Square-wave modulation with dual-axis decoupling in SERF comagnetometers

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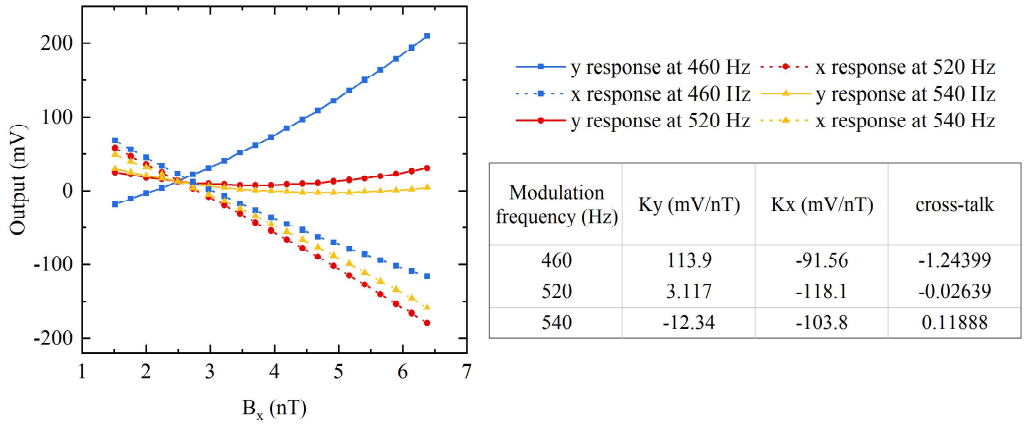
SERF comagnetometers have been widely applied in fundamental physics exploration and they are potential for inertial navigation. In SERF comagnetometers, suppressing low-frequency noise by applying modulation is common. It has obvious advantages to realize dual-axis measurement with a single-beam probe light by sinusoidal magnetic field modulation [1]. However, in the K-Rb-^{21}Ne comagnetometer, the magnetic field felt by electrons is about 100 nT and the residual magnetic field causes the cross-talk. A method proposed to eliminate the cross-talk causes the degradation of self-compensation ability [2]. By studying the dynamic response of coupled spin ensembles to the modulation, we propose a square-wave modulation method to improve the low-frequency sensitivity. It can eliminate the cross-talk while retaining self-compensation capability by working in electronic resonance conditions. This method simultaneously realizes dual-axis information measurement and decoupling, which has great significance for the low-frequency noise suppression and integration of SERF comagnetometers.



Modulation frequency (Hz)	Ky (mV/nT)	Kx (mV/nT)	cross-talk
460	113.9	-91.56	-1.24399
520	3.117	-118.1	-0.02639
540	-12.34	-103.8	0.11888

Figure 1: The cross-talk is almost eliminated at 520 Hz (the electronic precession frequency). The cross-talk is defined as the ratio between output slopes of coupling and sensitive axes.

References

[1] Li Z., Applied Physics Letters **89**, 134105 (2006).

[2] Y. Liang, Physical Review Applied **17**, 024004 (2022).