

Zeeman Effect in the Forbidden Transition $5P_{3/2} \rightarrow 6P_{3/2}$ in Atomic Rubidium as a Magnetometry Tool

Angel Saturnino Estrada-Román,

J. Roberto Alonso-Garduza, Gersain G. Quiroz-Sánchez, Luis Duque-Maldonado, Jesús Flores-Mijangos, Fernando Ramírez-Martínez, José Jiménez-Mier

Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México (UNAM), Ciudad Universitaria, 04510 Mexico City, Mexico

angelsatu@ciencias.unam.mx,
jimenez@nucleares.unam.mx

Abstract

Electric-quadrupole transitions are frequently used in atomic clocks based on optical lattices [1], and as sensitive probe of atoms dynamics in magneto-optical traps [2]. In this work, the $5P_{3/2} \rightarrow 6P_{3/2}$ electric-dipole-forbidden transition in a hot vapour of atomic rubidium is studied in the presence of a magnetic field in the weak and strong field regimes. The experiment is performed in a rubidium cell with two external cavity diode lasers (ECDLs) in a counterpropagating configuration. A 780 nm laser at the D2 electric-dipole transition prepares atoms in the $5P_{3/2}$ state, and a 911 nm laser produces the $5P_{3/2} \rightarrow 6P_{3/2}$ electric-quadrupole transition. Both beams are linearly polarized in the direction of the magnetic field. Detection of atoms in the $6P_{3/2}$ state is monitored by the 420 nm fluorescence decay ($6P_{3/2} \rightarrow 5S_{1/2}$) via current-modulated phase detection. The experimental geometry determines the electric-dipole ($\Delta M_F=0$) and electric-quadrupole ($\Delta M_F=\pm 1$) hyperfine selection rules. Transition probabilities and Breit-Rabi diagrams of all involved states and their differences using these selection rules are presented. This allows for the identification of the resonant frequencies of the spectral lines as functions of the magnetic field in both the weak and the strong limits. Theoretical predictions agreed with the experimental data. Future work includes the calculation of line intensities via a population equations model, and the

measurement of anomalies in the Landé g-factors of the $6P_{3/2}$ state.

References

- [1] Ludlow, Andrew D., et al. Rev. Mod. Phys. 87.2 (2015): 637-701.
- [2] Hoyos-Campo, L. M., et al. New J. Phys. 26.10 (2024): 103033.

Figures

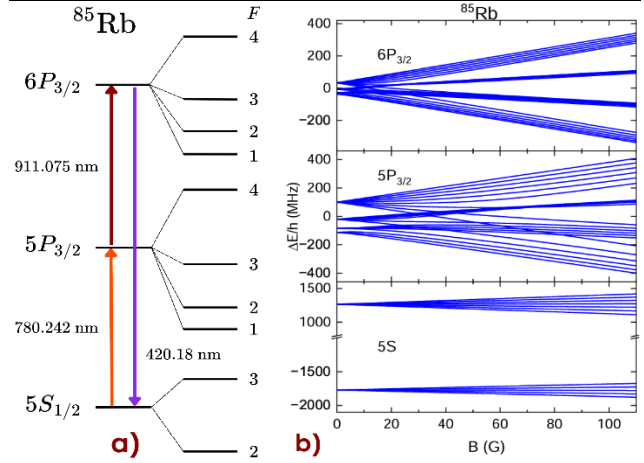


Figure 1: Atomic system: **a)** energy levels and **b)** Breit-Rabi diagrams of the involved states.

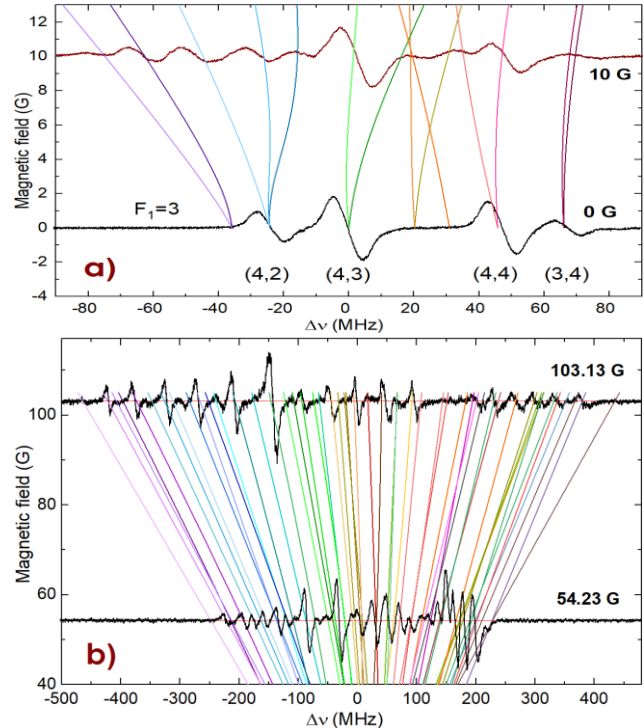


Figure 2: Forbidden transition $5P_{3/2} \rightarrow 6P_{3/2}$ in the **a)** weak field and the **b)** strong field regimes.