

The Impossible Beam

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Body

The phone rings at 6:15 A.M. In my stupor, I pick it up and hear: "Good morning, Rock Radio 690 here! Is this the professor who wrote the 'Star Trek' book?" My caller, it seems, has an urgent question: "Have you heard about the news reported from Austria on quantum teleportation of photons?"

This may sound like a weird dream (or nightmare, depending upon your attitude toward physics), except that it actually happened. A group of European scientists have destroyed a single particle of light in one place and reproduced it instantly somewhere else in their lab, the equivalent of teleportation.

You may have missed the news, but be assured that few Trekkers did. Let's go back in time 30 years. Gene Roddenberry, the creator of "Star Trek," didn't have the budget to show a starship landing on a different planet each week. So when he was asked how the crew would get down to where the action was, he responded, "We'll beam them down!" Thus was the Transporter born, and the phrase "Beam me up, Scotty" soon became a part of popular culture.

And why not? Who wouldn't want to be transported instantly to their destination without having to endure lost luggage and packed planes? But there is a problem: the Heisenberg Uncertainty Principle of Quantum Mechanics states that we can never simultaneously measure exactly where each particle in your body is and what it is doing. Clearly we need to know both things if we are to re-create your body exactly, atom by atom.

Or do we? The experimental physicist Anton Zeilinger and his colleagues in Austria, following on an original proposal by an American physicist, Charles Bennett, and his colleagues at I.B.M., showed that it is precisely possible to destroy an individual particle -- in this case the quantum of light called a photon -- in one place and instantly (yes, faster than the speed of light!) transfer its properties exactly to another photon on the other side of the room -- or, if you set things up correctly, on the other side of the galaxy! This is the stuff that dreams are made of, which explains the early morning phone calls with the burning question, How long might it be before we could transport a person?

Well, sadly, the answer still is, probably never. Quantum mechanics tells us that elementary particles carry, in essence, much more information than we can get ahold of in a single measurement and, moreover, that measuring

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them inevitably changes them in the process -- the root of Heisenberg's principle. The clever researchers in Austria and the United States were able to get around the Heisenberg principle by never actually measuring the first photon before destroying it and transferring its identity.

They did so by exploiting the quantum mechanical nature of the elementary particles themselves: if undisturbed, they can carry and transfer information that is not directly accessible by the measurement process. But this trick won't work with people, or any large, classical objects, where this extra information would be washed out by interactions before you could transfer it.

So, is all of this in the end mere gamesmanship by physicists who try to exploit the eccentricities of nature for their own amusement? Not really. The techniques of quantum teleportation may not make air travel obsolete. But as computers become smaller, these same techniques may allow the development of "quantum computers," which directly exploit the quantum weirdness of nature at its smallest scales to perform calculations in seconds that would require present-day computers longer than the age of the universe. Indeed, I claim that this very sort of technique will change 21st-century technology more than any single development has affected technology in the 20th century.

My own hyperbole notwithstanding, perhaps the prospect of quantum computing doesn't seem as exciting as teleportation. What would it take to make it so? Perhaps the realization that such computers might re-create another popular vision from the Big Screen. With potentially faster computers comes the possibility of intelligence and self-awareness, and with that comes the possibility of HAL, or perhaps his less malevolent cousin, Data. Stay tuned.

Graphic

Photos (Amy Franceschini)

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