Quantum Spookiness Spans the Canary Islands

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DENVER − The reach of the spooky quantum link called entanglement keeps getting longer. A team has transmitted entangled photons some 144 kilometers (89 miles) between La Palma and Tenerife, two of Spain's Canary Islands off the coast of Morocco. Physicist Anton Zeilinger of the University of Vienna, the group's leader, presented the results to his colleagues this week at the American Physical Society conference.

The distance achieved is 10 times farther than entangled photons have ever flown through the air. When two photons or other particles are in this state, what happens to one determines the fate of the other, no matter how far apart they are. Zeilinger compares the phenomenon with throwing a pair of dice that land on matching numbers every time.

Using a laser, the researchers created entangled pairs of photons on La Palma and fired one member of each pair to a European Space Agency (ESA) telescope on Tenerife, which had to make rapid, small adjustments to receive the photons, Zeilinger says. In another presentation, physicist Richard Hughes of Los Alamos National Laboratory described recent experiments in which his group fired a series of nonentangled photons 185 kilometers down a conventional optical fiber.

In both cases, researchers demonstrated that they could transmit randomly oriented, or polarized, photons, which are suitable for sending messages that cannot be intercepted without garbling the information. Called quantum keys, such transmissions could allow users to scramble messages in a way that is potentially unbreakable.

Quantum keys are limited in range because they typically have to be transmitted as single photons−entangled or not−which can become lost in noise. But the photons cannot be reproduced without destroying the information they contain. Researchers are therefore keen to find out how far they can travel.

Hughes says his group employed highly sensitive detectors normally used in astronomy. "It's a basic science result establishing the limits of what you can do,"

he says. "It looks very feasible to go much farther than 185 [kilometers] using these detectors," he adds, perhaps 200 kilometers or more. Zeilinger has set his sights much higher−literally. He is lobbying the ESA to fund an experiment that would shoot entangled photons to the International Space Station and back to Earth, which he says could expand the range of entanglement and quantum key distribution to 1,500 kilometers.

Zeilinger says such an effort would cost about $50 million and require refined new light sources and receivers as well as the support of ESA member countries. If the project gets the go−ahead, he says the experiment may take a decade to set up.

Back on Earth, Zeilinger is part of a consortium of European research groups, called SECOQC, which is working on a fiber−optic quantum key network that would crisscross Vienna. He says the group plans the first demonstration of the network next fall.

Researchers say they do not know when or if banks, governments or other institutions would want to adopt quantum keys. "One of the biggest hurdles would be finding someone who wants to use it and convincing them it's secure," Hughes says. Standard encryption, he notes, "certainly works for me when I'm buying stuff from Amazon."

Zeilinger adds that the new quantum key transmitters are still millions of times slower than conventional fiber−optic communications, making them impractical for the time being.

So why does he do the experiments? For the fun of testing entanglement's reach, he says. "I am dreaming of an experiment where you do it between Earth and [the] moon. [And] if this Mars mission ever takes off," he says, "they are [going to be] bored for nearly a year ? so they might as well do an entanglement experiment with Earth."

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