Performance of the Coupled Dark State Magnetometer for the Jupiter Icy Moon Explorer Mission

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The Coupled Dark State Magnetometer (CDSM) [1] is a scalar instrument specifically developed for magnetic field measurements in space. The measurement principle bases on the coupling of two dark state resonances prepared by the Coherent Population Trapping (CPT) effect [2]. The coupled CPT resonances are used for a differential measurement of the magnetic field depend frequency shifts of the ground state transitions due to the Zeeman effect. By the differential measurement, the influence of unwanted frequency shifts, caused by e.g. sensor temperature or laser intensity changes, on the magnetic field measurement are compensated. The first application of the CDSM in space is aboard the China Seismo-Electromagnetic Satellite (CSES) mission launched in February 2018 [3]. Further, the CDSM was selected for the upcoming JUpiter ICy moons Explorer (JUICE) mission by the European Space Agency which will be launched in 2022. For the CSES mission, the magnetic field strengths are in the range of $18 - 56\,\mu$T. However, for the JUICE mission, magnetic field strengths are investigated which can become lower than 150 nT. In this measurement range, the CPT resonances converge and overlap depending on their resonance structure. In order to keep the required accuracy of ± 0.2 nT for the JUICE mission over the whole measurement range, a new sensor was developed which improves the performance of the magnetometer compared to the sensor used for the CSES mission. The sensor design for the JUICE mission and performance measurements of the instrument with regard to the JUICE mission will be presented.

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