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Shortcut to generation of macroscopic superposition states via coherent driving field

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We propose a scheme to generate macroscopic superposition states (MSSs) of two classically distinct states in spin ensembles where a coherent driving field is applied to accelerate the process of generating MSSs via a nonlinear interaction [1]. The numerical calculation demonstrates that this approach allows one to generate a superposition of coherent spin states (CSSs) of the spin ensemble with a high fidelity above 0.97 for 300 spins. For a larger spin ensemble, the fidelity stays above 0.84 for an ensemble of 500 spins. The generated MSSs exhibit nonclassicality even when the number of spin fluctuates: With a 5% fluctuation of in the number of spins, the parity of the number of $+x$ and $-x$ directed spins exhibits a fringe with respect to the rotation angle about the z axis. The nonclassicality of the generated MSSs is also robust against the fluctuation in the coherent driving strength. The time to generate an MSS is also estimated, which shows that the significantly shortened state-preparation time allows one to achieve such MSSs within a typical coherent time of the system [2,3].

[1] E. Yukawa et al., Phys. Rev. A **97**, 013820 (2018); [2] H. Strobel et al., Science **345**, pp. 424-427 (2010); [3] J. G. Bohnet et al., Science **352**, pp. 1279-1301 (2016).

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