Magnetic angular dependence of the laser frequency stabilization as a function of neon buffer gas pressure within ^{87}Rb

Christoph Amtmann[1], Michaela Ellmeier[1,2], Andreas Pollinger[2], Christian Hagen[1,2], Irmgard Jernej[2], Alexander Betzler[1], Martín Agú[2], Werner Magnes[2] and Roland Lammegger[1]

[1] Institute for Experimental Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria
[2] Space Research Institute, Austrian Academy of Sciences, Schmiedlstraße 6, 8042 Graz, Austria

The Coupled Dark State Magnetometer (CDSM) [1] is a scalar magnetometer which is based on the coupling of Coherent Population Trapping (CPT) resonances [2]. It is especially designed for scientific space applications. Several of these resonances are excited within the ^{87}Rb D_1 line to enable an omni-directional detection to the magnetic field strength. Frequency modulated light from a Vertical-Cavity-Surface-Emitting-Laser (VCSEL) diode is used to excite these CPT resonances in a Λ-shaped scheme with the first order sidebands, see figure 1. The magnetometer uses a single vapour cell approach in which the same Λ-shaped light fields are used for the formation of the CPT resonances as well as the laser frequency stabilization. Therefore, two one-photon excitations are established simultaneously. Depending on the angle between the direction of laser light propagation and the magnetic field, different hyperfine dipole matrix elements are responsible for the optical absorption strengths of these one-photon excitations. For circular polarized light and at an angle of 0°, the σ transitions and for an angle of 90° the π transitions dominate [3]. For the angles in-between, the absorption is a mixture of both transition types. In order to reduce the CPT linewidth, neon as a buffer gas is added to the ^{87}Rb gas. This buffer gas effects the one-photon transition strengths and depends on its amount within the cell. Their impact on the laser frequency stabilization as a function of the magnetic field angle will be presented.

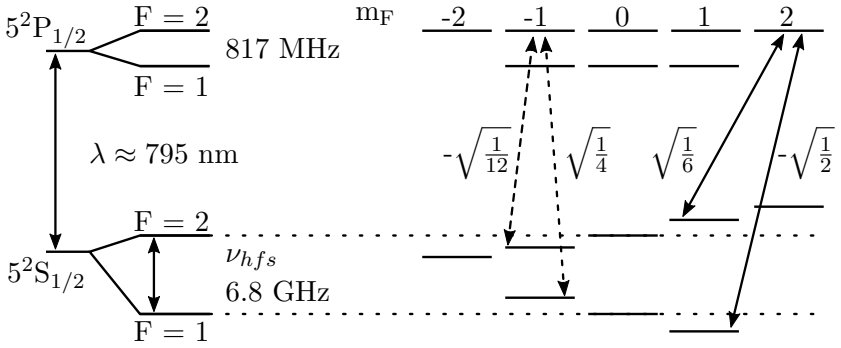

Figure 1. One possible Λ-shaped excitation for σ (solid) and π (dashed) transition within the hyper structure the ^{87}Rb D_1 line. Their corresponding dipole matrix elements are noted.

[1] R. Lammegger, Patent, WO/2008/151344 (2008)
[2] E. Arimondo, Coherent Population Trapping in Laser Spectroscopy, Progress in Optics 35, 257 (1996).
[3] D. A. Steck, Rubidium 87 D Line Data (revision 2.1.5, 13 January 2015)