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Spinor Bose-Einstein Condensate Interferometer within the Undepleted Pump Approximation: Role of the Initial State[1] JIANWEN JIE, QINGZE GUAN, DOERTE BLUME, Homer L. Dodge Department of Physics and Astronomy, The University of Oklahoma, 440 W. Brooks Street, Norman, Oklahoma 73019, USA — Most interferometers operate with photons or dilute, non-condensed cold atom clouds in which collisions are strongly suppressed. Spinor Bose-Einstein condensates (BECs) provide an alternative route toward realizing three-mode interferometers; in this realization, spin-changing collisions provide a resource that generates mode entanglement. Working in the regime where the pump mode, i.e., the $m = 0$ hyperfine state, has a much larger population than the side or probe modes ($m = \pm 1$ hyperfine states), spinor BECs approximate SU(1,1) interferometers. We derive analytical expressions within the undepleted pump approximation for the phase sensitivity of such an SU(1,1) interferometer for general quantum states. The interferometer performance is analyzed for two specific classes of initial states, pure Fock states and coherent spin states, with single-sided seeding, and with double-sided seeding. The validity regime of the undepleted pump approximation is assessed by performing quantum calculations for the full spin Hamiltonian. Our analytical results and the associated dynamics are expected to guide experiments as well as numerical studies that explore regimes where the undepleted pump approximation is invalid.

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