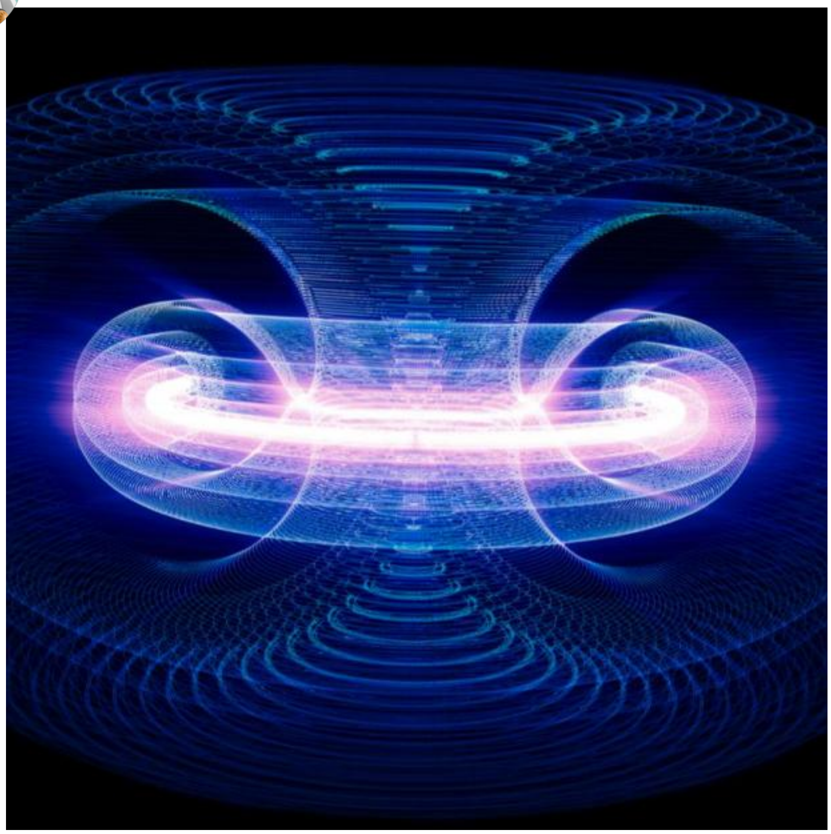


Getty Images

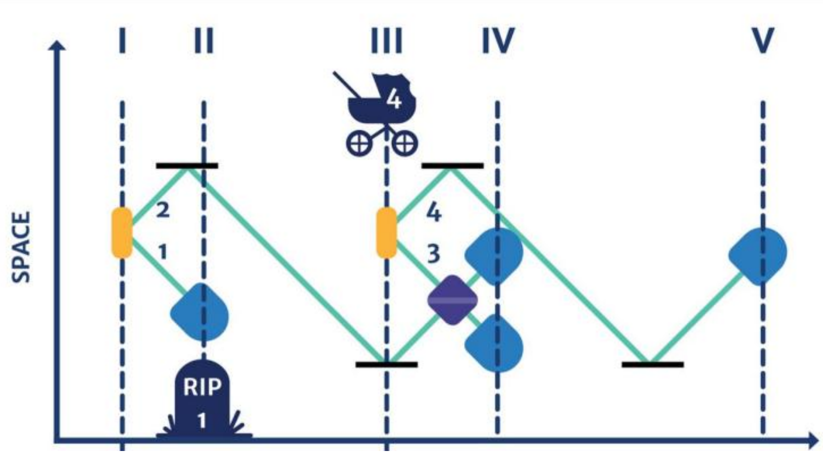
Entangled Qua Particles Can "Communicate Through Time

By: Ashley Hamer

In the world you know, actions have ca objects exist as one thing or another, it is whether you observe it or not.

August 01, 2019

In the quantum world, those rules go out the window. Take quantum entanglement, for example. You can make two quantum particles interact, then put them at opposite ends of the universe, and measure one. Whatever measurement you get, the other particle takes on a corresponding quality instantaneously, no matter the distance. Well, forget distance — particles can even be entangled through time.



Getty Images

Teeny Tiny Time Travel

To understand quantum entanglement, think about a pair of gloves. If you open a box and see a right-handed glove, you know that its mate is left-handed, even if it's nowhere to be seen. But in quantum entanglement, it's as if opening the box and seeing a right-handed glove actually turned the other glove left-handed — both were in a "superposition" of right- and left-handedness until one was observed, and both changed their states in relation to each other. It's what Einstein called "spooky action at a distance."

This entanglement, it turns out, extends to time as well — "spooky action at a delay," as George Musser put it in Quanta Magazine. In 2013, a team of researchers at the University of Jerusalem actually demonstrated this weird phenomenon in the lab. Here's how they did it.

First, they entangled a pair of particles (1 and 2, in step I of the diagram above). Next, they measured a property of particle 1 (step II) — and when you measure something in a quantum system, it's dead. Bye-bye, particle 1. Meanwhile, particle 2 kept on whizzing along while the team entangled a new pair of particles, 3 and 4. Then, they measured particle 3 with particle 2 in a way that transferred their relationships with their old pairings onto their new 2-3 pairing (step IV). Particle 4 is whizzing off by itself, and eventually, the team measures it. The measurement was correlated with the measurement of particle 1, even though particle 4 didn't even exist when particle 1 died.

Did measuring particle 1 send information to the future to affect particle 4? Did measuring particle 4 retroactively change the measurement of particle 1? Neither question makes sense because, as hard as it is to fathom, quantum systems don't have definite properties. Their properties change based on when and how they're measured. Both options are true, and neither. Forget it; it's quantum town.

Heads, You Won; Tails, You Lost

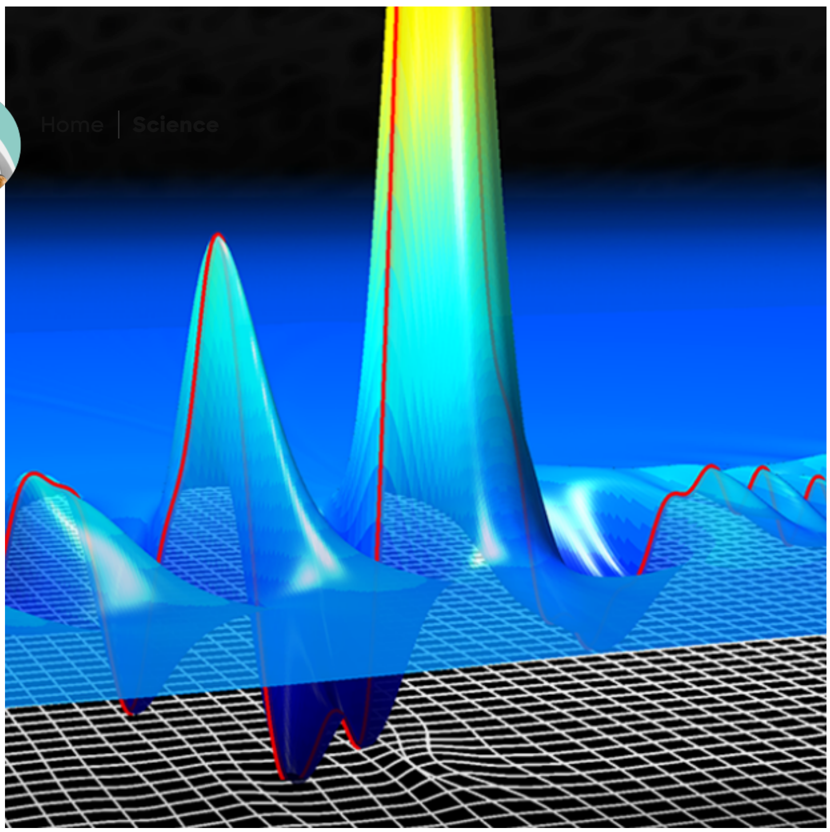
For a more real-world example, consider this thought experiment conceived by physicists at the University of Vienna. Alice and Bob play a coin-toss game; they take turns secretly tossing a coin, then writing down their result and their prediction for the other person's toss on a piece of paper. When they're done, they give their paper to the other person, and the other person tosses their coin.

Say Alice does the coin toss first and writes down her result and her prediction, then hands her paper to Bob. Alice has a 50 percent chance of being right, but Bob knows the answer, so he'll have a 100 percent chance of being right. The opposite would happen if Bob went first. Whatever order they do it in, it always averages out to a 75 percent success rate overall. But if you don't have them do this in a certain order, and you swap the paper for a quantum particle and the coin-toss results for measurements of that particle, you get an 85 percent success rate.

Weird, right? It's as if seeing the results retroactively improves the players' chances of guessing right, as if they can look into the future. That's entangled time. It's not just a mind-bending thought experiment, either — if we can harness it, it could mean big things for future technology. We're already tinkering with encrypting communication using quantum entanglement through space. If we could do it through time, who knows what kind of breakthroughs could arise?

This article first appeared on Curiosity.com.

Home | Science



Shutterstock

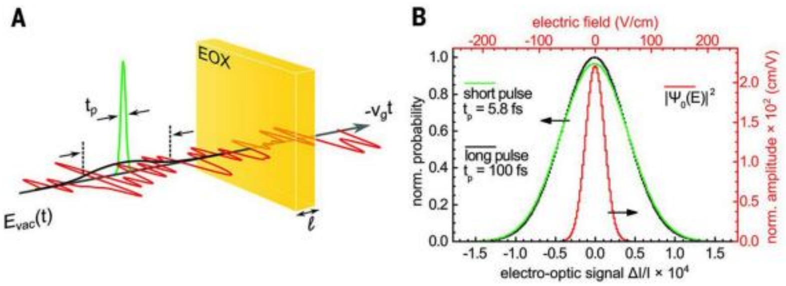
Empty Space I Empty, And Qu Researchers N Direct Evidenc

By: Ashley Hamer

In the quantum world, things aren't al them to be.

August 01, 2019

If there's one thing you need to know about the quantum world, it's that things aren't what you expect them to be. Nothing, for example. In classical physics, nothing is a space devoid of stuff. But according to quantum theory, nothing is chock-full of stuff. Scientists have had weak evidence of this nothing-stuff—or quantum vacuum fluctuations, if you want to get technical—since the 1940s, but new experiments may have given us direct proof of its existence. That could mean very, very big things for quantum research.



Science Magazine

A Churning Stew Of Nothingness

To get even more specific, classical physics defines nothing, or a vacuum, as a space devoid of matter in the lowest possible energy state. When you delve into the quantum realm, this definition poses a problem. You've probably heard of Heisenberg's uncertainty principle, even if you may not totally grasp it. In essence, it says that there's a limit to what we can know about quantum particles. Because everything in quantum mechanics is both a wave and a particle, if you know a particle's position you can't know its momentum, and vice versa. This boils down to the idea that the vacuum isn't really empty. It's actually churning with smatterings of particles that disappear and reappear at random, creating a fluctuating energy field.

Of course, that's just because Heisenberg says so. We've never had actual proof of this so-called energy field. In the 1940s, scientists found indirect evidence of it by examining the radiation emitted by hydrogen atoms and the forces exerted on closely spaced metal plates, but that was it. Then in 2015, a team of German scientists led by Alfred Leitenstorfer announced that they had directly detected that fluctuating energy field by firing a super-short laser pulse into a vacuum and seeing tiny changes in the polarization of the light. Those changes, they said, were caused by the fluctuations in the quantum vacuum. Still, since many things could potentially cause that fluctuation, that result was up for debate.

A Traffic Jam In Empty Space

Finally, in January 2017, Leitenstorfer and his team published what might be the smoking-gun evidence for quantum vacuum fluctuations. They again used a super-short laser pulse—specifically, a few femtoseconds long, which is half the size of a wavelength of light in the range they were studying—to generate what's known as "squeezed light," or light that has been slowed down in a certain segment of space-time. That squeezing, according to the press release, works sort of like a car causing a traffic jam: "from a certain point on, some cars are going slower. As a result, traffic congestion sets in behind these cars, while the traffic density will decrease in front of that point. That means: when fluctuation amplitudes decrease in one place, they increase in another."

But wait—that's not the best part. If these scientists actually found a way to detect particles without disturbing them, they may have unlocked a door that has been closed to scientists as long as quantum physics has existed. We've never been able to directly detect quantum particles before, and this new technique may be the way. Their findings need further verification, as all good science does, but if it's true, this could mean very big things.

This article first appeared on Curiosity.com.