Distributed Quantum Metrology with Squeezed Light and Homodyne measurements

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Squeezing is a well-established resource to achieve quantum-enhanced sensitivity in linear optical networks [1-3]. Compared with approaches that exploit entanglement as a quantum resource, these protocols show a number of advantages, such as the feasibility of the probes employed and of the measurement performed and robustness against decoherence. Despite the advantages, squeezing-based strategies found in recent literature still exhibit experimental challenges that require to be overcome in order to make the squeezing approach feasible in the most experimental situation – *e.g.* strict limitations on the range of values of the unknown parameter φ to be measured, which is usually assumed to be small, and on the form of the linear network which encodes it. Here we address these limitations in detail, while reviewing several protocols that manage to alleviate, if not solve, the impracticalities in different scenarios – *e.g.* estimation of a single distributed parameter [4,5], or of a function of multiple independent parameters [6]. In particular, we find that it is always possible to reach Heisenberg-scaling sensitivity $\delta\varphi = \mathrm{O}(N^{-1})$, where N is the average number of photons in the probe employed, for any given M-channel linear network which encodes in an arbitrary way a single unknown parameter or a function of unknown parameters. This is possible by employing only a single squeezed probe and homodyne measurements.

References

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