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**Quantum-enhanced sensing using non-classical spin-states of ultracold dysprosium atoms** THOMAS CHALOPIN, Lab. Kastler Brossel, College de France, CNRS, ENS-PSL Univ, Sorbonne Universite, ALEXANDRE EVRARD, VASILIY MAKHALOV, TANISH SATOOR, JEAN DALIBARD, RAPHAEL LOPES, SYLVAIN NASCIMBENE, Laboratoire Kastler Brossel, College de France, CNRS, ENS-PSL University, Sorbonne Universite, Paris, France — Non-classical states are of fundamental interest in quantum-enhanced metrology. While classical sensors are bounded in precision by the standard quantum limit (SQL), a quantum sensor with entangled constituents can go beyond and reach the the Heisenberg limit (HL). However, the most sensitive states involve complex non-gaussian quantum fluctuations, making their practical realization, manipulation and measurement challenging. Here, we beat the SQL using non-classical spin-states encoded in the electronic spin J = 8 of ultracold dysprosium atoms. We use a non-linear light-induced spin coupling to drive coherently a classical, spin-polarized state to a quantum superposition of coherent states with opposite magnetizations. We measure a sensitivity to magnetic field enhanced by a factor 13.9(1.1), close to the HL (2J = 16). We also show that our single magnetic sublevel resolution enables us to measure the optimal sensitivity of non-gaussian (oversqueezed) states, well above the capability of squeezed states, and more robust to environmental noise than superposition states.

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