Q 3: Präzisionsmessungen und Metrologie I

Zeit: Montag 14:00–16:00 Raum: 3D

Gruppenbericht Q 3.1 Mo 14:00 3D

A Michelson-Morley Type Test of Lorentz Invariance using electromagnetic Resonators — •Alexander Senger[1], Katharina Möhle[1], Moritz Nagel[1], Sven Herrmann[2], Evgeny Kovalchuk[1], Holger Müller[2], and Achim Peters[1] — [1]Institut für Physik, Humboldt-Universität zu Berlin — [2]Physics Department, Stanford University, USA

The experiment of A. A. Michelson and E. W. Morley, has served as a sensitive test of special relativity and Lorentz invariance for more than a century now. Modern versions of this experiment rely on the comparison of electromagnetic eigenfrequencies of rotating high-finesse resonators. This approach allows to search for tiny violations of Lorentz Invariance in the optical sector of the underlying test theory (SME, Standard Model Extension), and also for deviations regarding the electronic properties of the material used to build the resonators.

We report on the progress made in our improved version of the experiment, where the measurement is performed by monitoring an optical resonator continuously rotating on a precision turntable, which currently allows for a sensitivity at the 10^{-17} level for a direction dependent variation of the speed of light. We discuss limiting effects in our setup and present steps towards a measurement spanning more than one year which should give an improvement of at least an order of magnitude in accuracy compared to previous tests. Furthermore, we present results from a collaboration employing two complementary experiments leading to limits on Lorentz Violation in the electronic sector of the SME.

Gruppenbericht Q 3.2 Mo 14:30 3D

A Picometer Resolution Heterodyne Interferometer for LISA and its Application to Technology Verification — •Dennis Weise[1], Martin Gohlke[1,2], Thilo Schuldt[2,3], Thomas Heinrich[3], Ulrich Johann[1], Achim Peters[2], and Claus Braxmaier[3] — [1]EADS Astrium GmbH — [2]Humboldt-Universität zu Berlin — [3]HTWG Konstanz

Within the LISA Mission Formulation study currently funded by ESA, EADS Astrium has developed and investigated various concepts for the LISA payload architecture, all of which utilize an Optical Readout (ORO) to detect relative motion between the inertial reference (i. e. the proof mass) and the spacecraft. In collaboration with the Humboldt University Berlin and the HTWG Konstanz, a prototype ORO has been realized over the past years, which meanwhile is close to achieving the required picometer-sensitivity in translation and nanorad-sensitivity in attitude metrology. The polarizing heterodyne interferometer is characterized by a highly symmetric setup and employs differential wavefront sensing for determination of the proof mass tilt in 2 degrees of freedom. We will discuss the experimental setup and its latest performance, as well as its application to first verification of critical LISA subsystems. For example, the interferometer has been applied to characterize the CTE of various CFRP samples with ultra-high sensitivity, including “near-zero-CTE” tubes. Our current activities further include novel developments for other critical parts of the optical metrology chain, namely the laser source and the phasemeter, where the respective approach and first results will be presented.

Gruppenbericht Q 3.3 Mo 15:00 3D

LISA Pathfinder: spaceborne testbed towards millihertz gravitational wave astronomy — •Felipe Guzman Cervantes[1], Frank Steier[1], Antonio Francisco Garcia Marin[1], Michael Troebs[1], Anneke Monsky[1], Martin Hewitson[1], Gudrun Wanner[1], Ingo Diepholz[1], Oliver Jennrich[2], Gerhard Heinzel[1], and Karsten Danzmann[1] — [1]Albert-Einstein-Institut Hannover — [2]ESA-ESTEC

LISA Pathfinder is a ESA technology demonstration mission planned to be launched in 2010 to test LISA core technologies that cannot be tested on ground. The LISA Pathfinder satellite carries two experiments: the LISA Technology Package (LTP) from ESA, and the Disturbance Reduction Noise (DRS) from NASA. The LISA Technology Package will primarily demonstrate test mass drag-free control and isolation to better than 3×10^{-14} ms$^{-2}/\sqrt{\mathrm{Hz}}$, and spacecraft control with micronewton thrusters. A set of 4 heterodyne Mach-Zehnder interferometers is utilized for the read out of test mass displacement and rotation to better than 10 pm/$\sqrt{\mathrm{Hz}}$ and 10 nrad/$\sqrt{\mathrm{Hz}}$ in the frequency range from 3-30 mHz respectively. Currently we are testing engineering models of different subsystems and preparing a test bed for investigations on flight hardware. This talk presents the current status in the development and implementation of the LISA Technology Package and a series of tests conducted as software and hardware simulations for on-orbit operation.

Gruppenbericht Q 3.4 Mo 15:30 3D

LISA: Laser interferometry for the spaceborne gravitational wave detection — •Antonio Francisco Garcia Marin[1], Felipe Guzman Cervantes[1], Frank Steier[1], Simon Barke[1], Christian Diekmann[1], Roland Fleddermann[1], Benjamin Sheard[1], Michael Tröbs[1], Juan Jose Esteban Delgado[1], Iouri Bykov[1], Jens Reiche[1], Oliver Jennrich[2], Gerhard Heinzel[1], and Karsten Danzmann[1] — [1]Albert-Einstein-Institut Hannover, Max-Planck-Institut für Gravitationsphysik and Universität Hannover, Germany — [2]ESA ESTEC, Noordwijk, The Netherlands

The Laser Interferometer Space Antenna (LISA) is a joint ESA-NASA mission designed to observe gravitational waves in the frequency range between 0.1 to 100 mHz, where ground-based detectors are limited by terrestrial noise. Sources in this frequency range include supermassive black holes and galactic binary stars. LISA consists of three identical spacecraft separated by 5 million kilometers carrying a total of six free flying test masses in heliocentric drag-free orbit. The fluctuations in separation between two of these test masses located in different satellites will be measured by laser interferometry with picometre precision. I will present a brief overview of the LISA mission with special emphasis on the laser interferometry, the research field at the Albert Einstein Institute.