Magnetically-silent vector magnetometry based on the free induction decay of atomic spin polarization

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The study of magneto-optics, the interactions of resonant light with atoms in magnetic fields, has long served as the basis of optical magnetometers [1, 2]. The resulting magnetometers fall into two broad classes; driven magnetometers, where some form of feedback maintains a resonance condition, and free induction decay, FID, where a resonance condition is prepared and monitored during the natural decay of the system transient response. One advantage of FID magnetometers when compared to driven magnetometers such as the optically detected magnetic resonance Mx method [3, 4], is that FIDs are self-calibrating. The free nature of the precession makes it possible to measure the absolute value of the magnetic field.

For many applications it is preferable that the magnetometer operation does not disturb the environment being measured, as it occurs, i.e., by the rf magnetic drive field of the Mx magnetometer, or by the spin-manipulation (π/2) pulses used for FID magnetometers.

In this contribution, we detail our progress toward a magnetically silent (all-optical) magnetometer based on Bell-Bloom pumping to create a magnetization of Cs atoms in anti-relaxation coated vacuum cells, followed by a measure of the resulting FID. The direction and amplitude of the magnetic field are reconstructed by monitoring the transmitted light intensity of the three nonparallel beams traversing the paraffin-coated vapour cell. The sensitivity and the limitations of the method will be addressed.

References:
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