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Multi-Spatial-Mode Noiseless Optical Amplifier[1] NEIL CORZO-TREJO, ALBERTO MARINO, PAUL LETT, Joint Quantum Institute / NIST-UMD — One of the most commonly-used optical linear amplifiers, the phase-insensitive amplifier (PIA), always degrades the signal-to-noise ratio of the amplified signal, and the degradation depends on the amount of gain. This problem can be avoided by the proper use of a phase-sensitive amplifier (PSA). An ideal PSA, under certain conditions, can amplify signals without degrading the signal-to-noise ratio of the input. In this sense, the PSA behaves as a noiseless amplifier. In particular, if the PSA can support multiple spatial modes it could perform noiseless amplification of images which is an important goal in imaging research. We implement a phase-sensitive optical amplifier using a four-wave mixing (4WM) process in rubidium vapor. We observe performance near the quantum limit for this type of amplifier over a range of experimental parameters. We compare the results to the ones expected for a PIA and find that our PSA behaves better than the PIA, as expected. Additionally, we observe that the amplifier supports multiple spatial modes (images) without a significant degradation of the input signal-to-noise ratio. To confirm the multi-spatial-mode character we study the behavior of the 4WM-based PSA for different spatial patterns and different spatial frequencies.

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