About long term stability of the self-generating magnetometer in weak magnetic field

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The reason of quantum devices resonance frequency long term drift is technical noise with spectral density of $S_{\delta n} = A_f/2\pi\omega^n$, where constants A_f and n can be obtained from experimental data only. On the other hand, such device properties are mainly determined by longitudinal and transverse relaxation time which effect signal's profile and intensity. Optically pumped self-generating magnetometer is a quantum device, so its spin saturation operating mode analyses provides information about resonance frequency long term drift prediction as self-oscillating technical linewidth. In this work we present the results for a particular case n=2 considering signal's amplitude and phase fluctuations. In this case technical linewidth equals:

$$\Delta\omega_T = (\pi A_\phi t)^{\frac{1}{2}}(\tau_1^2 + \tau_2^2)(\omega\tau_2\tau_1^3)^{-1},$$

where ω is self-generating frequency, t – observation time , τ_1 and τ_2 - longitudinal and transverse relaxation times, assumed pumping light effect. Technical linewidth is independent from t for n<1 and depends on SNR and τ_2 only.

Technical linewidth can be controlled with Allan variance utilization. This parameters were compared in the experiment with laser pumped alkaline vapor magnetometer in various conditions (operational frequency, magnetic field gradient, laser spectrum variation).