When he tried to prove quantum mechanics isn't as odd as it seems, this unlikely guru ended up twisting reality another turn into the weird zone where particles light-years apart may communicate instantaneously

INTERVIEW

JOHN BELL

More than 25 years ago John Bell had a chance to tell off the great Danish physicist Niels Bohr, one of the founding fathers of quantum mechanics "It was the inauguration of CERN " Bell recalls "I went up in a hotel lift with him I didn't have the nerve to say, 'I think your Copenhagen interpretation is lousy' Besides the lift ride wasn't very long Now if the lift had gotten stuck between floors, that would have made my day! In which way I don't know " Bell roars

Bell has a curious position in the pantheon of particle physicists At CERN the monstrous European physics laboratory outside Geneva where he works his colleagues consider him a shrewd puzzle solver He's a fellow who slowly but surely helps to advance the field by patiently unraveling the threads of tiny, concrete problems left after more speculative minds have forged recklessly ahead But there is another set of people—nonscientists mostly—who look upon him as an intellectual saint for his work interpreting the meaning of quantum mechanics the theory that describes the world of the atom To them he is something of a quantum guru

Redheaded red bearded Bell has always been troubled by quantum mechanics Born in Belfast Northern Ireland in 1928 he first encountered quantum theory while at the local technical college and found it strange indeed Quantum mechanics seemed to say that the entities of the subatomic world—electrons photons and the like—cannot be pinpointed They exist in a haze of random possibilities until "actualized" in particular circumstances as when a scientist performs a concrete experiment on them Does that mean that the properties of matter are in effect created by human beings? That was indeed a suggestion of Bohr's Copenhagen interpretation It was vainly

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challenged by Einstein, who argued that future physicists would discover presently unknown factors. These "hidden variables" would eliminate the randomness and uncertainty of quantum mechanics and allow physicists to measure the behavior of subatomic particles as if they were billiard balls. Others argued that no such return to determinism (the old belief in certainty) was possible. At the lowest levels of matter, they said, things don't really exist until you look at them.

Bell graduated from college in 1949, began work as an accelerator physicist, and in 1960 wound up at CERN. Continuing to harbor reservations about the Copenhagen interpretation, he ultimately set out to refute it. To his surprise, his conclusions suggested that quantum mechanics is even stranger than anyone suspected. In two brilliant papers, the first published in 1965, he proved what is known as Bell's theorem. Roughly, Bell's theorem says that when two particles are emitted in opposite directions and the properties of one of them are "actualized" by being measured, the properties of the other will be found to be correlated, or linked, when it, too, is measured—no matter how far apart the particles are. It's as if there were some kind of instantaneous communication between them. Bell's theorem mathematically eliminated the possibility that a "hidden variable" could explain this connection. Somehow the particles are linked, even if there are light-years between them.

Bell's theorem has acquired near-religious status among certain popular authors who feel it proves the ability of subatomic particles to "think," the basic "wholeness" of the universe, faster-than-light communication, and a host of other mystical footaraw—what the late great physicist Richard Feynman called "the cargo cults of science." Experiments proving Bell's theorem, wrote Michael Talbot recently in *Beyond the Quantum*, constitute "the final proof that reality as we know it does not exist at the subatomic level." Bell himself has been summoned to dine with the Dalai Lama and to address the students and faculty at Maharishi University. Strange company for a self-described "cold-blooded" physicist who likes nothing better than to talk about particle accelerators with his physicist wife, Mary.

We first asked Bell over the telephone whether he himself felt he had demonstrated that "reality doesn't exist." He responded by warning us that he is an impatient, irascible sort who tolerates no nonsense. He did, however, agree to speak with us, jotting down the appointment, we later learned, in his *Pocket Diary for Physicists*, which lists the birthdays of famous scientists. In the flesh, we found him to be a soft-spoken man who talked extremely patiently to us for several hours.

—Charles Mann and Robert Crease

Omni: From your student days, were you always interested in physics?

Bell: I was interested in philosophy first. But then I got frustrated with it because each generation of philosophers seemed to overturn the generation before. That was how I got into physics, because it was not so far from philosophy, and there was an accumulation of knowledge.

Omni: Hasn't each generation of physicists overturned the previous one?

Bell: No. I think it's true there are scientific revolutions—big changes at a few points. But it's very seldom that anything is scrapped. We still have Newton's equations, although Einstein's conception of space has replaced Newton's. We still have Maxwell's equations, although quantum field theory has replaced classical field theory. Things still fall the way Galileo said. It all builds up.

When I came to learn quantum mechanics, which I did very soon after I went to the university, I was dissatisfied with the expositions I found. This wave function—one never knew whether it was something real or some kind of bookkeeping operation.

> *When we get down to things beyond our immediate experience, the concept of "out there" and "really there" and so on begins to lose its relevance.*

Omni: What's a wave function?

Bell: If you do any careful experiment with electrons, there comes a point when you see that they are not behaving according to classical mechanics. The electrons seem to be influenced by some kind of wave, so they can show interference patterns. Not any one electron but many electrons arriving on a photographic plate build up an interference pattern. So somehow you have particles—because you see a series of little spots on your plate—and a wave, which directs them in some way. The relation between this wave and the particles has never really been clearly understood. One knows the mathematics of the wave, and one has the rules for translating the amplitude of the wave into a probability distribution for particles [a kind of mathematical "map" charting the places where a particle might land], but physicists have not agreed on whether the wave is really there.

Omni: So quantum mechanics explains these particles in terms of waves, and nobody is sure if any of it is real in any ordinary sense. Well, *are* there real objects out there at all?

Bell: I believe there is something out there. But the philosophy that has grown up with quantum mechanics, the Copenhagen interpretation, calls that reality into question. It says we're not entitled to assume something is out there. Perhaps we are entitled to on the gross scale. I am entitled to assume that you're out there, but I am not entitled to assume that you are made of electrons that are out there. Somehow when we get down to these things beyond our immediate experience, the concept of being "out there" and "really there" and so on begins to lose its relevance.

Omni: Why don't we have an adequate mathematical description of these things?

Bell: To call it a description of things is already to imply the *things*. Ordinary quantum mechanics doesn't sort out the difference between "description" and "thing." It is only description. Einstein was always asking, "What are the things described?" Think of insurance actuarial tables—you'll find curves identifying the probable age of death of a person who is a given age now. But in order to make that meaningful, you need the concepts of people and death. If you had only the curve you'd ask, "What is it the probability *of*?" And the answer to this question is *missing* in ordinary quantum mechanics—until you come to the gross level, where it's the probability of the result of an experiment. So you can talk about experimental equipment in this way. But the electrons and so on—these you are not allowed to speak about. You can't talk of them.

Omni: These waves are like literary characters that don't exist apart from the words that describe them but nonetheless have a certain reality for us.

Bell: That's a good analogy. And it's as if the book nevertheless had consequences at certain places. Here are these fictitious characters, but at some point the characters cease to be fictitious.

Omni: What is the Copenhagen interpretation? Can you describe it?

Bell: *The Copenhagen interpretation* is a very ambiguous term. Some people use it just to mean the sort of practical quantum mechanics that you can do—like you can ride a bicycle without really knowing what you're doing. It's the rules for using quantum mechanics and the experience that we have in using it. There are big things like laboratory instruments, and there are little things like electrons. The big things we can treat classically, but the little things like electrons have dynamics governed by waves. And there is such a difference in scale between the little ones and the big ones that it doesn't matter much where you draw the boundary. The rules of pragmatic quantum mechanics, which are absolutely marvelous, work extremely well. And you could say these also came from Copenhagen, at least in part. Niels Bohr, the genius of Copenhagen, was one of the key people who clarified these rules.

Then there's another side to the Copenhagen interpretation, which is a philosophy of the whole thing. It tries to be very deep and tell you that these ambiguities, which you worry about, are somehow irreducible. It says the ambiguities are in the nature of things. We, the observers, are also part of nature. It's impossible for us to have any sharp conception of what is going on, because we the observers, are involved. And so there is this philosophy, which was designed to reconcile people to the muddle. You shouldn't strive for clarity—that's naive. Muddle is sophisticated. I have heard distinguished people say that this philosophy was important to them as physicists. It allowed them to feel somehow that these things were understood and that nothing could be done except what they were doing. Then they got on with their work. Einstein called it the "tranquilizing philosophy" from Copenhagen on which the true believer can find a soft pillow on which to rest his head. Let him lie there!

Omni: As a student, you weren't reassured by the Copenhagen interpretation.

Bell: When I found the professors repeating what I saw written in the textbooks, I got angry and said it was nonsense. My professors were actually very tolerant, because I pestered them a great deal. But from time to time I could see that they were at the end of their patience.

Omni: Part of the problem is that there's a quantum world where this strange wavy stuff happens and you have an ordinary world where ordinary unwavy stuff happens—and you don't know where to draw the line between them. Is it like knowing that there are the colors blue and green but not knowing at what point blue stops and green starts?

Bell: The present situation is that we have a set of equations for blue and another for green. At the boundary you can pretend it's either blue or green to a very good approximation, and it doesn't make much difference. The world where we are obliged to use quantum mechanics is very, very remote from us. And somewhere between here and there is this change in language. So far in practice it doesn't matter where we change the language, roughly speaking from particles to waves. And that's why you can get along in practice without deciding it. But it's still a problem theoretically, such a puzzle. You work as if there were two separate worlds, a blue world and a green world, blue equations and green equations. It *can't* be right.

Omni: When you went to the university, quantum mechanics was less than twenty years old. Newtonian mechanics, which said everything in the universe was definite and predictable, was replaced by quantum mechanics, which said on the subatomic level many things were random and the laws could only be statistical. Were physicists still dismayed?

Bell: When quantum mechanics was invented everybody must have asked, "Can we imagine a more complete theory in which the predictions would not be of a statistical character?" Einstein and [Nobel laureate] Louis de Broglie were certainly among the first to press this question. But the orthodox line quickly became, No, there is no possibility of finding a more complete description than that given by quantum theory. Nature is inherently statistical, so the statistical aspect of quantum mechanics is not provisional or temporary.

Then in 1932 [mathematician] John von Neumann gave a "rigorous" mathematical proof stating that you couldn't find a nonstatistical theory that would give the same predictions as quantum mechanics. That Von Neumann proof in itself is one that must someday be the subject of a Ph.D. thesis for a history student. Its reception was quite remarkable. The literature is full of respectful references to "the brilliant proof of Von Neumann," but I do not believe it could have been read at that time by more than two or three people.

Omni: Why is that?

Bell: The physicists didn't want to be bothered with the idea that maybe quantum theory is only provisional. A horn of plenty had been spilled before them, and every physicist could find something to apply quantum mechanics to. They were pleased to think that this great mathematician had shown it was so. Yet the Von Neumann proof, if you actually come to grips with it, falls apart in your hands! There is *nothing* to it. It's not just flawed, it's *silly*. If you look at the assumptions made, it does not hold up for a moment. It's the work of a mathematician, and he makes assumptions that have a mathematical symmetry to them. When you translate them into terms of physical disposition, they're nonsense. You may quote me on that: The proof of Von Neumann is not merely false but *foolish*!

Omni: Didn't Einstein point out the deficiency in the orthodox view?

Bell: Einstein was convinced that something must lie behind the statistical quantum mechanics that would not be statistical in origin. In 1935 Einstein, Boris Podolsky, and Nathan Rosen then produced their famous argument, which was an extremely powerful one. It said that because quantum correlations exist between distant objects, and in certain circumstances *perfect* correlations between such objects, you *could not* believe that there was independent chance in what the objects were doing.

Omni: We don't get it. Suppose we take a coin and slice it in half along the edge. We seal each half in different envelopes. We take one, you take the other, and we travel to opposite sides of the earth. We open our envelope, and it's heads. We know yours is tails. What's so strange about that?

Bell: There is no mystery because the head and the tail were there *all along* from the beginning. But suppose you didn't believe each bit was either heads or tails until the moment you looked at it. And then it just chose at whim, at hazard, by chance, to be heads or tails. How could you believe

that the other one would coordinate its response? The head and the tail that are "there before you look" are simply *not included* in the quantum description. It tells you about the *results* of your observations beforehand, there is just a wave function, which has neither head nor tail. And Einstein objected to that. He said to make sense of this situation we must believe that the head and the tail are there from the beginning and are just revealed when we look. So he took, like you, a commonsense attitude to this. You see Einstein took the view that quantum mechanics is incomplete. It doesn't tell you the whole story. And for me Einstein's was a compelling argument.

Again, part of that psychohistorical study I would like to see is why it did not impress the Copenhagen people, especially Bohr. But in the end it turns out that these other people were, in a way, right, because what I am notorious for, the so-called Bell's theorem, is just for showing that Einstein's explanation doesn't work. Einstein's explanation works so long as you have perfect correlations, which means measuring the same component of spin on the two sides [spin is a measure of a property similar but not identical to the rotation of a particle on its axis]. But as soon as you are measuring in a nonparallel direction, you get results that cannot be explained by Einstein's idea that the answers existed before the experiment.

Omni: Didn't anybody react to Einstein, Podolsky, and Rosen?

Bell: In 1952 David Bohm gave a fully worked out hidden-variable account of quantum mechanics in which everything was deterministic and definite. The kind of ignorance was of the trivial kind: *Nature knows, but I don't know*. That was a big thing for me. It told me that Von Neumann was wrong, because Bohm had done what Von Neumann had shown to be impossible. Bohm's paper wasn't rigorous. It didn't have big displays of axioms, theorems or lemmas [corollaries]. But one could see immediately that what he was saying was right. My reservation about his work and that of others in the physics community was that it was nonlocal: that what you do here [he points] has immediate consequences in remote places [pointing out window]. And that was *extremely* odd.

Omni: What does *locality* mean?

Bell: It's the idea that what you do has consequences only nearby, and that any consequences at a distant place will be weaker and will arrive there only after the time permitted by the velocity of light. Locality is the idea that consequences propagate continuously, that they don't leap over distances. And so the question immediately posed itself: Is that inevitable? Can you find another way of refuting Von Neumann that does not have this feature of nonlocality?

Omni: Bohm's paper was written when you were a recent graduate. Yet despite your doubts about the Copenhagen interpretation, you didn't write anything on it until twelve years later. Had the problem just dropped out of your mind?

Bell: It was never completely out of my mind. I always knew that it was waiting for me. So when I went to the Stanford Linear Accelerator Center at the end of 1963, arriving in California the day after President Kennedy's assassination—it was a very odd experience to find everybody crushed. The quantum problems were very much in my mind. And that's where I wrote the papers that subsequently became notorious. First of all, I wrote a paper refuting all the proofs known to me of impossibility theorems for hidden variables. While doing that I saw that this problem of locality was vital. So that paper ended with this question: If you make locality a condition, can you then make a good proof of the impossibility of hidden variables?

The second paper answered that question. I tried to imagine what hidden variables there might be that would avoid the nonlocality of Bohm and nevertheless account for the quantum correlation. And I found that I couldn't do it. Something always went wrong. And then I began to suspect maybe it was impossible.

> *"The theorem says that maybe there must be something faster than light, although it pains me to say so. It implies that Einstein's concept of space and time isn't tenable"*

Omni: So is this the price that not only Bohm but everybody has to pay?

Bell: That's right. Then when I suspected the impossibility and I made a phase transition in my mind, I started looking for the proof of impossibility. And I found it.

Omni: What you expected when you started wading into this more than twenty years ago and what actually came out were very different things.

Bell: That's true. Yet I'm not so sure what I felt then. I certainly was indignant with the expositions that I saw and with arguments that I saw. I felt a great desire to knock them down. Whether I expected to come out with an Einsteinian interpretation of quantum mechanics is not clear to me. What I succeeded in doing was showing that such an interpretation as I sought was not possible. It wasn't possible even for the arguments that I now regard as good arguments [chuckles] as distinct from the bad arguments like Von Neumann's that I had seen before. What I really wanted was a clear argument rather than to justify any particular conception of the world. From what I know of my own character, which is somewhat stubborn, I am often more concerned with the conduct of the debate and its logic than with the actual truth.

Omni: But don't you think logical debate is the way to truth?

Bell: You need both sorts of people in the world—people who don't care about the logic but only about the truth and who intuit what it is, and people who are concerned about the logic. The great physicists combine the two concerns, but most of us are lucky to contribute on one side. The whole activity is cooperative in the end.

Omni: What did this second paper, the one containing Bell's theorem, tell us?

Bell: The theorem tells you that maybe there must be something happening faster than light, although it pains me even to say that much. The theorem certainly implies that Einstein's concept of space and time, neatly divided up into separate regions by light velocity, is not tenable. But then, to say that there's something going faster than light is to say more than I know. If anything goes faster than light, then I could imagine that if you were tossing a coin, I might be able to make it do an extra turn [without so to speak touching it]. But you would never know I had that power, because you wouldn't know whether it was coming down heads or tails anyway. And I wouldn't know that I had that power.

Omni: Because you'd see only the final result, which would be heads or tails, you couldn't see what it would have been had you not exercised that power.

Bell: Exactly. And it's only in the analysis of this question of "what would have been" that the theorem obliges you to introduce such funny connections. The calculations that we do in quantum mechanics make certain predictions for whether the detectors in an experiment both say yes or both no, or disagree. And it's those predictions that are incompatible with any mechanism that does not go faster than light.

Omni: How were these papers received?

Bell: There was not great reaction at first. I suppose that anybody who read it just thought, *Well, that's an interesting puzzle*. And then in 1969 people proved a more practical form of the result and proposed an experiment. Then people started doing the experiments. The results confirmed ordinary quantum mechanics and therefore disconfirmed Einstein's hopes. Then there was more and more publicity.

Omni: What importance does all of this have for physicists?

Bell: It's a hard question, even an embarrassing question. Quite a lot of physicists are content with the fact that quantum mechanics is something that works, yet which is by no means worked out. All the developments we see around here are based on that, and it's doing just fine. So my theorem is a marginal sort of thing.

Omni: Is there some big problem hidden in these quantum muddles?

Bell: Yes. For me the big question is the role of Lorentz invariance which in some obscure way tells you that something cannot go faster than light. During the nineteenth century people became convinced that light, like sound, was a wave motion. Just as sound waves move in air, light has to move in a medium, which had come to be called the ether. Now as you move through the air the velocity of sound relative to you changes. It will come more quickly toward you from a distant source as you move toward the source and so on. The trouble was that with light this was found not to be the case.

If you think of the earth as moving around the sun, then it's moving in different directions at different times and at different velocities. So if you measure the velocity of light passing through your laboratory, sometimes the ether should be running against your motion and other times with your motion, and you should see different velocities of light relative to your laboratory position. Well, people didn't. They found that the velocity always seemed the same relative to the laboratory. To explain that, Irish physicist George FitzGerald invented the idea that moving bodies actually contract. Next Irish physicist Joseph Larmor invented the idea that moving clocks go slower. He said that when you *think* you're measuring the velocity of light, you're fooled by your clocks having changed their rates. These things happen in just such a way as to make you *think* light is still moving with the usual velocity.

Then Einstein came along and questioned this "conspiracy" to make things unobservable. If this "unobservability" [of light] is systematic, it must be really an expression of some deep truth, he said. And the deep truth is that all laws of nature are such that you cannot detect uniform motion in any laboratory. That idea has come to be called Lorentz invariance because [the great Dutch physicist] Hendrik Lorentz was one of Einstein's predecessors in working out this idea. And that imposes certain restrictions on the equations of theoretical physics.

This principle of Lorentz invariance was speculative when Lorentz formulated it around about 1900. But now it has been so solidly built into physical theory that it is extremely difficult to consider giving it up. The idea that somehow nature has no preferred velocity and no preferred inertial reference system [such as ether] has paid off enormously. But this idea presents one of the biggest difficulties in formulating quantum mechanics in a sensible way, because when you look at these funny paradoxes of Einstein, Podolsky, and Rosen, they seem to imply that something goes faster than light. But Lorentz invariance is very embarrassed by anything going faster than the speed of light, because it would seem to say that you should be able to measure the simultaneity of distant events more precisely than you can using light. Yet somehow the fact that light is the quickest measurement available is built into the theory of relativity. Now it's not as simple as that, and that's just the kind of thing I would like to investigate. What restrictions on velocities—and velocities of what—are really imposed by Lorentz invariance?

Omni: People have found in this connection between distant events a sort of scientific affirmation of Zen Buddhist thought in which every part of the universe is related to every other within the whole.

Bell: The idea that there is a relation to Eastern mysticism comes already from Bohr and maybe before. Bohr's coat of arms, which he chose himself, has the yin-yang symbol embodied in it. He thought that the ambiguities we face in physics are related to the ambiguities that Eastern mystics have faced—the union of the observer and the universe and so on. That theme was taken up in particular by Fritjof Capra. His book *The Tao of Physics* has sold many copies, but I have no responsibility for that. I got into the picture and people found I had deepened the mystery.

"The Dalai Lama said that if physics was committed to a once-only universe, then "the Buddhists would have to study their scriptures." There's room for maneuver."

I think that's true, because my result destroyed the possibility that the world could be Einsteinian. But it must be something more complicated than that. There is some kind of hidden connection.

So the ecological people. Green people, people who feel that ordinary science is cold and materialistic and hostile—they liked my result. It brought back a warm togetherness. I have some sympathy with that. I cannot write like that because I don't see it like that. But still, I'm usually on the same side as those people in other things, like conservation and soft science and whole-meal bread and all those things. I even feel quite warm toward those people.

Omni: But you don't see it that way.

Bell: No, because I don't have that mystical insight. I am essentially an agnostic about religious and spiritual matters. When people give answers to these questions, I think it's wishful thinking. I don't feel hostile toward these people, but I just don't share their enthusiasm at finding answers to questions that seem to me unanswerable. I admit that there are questions that science cannot answer—that science cannot even ask. But I myself don't have answers to these questions. When I hear people saying we've finally answered it, and the answer is Buddhism or Taoism or something else, I just have to say that when I look at those things I don't find the answer. Even so, if other people find the answers there, I'm not going to campaign against them. That's their business. They are doing no great harm. There are ideologies that are much more vicious than Buddhism.

Omni: This movement to link physics and mysticism—do you think it's bad?

Bell: I don't think it's evil, but I don't think it's right. In my opinion physics has not progressed far enough to link up with psychology or theology or sociology. What we deal with in physics are the very *simplest* questions. We simplify situations to the limit in the hope of finding that the laws of simple things can be built up into the laws of complicated things. The kinds of problems we address ourselves to in physics are just too remote from anything of spiritual concern to be relevant. I don't think Bell's theorem moves you nearer to God.

Omni: Are people simply picking up the poetic resonances of these ideas?

Bell: Yes! Now, poetry—that's the correct way to see it. Poetry isn't addressed to solving the problems of physics. It is addressed to touching human emotions. If it has a message, it's not on the intellectual level. So as poetry I can appreciate Capra and others. But as physics, I don't appreciate them at all. Now, the test for a physicist of whether those people have something to contribute would be to ask them not to interpret what we have done already but to tell us what is going to happen next. If they can tell us the mass of the Higgs boson [a theoretical new particle], and if we find it, there we are all going to learn their philosophies. [Laughs] We'll all go and sit at the feet of Maharishi if he tells us where the Higgs boson is to be found.

I have the feeling that these things do not come from genuine mystics but from amateur mystics, people who find this romantic possibility opening and see some parallel with physics. People who have devoted their lives to mysticism are not doing this. They make the judgment that they don't know enough about physics. Physics is technical. You can't learn it too well by reading popular books. But my feeling is that those guys feel they are onto something much bigger than physics. They are not going to worry about whether there are three quarks or six.

Omni: Why is it that mystic physics books sell so well?

Bell: People are looking for comfort, and if somebody offers it to them, they try hard to believe it. These ideas really mean that we live in a less hostile world, with the possibility of coupling to the heart of things. It's comforting to think that not only are priests and mystics saying this, but now we have the physicists with their machines verifying it. The idea that people are back in the middle is very comforting, so it's easy to seize upon. You'd have to be a masoch-

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ist or a sadist to insist that we are really not very important or are just incidental to the whole thing, although that actually is often my own impression.

Omni: It doesn't all fit together.

Bell: I guess not! But it doesn't hurt me a lot, because I find I can live with the idea that there can be different departments of knowledge and that you don't have to make them all fit in one. I have actually discussed that more than I would have, because the Dalai Lama visited CERN once, and I was a member of the dinner party.

The dinner was a bit frustrating because it was clear that the Buddhists knew little about Western science, and the scientists little about Buddhism. It was clear that the Buddhists were *absolutely* inward looking. They were not trying to explain the mass of the electron or anything like that. They had their own tradition, and insofar as it has any bridge to Western science, it would be to psychology, because it's a discipline of personal salvation. Personal spiritual expansion. There wasn't much communication, as I say, but the people were all friendly toward one another.

We sat at a long table: on one side were ten Buddhists, many in their saffron robes, including the Dalai Lama and his interpreter. Opposite them were ten physicists: the director general, the chief of the theory division, other important people, and myself—because they thought Bell's theorem might have something to do with Buddhism. The Dalai Lama, through his interpreter, said more or less that there could not be a conflict between Buddhism and science because both were looking for truth. I pressed him on the eternal recurrence. The Buddhists, he said, believe in metempsychosis on a personal level and on the scale of the universe—things repeat endlessly. The conception in physics at the moment, I told him, is that things began with a bang, and it happens only once. That's just a fashion—physicists could change their line easily. I asked the Dalai Lama whether Buddhists also could change their line. He said that if it became clear that physics was permanently committed to a once-only universe, then [imitating the sage], the Buddhists would have to study their scriptures very carefully; there is usually room for maneuver! [Laughs uproariously]

Omni: That must have been one of the odder spinoffs of your brand of physics.

Bell: The European branch of Maharishi University is here in Switzerland, in a little place called Seelisberg, overlooking Lake Lucerne. A number of people were invited to this meeting on religion, physics, quantum mechanics, consciousness, and so on. We all made little speeches, and Maharishi gave his comments. He was surrounded by acolytes—especially ladies in white robes—who said nothing and smiled admiringly on us all. That atmosphere, a mixture of piety and admiration, made me a bit uneasy. It's not the sort of atmosphere in which you can have a hard-hitting exchange of views. [Laughs] But they are vegetarians, and I'm a vegetarian, so I liked that. Maharishi is an extremely good-humored man. He laughs, makes wisecracks. Big smile. I remember somebody on Swiss television attempted to cross-examine him in a hostile way and mentioned all the money he makes. He said [switching to a high-pitched Yogi voice], "Oh, I know nothing about money. Anyway, however much there may be, it is not enough!"

Omni: What did you tell them?

Bell: My attitude is all very cold-blooded. I said you *can* make analogies between quantum mechanics and consciousness, but that these are no more than analogies. That thesis was received politely. They all nodded their heads and said nothing.

Omni: What do you think about spending your time with all of these people?

Bell: Mostly it's just good fun for me. Scientists should try to communicate with nonscientists; it's a proper activity. What my colleagues think about it, I can only guess. To me they are polite. Ah, I suspect they think it's not absolutely kosher, that it's not real science—that it's show business. I suspect that my reputation is damaged in their eyes by this side of my life.

It's a terrible tragedy that we are all so limited. Each of us has the ability to make some little contribution in a field in a lifetime of training and effort, and other people are doing that in other fields, and there is really so much that each of us does not participate in. Sometimes I'm just depressed by that. There's so little that I know about everything except physics and even except a small corner of physics. So I think it's natural and reasonable and right that at least in a nontechnical way we try to find out about what is happening elsewhere in the world. When people come to ask me what's happening in my world, I try to tell them—and I learn a bit about their world.

Omni: Yet you've said the incompleteness of quantum mechanics is a hard problem to do something major with—that people destroy their careers fixating on it.

Bell: But that's true of all big problems. Take the problem of free will. Nobody has the idea it's unimportant or trivial. But would you advise a person to make his career thinking about free will?

Omni: Do you think there are still big problems open in physics today?

Bell: Yes. And this particular question of locality is still open, in my opinion. I think we have not found a way of digesting this situation. We have the formulas of quantum mechanics, and they work extremely well, but I have not digested them. There certainly remains something to be said, some illumination to be found. ∞