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Homodyne receiver for near-optimal phase estimation and communication in the presence of phase diffusion

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Phase diffusion represents a crucial obstacle toward the implementation of high-precision interferometric measurements and phase-shift-based communication channels. We present our recent theoretical and experimental results based on a homodyne receiver in the case of two different scenarios: phase estimation and binary optical communication channels based on phase-shift keyed coherent signals. We show that homodyne receiver is a near-optimum receiver for the detection of a phase shift of coherent signals in the presence of large phase diffusion. Interestingly, the ultimate bound to interferometric sensitivity is achieved already for a small number of measurements (hundreds) without exploiting nonclassical light. We prove theoretically and demonstrate experimentally that a discrimination stategy based on homodyne detection is robust against phase diffusion. Homodyne receiver beats the performance of Kennedy one as the signal energy increases, and achieves the Helstrom bound in the limit of large noise. Furthermore, for any value of the energy (also in the low energy regime) there is a threshold value of the phase noise, which makes homodyne detection performing better than the Kennedy receiver in the presence of phase diffusion.