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Advancement of quantum communication through entanglement

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Abstract content
   (Max 300 words)

Quantum communication exploits some of the fundamental features of the quantum world, namely, the superposition principle and the Heisenberg uncertainty relation. The most advanced quantum information related technology at present is Quantum Key Distribution (QKD) which is a process that involves transmitting a secret key between two individuals. The most vital characteristic of such a method is that the secrecy of the generated key is guaranteed by the laws of nature.

QKD systems, although capable of producing provably secure keys, must in itself be trusted. Entanglement provides this additional layer of security. To obtain entanglement, photons must undergo a second-order nonlinear process which is referred to as Spontaneous Parametric Down Conversion. Here, we will outline an optical system used to generate entanglement. Upon obtaining an entangled photon pair, a fibre coupled single photon detector in conjunction with polarising filters was used to detect, analyse and verify their non-classical polarisation correlation. The aim was to characterise the aforementioned system.

A test for entanglement of photon pairs involves a measurement of correlation curves in two non-orthogonal bases namely the rectilinear and the diagonal bases. This was measured to a visibility of 91% for both bases. Entanglement was also verified by means of proving the violation of the CHSH (Clauser, Horne, Shirmony and Holt) inequality which states that in local realistic theories the absolute value of a particular combination of correlations between two particles is bounded by 2. Within the system mentioned the violation was measured to be 2.71 ± 0.03 which verifies entanglement. The purity of the states generated was also measured by performing a state tomography and hence constructing of the two-photon density matrix to determine the fidelity of the system. Furthermore, we touch-on exploiting QKD together with entanglement to shape a quantum network.

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Level for award
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PhD

Main supervisor (name and email)
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Prof. F. Petruccione, petruccione@ukzn.ac.za, UKZN

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Primary author: Ms ISMAIL, Yaseera (UKZN)

Co-authors: Dr MIRZA, Abdul (UKZN); Prof. FORBES, Andrew (CSIR-National Laser Centre); Prof. PETRUCCIONE, Francesco (UKZN)

Presenter: Ms ISMAIL, Yaseera (UKZN)

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