THE SWARM MAGNETOMETRY PACKAGE

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High precision measurements of the geomagnetic field have been and are essential to provide insight into the internal structure of the Earth and the solar interaction with the Earth's magnetic field. These measurements reveal the resulting magnetic field that stems from the superposition of three sources: the core field, the crustal field and the current driven field. The spatial and temporal structure of these sources are very different from each other, and therefore not only signal extraction methods and modelling but also measurement strategies have to be taken into account in order to successfully separate these signal contributors. Furthermore, this decomposition process requires that the global field is known at any given time with a relatively high accuracy, wherefore accurate magnetic field mapping is only viable using spaceborne observations.

The data obtained from one single spacecraft is extremely valuable. The first mission to ever map the Earth's magnetic field vector at LEO was the NASA MAGSAT (1978-9). Twenty years later, the Danish Ørsted micro satellite (1999-), the German CHAMP (2000-), the Argentine SAC-C (2000-5) have been designed specifically for mapping the LEO magnetic field. Common to these resent missions is the magnetometry package, which utilizes a vector field magnetometer co-mounted with a star tracker (2 in the case of CHAMP) on an optical bench.

As the accuracy of the instrument package has constantly increased, as well as the modelling methods have been improved towards optimized signal decomposition, it has been realized that simultaneous data from several points in space is needed, if the ultimate modelling barrier, the spatial-temporal ambiguity, has to be broken.

The ESA Swarm mission under the Living Planet Programme consists of three identical spacecraft orbiting in near polar orbits with altitudes varying between 400km to 550km. This constellation is to map the magnetic field of the Earth with unprecedented spatial and temporal accuracy. For this purpose, each spacecraft will be equipped with a vector field magnetometer and three star trackers co-mounted in an optical bench, which will ensure 100% data coverage over the orbit with arcsecond accuracy. This accuracy of the magnetometry package is essential for fulfilling the mission objectives.

This paper describes the basic design characteristics and the performance potentials of the Swarm Magnetometry Package. The key performance parameter is an absolute attitude recovery accuracy in the arcsecond range over time, temperature and aging. The methods used to achieve and validate this accuracy are discussed, as well as the potential for using this methodology on other future missions with extreme stability and accuracy demands.

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