A Voigt effect based 3D vector magnetometer

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We describe a method to dispersively detect all three vector components of an external magnetic field using alkali atoms based on the Voigt effect. Our method relies on measuring the linear birefringence of the radio frequency dressed atomic medium via polarization homodyning [1]. This gives rise to modulated polarization signals at the first and second harmonic of the dressing frequency. The vector components of the external magnetic field are mapped onto the quadratures of these harmonics. We find that our scheme can be utilised in both cold and hot atomic gases to detect such external fields in shielded and unshielded environments. In the shielded hot vapour case we achieve field sensitivities in the $\mathrm{pT}/\sqrt{\mathrm{Hz}}$ range for all 3 vector components, using pump-probe cycles with 125 Hz repetition rate, and limited by the short coherence time of the cell. Finally, our scheme has a simple single axis beam geometry making it advantageous for miniature magnetic field sensors.

[1] S. Jammi, T. Pyragius, M. G. Bason, H. Marin Florez, T. Fernholz, Phys. Rev. A, **97**, 043416, (2018).