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A cavity-QED protocol for precise field sensing in the optical domain[1] DIEGO BARBERENA, ROBERT LEWIS-SWAN, JILA, NIST, Center for Theory of Quantum Matter and Department of Physics, University of Colorado, JUAN MUNIZ, JILA, NIST, and Department of Physics, University of Colorado and Instituto de Física, Facultad de Ingeniería, UDELAR, DYLAN YOUNG, JULIA CLINE, JAMES THOMPSON, JILA, NIST and Department of Physics, University of Colorado, ANA MARIA REY, JILA, NIST, Center for Theory of Quantum Matter and Department of Physics, University of Colorado — In the context of quantum metrology, optical cavity-QED platforms have primarily been focused on the generation of entangled atomic spin states useful for next-generation frequency and time standards. We report a complementary application: The use of optical cavities to generate non-classical atom-light cat-states for quantum-enhanced sensing of small field displacements. We show that even in the presence of intrinsic photon loss from the cavity, the collective enhancement of atom-light interactions allows for potential metrological gains of 10-20 dB below the standard quantum limit in state-of-the-art cavity-QED systems operating with long-lived alkaline-earth atoms. Our protocol opens a path for sub-SQL sensing of electromagnetic fields in the optical domain, and could have applications in circumventing shot-noise limitations in optical interferometry, as well as in other frequency regimes since it is applicable to a broad range of platforms featuring similar types of spin-boson couplings, such as trapped ion arrays and opto-mechanical systems.

[1]AFOSR, ARO, DARPA, NSF, NIST

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