Calibration of a novel scalar magnetometer

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Scalar magnetometers measure the magnitude of the magnetic field with high absolute accuracy. A new type of an optically excited scalar magnetometer is currently being developed for space application by two research institutions in Graz, Austria. The use of a specific quantum-optical effect allows omni-directional measurements with an all-optical sensor design without magnetic feedback and excitation signals at the sensor. A first demonstration of the new instrument in space is planned aboard the Chinese Electro-Magnetic Satellite mission to be launched in December 2016.

A new type of scalar magnetometer, called Coupled Dark State Magnetometer (CDSM), is currently under development in a close cooperation between the Space Research Institute of the Austrian Academy of Sciences and the Institute of Experimental Physics of the Graz University of Technology.

The CDSM is an optically pumped magnetometer which uses the energy from a specifically modulated laser diode for exciting the electrons of rubidium atoms in order to measure the magnitude of the magnetic field (Lammegger 2008). The measurement is based on the Coherent Population Trapping (CPT) and Zeeman effects. The energy shift of the atomic levels is described by the so-called Breit-Rabi formula where only fundamental natural constants are contained. The switching between different CPT resonances enables omni-directional measurements, i.e., any angle between the magnetic field direction and the optical reference axis of the sensor.

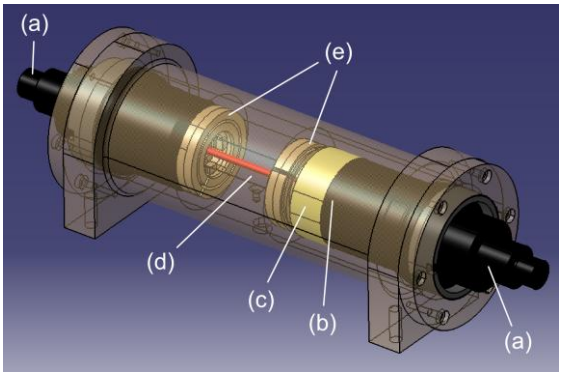

Figure 1: 3D model of the CDSM sensor with two fibre couplers (a), a polarizer (b), a quarter-wave plate (c), a 25mm long Rb-filled glass cell (d) mounted between two damping elements (e) and the sensor housing.

A prototype for space application has been built up since 2012 with funding from the Austrian Space Applications Programme and a Strategic Initiative of ESA (Pollinger 2013). The calibration of the CDSM will to a large extend take place in the new geomagnetic part of the Conrad Observatory by comparison with the reference instruments of the observatory. A first test measurement took place in March 2013 (Fig. 2) and a lot more testing is planned for 2014.

Figure 2: CDSM measures the Earth's magnetic field at the geomagnetic Conrad Observatory.

Beyond this activity, the Space Research Institute is highly interested in calibrating all sorts of space magnetometers in a specially equipped side tunnel of the observatory in the future.

References:

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