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Distributed Quantum Sensing for optical and atom interferometry

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We propose an estimation scheme based on the distribution of a single squeezed state among d interferometers to achieve highly sensitive estimation of multiple parameters. The scheme admits different implementations ranging from optical to atom interferometry. The fundamental component of our scheme is the "quantum circuit" (QC), a linear network that optimally distributes the squeezing generated at one of its inputs among d simple (Mach-Zehnder or Ramsey) interferometers, where d unknown parameters are then imprinted and the number of particles at the outputs finally measured. For any given linear combination of the parameters, we identify the optimal configuration of the QC that allows its estimation with maximal, sub-shot-noise sensitivity. Our "entangled" strategy, based on the mode-entanglement created by the QC, outperforms the rival and more common "separable" strategy, in which the same unknown parameters are estimated independently: the sensitivity gain being a factor d, at most. We show that these results are robust against the noise which may arise in the sensor network. Our new scheme paves the ways to a variety of applications in distributed quantum sensing.

Primary author(s) : Mr. MALITESTA, Marco (QSTAR, INO-CNR and University of Naples "Federico II"); Prof. SMERZI, Augusto (QSTAR, INO-CNR and LENS); Prof. PEZZÈ, Luca (QSTAR, INO-CNR and LENS)

Presenter(s) : Mr. MALITESTA, Marco (QSTAR, INO-CNR and University of Naples "Federico II")

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