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Optimized measurements for multiple state discrimination at the single-photon level[1]

F. ELOHIM BECERRA, Center for Quantum Information and Control, University of New Mexico

Measurements for nonorthogonal states of light, such as coherent states, are central for quantum and optical communication. The nonorthogonality of coherent states with small amplitude allows for practical implementations of quantum key distribution for secure communication. However, this nonorthogonality also prevents measurements from perfectly distinguishing among different coherent states, which fundamentally limits the amount of transmitted information in optical communication, particularly at low powers. Here, I describe our work on optimized measurements of nonorthogonal coherent states of light based on photon counting, optical displacement operations, and feedback. These elements provide a way to optimize measurements with enhanced sensitivities and reach sensitivity levels surpassing the limit of conventional Gaussian measurements, referred to as the quantum noise limit (QNL). We experimentally investigate various optimized strategies for discrimination of multiple nonorthogonal states with different sensitivities. Our experimental demonstration achieves discrimination below the QNL at the single-photon level in the presence of noise and loss. These optimized measurements can be used for enhancing information transfer in communication compared to the ideal Heterodyne limit in lossy channels and may be useful for quantum communication.

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