

Entanglement-enhanced quantum sensing via optimal global control with neutral atoms in cavity

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We present a deterministic protocol for the preparation of entangled states in the symmetric Dicke subspace of medium sized spin systems N up to 100, coupled to a common cavity mode that prepares entangled states useful for quantum sensing, achieving a precision significantly better than the standard quantum limit in the presence of photon cavity loss, spontaneous emission and dephasing [1]. The protocol combines a new *cavity driven geometric phase gate* [2] which can be utilized for exact unitary synthesis on the Dicke subspace, an analytic solution of the noisy quantum channel dynamics and optimal control methods to shape the laser pulses -- i.e. the classical photon field driving the cavity mode and a global laser driving spin rotations. This work provides a simple experimental route to entanglement-enhanced sensing with cold trapped atoms in cavities and can be extended to other spin systems coupled to a bosonic mode.

References

- [1] Srivastava, Vineesha, Sven Jandura, Gavin K. Brennen, and Guido Pupillo. "Entanglement-enhanced quantum sensing via optimal global control." *arXiv preprint arXiv:2409.12932* (2024).
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