Cavity-enhanced atomic magnetometer for micro-bio-magnetic measurements

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As a step toward optically pumped magnetometers (OPMs) with sub-mm spatial resolution, we demonstrate optical-cavity-enhanced measurement of atomic vapor spin polarization in a microfabricated vapor cell [1]. The technique, based on the Pound-Drever-Hall (PDH) method, measures the line shift of a circularly-polarized cavity mode, caused by the spin-dependent circular birefringence of the vapor. In contrast to other OPM probing techniques, the optical observable is the phase of a single polarization, rather than a differential phase shift as in Faraday rotation. The method appears well-suited to improving the effective optical path in micro-fabricated atomic vapor cells, analogous to what has been done with multi-pass geometries in macroscopic cells. The signal enhancement will be proportional to the cavity finesse, $\mathcal{F} \approx 18$ in our case (for a blue detuning of $2\pi \times 115\,\mathrm{GHz}$). We describe the application of the OPM to study the ability of magnetotactic bacteria (MTB) to orient in an external magnetic field, which along with their ability to migrate towards regions depleted in oxygen, make MTB potential candidates for cancer treatment [2].

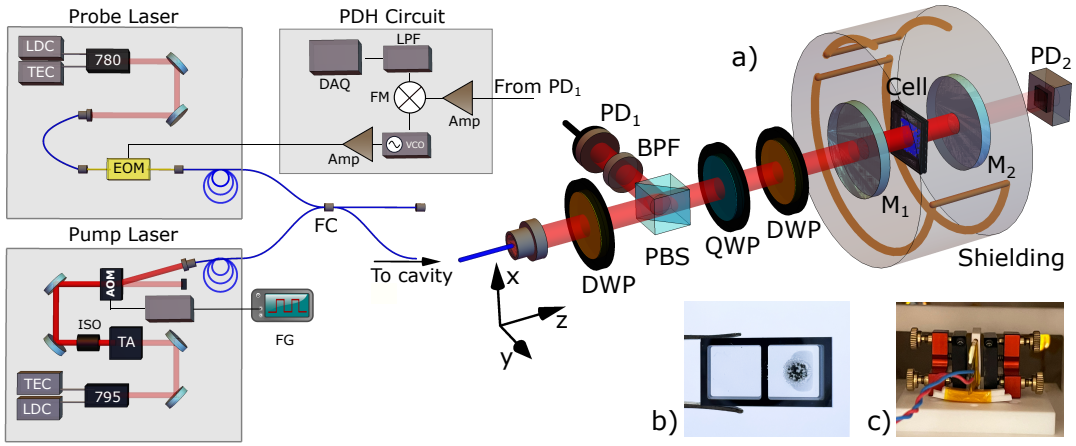

Figure 1. Experimental setup for cavity-based detection of atomic polarization.

[1] M. Hernandez Ruiz et al., Cavity-enhanced detection of spin polarization in a microfabricated atomic vapor cell, Phys. Rev. Applied **21**, 064014 (2024)
[2] M. Marmon et al. Colloquium: Magnetotactic bacteria: From flagellar motor to collective effects, Rev. Mod. Phys. **96**, 021001 (2024).