First noiseless single photon amplifier

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Research physicists have demonstrated the first device capable of amplifying the information in a single particle of light without adding noise.

The research collaboration, involving Griffith University, The University of Queensland and University of Science and Technology of China, was able to amplify the noisy quantum state of a single photon subjected to loss, without adding noise in the process; in fact, their amplification reduced the noise in the quantum state.

The results have been published today in "Heralded noiseless amplification of a photon polarization qubit", on the *Nature Physics* website.

Team leader, Professor Geoff Pryde from Griffith University's Centre for Quantum Dynamics said the breakthrough would provide a new tool for all sorts of new quantum technologies.

"This is the first time the information stored in a single photon has been amplified," Professor Pryde said.

"The technique works by combining the noisy quantum state with a 'clean' single photon in the amplifier, and using quantum teleportation to transfer the information onto the new photon.

"The most obvious application for this work is in improved quantum cryptography; secret messaging which is guaranteed secure by the laws

of physics."

It is expected the results will stimulate further interest in the fundamental laws that govern how well amplifiers can work and in developing uses of noiseless amplification techniques for other quantum information technology applications.

Research into such applications is being pursued in Australia's Centre of Excellence for Quantum Computation and Communication Technology, as well as around the world.

Fellow team member Professor Tim Ralph from the University of Queensland said this breakthrough was the culmination of years of research.

"We have been developing the ideas and experimental techniques that led to this breakthrough for the past 4 years," Professor Ralph said.

"Quantum information is useful but very fragile and normal amplification techniques destroy it.

"The key feature of our photon amplifier is that it preserves the quantum information and may help overcome the current distance limitations of quantum communication."

More information: Heralded noiseless amplification of a photon polarization qubit, *Nature Physics*, DOI:10.1038/nphys2469

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