Better light measurement through quantum cloning

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(PhysOrg.com) -- "One of the things we have been studying is how the world works on a really small scale," Bruno Sanguinetti, a scientist at the University of Geneva in Switzerland tells *PhysOrg.com*. "At the quantum level, the world can behave in ways that are far from our everyday experience. For example, information at the quantum level cannot be copied exactly." This is different, he continues, from the ease with which we can copy information in the classical regime.

Sanguinetti is interested in how differences between what happens in the quantum world and what happens in the world of classical physics can be used to enhance technology. “It is interesting to see how fundamental concepts can be used to develop practical applications,” he says. Among the possibilities Sanguinetti sees is the field of radiometry, measuring quantities of light. “This is a common task in physics research labs, and in telecom applications,” he points out.

Along with Enrico Pomarico, Pavel Sekatski, Hugo Zbinden and Nicolas Gisin, all colleagues at the University of Geneva, Sanguinetti is exploring how fundamental differences between the quantum and classical regimes can be used to simplify radiometry. Their work is described in Physical Review Letters: “Quantum Cloning for Absolute Radiometry.”

For the past 100 years, the precise measurement of light quantities has required complex equipment and techniques only available in metrology labs. “Precision has increased, but the methods for detection have become very complicated,” Sanguinetti says. “Our system is much simpler, you could have it in your own lab, directly calibrating your equipment."

The team at Geneva developed a device that makes use of cloned photons to perform an absolute measurement of luminous power. "We use an optical fiber doped with atoms, that are excited to a state that allows them to emit light. The photons to be measured enter the fiber and stimulate the emission of other photons by the atoms. These other photons are the clones, imperfect copies of the input photons," Sanguinetti explains.

How accurate the copies are depends on how many photons you have to begin with. With more photons, moving the system from the quantum regime into the classical regime, the copies become more accurate. This principle allows a good measurement of light power, without a great deal of complex equipment. "We tested our device against a detector calibrated to the best available standards. We saw that the two matched, and that told us that our experiment was good," Sanguinetti says.

Understanding that quantum cloning takes place with increasing fidelity as the system becomes classical is the basis for this experiment. "Our results show that it is possible to measure quantities of light fairly simply," Sanguinetti says. "This could have applications in labs, for other fundamental experiments involving light, or it could have very practical applications for measuring light in telecom fiber optics."

"Understanding quantum cloning, has enabled us to reach a relatively high degree of precision with a simple setup," Sanguinetti points out. "I have a great deal of hope that this will be a step in going even further towards using fundamental quantum principles in technology development."

More information: Bruno Sanguinetti, Enrico Pomarico, Pavel

Sekatski, Hugo Zbinden, and Nicolas Gisin, "Quantum Cloning for Absolute Radiometry," *Physical Review Letters* (August 2010). Available online: link.aps.org/doi/10.1103/PhysRevLett.105.080503
Note: This work follows up on an experiment reported by in this article *on Wired.com.*