Magneto-optical resonances in a nanosize gas cell: experiment and theory for the cesium D_1 line

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Magneto-optical resonances in alkali vapor cells can be used to measure magnetic fields very precisely. However, their typical dimensions do not allow very good spatial resolution. To achieve good spatial resolution, we used a special kind of spectroscopic cell – the extremely thin cell (ETC) [1]. The ETC allows experiments at different values of the cell thickness at the point of interest from ~ 100 nm to ~1 μm. The small distance between the cell windows means that atoms that are moving perpendicularly to the windows are likely to collide with the windows before they absorb and fluoresce. Thus, they do not make a significant contribution to the laser induced fluorescence (LIF) signal and the Doppler effect is reduced. This approach allows for a relatively simple experimental apparatus to provide sub-Doppler resolution.

In order to describe accurately the experimental signals in the ETC (Fig. 1) it was necessary to expand the theoretical model by adding a more accurate treatment of collisions with the walls and clarify the role of fly-through relaxation effects in the laser beam [2]. The experimental signals become a stringent test for the theoretical model.

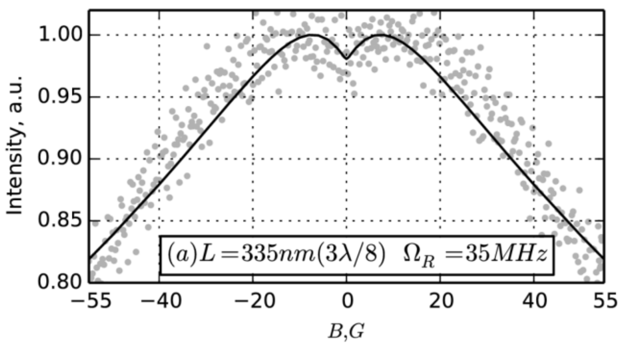

Fig.1 Magneto-optical resonance shape measured in ETC for Cs D_1 transition F_g=4 → F_e=4 at cell thickness of 335 nm (points – experiment, solid line – theory)

Furthermore using the potential of alkali metal vapour to measure magnetic field values in combination with the ETC's small size allowed us to make a device to measure the magnetic field gradient with a spatial resolution of a few hundred nanometres.

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References

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