Magnetic field vector measurements with coupled coherent population trapping resonances

Christoph Amtmann[1,2], Martín Agú[2], Alexander Betzler[2], Irmgard Jernej[2], Sunny Laddha[1], Werner Magnes[2], Andreas Pollinger[2], Roland Lammegger[1]

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

The Coupled Dark State Magnetometer[1] is an optically pumped scalar magnetometer based on the quantum mechanical interference effect of coherent population trapping in the hyperfine structure splitting of the ^{87}Rb D_1 line. The magnetometer is especially designed for scientific space missions and was launched to space in 2018 for the first time. Currently, the instrument operates on three satellites (CSES-1, JUICE, MSS-1). The magnetometer detects the magnetic field strength introduced Zeeman shift of the ground state splitting of coupled CPT resonances. The instrument measures omnidirectional by utilising two sets of coupled CPT resonances. The coupled CPT resonance amplitude of one set has a $\cos^2\theta$-dependence on the angle θ between the laser light propagation direction (within the vapour cell) and the magnetic field vector, while the other set has a $\sin^2\theta$-dependence[2]. By switching between both sets, the scalar magnetometer operates without dead zones[3]. For measurements of the magnetic field vector, the resonance amplitudes of both sets can be used to determine the angle θ. Therefore, a calibration curve has to be created in a coil system where the amplitude ratio of both sets is associated with the angle θ. Accurate vector measurements require a high stability of the initial calibration against changing external parameters, over a long period of time. The presentation will give first results on the long-term stability (several days) of the angular calibration and will discuss its potential for geomagnetic applications such as delta inclination - delta declination measurements.

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