Albert Einstein in Japan: 1922

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namely, the probability density for the distribution of the excited atom right after excitation by the radiation pulse.

Consistent with the earlier discussion we find that the observation that a photon is not scattered results in a modification of the center-of-mass wave function of the atom. The resulting reduction in the probability density of finding the atom in the beam ($r < a$) when the photon is not scattered is identical with the probability density of obtaining a scattered photon, hence finding the atom in the beam.

With the assumptions that $\tau \ll \tau_r$ and that $t \leq \tau$, the calculation can be carried out to all orders. The only state vectors appreciably excited are $|0,n,0,\ldots\rangle$ and $|1,n-1,0,\ldots\rangle$. Adopting a real envelope function $f(t)$ and defining a new element of time dt^* such that

$$dt^* = f(t)dt, \tag{32}$$

gives the two equations

$$\begin{aligned} f^{-1}\tilde{H}_1\tilde{\psi}_0 &= i\,\partial\tilde{\psi}_1/\partial t^*, \\ f^{-1}\tilde{H}_1\tilde{\psi}_1 &= i\,\partial\tilde{\psi}_0/\partial t^*, \end{aligned} \tag{33}$$

where $\tilde{\psi} = \tilde{\psi}_0 + \tilde{\psi}_1$ and $P\tilde{\psi} = \tilde{\psi}_0$. Here, $f^{-1}\tilde{H}_1$ is time independent. The equation (33) yields the equation

$$nV^2|u(k_0,\mathbf{x})|^2\tilde{\psi}_{0,1} + \partial^2\psi_{0,1}/\partial t^{*2} = 0, \tag{34}$$

with the solution

$$\begin{aligned} \tilde{\psi}_0 &= \cos(\theta/2)v(\mathbf{x})|0,n,0,\ldots\rangle, \\ \tilde{\psi}_1 &= \sin(\theta/2)v(\mathbf{x})|1,n-1,0,\ldots\rangle, \end{aligned} \tag{35}$$

where $\theta = 2\sqrt{n}V|u(k_0,x)|t^*$. For $t > \tau$ the atom can no longer create or destroy a photon with $j = 0$. Hence $\tilde{\psi}_0$ is constant for $t > \tau$. The measurement projection P carried out at $t \gg \tau_r$ gives this result. To the extent that $|u(k_0,\mathbf{x})|$ is uniform over the focus the pulse intensity n can be adjusted to yield a pulse with $\theta \cong 180°$ for $r < a$. ($\theta \cong 0$ for $r > a$.) For this choice of n the absence of a scattered photon implies the absence of the atom from the radiation beam.

III. SUMMARY AND CONCLUSION

We now seem to have at least a partial resolution of the paradox. The deduction that (after the observation) the atom is *not* located in the radiation beam is based on the *absence* of a scattered photon. This apparently correctly implies that the quantum state of the electromagnetic field has not been affected. Nonetheless, the center-of-mass wave function of the atom has been changed to eliminate the atom from the beam and in the process the expectation value of the atom's center-of-mass motional energy has been increased.

The apparent lack of an interaction between the atom and the electromagnetic field is only illusionary. In lowest order the perturbation calculation shows that the change in the atomic center-of-mass wave function is associated with the absorption of a photon from the incident wave packet and the subsequent return of the photon to the packet. If the absorbed photon could have been assumed to have had a well-defined momentum and energy (as is usually the case) this type of photon absorption and re-emission would not result in the transfer of either momentum or energy to the atom. But, as we have seen, the observation requires the photons to be initially in a state for which neither the momentum nor the energy of the photon is well defined. Consequently, the photon exchange can result in a momentum or energy transfer.

The position measurement of the atom is self consistent in the sense that an immediate repetition of the measurement finds the atom to be missing from the beam if the first one found it missing. But there is an important difference between the two measurements. The second one is not accompanied by any additional transfer of translational energy to the atom. The first one appears to be more than a position measurement. It *generates* a state of definite position and determines that position ($r > a$ or $r < a$). The second measurement only confirms the result.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge a helpful suggestion from Victor Weisskopf about 1940. I also appreciate a helpful conversation in 1974 with my colleague E. P. Wigner. This work was supported in part by the National Science Foundation.

[1] W. Heisenberg, Z. Phys. **43**, 1972 (1927).

[2] M. Jammer, *The Philosophy of Quantum Mechanics* (Wiley, New York, 1974), see pp. 61–71.

[3] Reference 2, pp. 471–527.

[4] L. N. Cooper, in *The Physicists Conception of Nature*, edited by J. Mehra (Reidel, Boston, 1973).

Albert Einstein in Japan: 1922

Ippei Okamoto, Author and Kenkichiro Koizumi, Translator

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TRANSLATOR'S INTRODUCTION

In 1922 Albert Einstein accepted an invitation to visit Japan. Welcomed by the Japanese public with an excitement and enthusiasm reserved in most countries for the idols of stage and screen, he spent most of November and December of that year on lecture tour.

Dr. Einstein was warmly and sincerely admired in Japan, not only for his scientific genius, of which his Japanese hosts had been well aware before his arrival, but also for the extraordinary human qualities he manifested in person, which the Japanese were able to perceive at once, across all barriers of language and culture.

Einstein's trip was extravagantly covered by the press; his itinerary and his speeches were reproduced; and several people who were close to him during those months published their reminiscences. None of these publications, however, surpasses the small masterpiece produced by Ippei Okamoto

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and translated here. Okamoto, a painter in the Western tradition who was employed at the time as a cartoonist for the Asahi newspaper in Tokyo, traveled with the Einstein party, not on assignment, but on his own, out of personal admiration and the wish to observe the great scientist at close range. Although more than fifty years have passed since he penned them, Okamoto's simple, unpretentious words and perceptive sketches speak with rare freshness and intimacy, and bring us even closer to one of the few gentle heroes our century has produced.

ABOUT THE AUTHOR

Ippei Okamoto (1885–1948) graduated from the Western Painting Division of the Tokyo Academy of Art in 1910. Although gaining a reputation as an oil painter in the Western style, he was best known to the Japanese public as cartoonist for the Asahi newspaper in Tokyo. The popularity of his cartoons was largely responsible for a revival of that art in Japan. Later, he spent nearly six years working and studying in Europe from 1929 to 1935. His wife was the well-known Japanese novelist and poet Kanoko Okamoto (1889–1939) and their son is the internationally noted painter Taro Okamoto.

I. THE FLAVOR OF THE MAN

My personal wish

Dr. Einstein, they say, is a man who has just turned all our previous concepts of knowledge upside down. What sort of a person could this Dr. Einstein be? I simply have to have a close look at this man with my own eyes and exchange a few words with him. There is probably not a soul in the whole world who does not personally share this wish of mine.

This desire sets me into motion. At the Ueno Terminal I catch the night train. Dr. Einstein is now in Sendai.

I arrive in Sendai early in the morning, and got to the Sendai Hotel where he is staying. I explain to Mr. Yamamoto, Dr. Einstein's host, what it is I hope to do, and he readily consents. People are tiptoeing along the corridor in front of Dr. Einstein's room. They don't want to disturb his sleep.

In the meantime I hear all sorts of details about Dr. Einstein from Mr. Inagaki, the lawyer who is accompanying him around Japan.

Dr. Einstein's hair

Everybody is talking about Dr. Einstein's hair. It makes him look like a philosopher. Already there are some who are imitating his hairdo, and it looks like the start of a fad. But Dr. Einstein has never in his life called on the services of a barber. Mrs. Einstein just trims off the stray locks that get a bit long.

It would certainly be convenient to have hair like Dr. Einstein's. Whenever it grows to the point where it reaches his collar it simply curls up beautifully all by itself in a most artistic way. And the locks that are trimmed off never go to waste. There are a lot of hands waiting to receive them as a souvenir. And they prod Mrs. Einstein: "Wouldn't you say it's time to trim the professor's hair again?"

Leading a large elephant

Presently there is word that Dr. Einstein is awake. Reports continue to come in. Dr. Einstein went down to the bathroom to take a bath, but being clumsy he succeeded in getting half the skirt of his bathrobe wet. That's the state he was in when he walked back to his room.

At the appointed time for breakfast a waiter arrived and, not knowing any German, took Dr. Einstein wordlessly in tow and led him down to the dining room. Dr. Einstein, who is a very big man, came to a halt in the still-unlit dining room and announced, "You have finally succeeded in leading a large elephant into a dark room."

The Waiter then brought him both steak and cold meat dishes, but Dr. Einstein demured. "I don't want to eat with unnecessary extravagance," he said, and sent one back.

Sendai time

His eyes wide with alarm, Dr. Einstein came into our room pointing at his wrist watch. It was past time for the start of his public lecture. Someone explains "Sendai time." In Sendai the "appointed time" is always believed to be a deliberate exaggeration. He looks incredulous.

At this point I am introduced to Dr. Einstein. Not at all in keeping with his mammoth proportions, he has a whisper of a voice and a soft smile that is sheer poetry.

Doctor of democracy

Every time he leaves the hotel Dr. Einstein places his feet neatly together and gives a polite Japanese-style bow to each hotel employee as he goes out. After he has put on his shoes in the entryway he even turns around the hotel slippers he has just taken off so that the next entering guest can step into them easily. Dr. Einstein is acknowledged as a man of democracy. He has a quiet way of walking as if he is afraid of alarming the Truth and frightening it away.

His lecture style

The audience has already gathered at the public hall. The lecture is on relativity, with Dr. Aichi as interpreter.

Dr. Einstein's habit of running the tips of his left fingers back and forth along the little groove in the edge of the lecturn somehow strikes me as evidence that he is at heart a man of integrity. And his habit of standing with one foot crossed over the other suggests that he is modest by nature. He speaks as if he were conversing, affectionately, with a smile on his face, like someone who is gently teasing a child.

Too much for the Governor

Dr. Einstein proceeds with his lecture, drawing explanatory diagrams on the blackboard with a piece of chalk. The lines are drawn lightly and artlessly; they possess accuracy, and yet at the same time they have a certain softness.

Using the system of coordinates, he starts his explanation with the laws of conventional physics, and then moves to relativity. As I understand it, according to this new truth, when you measure time and space from inside a moving train and again from a motionless spot on the ground and compare the results they are clearly different. He explained the principles involved in this with the greatest simplicity. The morning lecture ends here.

While I sat sketching, with my legs tucked up under me on one of the auditorium seats, the cold air creeping more and more brazenly up my knees and over my lap, I listened to this miracle. I felt there was a certain air of mystery surrounding the Doctor. Yet perhaps in his eyes, the incomprehensible mystery would be found in people like us who still live according to the old conventional truth. In the middle of the lecture, Governor Chikaraishi mumbled, "This is beyond the likes of me," and made his escape.

Mr. Tsuchii's open-mouthed astonishment

Lunch was served at the hotel. The Sendai poet, Mr. Bansui Tsuchii, came to visit Dr. Einstein, bringing with him two bound sets of woodblock prints. He wanted Dr. Einstein to pick the set he liked best and keep it as a gift. One was Hiroshige's *Fifty-three Stations on the Tokaido* in color. The other was Hokusai's *One Hundred Views of Mt. Fuji* done in pale inks. Dr. Einstein chose the latter. As a result Mr. Tsuchii, opening and closing his great jaws, fervently praised Dr. Einstein's aesthetic eye. I listened to Mr. Tsuchii from as far away as possible so as not to be swallowed up by his big mouth.

Dr. Einstein, the nature lover

At the conclusion of the public lectures Dr. Einstein went to Matsushima for some sightseeing.

In the train on the way there Dr. Einstein becomes unusually expansive. He is apparently a lover of nature. He comments on the delicacy of the branches and leaves of Japanese trees, on the light and unencumbered quality of Japanese houses, which are constructed of wood, and makes other similar observations. I understand not only that he has the personal hope, but that there is a good possibility, he will come to live in Japan. Peering intently out of the window he presses those who accompany him for explanations. (Translator's note: in the 1920s Einstein was suffering from increasingly open antisemitism in Germany and his life had even been threatened. He was already at this time giving thought to making his home outside Germany.)

Dr. Einstein's inscription

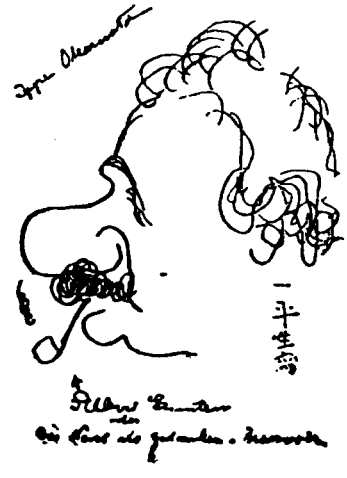
Dr. Aichi turned around in his seat and said to Dr. Einstein sitting behind him, "Herr Okamoto was sketching you in the lecture hall." That was true. And within a short time my sketch book was being passed from hand to hand and a judging competition was held to see which portrait was the best likeness. While this was going on I made an impromtu sketch of Dr. Einstein's profile on the spot and requested him to inscribe something on it. In the sketch his nose turned out to be somewhat exaggerated. First Dr. Einstein autographed the sketch for me. Then, above the "A" in "Albert" he drew an arrow pointing toward the picture as an indication that the portrait was of him. Then below "Albert Einstein" he wrote, "*oder die Nase als Gedanken-Réservoir.*"

I ask Mr. Inagaki, the interpreter, to explain it to me. I am told it means that speculation takes place in the nose—that the noise is a tank, a réservoir. Where thought usually takes place in the head, in this portrait all thought has been relegated to the nose, which is the think-tank, the thought-réservoir. The last word is French. Dr. Einstein is an admirable humorist. I will treasure this inscribed sketch for the rest of my life.

We arrive at Matsushima. The sketch I made depicts us taking a short rest at an inn there. Dr. Aichi is at the lower right-hand corner, and across from him on the right, warming his hands at the hibachi, is Dr. Honda. I will describe what went on during that rest period in detail in a later section.

A cold inlet in the evening mist

The wind is cold. The sun begins to set. As we walk along the Matsushima beach, traces of remaining snow freeze fast to the soles of our shoes. Islands scattered in the sea maintain discrete distances from each other, yet look as if they long to huddle closer; some of the baby islands have already snuggled into the bosom of the mother islands. The scene hangs like a picture scroll, devoid of range or motion, and I give to it the title "A Cold Inlet in the Evening Mist." Slowing his pace, Dr. Einstein marvels at the beauty of the scenery. Entranced, he utters quiet words of admiration, and using the stem of his small pipe as a brush, he traces in the air the outlines of the scene. And yet like any other ordinary foreigner, he demonstrates no interest at all in the full moon nor in the sound of the temple bell. (Note:



Two aspects of Matsushima celebrated, century after century, by Japanese poets.)

Masamune's squinting eye by flashlight

We enter the Zuiganji Temple after dark. When the priest who serves as a guide for visitors hears it is Dr. Einstein, he throws himself into high gear.

He succeeds in rustling up a flashlight from the priests' quarters and begins by directing its beam into the dark to illuminate the wooden statue of Date Masamune. "Doctor, please step forward a little more," he urged. You see, don't you, that one of Lord Masamune's eyes is squinting." (Note: Date Masamune (1567–1636), a daimyo famed as a warrior, politician, and patron of the arts, was blinded in the right eye by small pox as a child, and in adulthood, bore the epithet "The One-eyed Dragon.") Then, in the entryway, pointing to a transom carving of a tiger among some grapes executed by Hidari Jingoro, he proceeds: "The tiger's stripes along the hind thigh and over the front elbow joints are shown by means of the natural grain of the wood, etc., etc." But Dr. Einstein is less interested in such things than in the temple's architecture, especially the structure of the ceiling and roof. As we were about to leave the temple, a photographer took a picture of us, setting off a magnesium flash. Dr. Einstein knit his brows. "The ceiling is going to get all sooty from that smoke!" he muttered.

Those who want some always make the first move

We go to a Japanese-style room on the second floor of an inn for a short rest. Dr. Einstein is not accustomed to sitting in Japanese fashion on tatami floors, but feeling compelled to give it a try he is about to sit on the floor when we all seize hold of him and stop him. Piling several cushions one upon the other, we seat him up on top, and then arrange ourselves on the floor around him in Japanese banquet fashion. It looks exactly like a welcoming party for an envoy from one of the 17th-century Dutch missions to Japan. As a preventative for the common cold, Mr. Yamamoto calls for a bottle of sake. He then proceeds to press it eagerly on the others first. Dr. Einstein watched this scene and laughed. "We have a saying in the West: 'Those who want some always make the first move.' I wonder if that's not the case with Herr Yamamoto!"

Research on seaweed

Dr. Einstein doesn't drink. We urge on him only the thin, tiny sheets of toasted seaweed that are served with the drinks. First he holds a piece up to the light and examines it. Then he says, "I understand it has a very delicate flavor, so I will have to sensitize my tongue first." And with that he puts his pipe in his mouth, takes a puff, and exhales. Then, with his head cocked to one side, he takes a taste. The verdict: "Very nice."

A calisthenics instructor of very short stature

Back at the hotel we share a table for dinner and then drive together to Tohoku University to attend a welcoming party. First, we got to a hall where the students have gathered. Their representative reads a welcoming speech. It expresses an adoration that verges on idolatry. Next are Dr. Einstein's words of reply. A calisthenics instructor of very short stature then comes forward and leads them in a chorus of "Banzai" ("Long Live Dr. Einstein").

Party preparations have been completed in a conference room of the University's new College of Engineering. They lead Dr. Einstein there, stand him in the middle of the room, and then the professors of the University line up in order to be received in audience by him. Taken one by one, each of these men is supposed to be an authority in his field, yet seeing them lined up like this in a row I can't help thinking, no offense intended, that they certainly are a countrified-looking lot. Stepping up to Dr. Einstein to shake his hand there are the self-conscious ones; the awestruck; the fervent; those who try their best to assume an attitude of equality; and those who are holding their breath. Really, if only they weren't so prone to factional squabbling, scholars could be the most winsome little creatures on earth. To each of the more than fifty people who shake his hand Dr. Einstein gives a soft smile. This means he has to produce a smile more than fifty times. Standing next to Dr. Einstein, introducing each man as he comes, is that very short calisthenics instructor. I later inquired about him and he turned out to be the University President, Dr. Ogawa! Now that you mention

it, the glint in his eyes was too sharp for a calisthenics instructor.

Morris

The conspicuously tall foreigner standing in the line of professors is the pride of Tohoku University, the world famous Austrian botanist, Professor Morris.

Tohoku University invited Professor Morris to join the faculty by promising him a fat salary and even building him a Western-style house. Professor M. turned down the house; he lives a simple life, eating and sleeping in his laboratory-office.

Although older than Professor Einstein, it is my understanding that sometime in the past Professor M. had attended Professor Einstein's lectures. Their greetings to each other were quite long. All of us gaze entranced at this magnificent exchange.

Halfway through the party, each of these two great authorities inscribes his name with brush and ink on the brand-new wall of the conference room to commemorate the occasion.

The next day Dr. Einstein heads for Nikko.

A certain rich man's view of relativity

The following is a story someone in our party told me to help pass the time while on the train to Nikko. The other day Dr. Einstein visited the home of a certain wealthy man in order to see his art collection. Upon meeting Dr. Einstein, the man, in a flush of overwhelming admiration, said: "I understand, Doctor, that you do research on that place high above the clouds called space; there certainly can be no doubt, therefore, that you are truly a superior man." The rich man thinks space means heaven.

Dr. Einstein's view of the Japanese

Generally speaking Dr. Einstein apparently feels the Japanese are a refined people. In America, to beg for his autograph, people will just walk right up to him on the street and thrust a fountain pen in his face. The Japanese never behave like that. He feels that Japanese young people are especially appealing in the way they tend to be a little shy when meeting him: but that their inner natures show vigor and substance. The youth of Japan should keep in mind that they have been blessed by Dr. Einstein's words of praise.

Fresh ginger is a demon

For the noon meal we order Japanese-style box lunches. Dr. Einstein, who always likes to investigate something new, picks up his chopsticks along with the rest of us. He handles his chopsticks like someone who had poor table training as a child and who was allowed to grow to adulthood in that same state of neglect. He tastes almost everything in his box. He is startled to find that the pickled plum still has its stone. Pointing to a piece of fresh ginger, he says, "This one is a demon. When you put it in your mouth it suddenly bites you back."

Two crimes

Dr. Einstein has been forbidden by Mrs. Einstein to drink coffee because she says it is bad for his health. She thinks the same about Japanese food. But after lunch the waiter brought all of us coffee. Sipping his coffee, Dr. Einstein whispers: "Today I have committed two crimes against my wife. First, I ate Japanese food; the second is the coffee! Not a word to anyone! Not a word!"

"But what excuse are you going to give her if you get an upset stomach," inquires Mr. Inagaki.

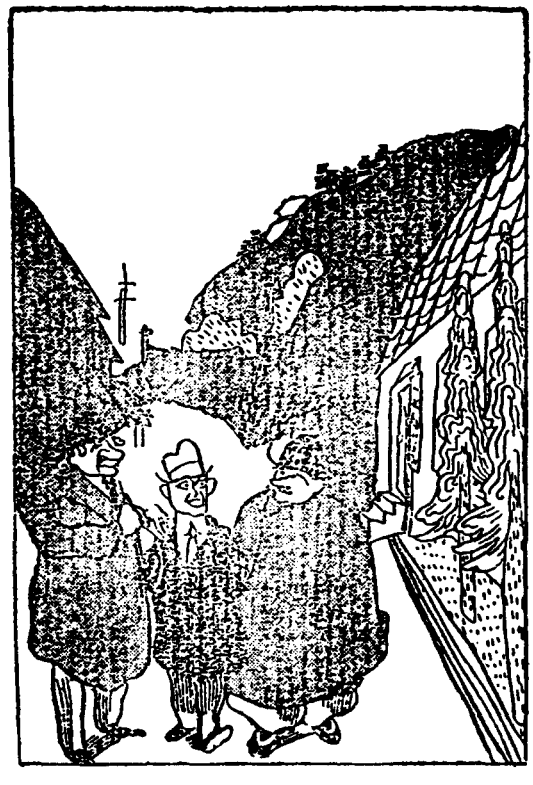
"I will lie to her and say it's because I smoked too much," he replies, drawing in his neck, sticking out his tongue, and producing a face that makes him look for all the world like a naughty little boy.

A slip of the pen by a Bern professor

At Utsunomiya, our host, Mr. Yamamoto, and his entourage head back to Tokyo, leaving the three of us, Dr. Einstein, Mr. Inagaki, and myself, on our own. Suddenly we don't know what to do with ourselves and can't think of anything to say. Near Imaichi we come to the old Onari Highway lined with crytomeria trees, and as we pass them Dr. Einstein tells us a funny story. "There was this professor in Bern, you see, who in an absent-minded moment in one of his articles started out a sentence with 'From the extreme cold of the north pole in the north to the extreme heat of the south pole in the south. . . .' Well, this caused a problem, and you know he finally had to resign from his post!"

How to tell a Japanese bank

Dr. Einstein is always fond of walking. I will itemize everything that especially caught his eye and halted his steps as he walked through the town of Nikko to the hotel: a signboard shaped like a sea bass in front of an ordinary little corner restaurant; the two-foot-long white radishes as big as your arm on sale at the grocery store; children playing the game of battledore and shuttlecock; a bank. In front of the bank he leans close to our ears and whispers, "There is always greenery planted in front of Japanese banks, isn't



there!" That, I think, is the sort of minute observation that no ordinary foreigner would be likely to make.

Mrs. Einstein

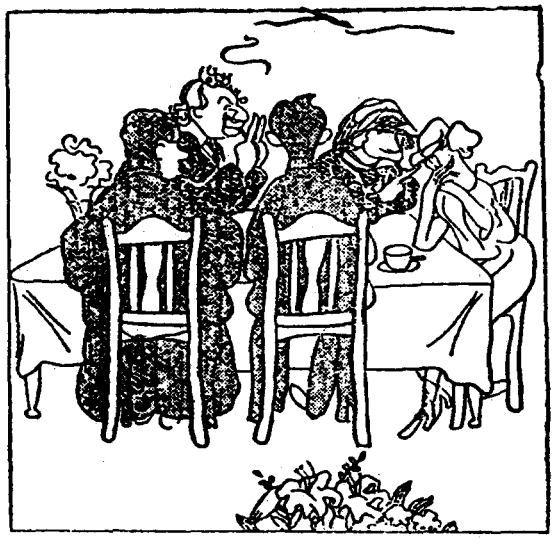
We settle in at the Kanaya Hotel. Toward evening Mrs. Einstein arrived from Tokyo in the company of Mrs. Inagaki. Mrs. Einstein seems to be an ingenuous sort of lady. She speaks a little English. Dr. Einstein understands English but never speaks it on his own initiative. His attitude toward his wife can be catagorized as the unusually understanding and protective type.

Dr. Einstein at the dinner table

At the dinner table Dr. Einstein is truly an outgoing and pleasant fellow. Without a word he eats whatever Mrs. Einstein orders for him. In rapid succession and always in good taste he fires off guileless little jokes. "How was your trip," asks Mrs. Einstein, to which he replies, pulling a mournful face, "Absolutely dreadful! I was not only forced to eat Japanese food and to drink coffee, but at night I was so lonely I could hardly sleep a wink." Then suddenly, with a charmingly ferocious shift in facial expression he utters, "Be that as it may, without you around bothering me all the time it was very relaxing."

Mrs. Inagaki, too, is a German; she still retains a certain girlishness about her. Dr. Einstein devotes himself enthusiastically to making her laugh. The subject matter: a description of his house back in Germany. His parodies are exactly like the exaggerated drawings that decorate fairy-tale books. "The chairs in our house are extremely elegant. But when a guest sits down in one it slowly collapses. We have a library as big as the whole world. Books are crammed into every square inch of it. But not one of them has ever been read. They're shut up in there so as not to interfere with the housecleaning. In comparison," he continues, holding up his forefingers about two inches apart, "my study is no bigger than this."

Modulating his voice to fit the subject and punctuating his story with gestures, he makes the conversation pivot suddenly, dip, soar, and veer precipitously; Mrs. Inagaki laughs until her sides ache. Mrs. Einstein, too, with tears of laughter in her eyes, aids and abets her husband's waggishness with encouraging words from the sideline.



An invitation from nature

The next day is bright and clear. We three men climb up for a look at Lake Chuzenji. Dr. Einstein turns his face happily up to the sky and says joyfully, "Today, no relativity, no invitations! This is true relaxation."

"It's nature's turn to invite you today." This impromtu remark of mine seemed to strike a responsive chord in Dr. Einstein, the poet; he looked at me and nodded several times.

We go to see the Hoto, Hannya, and Kegon falls in that order. He apparently has no particular interest in waterfalls. But he seems to derive the utmost pleasure just from looking up at them, peering down into the gorges below them, and wandering around the area on foot. As we come out near the lake we are suddenly engulphed in a snow storm. Hanging on to our hats we make a dash for the lake hotel. The snow glimmers white in Dr. Einstein's hair. Inside by the charcoal fire we enjoy a happy sense of deliverance. Gazing intently at the glowing charcoal he seemed for some time to be deeply moved. "If only I could take these glowing coals back to Germany!" he murmured.

Dr. Einstein and the inexplicable

We open the box lunches we had brought with us, and while we are eating Dr. Einstein asks about various things that puzzles him. The strangest thing of all, he felt, was that the Japanese, until a very recent period, lacked the sort of desire that would have opened their eyes to knowledge of the natural world. "How can it be that the Japanese of the past did not ask why it is hot in Fukuoka but cold in Sendai? Didn't that puzzle them at all?"

To this I replied, "In Fukuoka, when it was hot, people just quietly fanned themselves, and in cold Sendai they simply put on another layer of warm clothing. They did not question nature, they immersed themselves in it. That's what the Japanese of the past were like."

The conversation smacks a little of a Zen dialog. I wonder whether anyone comprehends it or not.

The dancing scrap of paper

After we have finished eating we gather around the

charcoal fire for a smoke. Dr. Einstein takes a scrap of paper out of his pocket. He tears its edges and releases it over the flame. The action of the carbon dioxide gas makes it dance upward, spinning round and round. Pointing his finger at the whirling paper, he looks at me and smiles. I can see nothing more than a scrap of paper dancing, yet there is surely more here than meets the eye. How lamentable it is to be such an ignoramus!

Dr. Einstein's manner of inquiry

I hear that while on board ship coming to Japan, Dr. Einstein amused himself at the dining table by lining up two drinking glasses and inserting a menu card in the space between them. As the ship rolled from side to side the menu card tipped, touching the right glass, then the left. By measuring the time intervals involved and doing a little mental calculation, he wiled away the time by figuring out how far the ship was listing.

In the light of that incident and his present feat of launching a scrap of paper into flight above a charcoal fire, it is clear that Dr. Einstein's manner of getting at the truth is not in the least rigid nor academic. He seems never to have lost his innocent, childlike curiosity; on the contrary it seems only to have grown bigger and stronger. He is always prepared, unwittingly, to serve the inspiration of nature. In this respect he is an artist to the core. And that is why you find in him both roundness and purity.

The inexplicable, continued

Dr. Einstein presses fresh tobacco into his beloved pipe, and between puffs, resumes his inquiries into things that puzzle him. He wants to know how often present-day Japanese go to temples. He observes that, on the one hand, Japanese believe the soul, after death, goes to heaven or hell, while, on the other hand, they also believe the souls of their ancestors reside in their descendants. He wonders if they do not feel some contradition here. And so forth. One can tell from his questions the directions in which his interests lie.

Had Dr. Einstein been born in old Japan

"I wonder how the Japanese of old thought about the movement of the sun?"

He seems terribly concerned that the ancient Japanese demonstrated so little inquisitiveness. We exchange a few remarks on this subject. Then he says, "If I had been living in those days, I'm sure I would have set up straight lines toward the sun running from the northernmost and the southernmost points in Japan, measured the angles, and determined the position of the sun," and with his finger he draws a scalene triangle on the table beside him. "And for your trouble you would have had your head cut off," I said. Everyone burst out laughing.

There is no Lake Chuzenji in Nikko

We start back to our hotel. The snow is so deep it is above our knees. We hurry across the Chuzenji Bridge.

In the blinding snow we cannot see the lake nor even its shoreline. Dr. Einstein says, "There is no lake in Nikko. It exists only on maps."

The telephone poles go faster

We had brought a jinrikisha and man out with us that day, but Dr. Einstein walks, and even insists on carrying his own packages. Since coming to Japan he has never once set foot in a jinrikisha. He says it is inhuman. He is such an egalitarian he dislikes receiving the attentions of anyone who gives the slightest appearance of being there to serve him. As a result we always have to be at great pains keeping these people far behind us and out of Dr. Einstein's sight. The road we are following has many curves. The telephone poles, however, follow a straight line. "Look, the telephone poles go faster than we do," says Dr. Einstein, jokingly.

The relativity of falling down

The snow-covered mountains look desolate. Their peaks are white; the lower edges of their skirts shade off from pale to deeper grays, as if the ink had slowly settled to the bottom. The only sound is the rustle of fallen oak leaves as they brush against each other in the whirl of snowy wind. On the frozen road Dr. Einstein slips and falls down. Foreigners have a clumsy-looking way of falling down. Mr. Inagaki, helping him to his feet again, says, "In terms of the theory of relativity, am I not right in saying that you didn't fall down? The earth titled, wouldn't you say?"

"I agree with you," says Dr. Einstein, "but it feels the same either way."

The grim smile of a bachelor

We arrive back at the hotel.

First I take a bath. Then I transport my warmed-up body back to my radiator-heated room and relax comfortably in a chair. Smoking a ciagrette I sink into a state of vacuity. Supreme bliss. A single fallen leaf came to anchor on the other side of my window pane and, like a ship in the offing, undulated in one spot at the mercy of the wind. Then, enticed by the snowstorm, it suddenly changed its mind, and edging its way off obliquely to the right, it fled.

Mr. Inagaki knocks on my door and says, "If you're feeling lonesome, come on over to our room." In the Inagakis' room next door there are two people, and the Einstein room houses two. But there is only one in my room.

Of course, now that I think of it, there is every reason why I should be lonely. I give the grim smile of one who, after more than ten years of marriage, finds himself a bachelor again. Then, making myself presentable, I go next door.

Sehr interessant

I ask Mrs. Inagaki whether she has noticed anything about Japanese people that she, as a German, feels to be strange. She says there is. It's that Japanese who can speak a little German always overuse the expression "sehr interessant" as a response. The expression means something like "very interesting."

Even when they don't know what she has said in German, they pretend they do by saying "sehr interessant." Once she informed someone that her shoe needed repairing, whereupon the person nodded profoundly and said "sehr interessant."

At dinner on the second night

Dr. Einstein brought to the dinner table a small gourd made into a bottle, a well-known souvenir of Utsunomiya. He pours water into it and enjoys drinking from it. I tell him the gourd is for saké and that is really tipplers who drink from gourds. With a great look of mock horror on his face, as if in fear of offending Mrs. Einstein, he hastily stuffs the gourd back in his pocket with an exaggerated flurry.

Dr. Einstein is a man inattentive to his own appearance. He sometimes comes out to meet guests with the front buttons of his shirt undone and with his bare chest showing through. This is the story Mrs. Einstein has for us at the dinner table.

I had been wondering what I could present to Dr. Einstein that would be of use to him, and decided to make him some drawings of present-day Japanese life. The night before I had chosen ten subjects and had drawn them on 10-inch squares of finely finished cardboard: a young girl dancing; a priest; a jinrikisha; a shopkeeper; a fish vendor; a man with a performing monkey; a ferryman; a farmer; a primary school student; and a young wife at her sewing. I take this occasion to present them to him. He is delighted. He tells me he is going to show them to the painter Liebermann (Translator's note: Max Liebermann, 1847–1935) when he gets home. If I had known that was going to happen I would have prepared them under somewhat less hurried circumstances. I feel a little gloomy about the whole thing.

After dinner Dr. Einstein plays the piano. Mrs. Einstein states proudly, "Even if he gives up being a scholar, the professor could earn an excellent living with his violin."

Kisses for Nikko

The next morning, explaining that it is because he has taken such a fancy to Nikko, he gives Mrs. Einstein an extra helping of kisses.

The working hours of a shrine maiden

We all go to see the Toshogu Shrine. First we stop at the building where distinguished guests are received and listen to the head priest tell about the shrine. From there we enter the sacred grounds.

A young shrine maiden is sitting in one of the shrine buildings. This sparks Dr. Einstein's curiosity. He asks her what her working hours are. She says it's an eight-hour day. The inquiry into the working hours of a shrine maiden is certainly original, to say the least. He has only a modest interest in the Yomei Gate or in the Sleeping Cat carved by Hidari Jingoro. Mrs. Einstein looks at the decorative tassels hanging from the fine rattan blinds and asks, "What do you clean with these dusters?"

The Crying Dragon is a famous attraction here. When you stand directly beneath the head of the dragon painted on the ceiling and clap your hands a groaning sound comes from the ceiling. "Doubtless an accoustical effect," says Dr. Einstein, dismissing it with utmost simplicity. In the presence of Dr. Einstein, even famous tourist attractions are forced to undergo changes in their relative values.

For worship or for sightseeing

Observing the people who have come to visit the shrine, Dr. Einstein comes up with the inquiry, "Are they here for worship or for sightseeing?" A most uncomfortable question.

A greeting from some primary school girls

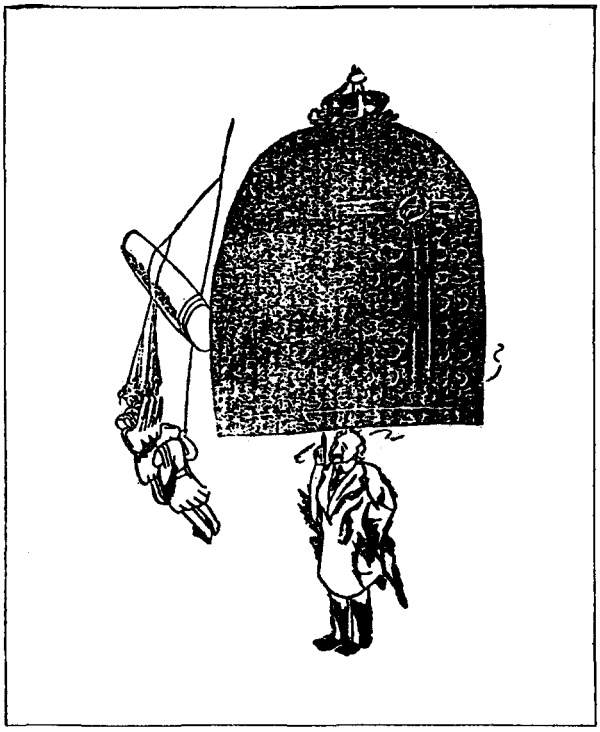
When we had finished our sightseeing and exited through the gate we were met by a primary school teacher with a group of little school girls in tow. The teacher, standing motionless and ramrod straight, began cheerfully to recite in painfully memorized English: "I am very happy to meet you." As he is speaking, Dr. Einstein, smiling gently, greets the students affectionately with such little gestures as taking off his hat and putting it on the head of one of the students. The rest of the students burst out laughing. The student under his hat looks as if she is about to dissolve into tears of embarrassment at any moment.

This little girl, as a result of having worn Dr. Einstein's hat, will no doubt be the talk of the school for some time to come.

This evening we return by train to Tokyo.

II. THE VENERABLE SAVANT, ILLUSTRATED

(1) At the Chioin Temple in Kyoto, the great bell, not normally struck for anyone, is struck for Dr. Einstein.



The way he listens to it is interesting. He climbs right up under the bell and stands directly beneath its center, savoring the fact that from inside a tolling bell its sound cannot be heard.

The priests have a profound knowledge of the *next* world; this, however, has left them little acquainted with the physical principles of *this* world.

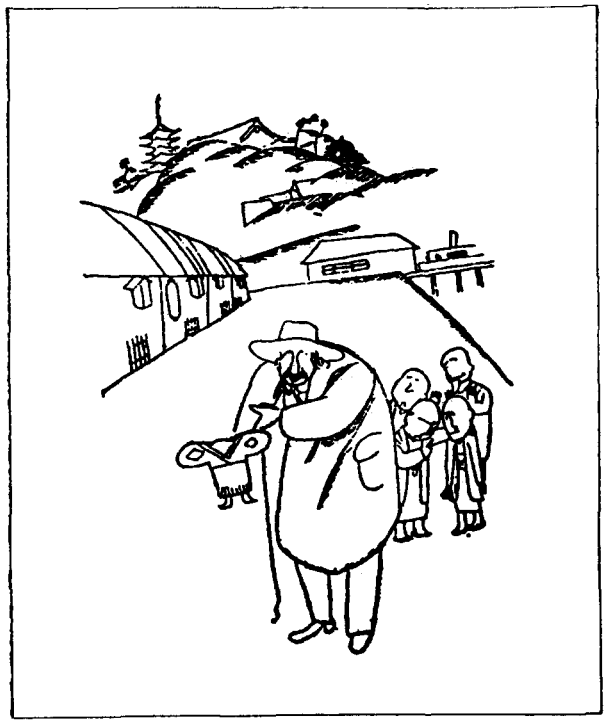
Hence, one can see by their faces that Dr. Einstein's behavior is totally inexplicable.

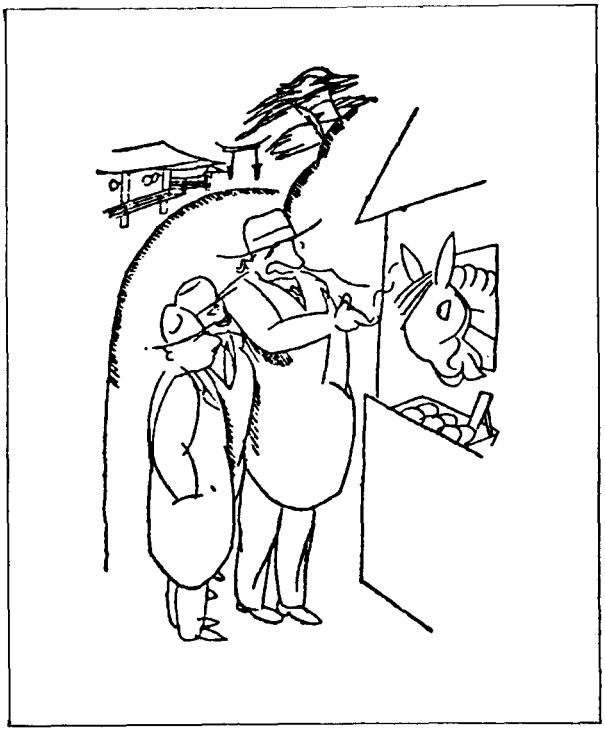
(2) Still at Chioin Temple, Dr. Einstein now stands in the corridor called"Nightingale Walk."

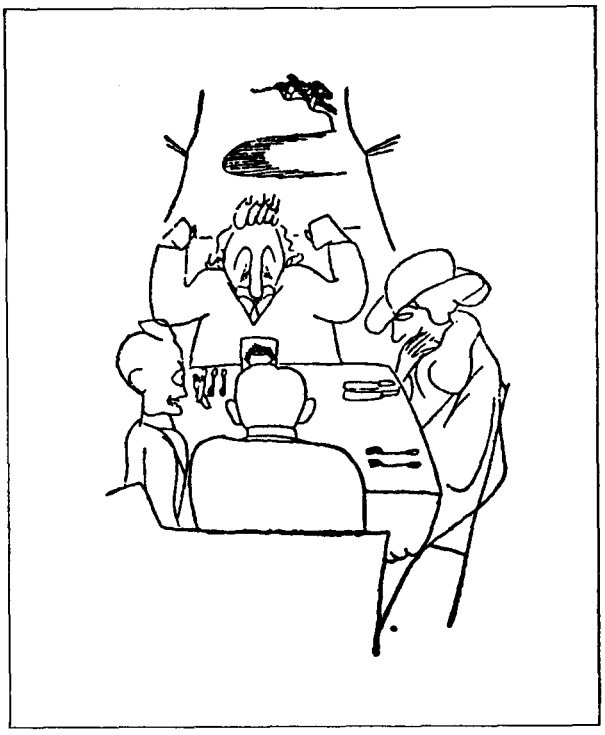
He is fascinated by the twitterings, like the calling of nightingales, which emanate from the floor boards as one passes along the corridor; it is hard to believe that such delicate sounds could be produced merely by the friction of one board against another. Like a child he tramps up and down the corridor. Dr. Ishiwara, who is accompanying us, assists him in his trampling with a perfectly serious face.

Treading out the sounds of nightingales, Dr. Einstein turns to Dr. Ishiwara: "In relation to sound frequency, K_1, K_2 is, as you know, . . ." He has started up again with his speculations on the theory of relativity or whatever; he cannot leave his research alone, even when he is out on an excursion. In its way, it is beautiful to behold.

(3) Dr. Einstein goes to Nara for a visit. Among the sacred deer at the Kasuga Shrine there are some that have learned how to bow. One of them bows to Dr. Einstein, begging for bread. In return, Dr. Einstein, too, executes a







bow.

When you look at the way Dr. Einstein bows to the deer you can see that it differs not one iota in body angle nor in respectful bearing from the bows he renders to Japanese dignitaries.

(4) Dr. Einstein has come to the island of Miyajima in the Aki district. He goes out for a walk.

Some island children have managed to launch a toy kite, but it is dipping and bobbing and won't fly right. Dr. Einstein adjusted the string for them. Up it soared beautifully.

Next, the wind died. The children looked up into Dr. Einstein's face again. Regretfully, the wind is out of his department. He looks back at them apologetically.

(5) At the shrine on Miyajima Island, the sacred horse stands with his head thrust out of the window of his stall; small offertory dishes are lined up in the customary manner in front of him.

Dr. Einstein speaks:

"I wonder whether or not a sacred horse realizes his sacred function. Probably he's aware of nothing but his appetite. That would make him just like a priest, wouldn't you say?"

(6) I hear that Dr. Einstein never looks disgruntled. But actually he does once in a while.

That's when Mrs. Einstein takes him to task for smoking his beloved pipe too much on the grounds that it is bad for his health. But the disgruntled look on his face is not just an ordinary run-of-the-mill variety. He looks slightly defiant, yet a little as if he is making sport with her, and still

at the same time he looks vaguely as if he hasn't the faintest idea what she is talking about.

In order to capture this complicated facial expression I have wasted 38 sheets of paper. And I certainly cannot pronounce this 39th a success either.

(7) In hotel dining rooms Mrs. Einstein always takes charge of ordering our meals. Tonight, however, because of a headache she cannot join us at the table.

Dr. Einstein, placing the menu in front of him, says he will order in her stead, and flexing his muscles, declares: "Under the pressures of the responsibility, I feel strong." We all laughed.

It is quite dangerous, however, to be fed by Dr. Einstein. He has no respect for the proper sequence of courses; the poultry dishes will come out first, then the fish dishes later.

And he himself is eating potatoes, which Mrs. Einstein does not allow him because she considers them too vulgar. (The foreign lady seated at the table in my sketch is not Mrs. Einstein, but Mr. Inagaki's wife.)

(8) Dr. Einstein comes to join us in Mr. Inagaki's room for a chat. He is incessantly cleaning his beloved pipe.

I offer an observation:

"Professor, it's hard for me to tell whether you smoke for the pleasure of smoking, or you smoke in order to engage in unclogging and refilling your pipe."

He replies, "My aim lies in smoking, but as a result things tend to get clogged up, I'm afraid. Life, too, is like smoking, especially marriage.

When the pipe cleaning is over he says the next job is going to be a little handicraft operation. With his knife he cuts away worn pieces of leather from the soles of his shoes and feeds them to the charcoal fire. It smells to high heaven.

No matter how many times we plead with him to stop, he just looks over at us, grinning, and continues to put pieces of old leather to the flames. Dr. Einstein has a certain devilish streak in him.

Bringing home the atomic world: Quantum mysteries for anybody

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A simple device is described, based on a version of Bell's inequality, whose operation directly demonstrates some of the most peculiar behavior to be found in the atomic world. To understand the design of the device one has to know some physics, but the extraordinary implications of its behavior should be evident to anyone. Except for a preface and appendix for physicists, the paper is addressed to the general reader.

PREFACE

The 1935 thought experiment of Einstein, Podolsky, and Rosen[1] challenged the quantum-mechanical doctrine that simultaneous values of incompatible observables are not only impossible to know, but also meaningless to contemplate. The correlations revealed by that experiment underly much of Einstein's subsequent insistence that the quantum theory, though it might well account correctly for all measurements, was only a step toward a more complete theory that would give meaning to the values of unmeasured properties.

For almost three decades the objections to Einstein's views on the reality of unmeasured properties were entirely philosophical. "One should no more rack one's brain about the problem of whether something one cannot know anything about exists all the same, than about the ancient question of how many angels are able to sit on the point of a needle."[2] In 1964, however, J. S. Bell[3] showed that such assumptions of existence can have observable consequences. These can be at odds with quantitative numerical predictions of the quantum theory, and thus, if the theory is correct, with observable physical behavior.

Experiments since Bell's paper[4] indicate that nature behaves consistently with quantum mechanics, but not with the concept of reality Einstein demanded from a satisfactory theory. The metaphysical conundrum with which Einstein, Podolsky, and Rosen attacked the accepted interpretation of quantum mechanics can now be extracted directly from a few simple facts, without any reference at all to the conceptual apparatus of the quantum theory. The point is no longer that quantum mechanics is an extraordinarily (and, for Einstein, unacceptably) peculiar theory, but that the world is an extraordinarily peculiar place.

In the paper that follows I present the Einstein–Podolsky–Rosen conundrum,[5] without mention of wave functions, superposition, wave-particle duality, the uncertainty principle, incompatible observables, electron spin, or any other quantum-mechanical notions. The argument is addressed to readers who know nothing of the quantum theory or, for that matter, of classical physics either. My aim is to bring such readers directly up against one of the most strikingly odd ways the world can behave. Those who follow the argument should be as able as practicing physicists to ponder the metaphysical implications of the Einstein–Podolsky–Rosen conundrum.

I begin by describing a certain device. The device contains some black boxes, but the relevant features of its behavior are fully described, just as one can fully describe what comes out of a radio when the knobs turn, without delving into electromagnetic theory.

In the second half of the paper I point out the conundrum posed by the existence of such a device. No resolution of the conundrum is offered. Many physicists simply deny that it is a conundrum,[6] a position readers can accept or reject for themselves.

There is an Appendix for physicists that explains what is in the black boxes. Understanding the explanation is no more essential to appreciating the wonders of the device

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