Towards a magnetically pulsed free-spin-precession magnetometer

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We present a study on an optically pumped magnetometer (OPM) which uses short magnetic field pulses based on the principle from [1]. We employ an in-house microfabricated Cs vapor cell and detect the intensity modulation of a weak circularly polarized probe laser beam due to the atomic free spin precession after the pre-polarization pulse. A pair of Helmholtz coils together with a custom-built coil current driver is used to apply the magnetic field pulse along the laser propagation direction in order to achieve a fast and clean pulse switch-off. A semi-automated data acquisition and analysis tool written in Python allows for the evaluation of the OPM performance [2]. We investigate the latter one, especially its sensitivity in terms of the Cramer-Rao lower bound, with respect to operational parameters as, e.g., magnetic field pulse strength and duration, probe laser power, and total measurement cycle time. In contrast to other OPM types operating in the Earth's magnetic field, the use of a single pre-polarization pulse does not require a feedback circuit implemented in the sensor. It can, therefore, be beneficial in a number of operation scenarios such as a strongly varying magnetic field amplitude or in case of limitation on sensor electronics such as mass, geometry, power consumption or even complexity.

[1] D. Hunter et al., Optical pumping enhancement of a free-induction-decay magnetometer, JOSA B **40**(10), 2664-2673 (2023).
[2] Z. Grujić, FAP-TiePie, GitHub, https://github.com/zoran-grujic/FAP-TiePie, (2023).