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Entanglement-Enhanced Sensing with Robustness to Noise

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In the quest to approach the fundamental Heisenberg limit in atomic precision measurements, central challenges are the generation and detection of highly entangled states. Both of these challenges can be mitigated by using collective interactions to facilitate the readout of an entanglement-enhanced interferometer. Such interaction-based readout can enable spectroscopy near the Heisenberg limit even with noisy state detection, as I will illustrate with a scheme that harnesses non-Gaussian oversqueezed states [*Phys. Rev. Lett.* **116**, 053601 (2016)]. Motivated by this scheme, and by broader prospects in quantum control, I will describe progress in engineering coherent long-range spin interactions among cold atoms strongly coupled to an optical cavity.