Study of pump-probe schemes for optically pumped magnetometers using an automated setup

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Optical magnetometers using two separate laser beams for optical pumping and probing of spin polarized atoms interacting with the magnetic field offer increased design flexibility compared to single beam implementations [1]. As a two-beam geometry provides more options in tuning of operational parameters (like pump and probe beam power, frequency, and polarization), this approach generally leads to an enhancement in important figures of merit, i.e. magnetometer sensitivity and accuracy, at the cost of a more complex setup. We investigate an rf-driven magnetometer using a paraffin-coated cesium vapor cell [2], with pump and probe beams operated on or near the cesium D_1 transition (cp. Fig. 1). Our setup allows for automated control of magnitude and direction of the magnetic field vector $\vec{B}_0$ inside a 5-layer magnetic shielding, the power and frequency of pump and probe laser beams as well as the rf magnetic field amplitude B_1 by means of a LabVIEW code. For the evaluation of magnetometer sensitivity in dependence on important operational parameters, we record the magnetic resonance by automated sweeps of the rf-field frequency across the atomic Larmor frequency.

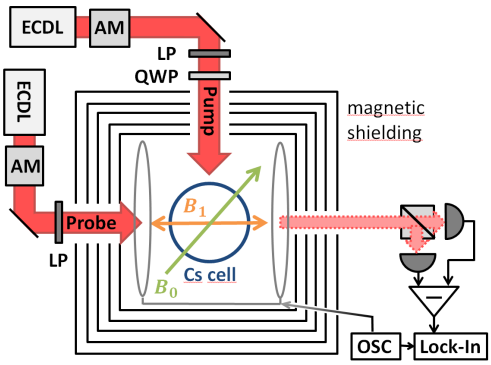

Figure 1. Scheme of our pump-probe rf-magnetometer setup. ECDL: external cavity diode laser, AM: amplitude modulator, LP: linear polarizer, QWP: quarter wave plate, OSC: oscillator.

We show results of initial studies on the amplitude and linewidth of the optically detected magnetic resonance in dependence on important operational parameters and evaluate different schemes for probing the cesium atoms, e. g., based on balanced detection of Faraday rotation and circular dichroism.

[1] D. Budker, and D. F. J. Kimball, Optical Magnetometry, Cambridge University Press, ISBN 9780511846380, (2013).

[2] N. Castagna, G. Bison, G. Di Domenico, A. Hofer, P. Knowles, C. Macchione, H. Saudan, A. Weis, A large sample study of spin relaxation and magnetometric sensitivity of paraffin-coated Cs vapor cells, Appl. Phys. B **96**, 763 (2009).