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DEVELOPMENT OF A SENSOR HEAD FOR SPACE-BASED QUANTUM GRAVIMETRY

Abstract

Climate change is one of the biggest challenges of the 21st century. For understanding the underlaying processes a precise measurement of its consequences is required. Gravimetric measurements from Space are a key tool in order to monitor global changes of the water distribution caused by the melting of glaciers and losses of ground water. Novel quantum sensors are a promising approach for an increased stability in the measurement. Using atom interferometry, the gravitational field of the Earth can be measured precisely. The technology is based on the quantum nature of atoms. They are prepared in an ultracold ensemble and their coherence is used to conduct interferometric measurements. The sensitivity with respect to gravity can be increased using long free-fall times that are available in Space. However, their adaptation and qualification for space is challenging. Due to the extensive European heritage and a close collaboration within the European Union an independent development and operation of a quantum sensor-based space mission can be realized. The CARIOQA-PMP project (Cold Atom Rubidium Interferometer in Orbit for Quantum Accelerometry – Pathfinder Mission Preparation) under the European Commission's Horizon Europe program aims for developing such a quantum sensor for space application. European industry (Airbus, iXblue, TELETEL, LEONARDO, G.A.C. Group) in collaboration with European research institutions (LUH, SYRTE, LP2N, LCAR, ONERA, FORTH, TUM, POLIMI, DTU) will build an engineering model of an accelerometer based on atom interferometry for a Quantum Space Gravimetry pathfinder mission. The pathfinder mission preparation is coordinated by the French and German space agencies CNES and DLR under CNES lead. Airbus Defence and Space has a long history on the forefront of Earth observation missions and will be responsible for the integration of the instrument. Additionally, Airbus Germany will lead the design, construction and initial operation of the sensor head, the Physics Package. In this module the atom-optical experiments are conducted. This involves several technologies like an ultrahigh vacuum chamber, the atomic reservoir, the magnetic shield as well as surrounding opto- and electro-mechanical components. The contribution will give an overview on the required technology and status of implementation.