# An optically pumped magnetometer based on a pump-probe scheme with amplitude modulated light

Tino Fremberg[1], Volkmar Schultze[1], Florian Wittkämper[1], Mark Kielpinski[1], Theo Scholtes[1] and Ronny Stolz[1]

[1] Leibniz Institute of Photonic Technology, P.O. Box 100239, D-07702 Jena, Germany

Magnetotactic bacteria (MTB) typically possess a magnetic moment of the order of magnitude of $10^{-15}$Am$^2$ [1], which generates a very small and localized magnetic field. For a direct measurement of this field with an optically pumped magnetometer (OPM) it is necessary to use a very small sensing volume of the Cesium vapor, placed in close proximity to the magnetic moment. This can be achieved by using a magnetometer with pump-probe scheme and small beam radii.
In an alkali vapor cell of sufficient buffergas pressure the sensing volume is defined by the intersection of the beams. Decreasing the active volume comes at the expense of an increased spin projection noise limit, but also leads to a lower average distance of the sensing atoms to the signal source, leaving an optimization task.
As the MTB are aquatic, they will be transported to the sensor in a microfluidic channel. This combination leads to geometric constraints, i.e. the magnetic field to be measured is oriented perpendicular to the laser beams.
Thus, we employ the well-known Bell-Bloom OPM configuration based on amplitude-modulated light [2] and extend it to a pump-probe configuration.
We present a study of the dependence of the OPM sensitivity on the size of the beam intersection volume.

[1] R. B. Frankel and R. P. Blakemore, Navigational compass in magnetic bacteria, J. Mag. Magn. Mtls., **15-18**, 1562-1564 (1980).
[2] W. E. Bell and A. L. Bloom, Optically driven spin precession, Phys. Rev. Lett., **6**, 280-281 (1961).