JOURNAL CLUB: Joint estimation of a two-phase spin rotation beyond classical limit

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Quantum metrology employs entanglement to enhance measurement precision. The focus and progress so far have primarily centered on estimating a single parameter. In diverse application scenarios, the estimation of more than one single parameter is often required. Joint estimation of multiple parameters can benefit from additional advantages for further enhanced precision. Here we report quantum-enhanced measurement of simultaneous spin rotations around two orthogonal axes, making use of spin-nematic squeezing in an atomic Bose-Einstein condensate. Aided by the F=2 atomic ground hyperfine manifold coupled t the nematic-squeezedF=1 states as an auxiliary field through a sequence of microwave (MW pulses, simultaneous measurement of multiple spin-1 observables is demonstrated, reachin an enhancement of 3.3 to 6.3 decibels (dB) beyond the classical limit over a wide range o rotation angles. Our work realizes the first enhanced multi-parameter estimation usin entangled massive particles as a probe. The techniques developed and the protocol implemented also highlight the application of two-mode squeezed vacuum states i quantum-enhanced sensing of noncommuting spin rotations simultaneously.

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