GR 14: Experimente zur Gravitation I

Zeit: Donnerstag 17:25–19:25 Raum: A214

GR 14.1 Do 17:25 A214

A New Type of Atom Interferometry for Testing Fundamental Physics — •Dennis Lorek[1], Andreas Wicht[2], and Claus Lämmerzahl[1] — [1]Center of Applied Space Technology and Microgravity, University of Bremen, Germany — [2]Ferdinand-Braun-Institut für Höchstfrequenztechnik, Humboldt-Universität zu Berlin, Germany

We present a new type of atom interferometry that provides a tool for ultra-high precision tests of fundamental physics. As an example we present how an atom interferometer based on hydrogen may be used to detect gravitational waves. The perturbation of the Hamiltonian by a gravitational wave is derived, the quantum interferometric measurement principle is described, and the size of the effect is estimated. We will discuss whether a gravitational wave causes a frequency shift which may be detectable with the next generation atom interferometers.

GR 14.2 Do 17:45 A214

Giant Matter Waves In Microgravity — •Thorben Könemann for the QUANTUS-Collaboration — ZARM, University of Bremen, Germany

We report on the first experimental demonstration of rubidium Bose-Einstein condensates in the environment of weightlessness at the earth-bound short-term microgravity laboratory Drop Tower Bremen, a facility of ZARM ("Center of Applied Space Technology and Microgravity") - University of Bremen. This pilot project is performed within the QUANTUS ("Quantum Systems in Weightlessness") collaboration to study the possibilities of Bose-Einstein condensation experiments in free fall on earth and the feasibility of ultracold quantum matter techniques on space-based platforms. Our approach is based on a compact, mobile, robust and autonomous operating drop capsule experiment to currently investigate Bose-Einstein condensates with longest expansion times (up to 1 second). For this purpose the drop capsule setup has to withstand decelerations of around 50g on every free fall. So far, we have successfully accomplished more than 170 drops with the QUANTUS apparatus since the beginning of November 2007. The pilot project QUANTUS gratefully acknowledges the support from the DLR ("German Aerospace Center") an institution of the BMWi ("Federal Ministry of Economics and Technology, Germany") under the support code 50 WM 0836.

GR 14.3 Do 18:05 A214

Sagnac Effect in a Proper Reference Frame — •Endre Kajari, Michael Buser, Cornelia Feiler, and Wolfgang P. Schleich — Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany

Cold atoms and degenerate quantum gases in space have the potential to extend the current limits of matter-wave interferometry. Several international projects aim for future space missions and local tests of general relativity. In particular, the QUANTUS collaboration currently studies the creation and time evolution of Bose-Einstein condensates in weightlessness at the drop tower facility in Bremen (ZARM).

In view of this fascinating experimental progress, we want to draw attention to the so-called proper reference frames which fit the needs of future satellite experiments. As an example, we apply these specific local coordinates to Sagnac interferometry and present the corresponding first two leading order contributions. We conclude by introducing a simple measurement scheme, which provides not only information about the rotation relative to the compass of inertia, but also about the spacetime curvature along the world line of the satellite.

GR 14.4 Do 18:25 A214

Long-term test of the isotropy of the speed of light using an optical-resonator-based apparatus — Christian Eisele, Alexander Yu. Nevsky, and •Stephan Schiller — Institut für Experimentalphysik, Heinrich-Heine-Universität, 40225 Düsseldorf

The isotropy of the speed of light is one of the best known invariance principles in physics. It is one aspect of Lorentz Invariance, which is a basic assumption of all theories of the fundamental forces. In the course of the past 120 years the isotropy has been tested with ever increasing precision.

We have developed a highly sensitive laser Michelson-Morley apparatus [1] and performed an extensive search for violation of the isotropy of c. The apparatus contains two orthogonal optical high-finesse resonators (F=180 000) to which two waves obtained from a monolithic 1064 nm Nd:YAG laser are frequency-stabilised. The resonators are embedded in a monolithic structure made of ultra low thermal expansion coefficient glass (ULE). The apparatus is continuously rotated using a highly accurate air bearing rotation table. The difference frequency between the resonators is measured as a function of the orientation in space. The apparatus is also actively stabilized from mechanical vibrations, tilt variations and temperature fluctuations.

We will report about the results of a measurement campaign of approximately one year duration. From the data we obtain coefficients describing a possible violation of Lorentz Invariance within two test theories, the standard model extension (SME) and the Mansouri-Sexl test theory. [1] Eisele et al., Opt. Comm. 281, 1189 (2008)

GR 14.5 Do 18:45 A214

New precise method for thermal recoil force computation with application to the Pioneer anomaly — •Benny Rievers[1], Claus Lämmerzahl[1], and Hansjörg Dittus[2] — [1]Zentrum für angewandte Raumfahrttechnologie und Mikrogravitation ZARM Universität Bremen 28359 Bremen — [2]DLR Institut für Raumfahrtsysteme Robert-Hooke-Str. 7 28359 Bremen

For high precision geodesic and fundamental physics missions such as LISA, LISA pathfinder and MICROSCOPE, exact knowledge of the disturbances is crucial for mission success. An important perturbation originates from non-symmetric heat dissipation. At ZARM a method for the exact computation of the resulting disturbance force has been developed. The method is based on the modeling of the spacecraft geometry in finite elements (FE) and raytracing. A thermal FE analysis is conducted to compute a surface temperature distribution of the craft. The FE model includes the geometry, material parameters and all contraints (conduction, radiation, environment) for the FE solution. The results of the analysis are imported into a raytracing algorithm which computes the resulting recoil force including reflection, absorption and shadowing effects. As a test case the Pioneer 11 radio isotopic thermal generators (RTG) are processed. The results point out that a more detailed thermal analysis for the whole craft is necessary as the simplified test case shows a recoil force that is non-negligible with respect to the Pioneer Anomaly. This analysis is ongoing and will enable the high precision computation of the Pioneer 11 heat dissipation perturbation.

GR 14.6 Do 19:05 A214

Mission simulation and free fall payload tests for MICROSCOPE — •Hanns Selig, Meike List, and Stefanie Bremer — ZARM, Universität Bremen, Bremen, Deutschland

MICROSCOPE is a french space mission for testing the equivalence principle in space. The mission goal is the determination of the Eötvös parameter eta with an accuracy of 10^{-15}. The launch is sheduled for 2012. As a member of the MICROSCOPE performance team, ZARM performs free fall drop tower tests of the MICROSCOPE differential accelerometers as well as mission simulations and the preperation of the mission data analysis in close cooperation with the french partners CNES, ONERA and OCA.

The free fall tests are essential for the validation of the sensor performance. The mission simulation includes satellite and test mass dynamics as well as interactions between the spacecraft and the orbital environment. The project concepts and current results of the free fall tests (MICROSCOPE accelerometer engineering model) and current simulation results of the influence of different mission parameters on the satellite and test mass dynamics are presented.