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Quantum cryptography goes wireless

Single entangled photons travel 144 km through the air.

Geoff Brumfiel

The optical ground-station on Tenerife received the quantum signal from 144km away

ESA

A team of European physicists has successfully transmitted a secure quantum 'key' between two of the Canary Islands, opening the possibility of long-distance, wireless quantum cryptography.

The team used a laser to send encoded photons from a telescope on La Palma to a second one on Tenerife, 144 km away. They announced their first results with bursts of photons earlier this year[1], but Anton Zeilinger of the University of Vienna presented data on single-photon transmission today at the American Physical Society's March meeting in Denver, Colorado.

Using just one photon is considered the gold standard in quantum cryptography, as there is no way to intercept the message without alerting the messenger. But looking for a single photon is trickier than spotting a number of them — especially if you're worried about losing photons to scatter in the atmosphere.

Zeilinger wasn't sure his team would be able to do it, but "it works", he says — albeit slowly. Their rate of data transmission was just 178 bits or single photons in 75 seconds. By comparison, a high-speed Internet connection transmits millions of bits per second.

Is anyone listening?

Quantum cryptography typically uses polarized photons to transmit information between a sender and a receiver. First researchers create two photons that are 'entangled', so they share the same polarization state. The photons' polarization direction is also randomly oriented vertically or at a 45-degree angle.

> **“ It works. ”**
>
> Anton Zeilinger,
> Universität Wien.

One of the photons is given to the sender, and the other is transmitted to the receiver. The receiver then puts the transmitted photon randomly through either a vertical or an angled polarizer. The photon will only pass through the filter sometimes, depending on its own polarization. Overall, assuming that the transmission was uninterrupted, the receiver should get the right information out of this process half of the time. But if an eavesdropper intercepts the photon, the success rate will be much lower. In other words, the two parties would know an eavesdropper was 'listening in'.

Natural interference can also destroy photon entanglement, which means that transmitting quantum encoded information is slow — only some of the photons retain their information. As a result, quantum networks transmit only a key, a relatively small code used to encode larger data sets.

Wired up

Most current systems transmit quantum keys through fibre-optic cables, but the faint signal of a single photon can only travel about 100 km through a modern cable system, according to Zeilinger. "You're basically limited to metropolitan areas," he says. By contrast, the open-air techniques he and colleagues have developed can send photons long distances with little loss — although you need large telescopes to post and receive them.

The results are impressive, although impractical for the moment, says Jian-Wai Pan, a quantum physicist at the University of Heidelberg in Germany. "Without an existing set of telescopes it would be extremely difficult," he says. Nevertheless, Pan says, the work is a proof-of-principle that opens the possibility of distributing quantum keys by satellite, which would allow them to be used worldwide.

Zeilinger says he is now working on a system that could be tested between Earth and the International Space Station.

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References

1. Schmitt-Manderbach, *et al*. *Phys. Rev. Lett.*, **98** . 010504 (2007).

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