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Detuning Enhanced Cavity Spin Squeezing YAN-LEI ZHANG, CHANG-LING ZOU, XU-BO ZOU, University of Science and Technology of China, LIANG JIANG, Yale University, GUANG-CAN GUO, University of Science and Technology of China — We have theoretically analyzed the experimental method [1] to squeeze unconditionally the collective spin of an atomic ensemble in a driven optical cavity. We find that strong atom-cavity coupling weakens the spin squeezing and the large detuned laser driving can improve the scaling of spin squeezing to $S^{-2/3}$, which is the ultimate limit of the ideal one-axis twisting spin squeezing. From our numerical solutions and analytical analysis, the large detuning is very important as the squeezing originates from the laser induced spin state dependent geometry phase. We also study the influence of scattering of photon into free space due to imperfect Raman scattering, and demonstrate that the optimal spin squeezing can be obtained with appropriate detuning. This improvement of spin squeezing by detuning is very feasible for experiments, without the requirement of preparation or post-selection of photon state. The detuning enhanced cavity spin squeezing can also be applied to other systems, such as nitrogen-vacancy centers in diamond, to prepare SSS for quantum metrology.

[1] I. D. Leroux, M. H. Schleier-Smith, and V. Vuletić, Phys. Rev. lett **104**, 073602 (2010).

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