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Theoretical analysis of the oscillating frequency in spin-exchange optically pumped spin oscillators.[1] ZHIGUO WANG, Interdisciplinary Center of Quantum Information, National University of Defense Technology — The atomic spin precesses continually when a positive feedback magnetic field is applied. The characteristics of this behaviour depend not only on the parameters of the spin ensemble but also on the feedback loop. We theoretically analyzed direct feedback and phase-lock feedback modes. We also compared the oscillating frequency of the spin oscillators driven by rotating and linear magnetic fields. In the direct feedback mode, the spin oscillator has a characteristic time of approximately twice the longitudinal relaxation time T_1, whereas in the phase lock feedback mode, the characteristic time is approximately the transverse relaxation time T_2 when $T_2 << T_1$. When the spin ensemble is driven by the rotating field, its oscillating frequency is $\omega = \omega_0 + \tan\varphi/T_2$, regardless of the feedback type. Here, ω_0 is the free Larmour frequency, and φ is the phase shift of the feedback loop. When the spin ensemble is driven by the linear field, its oscillating frequency is much more complicated. These findings will be useful to improve the accuracy of fundamental physical theory tests, such as the Lorentz-violation and EDM test, using spin oscillators.

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