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Quantum Interferometry with Microwave-dressed F=1 Spinor Bose-Einstein Condensates: Role of Initial States and Long Time Evolution QIMIN ZHANG, ARNE SCHWETTMANN, Univ of Oklahoma, EITE TIESINGA, Joint Quantum Institute, NIST and the University of Maryland — We numerically investigate atom interferometry based on spin-exchange collisions in $F = 1$ spinor Bose-Einstein condensates in the regime where both the truncated Wigner and the Bogoliubov approximations break down. The interferometer promises to beat the shot-noise limit even in the case of large atom-number population in the arms of the interferometer. Spin-exchange collisions in $F = 1$ spinor Bose-Einstein condensates, where two atoms with magnetic quantum number $m_F = 0$ collide and change into a pair with $m_F = \pm 1$, are useful to implement matter-wave quantum optics in spin space, such as quantum-enhanced interferometry, because the collisions generate entanglement and they can be precisely controlled using microwave dressing. Here, we show numerically that the sensitivity of spin-mixing interferometry can be enhanced to go beyond the shot-noise limit even with a large population of $m_F = \pm 1$ states, $1 \ll N_{m_F=\pm 1} \ll N$, and after long evolution times. This is done by using classically seeded initial states with a small initial population in the $m_F = \pm 1$ states and using long evolution times $t \gg h/c$, where c is the spin-dependent interaction energy.

Qimin Zhang
Univ of Oklahoma

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