

# Physics News Update

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## Attack of the Teleclones

Should quantum cryptographers begin to worry? In contrast with everyday matter, quantum systems such as photons cannot be copied, at least not perfectly, according to the "no-cloning theorem." Nonetheless, imperfect cloning is permitted, so long as Heisenberg's Uncertainty Principle remains inviolate.

According to Heisenberg, measuring the position of a particle disturbs it, and limits the accuracy to which its complementary property (momentum) can be determined, making it impossible to reliably replicate the particle's complete set of properties. Now, quantum cloning has been combined with quantum teleportation in the first full experimental demonstration of "telecloning" by scientists at the University of Tokyo, the Japan Science and Technology Agency, and the University of York (contact Sam Braunstein, [schmuel@cs.york.ac.uk](mailto:schmuel@cs.york.ac.uk) and Akira Furusawa, [akiraf@ap.t.u-tokyo.ac.jp](mailto:akiraf@ap.t.u-tokyo.ac.jp)).

In ideal teleportation, the original is destroyed and its exact properties are transmitted to a second, remote particle; the Heisenberg principle does not apply because no definitive measurements are made on the original particle. In telecloning, the original is destroyed, and its properties are sent to not one but two remote particles, with the original's properties reconstructed to a maximum accuracy (fidelity) of less than 100 percent. (The Heisenberg principle limits the ability to make clones as otherwise researchers could keep making copies of the original particle and learn everything about its state.)

In their experiment, the researchers didn't just teleclone a single particle, but rather an entire beam of laser light. They transmitted the beam's electric field, specifically its amplitude and phase -- but not its polarization -- to two nearly identical beams at a remote location with 58 percent accuracy or fidelity, out of a theoretical limit of 66 percent.

This remarkable feature of telecloning stems from the very magic of quantum mechanics: quantum entanglement. Telecloning stands apart from local cloning and from teleportation in requiring "multipartite" entanglement, a form of entanglement in which stricter correlations are required between the quantum particles or systems, in this case three beams of light. (An example of a multipartite entanglement is the Gigahertz state between three particles that was featured in [Update 414](#).)

In addition to representing a new quantum-information tool, telecloning may have an exotic application: tapping quantum cryptographic channels. Quantum cryptographic protocols are so secure that they may discover tapping. Nonetheless, with telecloning, the identity and location of the eavesdropper could be guaranteed uncompromised.

[Koike \*et al.\*](#), Physical Review Letters, 17 February 2006  
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For an earlier, partial demonstration of telecloning -- between an original photon and one clone at a remote location and another clone local to it -- see [Zhao \*et al.\*](#), Physical Review Letters, 15 July 2005

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