

TWO LECTURES ON THE WAVE-PARTICLE DUALITY

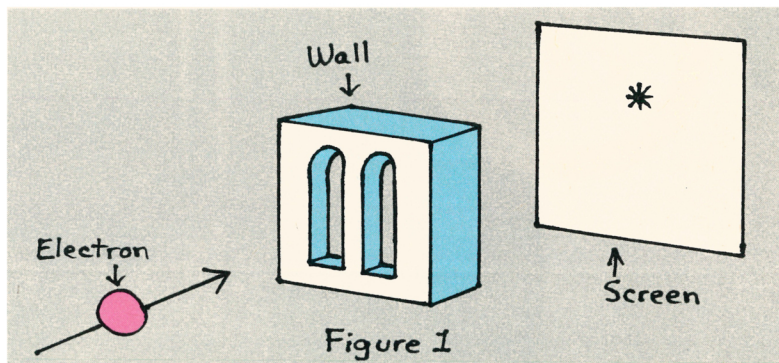
N. David Mermin

During the recent Presidential election, I dreamt that two of the candidates had concluded from interviews with focus groups that there might be some anxiety among the American public over the foundations of quantum mechanics. Concerned that by homing in on so esoteric a topic they could lose the attention of the people, the two men had made a direct assessment of public interest by quietly employing their rhetorical skills in unpublicized lectures at local events such as church barbecues, farmers' markets or demolition derbies. I could never learn soon enough about these performances, always arriving just as a lecture ended. By conducting exit interviews, however, I managed to put together fragmentary transcripts of what took place, which were so vivid that I was able to jot them down in the morning.

In a subsequent dream I read these texts back to my interviewees, who agreed that although I had failed to capture the full brilliance of the argumentation, I had at least succeeded in conveying the flavor of the insight these remarkable men brought to the problems that have puzzled and delighted physicists for so many years.

The candidates' experiments were not a success. Both men concluded that the time was not ripe to bring these great issues before the public. Indeed, in my third and final dream I was forced to endure an interminable postelection analysis on public TV, in which the panelists concluded that by distracting the two candidates from more pressing issues, their love of quantum mechanics had contributed significantly to their defeat. I'm sure there are lessons for physicists from this cautionary tale, but I offer here only the texts of the lectures themselves, which I believe form an impor-

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tant chapter in the intellectual history of our times.

The First Lecture

Now it's really very simple, OK? Over here's an electron, moving toward this wall, kind of like a cur dog slinking toward his kennel. Only there are two doors to the kennel, like the two doors in the wall here in figure 1.

Now, over here on the other side of the wall's a screen. Now then, the point is, the electron ends up making a mark on the screen, kind of like a fly makes a speck on a kitchen window? So the electron starts over here on the near side of the wall, and ends over here on the far side, in this little flyspeck. Now you and I, we ask, "How did that electron get from over here to over there?" They ought to be able to give us a straight answer to that question, right?

Wrong!

You and I, we ask, "Did that electron go through this hole or did it go through that hole?" and I find it fascinating that they will not give us a straight answer. They say, "That isn't a proper question." If you were in business and gave an answer like that they'd laugh you right out of the boardroom.

Now, of course it's a proper question. We know perfectly well it's a proper question. But! They go

around telling sensible folks like you and me that it isn't a proper question. Why are they doing that? Any child knows why. Point is, they don't know the answer! I rest my case.

Now then! They simply don't want to find out which door the electron went through! Isn't it just fascinating? They've been telling us this since nineteen hundred and twenty-five. For nearly 70 years they haven't been able to figure it out. They're still ducking that question! They'll do *anything* to avoid answering, making up tales about invisible waves and things not really being there that would have got them a whipping if they'd told them to their mothers when they were little. Now, when you get to be the boss here's what we're going to do.

Its just this easy. We are going to get the best minds together—world-class minds. And we'll say to them, "Just look at this—we've got an electron, we've got a wall with two doors, and we've got a screen on the other side of the wall." We'll tell them: "Boys, you just roll up your sleeves, don't be afraid to get your hands dirty, get in under that hood, and you watch that electron really carefully. Then you go and you have a raging debate about which door that electron went through, and when you've heard all the arguments and made all the points, then after that no-holds-barred discussion, you come out with

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a proposal: door 1 or door 2."

Then we have a town meeting. We bring that proposal to all of you and see what you think of it. If you've got a better idea, you just let us know. If it sounds like it'll work, we'll tear everything up and give it a try. But we have got to sit down and make up our minds and get on with the important stuff.

Now if you want more talk about not this door and not that door, both doors, no doors, improper questions, invisible waves, messing things up by poking around, and all that kind of slow dancing, then you don't need me and I've got better things to do with my time. But! If you want to answer this question once and for all, then I'm your man, and we'll get to work and settle the whole business. I'm not saying it's going to be easy—of course it won't, but we'll have a lot of fun together clearing it up. And when we've straightened it out all those boys in their blow-dried hair and thousand-dollar suits will come and say, "Well, you called our bluff, but we love you anyway." Fact is, they'll be tickled pink to know what door the electron went through!

I adore those quantum mechanics folks. They're fine patriotic citizens. But they have just got to stop denying what you and I can plainly see. Wouldn't it just be stunning if we got them together when we were done and they turned to us and just said, "Yes, you're right: It went through *that door*?" I rest my case!

The Second Lecture

I'll come right to the point. When they asked—when they said to him, "Governor, is the electron a wave or is it a particle?" the Governor said, and I'm quoting him here—he can't waffle out of it this time—this is what he said, and I quote: "It's neither; the concepts of wave and particle as we ordinarily understand them simply don't apply to the electron." Simply don't apply! That's what he said! And this is a man who wants to be President of the United States of America!

Now, let me tell you something. There's nothing new about this kind of talk. These are old, worn-out ideas. They originated over 75 years ago. In Europe! I'm not one to question anybody's patriotism and I really don't think patriotism has anything to do with quantum mechanics, *if you stop doing it at the water's edge*. But when you go off to a foreign capital—London, Moscow—he says he doesn't remember who he met there—and

you organize a group of people to go around saying it's neither a wave nor a particle—well I guess I'm just old-fashioned enough to think that it does matter which it is and I think the American people want straight talk about which it is.

I don't know about these two bozos: Big Bore and Uncertainty Man. Seems to me he was pretty certain about what he was up to back in the war, Mr. Un Certainty. Not one to question him myself, but I don't know about all this Un Certainty stuff. Not the kind of values I was brought up with, I can tell you that: Un Certainty!

Talk about uncertainty, in Montana the Governor says, "Oh, yes, sure, it's a particle." Then, *one day later*, he's in Alabama and he's saying, "Absolutely, it's a wave." Wait!—wait, it gets worse. He said—and this is in writing, he can't waffle out of this one—if he becomes President, you know—the Ronald Reagan High Energy Physics Center—you know what they're going to call it? The Waffletron!—but don't worry, it's not going to happen. Just the other day, he said, "Well, I guess on the whole I'd say it's a particle but there are circumstances under which it surely does behave like a wave."

Well Governor, maybe you can get away with that kind of talk in a rotten little state like Arkansas but we're talking big-league now. This is Oval Office stuff, buck-stops-here kind of thing. When that red phone rings at 4 in the morning... general at the other end, somewhere out in that desert... SCUDs flying over... half a million troops... world's oil supply on the line... and you say to him, "Well general, fact is it's neither a wave nor a particle but something else."... No way Josephine—buck stops!

You know, when we talk about family values, we mean knowing—really knowing—which hole the electron went through. It's the kids I'm thinking about. Call me old-fashioned, but those kids have to feel that, yes, their parents know where the electron is. That's what we mean when we talk about trust, about character.

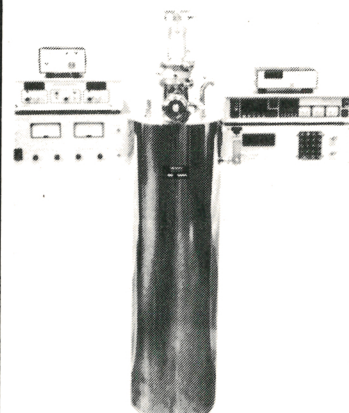
Think about this. Suppose you turn on the television someday and the announcer is saying, There is a major crisis—an infrared catastrophe, out there in the desert, or, yes, an ultraviolet divergence in one of our cities, right here at home. Ask yourself this: Who do you want behind that desk at that time—a man who can't decide whether it's a wave or a particle, or a man who can make those tough calls?

Thank you, thank you very much, and God bless Determinism. ■

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