Quantum information technologies by implementing hybrid variable resources

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Hybrid variable quantum resources refer to the use of both continuous variable and discrete variable tools available in quantum physics. Both of these resources have been widely explored independently and have found several existing applications in quantum domain. However, since each of them has some benefits (shortcomings) over the other, their use in a complementary or joint manner may be quite advantageous. For instance, using them together, one can generate and characterize more exotic non-classical and non-Gaussian states of light [1]. This talk initially aims to familiarize and demonstrate the use of these hybrid resources for applications in quantum information technologies.

For Photonic quantum computing, role of Schrödinger's cat state is quite crucial. It works as a qubit for hybrid variable quantum computing applications. Essentially it is a mesoscopic, non-classical and non-Gaussian state which can be shown to be a coherent superposition of two coherent states of light having opposite phases. We demonstrate breeding of cat states using a hybrid variable approach experimentally, in which single photons are mixed on a balanced beam splitter and one of the output ports is quadrature conditioned whereas the other output port is used for characterization of generated cat state [1]. The output cat state has been found to possess more than 60% fidelity with the expected theoretical cat state. These states could be used in an iterative protocol where the generated cat state is mixed with another single photon with quadrature conditioning providing control on fidelity and amplitude of the generated cat states. One can also see that use of several such steps may offer low generation rate of these states which can be improved using some storage of single photons such as a synchronized cavity in optical domain. The synchronized pulse optical cavities refer to those optical resonators which operate in pulsed regime and thus are having well defined mode properties in time domain [2]. They may be used for fast generation of few photon Fock states [3] and could also work as a short-time memory device, storing a weak pulse containing few photons for timescales ranging from several nanoseconds to several milliseconds. One can employ synchronized pulse optical cavities to approximate as an on-demand quantum source, for Fock state generation and realization of all cavity Schrödinger cat state for quantum information applications.

Finally, the talk aims to highlight some of our attempts towards realizing methods for secure quantum communication in free space and optical fibres. Our study also focuses to explore the effects of partial coherence of pump on quantum entanglement features of biphotons [4, 5]. Beams having partially coherent photons can be more robust against atmospheric losses and turbulence compared to their fully coherent counterparts, offering a way to achieve higher key rates in quantum communication applications.

References:

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