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Measuring states of laser light beyond the quantum noise limit[1]

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Quantum mechanics sets fundamental limits on how well we can distinguish different states of a physical system with intrinsic quantum noise. This quantum noise defines the limit in sensitivity and information capacity in conventional coherent communications with laser light, known as the quantum noise limit (QNL). In the 70's, Carl W. Helstrom showed that there are measurements that use information from the quantum properties of light and detection of single photons that allow for overcoming the conventional limits of detection for nonorthogonal states of light, such as light from a laser [1]. Helstrom's revolutionary work triggered many theoretical works investigating feasible measurements for coherent states that exceed the QNL and approach the limits allowed by quantum mechanics. These quantum measurements have great potential for improving security in quantum communications and optimizing information transfer in optical communications. In this talk, I will describe our theoretical and experimental work on measurement strategies for coherent state discrimination below the QNL. These strategies are based on optimized adaptive measurements with photon counting and have sensitivities that exceed the QNL under realistic noisy and lossy conditions. These new measurements can improve the transfer of information in communications beyond the classical limits of coherent detection. [1] Helstrom, C. W. "*Quantum Detection and Estimation Theory*," Mathematics in Science and Engineering 123 (Academic Press, 1976).

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