, please."

"The dean Eisenhart is out. May I help you?"

"Perhaps you tell me where Professor Einstein lives."

"Oh, I'm sorry, I can't do that. We don't want journalists to bother the professor, you know."

"Ach, but I am professor Einstein! I go for a walk and I forget where the home is."

I found a perfect English teacher: a six-year old girl, Amy, our neighbors' daughter. I helped her with her arithmetic homework. I bought a compass and showed her that the needle always points to the north.

Our neighbors, as well as all the inhabitants of Princeton, were very nice with us. I'm not sure America remembered I had invented such a thing as the theory of relativity. It saw me as a valiant opponent to the brutal dictator in Germany. The

governor of New Jersey gave a dinner for me. Then the president of the United States, Franklin D. Roosevelt, invited us to the White House.

I didn't receive his invitation. Flexner, who pretended he had to sift my mail for antisemitic and nazi threats, answered I was too busy to go to Washington. Flexner acted as if he owned the institute and all the people who worked there. I heard he had told off some students who wanted to interview me for a campus magazine. Then, when three teachers asked whether I'd join them to make a string quartet, he had refused in my name. He hoped I'd stay in my office and bring glory to the institute and its founder by finding the secret of the universe before the end of the semester.

During my previous trips in America, I had met rabbi Wise, a famous Jewish leader. He called me on the phone.

"When are you meeting the President, professor Einstein?"

"What president?"

"Mr. Roosevelt. Didn't you get the invitation?"

"Not that I know of."

"He hasn't lifted a finger on behalf of the Jews in Germany. I thought you might talk to him. His secretary promised me he'd send an invitation."

I wrote to the White House to accept the invitation. We had dinner with the President and his wife and even slept there. We talked about the situation in Europe. He spoke good German. I sent a postcard to my friend the queen of Belgium:

In the capital city
Of this great country,
Where the future is being created,
I have been invited
By a brave man,
Who fights as hard as he can.
While we talked of things old and new,
I thought about you.
To let you know, I decided I'd better
Send you this letter.

I complained to the Institute's trustees about Flexner.

"No self-respecting person could tolerate such interference. If you can't ensure undisturbed work, I suggest we discuss ways and means of severing our relation in a dignified manner."

If I had gone back to Oxford and become English, we would never have met, miss Peggy. I would have played no part at all in this bomb mess.

Flexner apologized and ordered the mail to be delivered directly to me. Helen Dukas did find antisemitic letters now and then. She kept them in a special file, because she knew it amused me to read them. "You are a Jew faker and a communist and should be barred from the United States," they said. "The Jews are as dangerous today as they were when they killed Jesus. They deserve to be starved to death. They insult the human race. No wonder the whole world hates these swindlers, these snakes, these skunks, these friends of Satan. They must be done away with."

It took me several years to understand that antisemitism was also quite common—in a less blatant guise, of course—in the high spheres of American academia.

* * *

Do you remember Leon Watters? A jolly chemist I had met at a formal dinner in Pasadena. He came visit us. As he had a big American car and a chauffeur, I asked him whether we could go and look at the countryside. What did I expect? We saw farms, fields, hills and woods. It reminded me of Bavaria, where I had spent my youth. Mr. Watters had a camera. The chauffeur took some pictures of us.

"It seems easy," I said. "May I try?"

I took pictures of Watters and Elsa. I had reviewed many patents for cameras and camera parts, but it was the first time I was using an actual camera.

Watters owned a large apartment on Fifth Avenue, right across Central Park. We spent a few days there at the end of March, 1934. We attended a benefit concert in Carnegie Hall for the workers in Palestine. There I saw the composer Arnold Schoenberg, a Jewish refugee like me. I liked the man better than his music. A benefit dinner followed the benefit concert. The newspapers called the evening a farewell occasion, as we had cabins reserved on a ship two days later.

At the last moment, I changed my mind. Elsa agreed with me. Dark clouds were hovering over Europe. We liked it in Princeton. Why move? I explained my misgivings to Schrödinger, who happened to be in New York for a conference.

"Congratulations for your Nobel prize, Erwin."

"Thanks, Albert."

"So you left Berlin. You're a good man."

"What else could I do?"

"The others stayed, didn't they? Not the Jews, of course. But you are not Jewish."

"Even if you were not Jewish, Albert, you would have left too."

"You went to England, is that right?"

"Oxford. We'll be able to work together. They're eager to see you over there. They told me you've decided to become English."

"Well, last year, yes… But now… If I go to Oxford, I'll also have to go to Leyden. Then I've promised to give lectures in Paris and Madrid. Opponents to Hitler would ask me to attend meetings everywhere. How could I refuse? Besides, Elsa has relatives all over Europe. They hope we'll help them. I'm afraid I lack the courage to undertake all this. Why shouldn't an old fellow be able to enjoy some quiet once in a while?"

"But I read in the paper that you were sailing to Antwerp day after tomorrow."

"Next year, maybe. I think I'll spend the summer here. Sailing… I think you knew Dr. Bucky, in Berlin. He's American, you know, so he moved back here when the nazis took over. He's renting a big house by the sea during the hot season, in a place called Rhode Island. He said I could come and stay there any time. As soon as he made his offer, I imagined a boat… I was ready to go to Europe, Elsa had packed her trunks, we had the steamship tickets, but I was thinking about that boat in Rhode Island all the time."

Elsa did go to Europe after all. Her daughter Ilse, who had settled in Paris, was seriously ill. She left in May. A few weeks later, I went to Rhode Island with Helen Dukas.

Bucky told me how the X-ray diaphragm he had invented worked. His son, who had given me a yo-yo in Berlin, had a small Kodak camera. Bucky was wondering whether he could adapt a version of his diaphragm for a camera such as this one.

"You got your Nobel prize for a study of the photoelectric effect, didn't you, professor Einstein?"

"I see what you're aiming at. If we had a small light-sensitive electric circuit, it could power a motor that would open or close the diaphragm."

"Right. Where would you put your light-sensitive circuit?"

Dr. Bucky and his son thought I was an expert about cameras and everything else, since I was the famous professor Einstein. I was lucky I had photographed Watters and Elsa not long before. We invented and patented a primitive "automatic camera" together.

Bucky's sons were skillful too. They had built a short-wave radio and a directional antenna, so we could listen to broadcasts coming from England, France and Germany. We laughed when we heard Hitler's ridiculous yapping, although it wasn't really funny.

I rented a sailboat. The wind was much stronger and the waves certainly higher than on my lake. I even broke my mast once. Then the coast guards towed me back to the harbor with their motor boat. Watters came from New York several times and we sailed

together. At first he wasn't sure he could trust me. I didn't bring a chart and knew neither the nautical signals nor the names of the ropes and things in English.

"Don't you wear a life jacket, professor?"

"Bah, if I have to drown, then let it be honestly."

"Better not to stray too far from the land, so we can at least swim ashore."

"Oh, I can't swim, anyway."

In August, I received a telegram from Elsa: her daughter Ilse had died in Paris. She was only thirty-seven. Margot, her other daughter, came to America with her. Elsa was quite distressed, of course. Although Ilse had worked as my secretary when we had opened the Kaiser Wilhelm Institute for Physics in my apartment in 1917, and I considered her a close friend, her death couldn't affect me as much as her own mother. Elsa seemed to resent this.

"Your thick skin looks pretty hale, with all this sailing around. Nothing tragic really gets to you. That's why you can work so well, I suppose."

"If I stopped sailing, would it change anything?"

My elder son, Hans-Albert, soon came to America too. "I just want to see how it is," he said. He stayed three months and found a job as an engineer in the South somewhere. He went back to Zurich to bring over his wife and his two sons.

Thousands of refugees dreamt of crossing the ocean. I tried to help as many as I could—teachers and students I had known in Berlin, members of the Einstein and Koch families. I sent certificates called "affidavits," which had the miraculous power of generating visas. Watters was very active too, but otherwise I didn't understand why the American Jews didn't do more for their European brethren.

* * *

The Institute for Advanced Study didn't pay me to take care of refugees, but to advance the study of physics. I had to overcome a small hurdle first: Mayer, my faithful assistant, decided to work on his own. My assistants usually left after a while, miss Peggy. They got tired of following me in my vain endeavors. I kept trying to goad equations into hatching a unified field theory, but the equations weren't in a hatching mood. I'm sure that "Einstein's former assistant" looked good on Mayer's résumé. I needed someone to do the math, you know. I play with the deep thoughts. Let somebody else compute and calculate.

Flexner became stingy, all of a sudden, and refused to pay a new assistant. He hadn't forgiven my disparaging letter to the trustees, obviously.

Nathan Rosen, a Brooklyn student, asked me whether I would accept to read his Ph.D. thesis. We met and I found him a very nice fellow. I couldn't offer him a regular

job, but I took him as a kind of stringer. Flexner accepted to sign a short-term contract, which he renewed grudgingly a few times. Rosen was a clever one. He didn't want to waste his time looking for the philosophical stone of the unified field. He thought he knew why I had failed in my quest. Pushing general relativity and quantum mechanics toward each other so they could meet half-way was a mistake. General relativity was as perfect as a Michelangelo sculpture. I shouldn't try to change anything about it. On the other hand, quantum theory was still a half-baked idea. Rosen suggested we study some of its flaws. We might be able to convince the theory's great priests to amend their views and explore new directions, more compatible with general relativity.

Such a project was precisely what I needed. I felt ten years younger as soon as we started working. Things developed so well that Podolsky, a "worker" at the Institute, whom I had met previously in Pasadena, soon joined us. In May, 1935, we published an article that became known as "the EPR paradox," for Einstein—Podolsky—Rosen. We started with two physical systems, for examples two particles such as photons or electrons. We supposed that the two particles interact in some way. Maybe they collide. When they do, they become one system. Then they go their own way, but—according to the equations of quantum mechanics—they remain "entangled" in a mysterious manner. When you study the first particle, it limits what you can know about the other one, even though it may be at the other end of the universe. As if information were traveling instantly across space… You remember that instant action at a distance can't exist, miss Peggy. So says special relativity.

Perhaps you've read in the papers this kind of story: two twin brothers who were separated at birth, being reunited by chance when they are forty years old, discover that they both married a woman named Brenda and drive a blue Ford. So what do you suppose? When the first twin bought his blue Ford, the second twin decided to buy a Ford car too. He hesitated between a red one and a blue one, but he felt he was losing his free will and was compelled to choose the blue car.

I called this "phantom action at a distance." It doesn't make sense. After having said that the Good Lord didn't play dice, I now added that he didn't practice telepathy either.

The purpose of our article wasn't to say that quantum theory was wrong. We just suggested it wasn't "complete" yet. Well, we caused quite a stir in the small world of quantum mechanics. Wolfgang Pauli mentioned the article in his course at the Zurich Polytechnikum: "Einstein has once again come out with a phony objection to quantum mechanics. If one of your first year comrades raised such an objection, I'd consider him a promising student. I wish somebody would bring Einstein to the second-year level in quantum mechanics so he'd stop bothering serious people."

Niels Bohr wrote a refutation of our objection. When you study the first particle, he said, it doesn't affect the second one, because it destroys their entanglement.

The only physicist who found some merit in my work was Schrödinger. Although his great equation stood at the very center of quantum mechanics, he just couldn't accept a theory that relied on probability. He made up his own paradox, with a cat in a box who was neither dead nor alive, to show that quantum mechanics didn't behave like a solid physics theory should.

Physicists who were not quanta experts, or were too lazy to do their homework, thought I had to be wrong because I was old and foolish. Lenard's gang, which now included most of German scientists, knew why my influence was shrinking: the world was beginning to understand that fake Jewish physics had failed in its devilish plan to poison pure Aryan science.

* * *

Podolsky went back to Caltech. I worked with Rosen on gravitation. Looking for that elusive link between gravitation and quantum mechanics, I tried to compress the mass of a star to the point where it becomes what is now known as a "black hole." I hoped the gravitational energy in the middle of the thing would be high enough to create particles that would seem to come into being elsewhere, having crossed a kind of singularity called an "Einstein-Rosen bridge." This manner of generating particles would explain why all the electrons in the universe have the same mass. We found equations, but failed to convince anyone that particles are indeed born this way.

Then we turned our attention to gravitational waves. A magnet or electric circuit produces a field. When the circuit changes or vibrates, it sends forth electromagnetic or "Hertzian" waves, which can be tamed to bring radio or television programs into your home. The gravitational field of a star can also change or vibrate in some cases—for example, when the star explodes, or when two stars rotate around each other. Then gravitational waves roam across the universe at the speed of light. We wrote the equations. Maybe someone will detect such waves in the future[37].

Rosen's "temporary" contract couldn't be renewed forever. Some Soviet university offered him a good position, so he left me. I took a new temporary assistant, Leopold Infeld, whom I had met in Berlin. With Banesh Hoffman, an English "worker" in the Institute, we showed how the equations of general relativity could yield equations for the movement of things.

* * *

[37] In 1979, Hulse and Taylor detected a loss of energy in a system of two stars rotating around each other. This could mean that they emit gravitational waves.

In the spring of 1935, when I should have gone to Europe for my summer jobs, I balked again. I just didn't feel like it. I hesitated, though. Not for the sake of my colleagues in Oxford or locked-up son in Zurich, but because I could have comforted my friend the second violin. She was now the queen mother. King Albert, who loved rock climbing, had fallen to his death in 1934 in the Belgian Ardennes. The new king, Leopold III, was Elizabeth's son.

We did leave America. We went to Bermuda, as we had to be out of the country to request immigrants' visas in an American consulate.

We rented a beach house in Connecticut. I found a pianist and played some music. I wrote a book about elementary physics with Infeld. He needed money, since Flexner had not renewed his temporary contract.

In the middle of the summer, some of our Princeton neighbors called us on the phone. "A pleasant old house has just been put up for sale on Mercer Street. We think you would like the trees in the garden." We bought the house. People joked that the *Institute for Advanced Study* should have been called *Institute for Advanced Salaries*. I was well paid, but I hadn't accumulated enough capital in my bank account to buy a house. Americans have a very realistic approach to money. A colleague advised me to sell a manuscript. It so happened that Margot had brought a suitcase full of old papers, which she had salvaged in Berlin. I found the manuscript of an article I had written in 1912. Although a big financial crisis was undermining the American economy, somebody paid a high price for it—more than enough to buy the house and renovate it.

While I played the violin, sailed and worked with Infeld, Elsa took care of the renovation. She opened a large window in my future office so I could look at the trees while meditating on the universe. She was tired and in poor health, but I thought the work would keep her from thinking about her dead daughter all the time.

Helen Dukas had been able to bring my portrait of Faraday from Berlin. I also hanged a portrait of Gandhi on the wall. He was the only politician I really admired

* * *

A publisher told me he was burying a "time capsule" that would be opened in a thousand years. He sent me a sheet of special extra-strong paper, guaranteed to last a thousand years, and asked me to write a few words for posterity. Here's what I wrote:

"Dear Posterity,

If you have not become more just, more peaceful and especially more rational than we are, or were, well, the Devil take you.

Having, with all respect, uttered this pious wish,

I am your (former) friend

Albert Einstein"

* * *

Soon after we moved into our new home, Elsa noticed that her eyes were swelling. She consulted some specialists, who diagnosed a severe circulatory and kidney weakness. They recommended complete rest. She stayed in bed for two months. Helen Dukas took care of the house. Watters had an electric refrigerator delivered to us, so we wouldn't have to go shopping every day. He liked Elsa and she liked him. His own wife was dead. He showed me her photograph when I was in his apartment (I used to sleep there when I spent a few days in New York City). I thought I might become a widower too. "The individual counts for little," I told him. "We place too much importance on the trivialities of living. Man is insignificant compared to the vast mysteries of the universe. "

My friend Marcel Grossmann died. I wrote to his wife that few people had helped me as much as he had. He had taken notes in the Polytechnikum while I was playing truant. He had asked his father to recommend me to the director of the Patent Office in Bern. He had collaborated with me on general relativity.

Elsa left her bed and we rented a house near a lake in the Adirondacks mountains. Watters was a frequent visitor. "Albert is in very good form," she told him. "He has accomplished a lot lately. He believes his latest work is the best he's ever done." She was happy when I worked a lot, but then, when we returned to Princeton in the fall and she had to take to her bed again, she was happy that I stopped working.

"You wander around like a lost soul, Albertle. My illness does upset you after all. I never thought you loved me so much."

She died on December 20th, 1936. She had never overcome the shock of Ilse's death two years before.

Mrs. Eisenhart, the wife of Princeton's dean, criticized my apparent callousness. "Your wife seems to do absolutely everything for you," she once told me. "Just exactly what do you do for her?"

Elsa had answered this kind of question in a letter to Watters, which he showed me after her death. "You cannot analyze Albert, otherwise you'll misjudge him. Such a genius should be perfect in every respect. But nature doesn't behave like this. Where she gives extravagantly, she takes away carelessly. You have to see him all of one piece. You cannot put him under one heading or another. Otherwise you have unpleasantness. God has given him so much nobility, and I find him wonderful, although life with him is exhausting and complicated, and in more ways than one."

I was fifty-eight. Infeld and Hoffmann suggested we take a break.

"You look exhausted, professor. Your skin is as white as chalk. We could stop at least a week or two."

"No, more than ever I need to work. I have to go on."

Bucky and Watters invited me to spend some time in this or that country house, but I refused. It is common knowledge that work is the best medicine against grief. I lived with my stepdaughter Margot, who had nursed Elsa through her illness and was very sad. Helen Dukas went on taking care of most practical things.

I wrote to Max and Heidi Born now and then. He taught in Edinburgh, in Scotland. As they had spent a year or two in India, she had become interested in Indian culture and wrote poems about yoga and what not. I sent news to Max. I told him that Rosen had gone to Moscow and that I was now working with Infeld, but that helping Jewish refugees was difficult because of the antisemitism in Princeton. I explained how I tried to consider heavenly bodies as singularities of the gravitation field. I told him that antisemitism was a small problem in the United States compared to the terrible racism against black people. I did like America, though. "I have settled down splendidly here," I wrote. "I hibernate like a bear in its den, and really feel more at home than ever before in all my varied life. This bearishness has been further enhanced by the death of my mate, who was more attached to human beings than I."

All the scientists who had spent years in Berlin or Göttingen were now coming and going across the ocean. Weyl told me that Max Born, whom he had seen in England or somewhere, mentioned my letter: "Einstein writes five pages about his research and his assistants and the sorry condition of black people in America. Then, in the middle of a paragraph toward the end, he announces his wife's death incidentally. Isn't it strange? Despite all his kindness, sociability, and love of humanity, he is totally detached from his environment and the human beings included in it."

* * *

I often walked to the university with a neighbor who taught political science. He knew I was working hard, as he could see the lights in my office late at night.

"Do you feel you are nearing your goal, professor?" he asked me.

"God never tells us whether the course we are following is the correct one. I have tried ninety-nine solutions and none works, but I have learned a lot. At least I know ninety-nine ways that won't work. I publish one of them now and then."

"Why would you do that?"

"To save another fool from wasting six months on the same idea."

The Institute was still located inside the university. I liked to attend physics seminars and meet promising students. In this manner, I could try to keep abreast of the latest

discoveries. In the Princeton cinema theater, they were playing a film where an Egyptian mummy came back to life—with unpleasant consequences, I suppose. To the students, I was just another mummy. My theories hadn't aged, though. I was thrilled when the young physicists explained the clever experiments they had set up to verify the equivalence of mass and energy. They measured and studied the energy of radioactivity, hoping to exploit it in some way.

Marie Curie (who had died in 1934) used to tell me that she studied radioactivity because nobody else did. Such a worthless subject was considered fit for a woman scientist. Things had changed a lot. Everybody hoped to find the new philosopher's stone: unlimited energy!

In radioactivity, the atom's nucleus spits various bits of stuff: alpha rays, similar to helium nuclei; beta rays, which are just electrons; gamma rays, made of pure energy. When an atom of uranium emits an alpha ray, it loses two protons. This turns it into an atom of thorium. A similar transformation takes place when thorium also emits an alpha ray. Thorium turns into radium, which turns into radon, which turns into polonium, which turns into lead. The nuclear reaction stops there, because lead is stable. The whole process smacks of alchemy. Instead of turning lead into gold, however, nature starts with precious uranium, worth much more than gold, and ends with vile lead. At every step, a little mass vanishes and some energy appears.

The American Association for the Advancement of Science invited me to be its guest of honor in Pittsburgh, where it held its annual meeting. I talked about mass and energy. I spoke in English to people who were not the usual university crowd, so sometimes they didn't understand a technical term. Watters saved my life by acting as an interpreter. American people are more lively than Europeans. I had covered the blackboard with equations and formulas. After going through some of the easy ones, I said: "So you see, it's quite simple". They shouted: "No! No!"

One of the journalists attending the lecture asked me a question: "There's lots of energy in your equation, professor. Do you think it will be possible to release it by bombardment of the atom?"

"I feel it will not be possible for practical purposes. The atom breaks down in the phenomenon of radioactivity, but we can't control it. Besides, it produces very little energy. Splitting the atom by bombardment is like shooting at birds in the dark in a region where there are few birds."

* * *

For a long time, instinct or luck had brought me as much success as a person could wish. This made me arrogant and stubborn, I guess. I kept looking for the united field

although I wasn't getting anywhere. At least my instinct set me to the right path when it convinced me to forgo my pacifism. I was sorry that French and English pacifists had not followed my example. Even the governments seemed blind to the danger and reacted in a shamefully mild manner to German aggressiveness. In 1938, Hitler gobbled up Austria, then annexed part of Czechoslovakia. The French and the English met the Germans in Munich and accepted the done deeds.

I often thought about my friend the queen mother of Belgium. Her son, Leopold III, instead of siding with France and England, declared his country "neutral"—as if you could remain neutral when facing Hitler.

When I wrote to Elizabeth, I told her about my life and my thoughts.

"Dear second violin,

"I just came back from Long Island, near New York, where I spent my summer vacations. I rented a house near a place called Peconic, on a quiet cove, next door to some Princeton colleagues and amateur musicians. We played Beethoven's ninth quartet, but I have to admit that the final fugue is a little too fast for my old bow. I find Beethoven too dramatic and personal, actually. While Bach and Mozart are my favorites (but don't expect me to say whether one or the other means more to me), I am quite moved by Schubert right now. I admire his superlative ability to express emotions and his amazing power of melodic invention. I always feel that Handel is good, but that he has a certain shallowness. I could say the same thing of Mendelssohn. Schumann and Wagner lack structure.

"My son is living in America now with his family. My sister, Maja, just came over from Italy. Although Mussolini isn't persecuting his own Jews like Hitler, he did expel foreign Jews. Her husband, Winteler, didn't want to cross the ocean. He is living in Zurich with his sister and her husband, my good friend Michele Besso.

"I have two new assistants, Bergmann and Bargmann. People pretend they never know who is Bergmann and who is Bargmann, but they are quite different from each other. I don't know whether I'll discover anything with them, or indeed before death comes calling. As Lessing[38] said: 'The search for truth is more precious than its possession.' I am grateful that fate gave me an interesting and maybe useful life, anyway.

"I do regret that I can't immerse myself in work as deeply as I used to. When I was looking for the equations of general relativity, I forgot the war raging around me. Now I just can't escape the awful feeling that Europe will soon face new horrors. The tragedy seems to be already written on the tablets of fate, so nobody tries to avoid it. Before

[38] German writer (1729-1781).

the life of nations moves forward again, they will have paid a heavy price in human lives."

In 1939, I celebrated my sixtieth birthday.

"You look much younger," Watters told me.

"Looks can lie. I find my physical powers decreasing. Taming the boat become harder. Also, I require more sleep now. My mental capacity hasn't diminished, thank God. I grasp things as quickly as when I was younger."

"Even if your mental capacity decreased a lot, we ordinary mortals wouldn't notice."

"My particular ability lies in visualizing the effects and possibilities of a theory. I grasp things in a broad way. I don't like to do the mathematical nitty-gritty. I leave it to my assistants! Before looking for meaning and logic, I look for beauty. When I'm judging a theory, I ask myself: 'Is this the way I would have arranged the world if I were the Good Lord?' It is quite obvious to me that the Old One likes things simple and beautiful."

* * *

I spent the summer in the Peconic house again. I sailed in the bay, played music with my neighbors, went into town to eat an ice-cream cone. My three women—Margot, Helen and Maja—came often. I was happy. I liked to sit in the sun at the bottom of a dune and look at the dance of surf and foam. The drops of water have been jumping for eons. As we can't pin down the precise causes of each drop's movement, it seems utterly random to us.

Let me quote the great Newton:

"I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore and diverting myself in now and then finding a smooth pebble or a prettier shell than ordinary whilst the great ocean of truth lay all undiscovered before me."

Hey, miss Peggy! Here begins the story of my involvement with this awful bomb.

In July, 1939, as I was working lazily on the patio in front of my house, I saw two men in city dress coming across the dune with a boy. I was barefoot, I wore an old sweater full of holes and a pair of short pants, so I found their suits, ties, black shoes and felt hats rather ridiculous. When they came close, I recognized one of them, a chubby fuzzy-haired fellow. I also knew the other, actually.

"Szilard! Wigner! Hungary in Long Island! Only Von Neumann is missing… I thought you had settled in England, Szilard."

"Nice to see you again, Einstein. I've been working in Columbia University for the last few months. I went to Princeton to find you. There I met Wigner, who drove me

here in his car. This young gentleman's name is Jimmy. Say, this is the end of the world."

"You had a hard time finding me?"

"They told us to ask for the house of Dr. Moore in Peconic. We've crisscrossed Peconic for hours. Nobody knows this Dr. Moore."

"I don't know him either. He owns this house."

"We were ready to go back to New York City, but then I saw Jimmy and asked him whether he knew where Professor Einstein lived. He brought us here."

"May I go now, sir? Will you be able to find your way back to the car?"

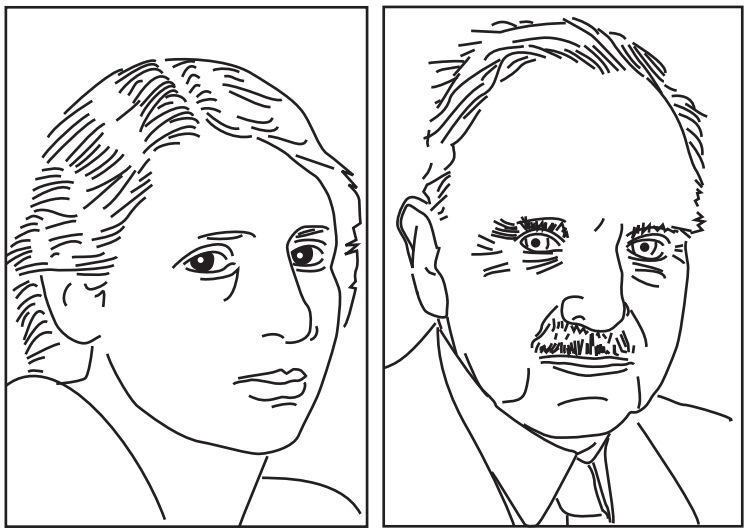
"Yes, Jimmy, thank you. Here's a dime to buy some candy."

"Now tell me, Szilard, why you've decided to trek over the dune with these ballroom shoes. There must be a good reason."

"Niels Bohr said he saw you briefly in Princeton. He worked with Wheeler, then went back to Denmark. He told you nothing, I guess."

"Told me nothing about what?"

"I'll reveal a secret matter to you. Did you know that Lise Meitner and Otto Hahn were bombarding uranium at the Kaiser Wilhelm Institute?"



"Everybody is bombarding uranium, Szilard. The daughter of Marie Curie… The Italian fellow, Fermi. I met him when he was Ehrenfest's assistant in Leyden… It's an old song. I remember that Rutherford bombarded nitrogen with alpha rays around 1920 and produced some oxygen. They dream of harnessing the atom's energy. Some people are making experiments in Princeton. They spend more energy than they get. I've listened to a lecture or two. I don't know much about that subject. We all need to find a way of wasting our time, I guess."

"Still after the unified field?"

"The ultimate equation is just around the corner."

"Listen, Einstein. In 1934, I filed a secret patent with the British admiralty."

"A secret patent? Is there such a thing?"

"The military dwell in their own separate world. They have their own clothes, their own food and their own patents. Anyway, when Chadwick discovered the neutron, in 1932, I thought it would make an ideal bullet to shoot at the nucleus. Much better than alpha rays. As it is neutral, the protons of the nucleus do not repel it. If you break a nucleus with a neutron, it is possible that two neutrons escape and go break two nuclei, which will send forth four neutrons, and so on."

"*Ach*, I have never thought about that… Quite frightening. Are you sure it is possible?"

"I call it a chain reaction. My secret patent covers the theory. Breaking nuclei with neutrons is possible, but can we really do it? Fermi found a way: you need to slow down the neutrons with hydrogen. So now it seems that Otto Hahn actually split uranium nuclei."

"In Berlin? When everybody says that war is coming? You're scaring me, Szilard."

"I came here to scare you, precisely. But wait for the rest of the story. You know Lise Meitner ?"

"I met her thirty years ago in Salzburg. I saw her now and then in Berlin."

"You know she's Austrian and Jewish. In 1938, when Austria vanished, she became German and so the Institute threw her out as a Jew. She found refuge in Sweden. Hahn went on with the experiments they were doing together. He bombarded uranium with slow neutrons. He used some barium to carry away whatever small quantity of radium might appear. As a good chemist, he weighed all his residues carefully. He found more barium after the bombardment than before. He wrote to Lise Meitner, in Sweden."

"He didn't file a secret patent, like you?"

"You're joking, but just imagine the Germans use the chain reaction to make a bomb… We're lucky they've expelled all their best scientists. Otto Hahn experimented and Lise Meitner explained. He questioned her, as he always did: 'Where does this extra barium come from?' They'd been working together for more than thirty years."

"I know Hahn. He is no fool. He protested strongly when the Jews were sent away, then he kept Lise with him as long as he could. He doesn't believe in Aryan science and all that junk. He thinks knowledge belongs to everybody. He knows what he has found and he wants the rest of the world to know."

"Writing to Lise was certainly the best way to spread the news. Her nephew, Otto Frisch[39], was working in Copenhagen with Niels Bohr. Toward the end of December, 1938, he went to Stockholm to spend the Christmas holiday with his aunt. During a walk in the woods, Lise showed him the letter and explained what had happened: Otto Hahn had broken uranium nuclei. This can produce barium, krypton and other elements that weigh about half as much as uranium. Frisch suggested the name 'fission' for the splitting of the nucleus. He went back to Denmark and told Bohr about it. Bohr compares the nucleus to a drop of water. If its volume gets too big, its surface can't hold together anymore and it breaks down. His work with Wheeler seems to show that the neutrons break the nucleus of uranium 235[40], which is especially unstable because it has an uneven number of neutrons. The main isotope is uranium 238. The proportion of 235 is one atom out of one hundred and forty."

"This is good news, in a way. Uranium 238 absorbs the neutrons and prevents your chain reaction."

"Don't rejoice too soon. Irène Joliot-Curie and her husband have reproduced Hahn's experiment and shown that the nucleus of uranium 235 does emit neutrons when it breaks, as I had predicted[41]. Fermi confirmed it here in New York."

"Fermi is in New York?"

"He went to get his Nobel prize in Stockholm and decided not to go back to Italy. His wife is Jewish. They have milder racial laws than the Germans, but his children would be barred from several professions."

"I'm thinking. All you have to do is separate uranium 235 from 238. Then you can make a bomb. It's not an easy task, though."

"Who'll do it first? The Germans? Whoever wants to try needs huge quantities of uranium to extract the active isotope from. I thought about you."

"Me? Do you think I own an uranium mine in my Princeton garden?"

"Most of the uranium ore is in the Belgian Congo. You, my dear Einstein, know the queen of Belgium personally."

"Queen mother. Her husband, the late king Albert, had told me he didn't have a say in his country's affairs. She's only the new king's mother. Besides, she's born in Germany. Tell you what: I'll write to someone I know in the Belgian administration. They shouldn't sell the Congo uranium to the Germans, is that it?"

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[39] He was known then as Robert Frisch. He switched to his middle name when he worked in Los Alamos, because there were already too many Roberts there.
[40] The nucleus of an uranium atom always has 92 protons. The number of neutrons can vary. Two atoms with the same number of protons but different numbers of neutrons are called "isotopes." The uranium 235 isotope (92 protons, 143 neutrons) is radioactive and unstable.
[41] The French team even filed a patent for an "atomic bomb" in 1939.

* * *

Szilard had prepared a letter, actually. I just had to sign it. He went back to New York with Wigner. I started thinking about the separation of uranium. The 235 isotope is three neutrons short when compared to 238, so it's lighter in the proportion of 3 out of 238. Let's say some grains of sand in the dune are slightly lighter than the rest. How would you separate them?

Ten days later or so, Szilard came again.

"You found yourself a new driver, Szilard."

"Wigner is gone to California. Let me introduce Edward Teller, another countryman."

"I've heard about you. You worked with Heisenberg in Leipzig… So, Szilard, did you send the letter?"

"Well, to tell you the truth, no. I wanted to clear the whole thing with the American authorities first. I talked to Alexander Sachs, a banker who knows President Roosevelt. He told me the President has a lot of respect for you, Einstein."

"I had dinner with him in the White House."

"Sachs says you should write to Roosevelt."

"Sure. The same thing? Belgian uranium?"

"I talked with Sachs, Wigner and Teller. We should go straight to the point."

Szilard had written a letter in English. He read it to me.

"Sir:

"Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation seem to call for watchfulness and, if necessary, quick action on the part of the administration. I believe, therefore, that it is my duty to bring to your attention the following facts and recommendations.

"Joliot in France, as well as Fermi and Szilard in America, have shown it may become possible to set up nuclear chain reactions in a large mass of uranium. Extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port with some of the surrounding territory. However, such bombs might prove to be too heavy for transportation by air."

This was just the beginning of a long letter. When I wasn't sure I understood a sentence, Szilard translated it into German. I made some remarks in German. He amended the English text with Teller's help. We worked hard. In the rest of the letter,

we recommended that some trusted person be chosen secretly to act as coordinator between the government and the people doing chain reaction research in Harvard, Columbia, Princeton, California. This person would also talk to diplomats so they'd explain the uranium problem to the Belgians, get funds from government services or private companies, and so on.

We added that Germany had acquired the large Joachimsthal uranium mines[42] by seizing Czechoslovakia and that people were working on uranium in the Kaiser Wilhelm Institute.

I signed the letter.

Miss Peggy, you remember I wrote: "Here begins the story of my involvement with this awful bomb" a few pages ago? Well, here ends the story of my involvement. I did write the equation $e=mc^2$, but this is just a law of nature. I'm sure people would have found how the sun produces its energy eventually. I never did any research on uranium, alpha rays, neutrons. If I had known how things were to turn out, I wouldn't have signed the letter. Today, I regret it. Sometimes, I think it is the greatest mistake of my life.

Oh, but you should try to understand one thing. If I hadn't sent the letter to President Roosevelt, the Americans would have made the bomb anyway. While Bohr had come to America and talked to Wheeler and others, Frisch had gone to England. Teams were already splitting the nucleus of uranium on both sides of the ocean. The only difference is that my name wouldn't have appeared in the story of the bomb's genesis. You wouldn't have said "your bomb" in a spiteful tone and we could have become friends.

Lise Meitner in Sweden and Max Born in Scotland refused to do any research that could be used to make weapons. The scientists can't always prevent the military from using their discoveries, but they can avoid encouraging them.

* * *

On September 1st, 1939, Germany invaded Poland and started World War II. Although Americans didn't seem to notice that a war had begun, much less a world war, President Roosevelt was following the events closely. Sachs thought this wasn't the best of times to give him our letter. He waited until October 11th.

Having spent an evening with Roosevelt, I knew he was a clever man. He interrupted Sachs even before he had finished reading.

"Alex, what you're after is to see that the Nazis don't blow us up… This requires action"

A few days later, I received a letter from the President.

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[42] These were silver mines in the Middle Ages. Some common silver coins were called "Joachimsthaler," then simply "Thaler." This is where the word "dollar" comes from.

"My dear Einstein,

"Thank you for your recent letter. I found this data of such importance that I have convened a board consisting of the head of the Bureau of Standards and chosen representatives of the Army and Navy to thoroughly investigate the possibilities of your suggestions regarding the element of uranium."

As soon as October 21st, that committee met with Fermi, Szilard, Wigner and Teller. Then nothing happened. The generals and admirals didn't agree with the President that "this required action."

Szilard was furious.

"You know what these fools say? 'You don't win wars with new gadgets, but with foot soldiers.' They joke that we should ask you to make a 'death ray.' Some of them actually believe you invented such a thing in Germany, but didn't tell the Nazis."

In March, 1940, Szilard asked me to sign a new letter to Roosevelt. It contained the latest news from Germany: Werner Heisenberg was in charge of the uranium research at the Kaiser Wilhelm Institute. He worked with Carl-Friedrich von Weizsäcker, a specialist of the nuclear reactions that take place inside the stars. We didn't know how fast they were progressing, but at least they were moving, which was more than we could say. Also, the Joliot-Curie had published results in a French physics review. This was to be be avoided, as friends and enemies could read it.

The committee met again. They invited me to attend, but I declined the offer. I said I had the flu, which was a kind of half-truth. Well-informed friends had told me that people in government cared neither about the war in Europe nor about uranium, so I preferred not to waste my time.

I learned after the war, from other well-informed friends, or maybe the same, what happened next. A delegation of first-rate English scientists crossed the ocean and went around the labs to check how the research was coming along. "They haven't started yet," the delegation reported. In England, Frisch and others had worked out the theory of the bomb on paper. They were stuck because they lacked uranium ore and the huge quantities of electricity needed to separate the useful isotope. America the rich was supposed to provide the ore and the power. Churchill scolded Roosevelt: "More than two years have passed, and you've done nothing! It seems you gave one thousand dollars to a team in Columbia university. Is this a joke? If you were bombed by the Teutons like we are, you'd worry in earnest about their next bomb."

Roosevelt found what you call "can-do" men to head a more efficient committee. The grand endeavor known as *the Manhattan Project* was born during a White House meeting on December 6, 1941. Your countrymen were in no hurry to follow the advice

contained in my letter. I'm sure you notice, miss Peggy, that this date is the very eve of the day when the American fleet was sunk in Pearl Harbor. Three days later, Hitler declared war on America.

Most of my colleagues vanished suddenly. I supposed they were working in some secret lab out West. I was told I could reach them by writing to a PO Box in Sante Fe, New Mexico.

Nobody told me anything. Scientists who worked for the Manhattan Project weren't allowed to talk about it. One of them, Vannevar Bush, remembering I had studied the movement of gas molecules long ago, gave me a problem to solve: if a gas is diffusing across a porous barrier, what is the relationship between the diffusion speed and the weight of the molecules? This was easy. I was glad I could help, but nobody asked me anything else. Aydelotte, the new director of the Institute for Advanced Study (the board had sent Flexner away in 1939, as everybody was complaining about him), told me Bush had received instruction not to work with me. Once more, my well-placed friends explained the mystery to me after the war. The FBI distrusted me. They didn't know the difference between pacifism and communism, so they considered me a dangerous communist. Let me tell you something really strange about this: police agencies like the FBI are ready to listen to the craziest rumors if only they come from colleagues belonging to similar agencies, for example the Gestapo. The Germans described me as more than a dangerous communist: the leader of the famous Jewish plot to dominate the world, a secret agent reporting to Stalin in person, the inventor of a death ray that could shoot down airplanes, and so on and so on. Some of it at least might be true, the FBI thought. They took great care to monitor Gestapo ramblings, but they didn't even know that I had played a part in the Manhattan Project by writing two letters to the President.

Of course, I understood what Vannevar Bush was trying to do. He had probably combined the uranium atoms with chlore or fluorine to obtain gaseous molecules, which he wanted to send across porous barriers. As the lighter molecules cross the barrier a little faster, their proportion in the gas increases slightly. By using many successive barriers, you can get a greater proportion of the uranium 235 isotope.

* * *

Wolfgang Pauli came to Princeton. He had been teaching in the Zurich Polytechnikum since 1928, but he didn't feel safe there anymore. The Nazis controlled all of Europe except England and Switzerland. If they wanted to go and get the Jews in Switzerland, they didn't need to cross a sea, but just a few narrow lakes. The Swiss might even decide to expel the foreign Jews to prevent a German intervention. Pauli

didn't consider himself Jewish, but his father was a converted Jew, which was enough for the Nazis.

Although he had often criticized me, I was glad to see him. We walked together and talked for hours about the universe and all that. He had become somewhat mystical in Zurich, under the influence of Dr. Jung—a famous psychoanalyst. He said duality played a great part in the structure of the universe and in our lives: wave and particule, good and evil, yin and yang.

"He told me he met you, Einstein."

"Who met me?"

"Dr. Jung."

"True. When I lived in Zurich, I attended a few formal dinners in his house. I found his ideas about the 'collective unconscious' rather muddled."

"You shouldn't apply the same criteria to ideas in psychology as in physics. He gave me good advice: to look for archetypes of knowledge in the work of Kepler, Newton, Maxwell and the other great scientists of the past."

"So did you find archetypes?"

"I certainly did. For example, you…"

"Me? I am an archetype?"

"That's right. You're world-famous because the collective unconscious sees in you the very type of the lonely and absent-minded professor, living so far from daily reality that he can unveil the deepest secrets of the universe. An incarnation of the mythical Dr. Faust, in a way."

Another luminary of the Institute for Advanced Study walked and talked with us: Kurt Gödel, an Austrian mathematician who had left his country in 1938. He wasn't Jewish, but many people believed he was, so life under the Nazis would have been dangerous. The staid Austrians and Germans didn't really know what "Jewish" meant. They used the word as a synonym for "strange" or "different from the others." Gödel was definitely strange. He considered that most of the food sold in stores was poisonous (especially in America), so he ate very little and looked like a ghost. I think he had spent time in psychiatric asylums.

People had left Germany in 1933 and Austria in 1938. The invasion of France in May, 1940 also sent Parisians across the ocean. Two French pianists, Robert and Gaby Casadesus, and a Czech composer living in Paris, Bohuslav Martinu, now taught in Princeton. Martinu wrote five easy pieces for me, which I played with one of the pianists. I gave Martinu the manuscript of a small article I had written.

My current manuscripts weren't as valuable as my old ones. A *Book and Authors War Bond Committee* sold manuscripts signed by famous authors to buy war bonds. I gave them an article about fields I had just written with Bargmann, but they weren't satisfied.

"We would have preferred a 1905 manuscript."

"I didn't know they would become more precious than gold, so I threw them away. I just kept printed copies."

The Princeton librarian found a way:

"Why don't you copy a printed article by hand, professor?"

"Really? Why not? It's an excellent idea! When others are doing so much for the war, this is the least I can do."

Helen Dukas dictated my *On the Electrodynamics of Moving Bodies* to me. I had to stop now and then.

"Did I really write this?"

"Look for yourself, Herr Professor…"

"Well, I could have said the same thing more simply."

An insurance company paid 6,5 million dollars for the manuscript. A few pages of paper aren't worth that much. I thought there was a kind of fetishism involved, which made me uneasy.

* * *

Szilard came now and then.

"With so many tailors in New York, you could buy a new suit, Szilard. You already wore this one when we worked together in Berlin twenty years ago."

"Look who is giving sartorial advice!"

He never mentioned New Mexico, but he knew what was taking place there, obviously. He always brought first-rate information.

"Heisenberg and von Weizsäcker have to overcome many tall hurdles. They don't know what to do about you, to begin with."

"About me? Why would they bother about me? An old man smoking his pipe across the ocean…"

"You and your Jewish theory! Lenard and his quacks have convinced the Nazi leaders that relativity is a Jewish joke. They need to backtrack in some way, but they must be very careful, lest they be accused of having become puppets of the Jews. So they're busy rewriting history. You've stolen your ideas from honest men, you know."

"Lorentz invented my theory?"

"He did indeed. He wasn't German, but at least he was 'Aryan.' As he never came really close to relativity, they say you also stole from Poincaré."

"A Frenchman? I remember that Lenard had replaced the ampère by the weber in his lab."

"They prefer a Frenchman to a Jew. They lost months because of this foolishness, anyway."

"Good. Then maybe you won't have to pursue your project."

"What project?"

"Okay, I know nothing of a project in New Mexico."

"Whatever happens there or elsewhere has become some sort of national priority; so they don't consult the scientists. We are requisitioned like soldiers and are just allowed to obey orders."

"At least you don't have to prove that your equations are Aryan."

"This would be difficult. All the Jewish physicists work on that project you know nothing about—except you, actually."

"You seem to know all kinds of people. You could tell them that I'm willing to help my new country in these tough times."

"I remember you as a staunch pacifist."

"When the moral values which sustain human life are threatened, we must defend them, by using force if necessary."

* * *

A Navy officer came to see me in 1943.

"Would you accept to do some theoretical work on explosive shock waves, professor?"

"Well, I can try, I guess."

"For example, we wonder whether we could get more power by launching two torpedoes at the same time. How can we be sure that the shock waves will enhance each other?"

"And not cancel each other?"

I found a solution. They tried it and it worked. They told me that they had saved five hundred thousand dollars (or some such sum) by avoiding the old-fashioned method—trial and error. They only gave me twenty-five dollars a day, but this was more than enough, as I enjoyed the wonderful pleasure of feeling useful.

"I am in the Navy," I told Pauli, "but I was not required to get a Navy haircut."

I saw Pauli every Thursday. We had tea at my home with Kurt Gödel and the English mathematician, philosopher and pacifist Bertrand Russell, who had arrived in Princeton

in 1943. We talked about reality. I was the only one to believe that we would be able to describe reality completely someday. They called me a hopeless idealist. In his most famous theorem, Gödel had shown that it was impossible to build a perfect mathematical theory. Russell and Hilbert, who had tried, were bound to fail. This was similar to the Heisenberg uncertainty principle, Pauli said. Building a complete theory of nature was impossible and would remain so forever.

Russell was slightly older than me. His white mane was as long as mine, but not as tangled. Few philosophers knew science as well as he did. He said that physicists shouldn't try to think like mathematicians.

"Gödel, while your mathematical systems are human inventions, we haven't created the universe. The inner reality of matter escapes us today, but it doesn't mean that we'll never know. To a philosopher, it doesn't make such a great difference. Even if our knowledge increases, we'll never be able to answer the ultimate questions: What is this universe? How did it appear (if it appeared)? Why does it exist?"

We commented the war news, of course. At the beginning of 1943, the Soviets beat the Germans in Stalingrad. We hoped the nightmare would soon come to an end. Nobody has heard of the terrible Nazi crimes yet, but we knew that millions had died already.

On Thursday, I had tea with Pauli, Gödel and Russell. On every other Friday, I received another guest: George Gamow, who worked for the Navy, like me. He was a jolly Russian giant, whom I had met a few times in Europe. He had just published one of the best—and funniest—books about relativity for the general public, *Mr. Tompkins in Wonderland*. You should read it, miss Peggy! He brought new requests from the Navy brass. Can we invent an electromagnetic gimmick that will provoke the explosion of a torpedo when it comes close enough to a ship, even if we don't have a direct hit? So now I was contributing to lethal explosions, like Nernst and Haber during the previous war. Bucky invited me to spend some time in his summer house, but I preferred to stay in Princeton and work for my country.

The American newspapers didn't know I had become such a fierce patriot. Some of them called me "the refugee Einstein." They didn't like Russell either and called him "Russell the nudist." He had spent six months in jail as a conscientious objector during the great war. Although he admitted the necessity of the current war, he still considered himself a pacifist.

"The German people have embraced the Nazis because we treated them too harshly after the war. This time, we'll have to forgive them sincerely and help them rebuild their country."

"What are you saying, Russell? They've destroyed Europe. The European culture, the civilized life, have vanished forever. All the Germans have marched behind their Führer like a single man. We must punish them without pity, so as to convince them not to try again."

* * *

I saw Niels Bohr in 1943.

"How did the Germans let you leave Copenhagen?"

"I escaped with my son. We crossed the straits that separate Denmark from Sweden on my sailboat. The English sent a special high-flying warplane to Sweden for us. I had to lie in the bomb rack or whatever it's called, in place of the bombs. They gave me a helmet, but it was too small…"

"I know lots of people with big heads, but yours is the largest. A real pumpkin!"

"I didn't hear the instructions they gave me in the headphones, so I didn't put the oxygen mask on when they climbed to twenty thousand feet. They needed to fly higher than the Germans fighter planes, you see. I fainted. They thought me dead."

"Nice death for a physicist."

"They revived me when we landed in Scotland. They said the Americans needed me for a secret project. They gave me a fake passport. My name is John Baker, now. I am not supposed to tell anybody, not even you."

"I hear bits and pieces, so I have a pretty good idea of what they're doing. Fermi managed to start a controlled chain reaction in Chicago toward the end of 1942, by alternating uranium bars and graphite bars that slowed the neutrons. Then they went to some secret place in the desert. I wonder what the Germans are doing."

"Heisenberg came to see me in Copenhagen. He says he wants to use uranium 238 to generate electricity, since our embargo prevents Germany from buying petrol."

"So he pretends his purpose is peaceful. Did you believe him?"

"Heisenberg was my assistant. I know him well. He is honest. He decided to stay in Berlin and prepare the future by working with students. People will be needed to rebuild Germany after this disaster. He lives in fear. I had the feeling that he was suffering terribly… When they asked him about a bomb, he told them it would take at least four or five years, knowing they refuse any project that can't be accomplished in six months[43]."

"I'm worried, Bohr. I'm afraid the next war will be even worse than this one. Imagine that several countries build these new bombs. The military will want to start

[43] Today's historians aren't as gullible as Bohr. Heisenberg failed because he followed a wrong road and was too stubborn to admit his error. The Americans succeeded because they tried many different methods.

preventive wars. There are influential scientists in all the countries. They should get together and warn the politicians."

"I thought so too. I was lucky enough to meet the English prime minister, Winston Churchill, then President Roosevelt. I suggested they tell the Soviets about the new bomb. Spreading the knowledge is the best safeguard against its misuse. They didn't like my suggestion. I saw I'd better not insist, lest they send me to some camp as a dangerous suspect. This isn't a scientific project, Einstein, but a military one. They don't want our advice. They know that Germany won't make such a bomb. They're already thinking of a war against the Russians."

* * *

During the year 1944, the Soviet army kept crawling westward. On June 6th, the Americans and English armies landed in Normandy. It was obvious that the Germans couldn't win the war anymore.

On March 25th, 1945, a chubby frumpy visitor came to Mercer Street: Szilard.

"How are things in the desert, Szilard?"

"I can't tell you anything, Einstein. I do need to talk to you, though… Things are not going so well, actually. Do you remember your letters to President Roosevelt?"

"Of course."

"You warned him he had better hurry if he wanted to make a bomb before the Germans. Now the Germans have given up any idea of making a bomb. They're crushed and will surrender soon. So why do we continue?"

"I talked to Bohr last year. He says the people in charge of the secret project are not interested in knowing what the scientists think."

"Precisely. The generals want to try their new toy. They say the war ain't over till Japan cries uncle."

"Japan isn't Germany. They don't intend to make this new bomb."

"I wouldn't bet my head on that. What's for sure is that they have even less petrol and electricity than the Germans, so it would take them years to separate the uranium. Let me tell you what many scientists think: our politicians don't care about Japan. They want to impress the Soviets. Show them what America can do."

"You mean they'll attack Japan with this bomb just to send Stalin a message?"

"Einstein, we must stop this craziness. I want to see Roosevelt and talk to him in the name of the scientists. If you could write one more letter…

We wrote a shorter letter than the previous one and I signed it again.

"Mr. President,

"The terms of secrecy under which Dr. Szilard is working at present do not permit him to give me information about his work; however, I understand that he now is greatly concerned about the lack of adequate contact between scientists who are doing this work and those members of your cabinet who are responsible for formulating policy. In the circumstances I consider it my duty to give Dr. Szilard this introduction, and I wish to express the hope that you will be able to give his presentation of the case your personal attention."

I had guessed what was brewing, of course, but I had to pretend I hadn't. We both knew that the generals were stupid enough to accuse Szilard of having revealed strategic secrets to me.

Szilard was very careful, or maybe too careful. Instead of going directly to the President's office, which might have aroused the curiosity of his military aides, he solicited Mrs. Roosevelt, whom one of the scientists knew well. She answered that the President would see Szilard on May 8th, 1945. As you certainly know, miss Peggy, President Roosevelt died suddenly on April 12th, 1945.

When he was Vice President, Truman had known nothing of the Manhattan Project. He met Szilard and read our letter. This whole business was so new that he didn't know what to think. As he didn't want to take a hasty decision, he sent Szilard to Byrnes, the Secretary of State, who was firmly in favor of using the bomb. Byrnes listened to Szilard politely and dismissed him politely.

Szilard wrote a petition with James Franck, one of the most respected scientists around. I knew him well in Germany, as he was only three years younger than me. He had found a convincing proof for Bohr's theory of the atom and received the Nobel prize in 1925.

The petition warned that whatever military gain the bomb might bring would be offset by the blow to the moral standing of the first nation to use such an awful weapon. It then suggested to explode the bomb on some desert island near Japan. Many scientists signed it in Chicago and other places, but in Los Alamos (by that time, I knew the name of the secret place in New Mexico), Oppenheimer asked the military censors to intercept it. Many Los Alamos scientists knew of the desert island option and favored it. Not Teller. Do you remember him? He had driven Szilard to my house in Peconic in 1939. He said this toy bomb didn't really matter. He wanted to make a much more powerful bomb, using the hydrogen fusion reaction that takes place in the sun. With such a bomb, the end of the world would become possible, so no country would dare begin a war…

A few brave men, for example Harold Urey and Jospeh Rotblat, resigned from the Manhattan Project when they understood the bomb wasn't needed against Germany.

* * *

I went to stay with the Bucky family at lake Saranac, where I had spent my last vacations with Elsa, in 1936.

On the evening of August 6th, Helen Dukas entered my office without knocking, which was very unusual. She seemed scared.

"Herr Professor, they just announced on the radio…"

"What's wrong, Helen? What did they announce on the radio?"

"In Japan, a bomb… They destroyed a whole city with a new bomb!"

"Oh, *Weh*[44]! They've done it…"

* * *

The energy of the Hiroshima bomb was due the fission of uranium 235. On August 9th, the Americans dropped a second bomb on the city of Nagasaki. It didn't use uranium, but plutonium, a new element produced in nuclear reactors. I thought the military had wanted to compare the two kinds of bombs.

On August 11th, a journalist came to the lake to interview me. I felt I had to fight a kind of irrational panic which was already sweeping the world.

"In developing atomic energy, which we should properly call 'nuclear energy,' science did not draw upon supernatural strength, but merely imitated the action of the sun's rays. Atomic power is no more unnatural than when I sail a boat on Saranac Lake."

"Have you worked on that bomb, professor Einstein?"

"Not at all. I am interested in the bomb in the same way as any other person. Perhaps a little more. However, I do not feel justified to say anything about it. I hope we shall use atomic energy for commercial purposes someday, for example to make electricity."

Before the end of the year, an authorized story of the bomb's genesis was published by some government bureau. It mentioned my letters to President Roosevelt. People barely knew Oppenheimer, the scientific leader of the Manhattan Project. They knew neither Szilard nor Fermi, Bethe, Wigner, Teller, von Neumann, Weisskopf, Rabi, Alvarez, Kistiakowski, Bohr, Otto Hahn, Lise Meitner and Otto Frisch—but they knew Einstein… That's when public opinion called me the "father" of the bomb.

I kept trying to set the record straight whenever I met a journalist.

"I have only signed that letter. I hadn't even thought that a chain reaction was possible. If I had known about the Szilard-Franck petition, I would have signed it. The

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[44] This is the same word as the English "woe."

only way to save civilization now is to create a world government and edict laws to protect the security of nations. As long as sovereign States continue to have separate and secret armament programs, new wars will be inevitable."

Szilard founded an Emergency Committee of Atomic Scientists with Urey, Rotblat, Weisskopf, Bethe and others. I accepted to become its chairman, but I knew the whole thing was useless. Research on the hydrogen bomb had already started under Teller's leadership. This new bomb is supposed to be so powerful that it takes a uranium or plutonium bomb to start it. The United States will soon have it, then the Soviet Union and other countries. If you don't want mankind to vanish, you'll have to do something about it, miss Peggy.

* * *

Pauli and Russell went back to Europe. I was sad when Pauli left. I told him I considered him my son and heir, as far as physics was concerned. Kurt Gödel remained in Princeton. We had talked so much that he began to work on the math of general relativity, hoping to simplify the equations[45].

I stayed too. I don't feel fully American, miss Peggy. I find your countrymen somewhat superficial. They have become quite military and aggressive recently. While they pretend to put liberty above everything else, they restrict the freedom of scientists, since they don't really allow them to criticize the arms race. As soon as one of us talks of peace, they suspect him of having given the secret plans of the atomic bomb to the Soviets. This is stupid. Hiroshima gave the secret away. The Soviets made the bomb on their own. Many other countries will also do it, sooner or later.

Toward the end of the war, Otto Hahn and Werner Heisenberg were brought to England with von Weizsäcker and von Laue and were kept not in a concentration camp, but in a country house somewhere. Then they returned to Germany and founded a "Max Planck Institute" to replace the Kaiser Wilhelm Institute. They invited me to come and work there. The allies have treated Germany with the utmost leniency—not because they have become pacifists like Russell, but because they expect to create a buffer against the Soviet advance. It seems to work, though, and people say that Germany has changed completely. Ah, but I can't forgive. I hate the country of my birth and shall never go back. How could I walk among the men who murdered my people? They used industrial methods, poisonous gases perfected by chemists, to kill millions of men, women and children.

I wrote to Heisenberg.

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[45] Gödel didn't do much. Someone simplified the equations slightly in the 60s.

"The conduct of the German intellectuals—seen as a group—was no better than that of the mob. The crimes of the Germans are really the most hideous that the history of the so-called civilized nations has to show. There is not even a trace of a sense of guilt or remorse in Germany. In these conditions, I feel a deep aversion to being involved in a business that represents part of German public life, simply out of a need for cleanliness."

Max Planck died in 1947. He was a close friend and a good man. He didn't fight the Nazis, but he suffered because of them. His younger son was executed for taking part in the generals' plot against Hitler. His elder son had died on the battlefield during the great war. Max Planck's posthumous papers include a report of a meeting with Hitler in 1933: "I tried to convince him that the dismissal of the Jewish professors destroys the university. It is useless. He is stuck in his obsession, cut from reality. He doesn't let me speak but always returns to the same foolishness. He'll bring Germany to some terrible disaster. He doesn't even control events, since his obsession has taken over. An avalanche has started; nobody can stop it. Whether I resign or not won't make any difference."

* * *

I live with three good lady friends: Maja (my sister), Margot (my stepdaughter) and Helen Dukas (my secretary). Oh, I must not forget Tiger, our cat!

Maja suffered a stroke in 1947 and spends a lot of time in bed. This makes me very sad, as we have become quite close since she came to live here. I read books by Xenophon and other good authors to her every evening—including our friend Bertrand Russell, who just received the Nobel prize for literature. My own health isn't too good either. My doctors, suspecting my longstanding stomach pains might be due to my gallbladder, or to a cyst in my abdomen, or to an intestinal ulcer, asked a surgeon to open me up two years ago. They found an aneurysm or swelling of the abdominal aorta—without any of them admitting he had been wrong, of course. It was as large as a grapefruit, they told me, so they couldn't remove it. Well, I have lived with it for more than twenty years, so I can expect to survive some more. I have promised Bucky to give up my pipe, eat boiled potatoes and drink sugarless tea.

I feel so weak that I can't hold my violin for any length of time. I play the piano, which I have studied a little as a child. A journalist asked me what I believe in. I answered: "Human fraternity." Actually, my faith in mankind is based on my daily encounter with Bach and Mozart.

* * *

While I am now an old man mainly known as a crank who doesn't wear socks, I am working more than ever. I don't intend to stop. I just wrote a letter to Max Born, who returned to Germany.

"I admit, of course, that there is a considerable amount of validity in the statistical approach, which you were the first to recognize clearly as necessary. I cannot seriously believe in it, though, because the theory cannot be reconciled with the idea that physics should represent a reality in time and space, free from ghostly actions at a distance. I am quite convinced that someone will eventually come up with a theory whose objects, connected by laws, are not probabilities but considered facts, as was until recently taken for granted. I can't base this conviction on logical reasons, but can only produce my little finger as witness. That is, I offer no authority which would command any kind of respect outside of my own hand."

I often walk to the Institute with professor Wheeler, who lives across the street. He once invited me to listen to a lecture by one of his students, Richard Feynman. Then he brought him to my home and we had tea together. Feynman perfected a branch of quantum theory called Quantum Electrodynamics. His description of reality seems to come straight out of a fairy tale. Time can run backward. A particle leads several lives or "histories" out of our reach. Our clumsy senses and instruments let us perceive a resulting echo of the particle's adventures, which he calls "sum over histories." What's truly amazing is that his topsy-turvy theory fits experiments with a wonderful precision. Feynman seems to imply that uncertainty and randomness play no part in the life of the particle, but result from our limitations. His reality is much stranger than in standard quantum mechanics, though.

The next morning, professor Wheeler was waiting at my door and we started together.

"So what do you think, professor Einstein? Doesn't this new way of looking at quantum mechanics make you feel that it is completely reasonable to accept the theory?"

"I don't know. I may be wrong, but perhaps I have earned the right to make my mistakes."

* * *

Yesterday, I asked a Princeton student whether Peggy was a nickname for Peggoty. He laughed.

"I think that Peggoty is derived from Peggy, which is a nickname for Margaret. Do you know a Peggy, professor Einstein?"

"Well, not really… I've heard the name, that's all."

* * *

Pauli compared me to Doctor Faust during the war. I'm trying to decipher a great mystery. I fight against ruthless time. Some say I've sold my soul to the Devil when I signed the letter to President Roosevelt. At least I've found my Margaret… I think I won't send you this long letter, miss Peggy, but I'm glad I've written it. You helped me, unwittingly, to reconcile myself to my fate. Thank you!

Conclusion

Maja died in 1951. "I miss her more than I would have thought," Einstein commented. Old friends came to Princeton: Niels Bohr, Max von Laue, Maurice Solovine. Max Born was willing to come, but he couldn't get a visa because he was an honorary member of the Soviet Science Academy.

While Einstein didn't believe the Jews should create a new country, he supported Israel after it was founded (in 1948). The prime minister, David Ben Gurion, never failed to stop in Princeton between a speech in New York at the UN and a meeting in Washington with President Truman or Eisenhower. Israel's prime minister leads the country, but there is also a president, who plays a symbolic role. The first president was Chaim Weizmann, who had crossed the Atlantic ocean with Einstein in 1921. Weizmann died in 1952 (he was seventy-eight years old). The Israeli newspapers suggested that Einstein become Israel's second president. Wasn't he the greatest living Jew—as well as a generous grandfatherly figure for the new State? Ben Gurion accepted the suggestion reluctantly.

"What shall we do if he says yes? He knows nothing about politics and doesn't listen to advice. We'll be in trouble!"

Abba Eban, the Israeli ambassador in Washington, called Einstein to offer him the job. A colleague who happened to be in Einstein's home when the phone rang reported that it made him quite nervous. "This is very awkward, very awkward," he muttered.

He wrote a letter to Ben Gurion.

"I am deeply moved by the offer from our State of Israel, and at once saddened and ashamed because I cannot accept. All my life I have dealt with objective matters, hence I lack both a natural aptitude and the experience to deal properly with people and to exercise official functions. For these reasons alone, I should be unsuited to fulfill the duties of high office, even if advancing age was not making increasing inroads on my strength. I am the more distressed over these circumstances because my relationship to the Jewish people has become my strongest human bond since I became fully aware of our precarious situation among the nations of the world."

This diplomatic letter didn't include all the reasons for Einstein's refusal. To a friend, he added: "Although many a rebel has become a bigwig, I couldn't make myself do that."

The early fifties were dark years for the world. The United States, then the Soviet Union, exploded hydrogen (or "thermonuclear") bombs. In the States, Julius and Ethel Rosenberg were sent to the electric chair on very weak treason charges—especially for

Ethel. Then Oppenheimer—who had become chairman of the Institute for Advanced Study—was declared a traitor as well. In the Soviet Union, antisemitism was revived when Stalin, before dying, accused his doctors, most of whom were Jewish, of trying to poison him as part of a "Zionist plot." Einstein wrote letters and signed petitions for the Rosenbergs and for Oppenheimer. He considered emigrating to Uruguay. He protested strongly against the escalation of the arms race. "Radioactive poisoning of the atmosphere and the end of all life on earth is becoming technically possible. At the end, looming ever clearer, lies general annihilation. The universe won't shed a tear when the earth vanishes, but it will be a pity that nobody plays Bach and Mozart anymore."

He advised young people to become plumbers rather than physicists[46]. He was quite proud when a plumbers' organization named him an honorary member.

On March 14th, 1955, he celebrated his seventy-sixth birthday. Some fifth-grade pupils offered him a tie clasp and a set of cuff links. He wrote to them on March 26th, 1955.

"Dear Children,

I thank you all for the birthday gift you kindly sent me and for your letter of congratulation. Your gift will be an appropriate suggestion to be a little more elegant for the future than hitherto. Because neckties and cuff links exist for me only as remote memories."

On April 11th, 1955, after an exchange of letters with his friend Bertrand Russell and Joseph Rotblat, he signed a petition known as the "Russell-Einstein manifesto," which launched the "Pugwash" pacifist movement.

Two days later, he collapsed and was taken to the hospital. Thomas Bucky and one of his Berlin doctors, Rudolf Ehrmann, were at his side. His son Hansi flew from California, where he lived. Einstein asked for a notebook to write a few more equations. He didn't fear death: "It is an old debt that one eventually pays. Yet instinctively, one does everything possible to postpone this final settlement. Such is the game that nature plays with us."

Thomas Bucky had given a yoyo to Einstein long ago. Now he had become a doctor like his father. He called one of his masters, who pioneered new operations and had repaired rupturing aneurysms. "I do not believe in artificially prolonging life," Einstein said. "My time has come." Hansi thought he'd be able to convince him to change his mind. "Just give me a little time," he said on April 17th. "I'll get him to say yes tomorrow."

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[46] After the war, Szilard gave up physics and become… not a plumber, but a biologist.

At 1:15 A.M. on April 18th, 1955, the night nurse noticed that Einstein's breathing was becoming strained. He said a few words in German—but she didn't understand that language—and died. The autopsy showed that an operation would have been useless.

One month earlier, his old friend Michelangelo Besso had died. Einstein had sent the following words to his children: "Now he has preceded me a little by leaving this strange world. This means nothing. For those of us who believe in physics, the distinction between past, present and future has only the significance of a stubborn illusion."

* * *

2005 was declared "the Einstein Year" to celebrate the hundredth anniversary of the great 1905 special relativity and quanta articles. Fifty years after Einstein's death, his ideas are still full of life. General relativity plays a central part in modern astronomy. For example, astronomers use massive galaxies as "lenses"—since they deflect light rays like ordinary glass lenses—the better to see what lies beyond them. In our daily life, we wouldn't get exact GPS coordinates if we used the theory of Newton. The numbers are corrected to take relativity into account.

Quantum mechanics lets us make sophisticated machines like PET scanners (used to locate tumors in our brains, etc.) Nobody worries about God playing dice anymore. When we wonder what to do with the waste in nuclear plants, we say that a certain material has a "half-life" of two million years. This means that half the atoms will have decayed and become harmless by that time. This is a random process. If we consider one atom, we don't know whether it will decay or not. We say the probability it will have decayed in two million years is fifty percent.

One the hottest fields of research today is the "ghostly action at a distance" that Einstein imagined in his EPR paradox. What he said was: "Quantum mechanics seems to imply that particles stay linked in a spooky way after an interaction. This is impossible, thus quantum mechanics is not a complete theory." Today we consider that quantum mechanics is indeed a fully effective theory, especially since Feynman and others have honed it to perfection. In 1964, an Irish physicist, John Bell, showed in a theoretical article that the EPR reasoning was quite valid—which means that particles do stay linked after an interaction. This is the exact opposite of what Einstein wanted to prove, of course. Bell suggested experiments, which a French physicist, Alain Aspect, performed twenty years later in Paris. Two photons became "entangled" and seemed to influence each other at a distance of forty feet. In the early nineties, a Swiss scientist, Nicolas Gisin, kept particles entangled for ten miles near Geneva. If this book

is still on sale in twenty years, you'll perhaps carry in your pocket a "quantum computer" using entangled photons. The actual computer (excluding the screen and keyboard and batteries) should be smaller than a fingernail and more powerful than today's biggest supercomputers.

People are still debating what happens exactly in the EPR paradox. A marketing wizard found a catchy name: "Teleportation of quantum states." As a consequence, if you look for the EPR paradox on Google, you find more sites of Star Trek fans than of scientific institutions. In real physics, you can teleport quantum states (maybe), but Scotty will never be able to beam you up.

At least one scientist, Freeman Dyson, an Englishman who worked on quantum electrodynamics with Feynman, says it doesn't bother him that we have two incompatible theories, relativity and quantum mechanics, for stars and particles. Most other physicists hope that Einstein's unification dream will be realized someday. His old friends and rivals, Heisenberg and Pauli, tried their hands at it after his death. There are promising and controversial "theories of everything" today. The "theory of strings" was invented in Japan around 1970. Later variants are known as "superstring theory" and "M-theory." The strings are little strands of energy, much smaller than any known particle. They create gravitation and the various particles by vibrating in different modes. Is this possible? Well, a four-dimension space is a little cramped for such strange gymnastics, so you need a ten- or eleven-dimension space. Einstein had actually explored a five-dimension space, suggested in 1921 by Theodor Kaluza and Oskar Klein. The extra dimensions are "curled," that's why we don't perceive them. The main problem with string theory is that nobody has found a way of checking whether it is true.

When Einstein was a young man, many physicists believed that they knew almost everything—and that a small contradiction between Galilean relativity and electromagnetism would soon be explained away. Einstein built his theory on that contradiction. This was the starting point of an amazing expansion of knowledge. We've found that the universe contains much more stuff, big and small, than we thought. So at least we've gained some wisdom: we now admit that we know almost nothing.

Somewhere on this planet, a young boy or girl is looking at a compass. Hey, the needle seems to move by itself! How come?

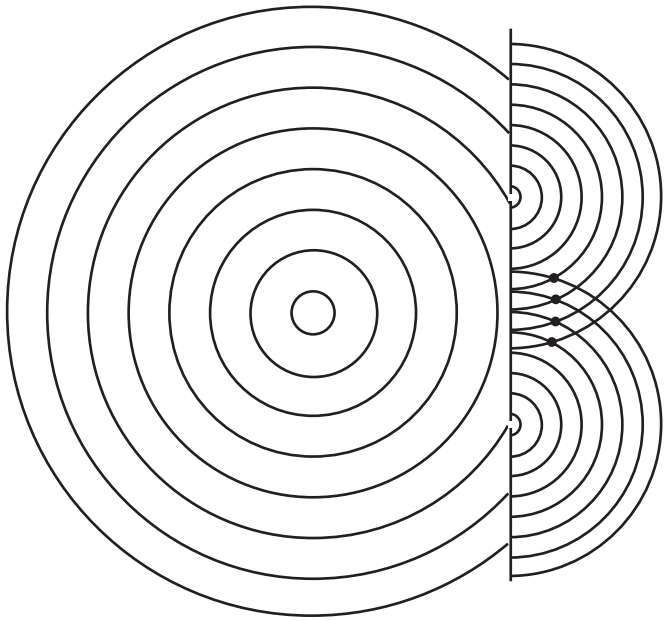
Bits and pieces.

1. Interferences

When you throw a pebble into the water, a circular wave appears and spreads outward. Water molecules go up and down—they don't move horizontally. What is propagated horizontally, using water as a medium, is energy. Sound is a wave that uses air in a similar manner for its propagation.

If you throw two pebbles in different places at the same time, two waves appear, then meet and interact. In the picture below, there is one pebble and one mother wave. A barrier with two holes replaces the two pebbles. In this manner, the two daughter waves are born at the same time and have the same strength.

When two wave crests overlap, they reinforce each other and you get a higher crest (shown as a black dot below). When two troughs overlap, you get a deeper trough. When a crest meets a trough, they cancel each other. This special pattern that appears when two waves meet is called "interferences."



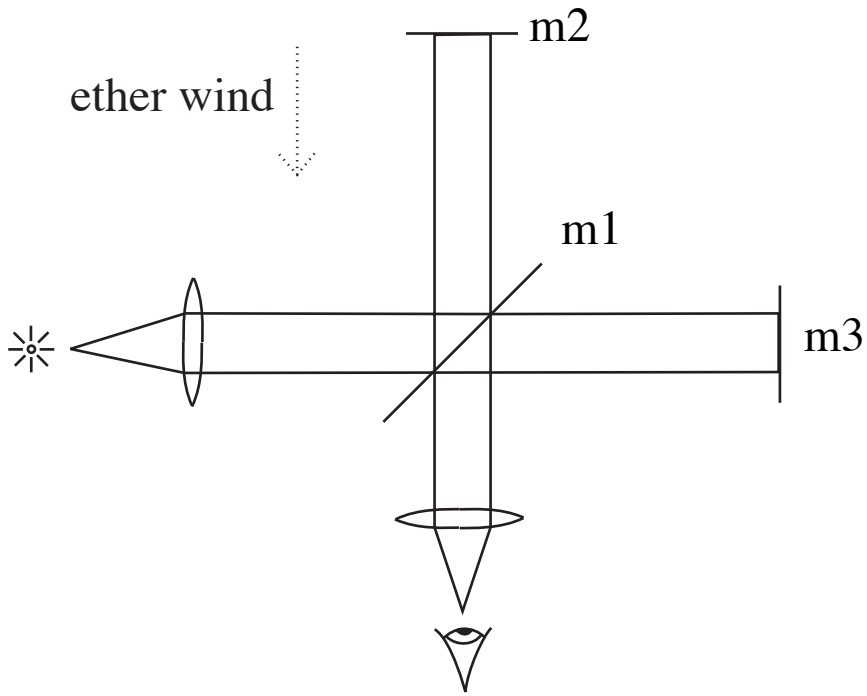
In 1801, an English eye doctor and physicist, Thomas Young, performed experiments with light in order to study our vision. He cut slits in a sheet of cardboard and put it in front of a light source. A typical interference pattern appeared on a screen behind the cardboard: very bright stripes where crests or troughs reinforce each other, dark stripes where light is cancelled. Until then, people were not sure whether light was made of waves (this was the theory of Huygens) or particles (Newton's opinion).

Young's experiment settled the argument in favor of waves—until Planck and Einstein discovered quanta.

Light seems to have a dual nature. Although it is made of pure energy, it can behave either as waves or as particles. Louis de Broglie suggested that material particles like electrons have the same dual nature. This was proved by performing the Young experiment on electrons. In the strange world of quantum mechanics, it has been shown that a single photon of electron can interfere with itself as if it went through both slits at the same time—but only if nobody is looking.

2. The Michelson experiment

This is a simplified picture of a complex instrument: a Michelson interferometer.



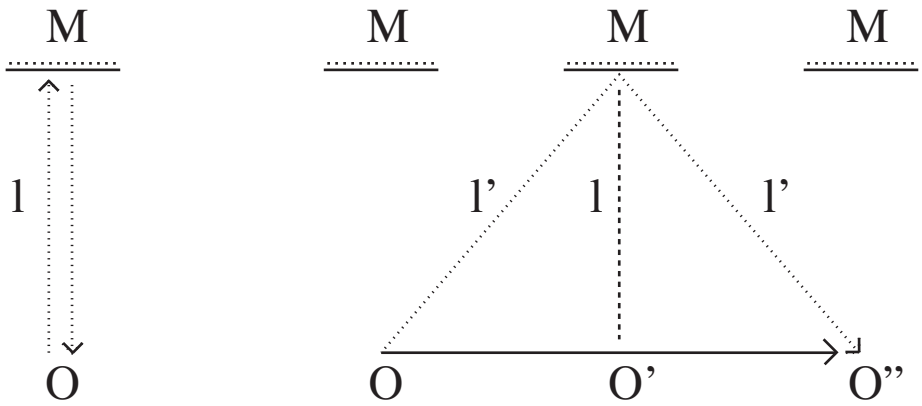
At left, a light source and a lens produce a parallel beam of light. It is split in two parts by m1, a two-way mirror. One part goes to the mirror m2, is reflected, goes through m1 and arrives in Michelson's eye. The other part is reflected by the mirror m3 and by m1 again before it reaches Michelson's eye.

Michelson wanted to measure the speed of the mysterious "ether wind," due to the movement of the earth across space—represented in the picture by an arrow. While the first half-beam of light goes upwind between m1 and m2, then downwind between m2 and m1, the second half-beam enjoys a crosswind back and forth between m1 and m3. A simple calculation shows that the second half-beam should reach Michelson's eye

slightly before the first one. The difference is large enough to create interferences. The experiment failed: Michelson didn't see any interferences.

3 Relativity and Pythagoras

Einstein introduced his main Special Relativity equation in the following manner during a lecture.



O is a point inside a very fast train. A passenger located in O has a quirky clock. The time that a beam of light spends going to a mirror M and coming back is the clock's beat.

At left, the train doesn't move relative to an outside observer.

At right, it moves with the speed *v* toward the right. The outside observer sees the passenger send the beam from O to the mirror M, but by the time the beam reaches M the passenger is already in O' and when the beam comes back the passenger is in O".

Einstein now does a very simple thing: he writes the Pythagorean theorem for the triangle *OO'M*. He begins with $l'^2 = l^2 + OO'^2$. Then he replaces l' with ct' (c is the speed of light, t' the time for the outside observer), l with ct, OO' with vt'. The equation gives the ratio between the time t' for the outside observer and the time t for the train passenger:

$$\frac{t'}{t} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

The famous equation $E = mc^2$ derives from this one.

Cast of characters

Adler, Friedrich (1879-1960). Einstein's classmate at the Zurich Polytechnikum. Son of Viktor Adler, leader of the Austrian social-democrat party. In 1916, he murdered the Austrian prime minister, whom he considered too bellicose. He was condemned to death, then pardoned.

Arago, François (1786-1853). French mathematician, astronomer and politician. Studied an anomaly of Mercury's orbit that was explained by general relativity.

Aristarchus of Samos (III$^{rd.}$ century B.C.) Greek astronomer. The earth circles the sun, he said, not the other way around.

Balfour, Arthur (1848-1930). English politician. Foreign minister during World War I, he declared that the Jews were entitled to a homeland in Palestine.

Becquerel, Henri (1852-1908). French physicist. Studying uranium salts, he stumbled on radioactivity.

Peter Bergmann and Valentin Bargmann. Einstein's assistants in Princeton.

Ben Gourion, David (1886-1973). Israel's first prime minister. He invited Einstein to become Israel's president after Weizmann's death in 1952.

Besso, Michelangelo (1873-1955). Polytechnikum alumnus, Einstein's colleague and close friend in the Bern patent office, member of the "Olympia Academy."

Bohr, Niels (1885-1962). Danish physicist. Invented the modern model of the atom. Most of the physicists who elaborated the theory of quantum mechanics studied in his Copenhagen institute.

Boltzmann, Ludwig (1844-1906). German physicist. Pioneered the "kinetic theory of gases," which inspired Einstein's articles about water molecules.

Born, Max (1882-1970). German physicist. Discovered the random factor in the behavior of particles. "I can't believe that the Good Lord plays dice," Einstein told him.

Bose, Satyadranath (1894-1974). Indian physicist. He sent Einstein a statistical study of photons from Calcutta, then met him in Berlin in 1925. Dirac called "bosons" the particles that obey "Bose-Einstein statistics," for example photons.

de Broglie, Louis (1892-1987). Pronounced "Dobroy." French physicist who suggested that electrons and other particles vibrated like light.

Brod, Max (1884-1968). German-language Czech writer, friend of Kafka. In a novel about the astronomer Tycho Brahé, he modelled the Kepler character on Einstein.

Brown, Robert (1773-1858). Scottish botanist. Looking at pollen dispersed in water, he discovered the "Brownian movement," which Einstein explained by analogy with the kinetic theory of gases in 1905.

Bucky, Gustav (1880-1963). Radiologist, invented an X-ray diaphragm still used today. Einstein's friend in Berlin, then in the United States. They patented several photographic gadgets together.

Bush, Vannevar (1890-1974). American engineer who played an important part in the *Manhattan Project*—and contributed to the invention of the computer.

Byrnes, James (1879-1972). Secretary of State in 1945, he told Harry Truman, when President Roosevelt died, that the army was perfecting an atom bomb.

Casadesus, Gaby (1901-1999) and Robert (1899-1972). French pianists. They spent World War II in Princeton and played music with Einstein.

Chadwick, James (1891-1974). English physicist. Discovered the neutron in 1932.

Chaplin, Charlie (1889-1977). Einstein met him several times in Hollywood.

Churchill, Winston (1874-1965). English prime minister during World War II. Einstein met him in 1933.

Copernicus, Nikolaus (1473-1543). Polish astronomer. He revived Aristarchus's heliocentric theory.

Curie, Marie (1867-1934). French physicist and chemist. Discovered radium and polonium with her husband Pierre.

Democritus (around 400 B.C.). Greek philosopher. One of the inventors of the atomic theory.

de Sitter, Willem (1872-1934). Dutch astronomer. He heard about general relativity when Einstein went to Leyden during World War I, then he talked to Eddington about it. He worked with Einstein in Pasadena.

Dukas, Helen (1895-1982). Einstein's secretary from 1928 until his death.

Eddington, Arthur (1882-1944). English astronomer. Made Einstein famous in 1919 when he went to Brazil during an eclipse and checked that the sun did bend a ray of light, as general relativity had predicted.

Edison, Thomas (1847-1931). People who said there was no theoretical physics in the United States gave him as an example of the "practical" American scientist.

Ehrenfest, Paul (1880-1933). Austrian physicist. Succeeded Lorentz in Leyden. Einstein's close friend.

Ehrenfest-Afanassova, Tatiana (1876-1964). Russian physicist, wife of Paul.

Ehrmann, Rudolf (1879-1961). Einstein's doctor in Berlin, then in America.

Einstein, Eduard (1910-1965). Albert and Mileva's younger son. He suffered from schizophrenia and spent most of his life in a psychiatric institution.

Einstein, Elsa, born Einstein (1876-1936). Her father was Einstein's cousin, her mother his aunt on his mother's side. Einstein married her in 1919.

Einstein, Hans Albert, or Hansi (1904-1973). Albert and Mileva's elder son.

Einstein, Hermann (1847-1902). Albert's father. Founded several electrical machinery workshops or factories in Germany and Italy.

Einstein, Jakob (1850-1912). Albert's uncle. Engineer and inventor. Hermann's partner in some of his endeavors.

Einstein, Lieserl (born in 1902). Albert and Mileva's secret daughter. She may have been adopted by a Serb family. Einstein's letters about her were discovered by his granddaughter after Hansi's death, so she is not mentioned in early biographies.

Einstein, Mileva, born Maric (1875-1948). Einstein's classmate in the Polytechnikum. They married in 1903.

Einstein, Pauline, born Koch (1857-1920). Albert's mother.

Elizabeth of Belgium (1876-1965). Bavarian princess, wife of king Albert of Belgium. Einstein's friend and violin partner. She founded a famous violin competition after World War II.

Epstein, Jacob (1880-1959). One of the main English sculptors in the XXth century. He made a bust of Einstein in 1933.

Eratosthenes (IInd century B.C.). Greek astronomer and mathematician. Director of Alexandria's library. He gave the first precise evaluation of the earth's circumference. He also invented a method to find prime numbers.

Euclid (III$^{rd.}$ century B.C.). Greek mathematician living in Alexandria. His *Elements* introduce most of the geometry still studied in high school and college.

Faraday, Michael (1791-1867). Self-taught English physicist. He created the science of electricity: how to make it, how to use it. He invented a new physical entity, the "field," which plays a primary role in general relativity.

Fermi, Enrico (1901-1954). Italian physicist. He built the first nuclear reactor (then called an atomic pile) in Chicago in 1942.

Fitzgerald, George (1851-1901). Irish physicist. He tried to explain Michelson's experiment by a contraction of matter. As Lorentz worked on similar lines, the equations are known as "Fitzgerald-Lorentz transformation."

Flexner, Abraham (1866-1959). American pedagogue. Founder of the *Institute for Advanced Study* in Princeton, he convinced Einstein to work there.

Frank, Philipp (1884-1966). Austrian physicist. Einstein's successor in Prague's German University. He wrote a lively biography ("Einstein, his Life and Times").

Freud, Sigmund (1856-1939). Einstein met him in Berlin in 1926.

Freundlich, Erwin (1885-1964). German mathematician et astronomer. He wanted to photograph the deviation of light in 1914 during an eclipse in Crimea, but the

expedition failed because of the war. As his wife was Jewish, he left Germany in 1933 and settled in Scotland.

Friedmann, Alexander (1888-1925). Russian mathematician and physicist. He was the first to suggest, around 1922, that the universe was expanding as a consequence of general relativity.

Frisch, Otto (1904-1979). Austrian physicist, nephew of Lise Meitner—who told him, during a Christmas visit in Stockholm in 1938, that Otto Hahn had split the atom of uranium. Later, working in England, he designed the future Hiroshima uranium bomb (with Fritz Peierls and others). He went to Los Alamos to implement his design.

Galileo (1564-1642). Italian physicist and astronomer. He perfected the telescope (while pretending he had invented it), discovered the satellites of Jupiter and the moon's craters. When the Church declared the heliocentric theory of Copernicus false and heretical, he promised not to teach it anymore. Then he was condemned for breaking his promise. He invented the first "theory of relativity."

Gamow, George (1904-1968). Russian-born American physicist. His theory of barrier-jumping electrons has lots of applications in today's electronics. A rival, joking about his theory of the universe's beginnings, called it "your Big Bang." The name stayed. He wrote very good books about physics, the best of which are *Mr. Tompkins in Wonderland* and *Mr. Tompkins explores the Atom*, published in 1940 and 1945, then updated several times.

Gandhi, Mohandas (1869-1948). Indian lawyer and politician. Einstein admired his non-violent stance so much that he posted his picture on the wall of his Princeton office (next to Faraday and Newton).

Gödel, Kurt (1906-1978). Austrian mathematician, author of a star theorem of 20th century math, early member of the *Institute for Advanced Study*. A Princeton wartime saying: "You never see Einstein without Gödel, you never see Gödel without Einstein."

Grossmann, Marcel (1878-1936). Einstein's classmate, then colleague in the Zurich Polytechnikum. He helped him with the math of general relativity.

Haber, Fritz (1868-1934). German chemist. There are twice more people on earth today than was thought possible. The main reason they don't starve is that Haber invented modern fertilizers. He also invented the explosives used by terrorists. He was Einstein's colleague and friend in Berlin. Einstein couldn't decide whether he was a good guy or a bad guy.

Habicht, Conrad (1876-1958). Einstein's classmate in the Polytechnikum, then one of the members of the de "Olympia Academy" in Bern.

Hahn, Otto (1879-1968). German chemist. He split the atom of uranium just before World War II and received the Nobel prize in 1944. It is said he should have shared it with Lise Meitner. She worked with him for twenty years, but had to leave a few months before the decisive experiment because she was Jewish.

Haller, Friedrich. Director of the Federal Patent Office in Bern. Einstein's boss from 1902 to 1909.

Harding, Warren (1865-1923). President of the United States in 1921. Welcomed Einstein in the White House.

Hasenöhrl, Friedrich (1874-1915). Austrian physicist. The crazy promoters of "Aryan physics" pretended he had invented the equation $E = mc^2$.

Heisenberg, Werner (1901-1976). German physicist. His "uncertainty principle" is one of the pillars of quantum mechanics. He headed the German nuclear program during World War II.

Hertz, Heinrich (1857-1894). German physicist. He discovered electromagnetic ("Hertzian") waves—as well as the "photoelectric effect," which Einstein studied later.

Hilbert, David (1862-1943). Considered the greatest German mathematician in the 20th century. Einstein consulted him about the equations of general relativity.

Hoffmann, Banesh (1906-1986). Einstein's assistant in Princeton. He wrote a good book about relativity and co-authored a biography with Helen Dukas ("*Albert Einstein: Creator and Rebel*").

Hubble, Edwin (1889-1953). American astronomer. He discovered galaxies outside the Milky Way—then found that distant galaxies were moving away from us, which confirmed the expansion of the universe. The main astronomical satellite bears his name.

Infeld, Leopold (1898-1968). Polish-born physicist. Met Einstein in Berlin, then became his assistant in Princeton. They wrote a book about physics together ("*The Evolution of Physics: The Growth of Ideas from Early Concepts to Relativity and Quanta*," 1938).

Ishikawa, Jun. Japanese physicist. Einstein's interpreter during his stay in Japan.

Joliot-Curie, Irène (1897-1956) and Joliot, Frédéric (1900-1958). Marie Curie's elder daughter and son-in-law. They discovered artificial radioactivity. In 1939, they reproduced Hahn's splitting of the uranium nucleus, then took a patent on the principle of an atomic bomb.

Jung, Carl (1875-1951). Swiss psychologist. Freud's friend, then rival. Einstein met him in Zurich.

Kafka, Franz (1883-1924). German-language Czech writer. Einstein may have met him in Zionist circles in Prague in 1911.

Kleiner, Alfred (1849-1916). Physics teacher in Zurich university. Supervised Einstein's docotrate thesis.

Koch, Cäsar. Einstein's maternal uncle. Lived in Antwerp.

Koch, Jakob. Einstein's maternal uncle. Lived in Genoa.

Kreisler, Fritz (1875-1962). Austrian violinist. Einstein's knew him well in Berlin.

Langevin, Paul (1872-1946). French physicist who worked with Pierre and Marie Curie—and was said to become very close to Marie after Pierre's death. Einstein's friend.

Lemaître, Georges (1894-1966). Belgian priest and astronomer. He suggested that an expanding universe had probably started quite small. He talked of a "primitive egg" or "primitive atom." His scientific ideas didn't interfere with his faith: he worked as the Pope's advisor for science.

Lenard, Philipp (1862-1947). German physicist. Invented "Jewish Science" and "Aryan Science". Hated Einstein. Loved Hitler.

Le Verrier, Urbain (1811-1877). French astronomer. Discovered a quirk in Mercury's rotation around the sun. Computing the planet's orbit with the equations of general relativity removed the quirk—which was the first convincing proof of the theory's truth.

Lloyd George, David (1863-1945). English prime minister during World War I. Einstein met him in 1933.

Locker-Lampson, Oliver (1880-1954). English member of parliament. Welcomed Einstein in London in 1933, then hid him in a country manor.

Lorentz, Hendrik (1853-1928). Dutch physicist. He came close to discovering special relativity. He already had the equations (as part of the "Fitzgerald-Lorentz transformation"), but didn't really understand what they meant. Einstein considered him his master.

Löwenthal, Ilse (1897-1934). Elsa Einstein's daughter.

Löwenthal, Margot (1899-1982). Elsa Einstein's other daughter. Lived with Einstein in Princeton.

Luxemburg, Rosa (1871-1919). Polish-born revolutionary leader. She was arrested and murdered in Berlin after the "Spartakist uprising."

Mach, Ernst (1838-1916). Austrian physicist and philosopher. His ideas criticizing Newton's absolute time and space influenced Einstein.

Magnes, Judah (1877-1948). American Jew, controversial director of the Hebrew university in Jerusalem.

Mann, Thomas (1875-1955). German writer. The nazis burned his books, so he escaped to Switzerland and the United States. He lived in Princeton, where he gave grand parties. Einstein, who had known him in Berlin, found the parties too fancy.

Marconi, Guglielmo (1874-1937). Italian physicist. He made the first radio set when he was only twenty-two.

Martinu, Bohuslav (1890-1959). Czech music composer. As he spent World War II in Princeton, he composed small violin pieces for Einstein.

Maxwell, James (1831-1879). Scottish physicist. He wrote the equations for Faraday's electromagnetic field and showed that light was an electromagnetic wave.

Mayer, Walther (1887-1948). Einstein's assistant in Berlin, then in the United States for a short while.

McCarthy, Joseph (1908-1957). This American senator, who saw dangerous communists everywhere, led a "witch hunt" from 1947 to 1954. He considered Einstein suspect because of his pacifist ideas.

Meitner, Lise (1878-1968). Austrian physicist. As she was Jewish, she left Berlin in 1938 and took refuge in Sweden. When Otto Hahn, her long-time partner, wrote to her and described his experiment with uranium, she understood he had split the nucleus. She told her nephew, Otto Frisch, who alerted his master, Niels Bohr. Szilard then brought the news to Einstein. Lise Meitner refused to work on the atomic bomb.

Mendel, Toni. Einstein's mistress in Berlin.

Mendelsohn, Erich (1887-1953). This architect built the "Einstein Tower" in Potsdam university.

Michelson, Albert Abraham (1852-1931). American physicist. The failure of his experiment to measure the "ether wind" highlighted the contradictions of classical physics. Michelson thought he hadn't been careful or precise enough, until special relativity said: "There is no ether wind because there is no ether."

Millikan, Robert (1868-1953). American physicist. He designed an experiment proving Einstein's hypothesis that light was made of quanta.

Minkowski, Hermann (1864-1909). Lithuanian mathematician. Einstein's teacher in the Polytechnikum. He simplified special relativity by introducing a four-dimension "space-time continuum."

Miyake, Hayashi. Japanese medical doctor. Einstein was his patient on board the steamer *Kitano Maru*, then his guest in Japan.

Nernst, Walther (1864-1941). German chemist. Founded the Kaiser Wilhelm Institute.

Newton, Isaac (1642-1727). English mathematician and physicist. He discovered that the same force moves a falling apple and the moon. As the proof needed calculus, he had to invent it.

Nicolai, Georg (1874-1964). Professor of cardiology in Berlin, nephew of the composer Otto Nicolai. He wrote an *Appeal to Europeans* with Einstein during World War I.

Nordmann, Charles (1881-1940). French astronomer. Welcomed Einstein at the border when he visited France in 1922. Later, he drove him to World War I's battlefields.

Oppenheimer, Robert (1904-1967). American physicist. From 1942 to 1945, he was the leader of the greatest team of scientists the world has ever known, in Los Alamos, New Mexico. Later, he directed Princeton's *Institute for Advanced Study*. He was put on trial for opposing Teller's hydrogen bomb. He was neither condemned nor fully cleared.

Pauli, Wolfgang (1900-1958). Austrian physicist. His "Pauli exclusion principle" explains why molecules combine—the object of chemistry—and also why, although atoms are mostly empty, we don't go through the floor.

Perrin, Jean (1870-1942). French physicist. His experimental work proved that Einstein's hypothesis about the Brownian movement was correct.

Pick, Georg (1859-1942, in the Theresienstadt concentration camp). Professor of mathematics in Prague's German university. He told Einstein he should study Ricci and Levi-Civita's "absolute differential calculus."

Planck, Max (1858-1947). German physicist. He discovered that energy was created or absorbed in a discontinuous way. He called the elementary grains of energy "quanta."

Plesch, Janos (1878-1957). One of Berlin's most famous doctors and hosts. Einstein became his patient—and guest.

Podolsky, Boris (1896-1966). One of the three authors, with Einstein and Rosen, of the 1935 "EPR paradox."

Poincaré, Henri (1854-1912). French mathematician and physicist. He invented the word "relativity" (to describe Galileo's theory). He came very close to special relativity, but stopped short. He never admitted that Einstein had succeeded where he had failed.

Pythagoras (VIth century B.C.—if he really existed). Greek mathematician. The theorem that bears his name is demonstrated in Euclid's *Elements*. Einstein found his own proof, his sister said.

Rathenau, Walther (1867-1922). German Jewish businessman and politician. Murdered by two young nationalist and antisemitic thugs. Einstein knew him well and liked him.

Reinhardt, Max (1873-1943). Austrian theater director, one of the pillars of German culture after World War I. He defended Einstein when the antisemites attacked him. As he was Jewish himself, he moved to Broadway in 1933.

Ricci (1853-1925) and Levi-Civita (1873-1941). Italian mathematicians. Einstein used their "absolute differential calculus" and "tensors" in general relativity.

Riemann, Bernhard (1826-1866). German mathematician. Invented a non-Euclidian geometry which, according to general relativity, describes our universe pretty well.

Rolland, Romain (1866-1944). French writer and pacifist. His most famous novel is "*Jean-Christophe*." Einstein met him in Switzerland in 1915.

Röntgen, Wilhelm (1845-1923). German physicist. He discovered X-rays and received the very first Nobel Prize for physics, in 1901.

Roosevelt, Franklin Delano (1882-1945). President of the United States from 1932 until his death. Invited Einstein to the White House in 1933.

Rosen, Nathan (1909-1995). American-born Israeli physicist. Another member of the "EPR paradox" trio.

Russell Bertrand (1872-1970). English philosopher and mathematician. Jailed as a pacifist during World War I. He spent part of World War II in Princeton, where he became Einstein's friend.

Rutherford, Ernest (1871-1937). English physicist (born in New Zealand). He discovered the alpha and beta rays of radioactivity, as well as the nucleus of the atom.

Sachs, Alexander (1893-1973). Banker who acted as go-between when Szilard wanted to show Einstein's letter to President Roosevelt in 1939.

Samuel, Herbert (1872-1963). High Commissioner in Palestine under English mandate, he welcomed Einstein there in 1923.

Schnabel, Arthur (1882-1951). Austrian pianist. Einstein met him in Berlin.

Schrödinger, Erwin (1887-1961). Austrian physicist. Although quantum mechanics relies to a great extent on Schrödinger's equation, he followed Einstein's example and refused to accept that God plays dice .

Solovine, Maurice (1875-1958). Einstein's student in Berne in 1902. Later, he moved to Paris and translated his books and articles into French.

Solvay, Ernest (1838-1922). Belgian industrialist and science buff. He organized regular meetings of the best physicists from 1911 on.

Sommerfeld, Arnold (1868-1951). German physicist. He adjusted several tidbits in the atom. He was known as a good teacher and a moral authority. Although he stayed in Germany, he didn't work for the Nazis.

Spinoza, Baruch (1632-1677). Dutch Jewish philosopher. He thought God didn't look like a bearded old man, but encompassed the whole of nature's mystery. His community considered him heretical and expelled him. When asked about his religion, Einstein often said: "I am a Spinozist."

Stern, Otto (1888-1965). German physicist. Einstein's assistant in Prague, then in Zurich.

Szilard, Leo (1898-1964). Hungarian physicist. In Berlin, he patented a liquid-sodium refrigerator with Einstein (used in some experimental nuclear plants). In 1939, he convinced Einstein to sign a letter to President Roosevelt about the splitting of uranium by the Germans. This letter was considered a symbolic beginning of the long process that ended in the Hiroshima explosion.

Tagore, Rabindranath (1861-1941). Indian poet and philosopher. He visited Einstein in his Caputh lakeside house.

Talmud, Max (1867-1941). Student who came for lunch every Thursday at the Einsteins. He gave Albert scientific books and encyclopedias. He moved to America and changed his name to Talmey.

Teller, Edward (1908-2003). Hungarian-born American physicist. He was his friend Szilard's second driver when he went to see Einstein on Long Island in 1939. As the so-called "father" of the hydrogen bomb, he is considered the main model for Kubrick's Doctor Strangelove. He was spurned by his colleagues not so much for fathering that terrible bomb as for being a witness for the accusation at Oppenheimer's trial.

Thompson, Joseph John (1856-1940). English physicist. Who discovered the electron? He did.

Tolman, Richard (1881-1948). American physicist. Worked with Hubble in Pasadena.

Truman, Harry (1884-1972). American President in 1945, he ordered the bombing of Hiroshima and Nagasaki.

Tuschmid, August. Taught physics to Einstein in Aarau.

Van't Hoff, Jacobus (1852-1911). Dutch chemist. He received the first Nobel Prize for chemistry, in 1901. Einstein succeeded him as a member of the Prussian Science Academy in Berlin.

von Laue, Max (1879-1960). German physicist. He received the Nobel Prize for photographing molecules with X rays. Einstein was very fond of him and considered him the only 100% honest German scientist after 1933.

von Neumann, Johannes or John (1903-1957). Hungarian-born American mathematician. One of the greatest mathematicians of the 20th century. Einstein's colleague in the *Institute for Advanced Study*. He wrote neat equations for quantum mechanics, contributed to the A bomb and the H bomb, but is mainly remembered today for his "game theory."

von Soldner, Johann Georg (1776-1833). Einstein's archenemy, Lenard, remarked that there was nothing new about the sun bending light rays, since von Soldner had suggested it already in 1801. Actually, this was the "Newtonian deviation," which was half the relativistic one. Lenard forgot to add that Cavendish had made the same suggestion before von Soldner.

von Weizsäcker, Carl-Friedrich (born in 1912). German astrophysicist. Studied how matter is created within the stars. Worked on atomic energy during World War II with Heisenberg, Hahn and others. Unclassified documents have shown that he was the one who convinced his colleagues, especially Heisenberg, to twist the truth after the war and pretend the scientists had sabotaged the Nazi effort toward a nuclear bomb. They didn't fail on purpose, actually, but because they insisted stubbornly on exploring a dead-end path.

Watters, Leon (1887-1967). American chemist and businessman. Einstein liked to have rich friends like him: he stayed in his New York apartment or his summer house, used his car and chauffeur, and so on. Einstein's biography by Denis Bryan relies a lot—maybe too much—on Watters's notes and diary.

Weber, Heinrich Friedrich (1843-1912). German physicist. Einstein's teacher at the Polytechnikum.

Weizmann, Chaim (1874-1952). Leader of the World Zionist Organization. First President of Israel. Einstein refused to succeed him in that position.

Wigner, Eugene (1902-1994). Hungarian-born American physicist. Szilard's first driver when he visited Einstein on Long Island in 1939. Worked on the "strong force" (known for a while as "Wigner's force"), which binds protons and neutrons in the nucleus of atoms—and explains the energy of the nuclear bomb. During the war, he

was in charge of the production of plutonium in Washington state. The plutonium was used in the Nagasaki bomb.

Winteler. Swiss family. Einstein lived in their home while a student in Aarau. The father taught Greek in the Aarau school. Einstein fell in love with one of the daughters—then seemed to forget about her when he met Mileva. Another daughter married Michelangelo Besso. The son married Einstein's sister, Maja.

Young, Thomas (1773-1829). English doctor and scientist. In 1801, the "Young experiment" proved that light behaves like a wave.

Chronology

1879 March 14. Birth in Ulm, in the south of Germany. Son of Hermann Einstein and Pauline Koch.
1880 Follows his parents to Munich.
1881 Birth of his sister Maja.
1885 Enters a Catholic primary school (in second grade). Studies violin.
1888 Passes the entry examination to Luitpold Gymnasium (high school).
1889 Max Talmud, a 21-year old medical student who eats at the Einstein home every Thursday, gives Albert scientific books.
1891 Discovers Greek geometry in a "little geometry book."
1894 Drops out of high school just before the final exam to join his parents in Milano, Italy—where they have moved after the failure of the Einstein electrical equipment company.
1895 Follows his parents to Pavia, where his father opens a new factory. Tries to enter the Zurich Polytechnikum, but fails because of poor marks in French and other non-scientific subjects. Enters the cantonal school in Aarau. Lives with the Winteler family and falls in love with one of their daughters, Maria.
1896 Gives up the German nationality. He will be stateless for the next five years. Enters the Polytechnikum.
1897 Meets Polytechnikum classmates Mileva Maric and Marcel Grossmann, and former Polytechnikum student Michelangelo Besso.
1899 Begins the long process to obtain Swiss nationality.
1900 While he graduates, Mileva fails. Sends his first article, on capillarity, to *Annalen der Physik*.
1901 Becomes a Swiss citizen. After the Polytechnikum refuses to grant him a position as assistant, teaches for a short while in the Winterthur technical college, then gives private lessons in Schaffhausen. Mileva, pregnant, goes back to her parents in Hungary.
1902 Birth of his daughter Lieserl. Moves to Bern. Becomes a third-class expert at the Patent Office. Death of his father, aged fifty-five.
1903 Marries Mileva, while Lieserl is probably given to adoption. Founds the Akademie Olympia with his private student Maurice Solovine and his former classmate Conrad Habicht.
1904 Birth of his son Hans Albert.

1905 "Miracle year." Publishes four articles in *Annalen der Physik*. Two introduce new calculations about molecules that are still used today. One is a decisive step in the elaboration of quantum theory. The last one, *On the Electrodynamics of Moving Bodies*, changes our approach to time, space and speed. It will become famous under a simpler name: Special relativity. The equation $E = mc^2$ appears in a supplement to the relativity article.

1906 Physics Ph.D. in Zurich university. Promoted to Expert second class at the patent office.

1907 Discovers, in a "thought experiment" about free fall, the "equivalence principle" between gravitation and acceleration. "The happiest idea of my whole life," he says.

1908 Becomes *Privatdozent* (assistant) at Bern University.

1909 "Extraordinary professor" of theoretical physics at Zurich University. Resigns from the patent office and moves to Zurich. Receives his first honorary degree in Geneva. Attends his first physics conference, in Salzburg, Austria.

1910 Birth of his second son, Eduard. His sister, Maja, marries Paul Winteler.

1911 Full professor of theoretical physics at the German University in Prague. Accepts Austrian nationality, but retains Swiss one. Attends the first "Solvay Congress" in Brussels. Meets Hendrik Lorentz, Marie Curie and other stars of physics.

1912 Professor of theoretical physics at the Zurich Polytechnikum. Works on general relativity with his friend Marcel Grossmann. During a visit in Berlin, renews acquaintance with his cousin Elsa Löwenthal, née Einstein.

1913 Planck and Nernst go to Zurich to offer him a membership in the Prussian Academy of Sciences and a position as founder of a new institute of theoretical physics.

1914 Moves to Berlin. When the war threatens, Mileva returns to Switzerland with the children—just before Einstein's first lecture at the Academy. Einstein publishes a pacifist "Manifesto to Europeans" with heart doctor Georg Nicolai.

1915 Consults mathematician Hilbert in Göttingen about the equations of general relativity. Presents general relativity during four lectures to the Academy.

1916 *Annalen der Physik* publishes the article he writes on general relativity and also prints it as a separate booklet. He writes a book, *On the Special and General Theory of Relativity, generally comprehensible*. Works on quantum theory. Suggests the principle that will give birth, much later, to the laser.

1917 Creates modern cosmology. Falls ill because of exhaustion and wartime lack of food. Moves to Elsa's building, where she can feed him and look after him. Opens a symbolic *Kaiser Wilhelm Institute for Physics* in a room there.

1918 Rejoices when the war ends. Accepts to give lectures in Zurich and Leyden..

1919 Divorces from Mileva, then marries Elsa. Becomes suddenly famous when Eddington observes the deflection of light by the sun—as predicted by general relativity—during an eclipse.

1920 After attending a rally against relativity (and Jews), writes an article attacking nationalist physicists, especially Lenard. Death of his mother, who spent her last months in his Berlin home.

1921 Lectures in Prague and Vienna. First American tour, with Chaim Weizmann, to raise funds for the Hebrew University in Jerusalem.

1922 Publishes an article on "unified field theory." Lectures in Paris and visits World War I battlefields. Becomes a member of the League of Nations' Commission for Intellectual Cooperation (precursor of today's Unesco). Cancels public appearances when his friend, German foreign minister Walther Rathenau, is murdered by antisemites. Sails to Japan for a series of lectures. Receives the 1921 Nobel Prize (at the same time as Niels Bohr gets the 1922 prize) for his study of the photoelectric effect within his 1905 article about quanta. Accepts, reluctantly, the government's claim that he has become German by joining the Academy.

1923 Stops in Palestine on the way back from Japan. Lays first stone of Hebrew University in Jerusalem. Back in Berlin, goes to Holland when told that his life is in danger—two days before Hitler's failed putsch in Munich. Hesitates to return.

1924 Meets Hungarian student Leo Szilard. They patent a liquid sodium refrigerator together.

1925 Tours South America. Publishes a statistical study of photons with Satyendranath Bose, an Indian student who wrote to him from Calcutta, then visited him in Berlin. "Messenger" particles like photons and gluons are today called "bosons," whereas electrons, quarks and neutrinos are "fermions."

1926 Meets Freud in Berlin. Max Born calls "quantum mechanics" the latest theory of quanta, formulated by Louis de Broglie (who called it "wave mechanics"), Schrödinger, Heisenberg and others. Born suggests that what oscillates in a particle's wave is the probability of the particle's presence. "I refuse to believe that the Old Man plays dice," Einstein writes to him.

1927 Opposes quantum mechanics during the Solvay Congress in Brussels.

1928 Has to stay four months in bed because of heart trouble. Builds a unified theory that contradicts his own general relativity. Helen Dukas becomes his secretary.

1929 Meets and befriends queen Elizabeth of Belgium. Celebrates fiftieth birthday. The city of Berlin offers him a house already leased to other people. Buys a small plot neat a lake in Caputh and builds his own country house.

1930 Re-affirms doubts about quantum mechanics at the Solvay congress. "Stop telling God what to do!" Niels Bohr says. First trip to Caltech, in Pasadena. During a New York stopover, advises young men to refuse military service.

1931 Meets astronomer Hubble, who just confirmed that the universe is expanding, as predicted by Friedmann's interpretation of general relativity. Attends the premiere of *City Lights* with Charlie Chaplin.

1932 Exchanges letters about peace with Freud at the behest of the Committee for Intellectual Cooperation. Accepts to become a member of the future Institute for Advanced Study in Princeton. He still has to go to California; when he leaves Berlin, tells Elsa they'll never see the Caputh house again.

1933 While he is in America, Hitler comes to power. Einstein declares he won't return to Germany. Gives up German nationality for the second time. Lives in Belgium, then England. Advises young Belgian men to do military service. In Zurich, sees Mileva for the last time, as well as his son Eduard, ill with schizophrenia and locked in a psychiatric institution. Moves to Princeton.

1934 Meets Roosevelt in the White House. Decides to stay in America. Elsa goes to Paris, where her daughter Ilse is dying. She comes back to Princeton with Margot, her other daughter.

1935 Buys a house at 112, Mercer Street in Princeton. With two assistants, Rosen and Podolsky, publishes a refutation of quantum mechanics known as "the EPR paradox."

1936 Elsa dies in Princeton. Margot, his stepdaughter, and Helen Lukas, his secretary, take care of him. Works with two new assistants: Leopold Infeld, who writes a book with him, and Banesh Hoffmann, who will write several books about him.

1937 His son Hans-Albert, having graduated from the Polytechnikum as an engineer, emigrates to the United States. Two new assistants yet again: Bergmann and Bargmann.

1938 Writes that Germany, which just annexed Austria, want to eliminate the Jews.

1939 His sister Maja leaves Italy because of antisemitic laws and moves to 112, Mercer Street. Prompted by Szilard, Einstein signs a letter to President Roosevelt warning him that the Germans could make a nuclear bomb. Hitler invades Poland, starting World War II.

1940 Becomes an American citizen.

1941 In December, on the eve of Pearl Harbor, Roosevelt launches the "Manhattan Project." Einstein is not allowed to participate, as the FBI considers him a dangerous communist. America at war with Japan and Germany.

1942 Enjoys walks and tea parties with Pauli and Gödel.

1943 Works for the U.S. Navy with Gamow.

1944 Writes a copy of his 1905 *On the Electrodynamics of Moving Bodies* article, which is sold $6 million for the war effort.

1945 Signs new Szilard letter to Roosevelt, expressing scientists' misgivings about the bomb. Roosevelt dies before reading it. Truman orders bombing of Hiroshima and Nagasaki. Einstein becomes pacifist again.

1946 Retires from his official Institute of Advanced Study position, but goes on working on united field. Becomes chairman of *Emergency Committee of Atomic Scientist*.

1948 Exploratory surgery finds an aneurysm of abdominal aorta. Mileva dies in Zurich.

1951 Maja dies in Princeton.

1952 Refuses to become president of Israel. Asks President Truman to pardon Ethel and Julius Rosenberg.

1953 Actively opposes senator McCarthy.

1954 Supports Oppenheimer, main victim of witch hunt in scientific circles.

1955 Signs a last manifesto, with Bertrand Russell, against the arms race. Dies on April 18th, in Princeton, when his aneurysm ruptures.