Analysis of the spatial dependence of laser-induced fluorescence for alkali metal vapours in an intense laser beam

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Magneto-optical resonances in alkali vapours have been studied for a long time [1], but a long-standing problem has been the difficulty in describing the resonance shapes in detail when high laser powers are used. In this study we tried a new approach to solving this problem theoretically, and the theoretical calculations were confirmed by experimental results.

The study consisted of two parts: - first, we described magneto-optical signals in alkali vapour obtained with a single laser. For this part we used an advanced theoretical model, which was an improved version of a model that had worked well for low laser powers [2] and had been used already to describe magneto-optical effects gas cells that were only a few hundred nanometers thick [3]. In this case, the shapes of magneto-optical resonances were determined by collisions with the cell walls and not by the fly-trough relaxation, which is one of the most important factors that influence resonance shape in ordinary cells. The additional feature that was added to the model described in [2] was dividing the Gaussian profile of the laser beam into multiple regions and performing calculations for each of them, taking into account the actual intensity in that region. Stationary solutions were obtained for each region, but the regions were coupled by the exchange of atoms between them. Measurements were done on the ^{87}Rb D_1 line.

For the second part, we described the population distribution and spatial intensity distribution by scanning a spatially narrow, weak probe laser through a spatially broad, intense pump laser. In this way, we could measure directly processes that took place at different parts of a Gaussian laser beam at larger laser power densities. In Fig. 1 one can see 3D plots of the experimentally measured fluorescence intensity (a) and the results of theoretical calculations (b) for the Cs D1 line. The intensity profiles agree qualitatively.

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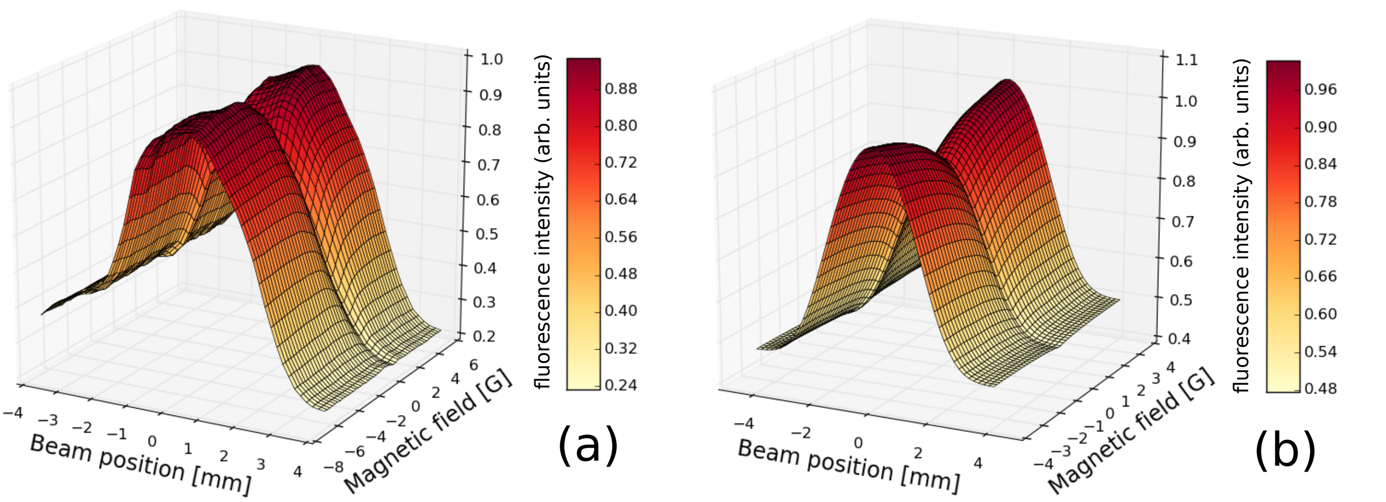

Figure 1: *3D plots of magneto-optical resonances: experimental measurements (a) and theoretical calculation (b) for Cs D_1 line transition F_g=3 to F_e=4 for the probe beam and F_g=4 to F_e=4 for the pump beam*

References

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