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Theoretical analysis of an atomic spin self-oscillator ZHIGUO WANG, Interdisciplinary Center of Quantum Information, National University of Defense Technology — We present the analytic solutions for atomic spin self-oscillator with and without rotating wave approximation. The spin ensemble is driven by a linear magnetic field which is produced by its output amplitude multiplied by k and phase shifted by φ. In appropriate condition, the spin will precess self-sustainably. We obtained analytic solutions for amplitude and frequency of the spin self-oscillator with slow-varying amplitude and phase approximation. Some interesting results are found. First, the setup time of the spin self-oscillator has a characteristic time of $2T_1$, and T_1 is the longitudinal relaxation time. Second, the oscillating frequency is a complicated function of parameters, including φ, transverse relaxation time T_2, k, oscillating frequency ω and longitudinal component of magnetic moment Mz. When φ is optimized, the oscillating frequency has nothing to do with T_2, k, Mz at both transient and equilibrium state. On the other hand, the frequency shift is reverse proportional to T_2 if φ is not optimized.

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