universität innsbruck

Department of Theoretical Physics

Theory Colloquium

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"Distributed quantum sensing"

Abstract

Distributed quantum sensing is at the forefront of multiparameter quantum metrology, offering a powerful framework where quantum states are spatially distributed among multiple sensing nodes to enable the simultaneous estimation of several parameters (See Ref. [1] for a review). Despite significant progress, a clear consensus on the advantages of quantum resources — such as entanglement and squeezing — over standard single-parameter schemes remains elusive.
In this talk, I will address the fundamental sensitivity bounds in distributed quantum sensing by analyzing a sensor composed by an array of spatially distributed Mach-Zehnder interferometers (MZIs) [2]. The model provides a fully analytical playground [3,4] of distributed sensing, with applications in clock synchronisation, inertial sensing and navigation.
I will provide a thoughtful comparison with separable schemes using independent MZIs, which highlights the tangible advantages of entanglement under different resource constraints. These results offer new insights into the role of quantum resources in distributed sensing and their potential to enhance practical multiparameter metrology.

[1] L. Pezzè and A. Smerzi, Advances in multiparameter quantum sensing and metrology, arXiv:2502.17396

[2] M Gessner, A Smerzi, and L Pezzè, Multiparameter squeezing for optimal quantum enhancements in sensor networks, Nature communications 11, 3817 (2020)

[3] M Malitesta, A Smerzi, and L Pezzè, Distributed quantum sensing with squeezed-vacuum light in a configurable array of Mach-Zehnder interferometers Physical Review A 108 (3), 032621 (2023)

[4] L Pezzè and A Smerzi, Distributed quantum multiparameter estimation with optimal local measurements, arXiv:2405.18404

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