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Proposal of creating spin cat states in Bose-Einstein condensates

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Lots of efforts are currently made in many areas to bring quantum effects to the macroscopic level. A particularly dramatic class of macroscopic superposition states are the so-called cat states, which has been demonstrated in experiment with over one hundred microwave photons. In our recent works, we have proposed an experimental scheme to create spin cat states in Bose-Einstein condensates (BEC) with the possibility of cat sizes of hundreds of atoms based on detailed study of atom loss [Lau et. al, PRL 113, 090401 (2014)]. Our scheme relies purely on the Kerr nonlinearity due to atomic collisions in BEC with two different hyperfine states. We show that with suitable choice of system, magnetic field and high trapping strength, it is possible to significantly increase the Kerr effect while suppressing the two-body loss. This results in small overall loss and fast cat time, hence, a large spin cat state. The existence of cat states can be proved by the homodyne detection on the optical readout. Our analysis also includes the effects of higher-order nonlinearities, atom number fluctuations, and limited readout efficiency.

Author: LAU, Hon Wai (IQST, Univeristy of Calgary)

Co-authors: Dr SIMON, Christoph (IQST, University of Calgary); Mr WANG, Tian (Cornell University); Dr DUTTON, Zachary (BBN Company)

Presenter: LAU, Hon Wai (IQST, Univeristy of Calgary)

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