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MAGNETO-OPTICAL RESONANCES IN ATOMIC RUBIDIUM AT D_2 EXCITATION

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A detailed study of nonlinear magneto-optical resonances observed on the D_2 line of atomic rubidium is presented. The well-known phenomenon of magneto-optical resonances [1-3] has attracted steady interest in recent years because it has various possible applications. A solid theoretical basis for describing the resonances has been established and tested in atomic rubidium at D_1 excitation in ordinary cm-size cells [4] and in an extremely thin cell [5]. Magneto-optical resonances of the D_2 line should be more challenging to describe theoretically, as the overall hyperfine structure is more complex, while the respective energy gaps between distinct excited-state hyperfine levels are smaller.

Extremely thin cells and ordinary cm-size cells were studied experimentally. A double scan technique [6] was applied: while a tunable diode laser was slowly scanned across several hyperfine transitions, rapid magnetic field scans were performed. A saturated absorption spectrum was recorded simultaneously using phase-sensitive detection so that the laser frequency of each scan could be known. Thus, magneto-optical resonances were recorded when the laser was tuned exactly to a particular hyperfine transition and also for well known detunings away from the transition. Experimental parameters such as laser power density and beam diameter were varied to test various physical conditions, and the total fluorescence signal versus the magnetic field was recorded.

The theoretical approach, also applied in Refs. [4] and [5], is based on the optical Bloch equations, which describe the time evolution of the quantum density matrix. The equations are treated in the dipole approximation to obtain rate equations for Zeeman coherences, which are solved for steady state conditions. As a result, the quantum density matrices of the excited- and ground-states are obtained, which allow the fluorescence signal to be calculated.

[1] J.-C. Lehmann and C. Cohen-Tannoudji, C. R. *Acad. Sci. Paris Ser*. IV 258, 4463 (1964).
[2] R. W. Schmieder et al., *Phys. Rev. A* **2**, 1216 (1970).
[3] G. Alzetta, A. Gozzini, L. Moi, and G. Orriols, *Il Nuovo Cimento B* **36**, 5 (1976).
[4] M. Auzinsh, et al., *Phys. Rev. A* **79**, 053404 (2009).
[5] M. Auzinsh, et al., *Phys. Rev. A* **81**, 033408 (2010).
[6] C. Andreeva, et al., *Phys. Rev. A* **66**, 012502 (2002).