Q 30: Poster Präzisionsmessungen und Metrologie

Zeit: Dienstag 16:30–19:00 Raum: Poster C2

Q 30.1 Di 16:30 Poster C2

Cold Atom Sagnac Interferometer — •Christian Schubert, Thijs Wendrich, Michael Gilowski, Ernst Rasel, and Wolfgang Ertmer — Institut für Quantenoptik, Leibniz Universität Hannover

Cold atom fountains and mater-wave interferometry have enabled many very sensitive measurements methods for fundamental physics and metrology [1]. We report on the status of our dual atom interferometer for the precise determination of inertial forces. Our device is based on synchronous operation of two counter propagating atom interferometers to discriminate between accelerations and rotations. The atomic source units are horizontal fountains each consisting of a 2D-MOT which loads a 3D-MOT with cold ^{87}Rb atoms [2]. The 3D-MOT uses a moving molasses technique to launch the atoms with about 4.4 m/s with a temperature of about 8 μK. The interferometer sequence itself has a Mach-Zehnder configuration realized with three optical Raman pulses for the coherent manipulation of the atoms. The atomic interference signal is measured using the fluorescence light of both output states of each interferometer, allowing normalized results that are insensitive to changes in the number of atoms in both directions. With this compact and transportable setup we aim to reach sensitivities of $2 * 10^{-9}$ rad/s for $1 * 10^{8}$ atoms per shot and a velocity of 3 m/s. This work is supported by DFG SFB407 and FINAQS. [1] C. Jentsch, T. Müller, E.M. Rasel, W. Ertmer, Gen. Rel. Grav. 36(10), 2197(2004). [2] T. Müller, T. Wendrich, M. Gilowski, C. Jentsch, E.M. Rasel, W. Ertmer, arXiv:0705.4544v1, accepted by Phys. Rev. A.

Q 30.2 Di 16:30 Poster C2

Laser Doppler Interferometry Mission for Determination of the Earth's Gravity Field — •Marina Dehne, Ben Sheard, Gerhard Heinzel, and Karsten Danzmann — Albert-Einstein-Institut Hannover, Max-Planck-Institut für Gravitationsphysik und Universität Hannover, Callinstr. 38, D-30167 Hannover

The aim of a future GRACE follow-on mission is to map with high resolution the gravitational field of the Earth. The space segment consists of two spacecraft in a Low- Earth Orbit (LEO), following each other with a seperation of about 10 km. The variations of that distance in the frequency range 1...100 mHz are to be monitored by the interferometer with nanometer precision. Data analysis to be performed on the ground will recover the information about the gravitational field from those measurements, in the form of the spherical harmonics from degree 6 to 240.

One possible orbit is a circular sun-synchronous orbit (i $=96.78°$) in order to provide a constant thermal environment and to avoid sunlight entering the optical axis between the two spacecraft. The atmospheric drag in a Low-Earth Orbit is significant and must be compensated. For this purpose, drag-free technology such as developed for LISA Pathfinder is ideally suited. The proposed interferometer makes use of technologies developed for LISA and LISA Pathfinder.

The goal of this work is to develop an interferometer breadboard which fulfills the requirements ($2.5\,\mathrm{nm}/\sqrt{\mathrm{Hz}}$ from 10 to 100 mHz, increasing as 1/f between 10 and 1 mHz) under the given other constraints of the mission.

Q 30.3 Di 16:30 Poster C2

A quantum radiation-pressure noise dominated interferometer — •Stefan Gossler, Yanbei Chen, Stefan Danilishin, Daniel Friedrich, Kentaro Somiya, Tobias Westphal, Kazuhiro Yamamoto, Karsten Danzmann, and Roman Schnabel — MPI für Gravitationsphysik (AEI) und Institut für Gravitationsphysik der Leibniz Universität Hannover, Callinstr.38, 30167 Hannover

The second generation of interferometric gravitational-wave detectors will be limited by quantum noise of the light field in most of the detection band: while shot noise will limit the sensitivity at high frequencies it is quantum radiation-pressure noise that will be limiting at low frequencies. Despite the effort of various groups all over the world so far no interferometric measurement that is dominated by quantum radiation-pressure noise has been obtained yet. A mechanical device to couple the quantum fluctuations of the light field to displacement of a sensor is crucial to these measurements. We present our design of such a sensor and the general concept to accomplish the first ever measurement of quantum radiation-pressure noise.

Q 30.4 Di 16:30 Poster C2

Frequenzmessung eines optischen Frequenznormals über ein Glasfasernetz — •Osama Terra[1], Burghard Lipphardt[1], Gesine Grosche[1], Jan Friebe[2], Ernst Rasel[2] und Harald Schnatz[1] — [1]Physikalisch Technische Bundesanstalt, Braunschweig — [2]Institut für Quantenoptik, Universität Hannover , Hannover

Im Rahmen des SFB 407 untersuchen die Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig und das Institut für Quantenoptik (IQO) der Universität Hannover eine neue Methode zur Messung des Uhrenübergangs des Mg Frequenznormals. Bisher wurde diese Frequenz mit Hilfe einer transportablen Cs Uhr oder einem auf GPS stabilisierten Quarz vermessen. Um das Mg Normal besser charakterisieren zu können und dessen Potenzial voll auszuschöpfen, ist es erforderlich, kurzzeitstabilere Oszillatoren als Referenz zu benutzen. Mit optische Uhren, wie sie in Staatsinstituten betrieben werden, lassen sich wesentlich kleinere Unsicherheiten und höhere Kurzzeitstabilitäten erreichen als mit Mikrowellennormalen. Dazu ist es aber erforderlich, dass die hohe Stabilität und Genauigkeit der optischen Uhren auch an weit entfernten Standorten zur Verfügung gestellt werden kann. Hierzu wird ein Laser bei 195 THz (1,55 μm) mit Hilfe eines Frequenzkammes auf die optische Referenzfrequenz stabilisiert und dessen Frequenz über einen 70 km langen Glasfaserlink nach Hannover gesendet. Anschließend wird das trägerfrequente cw-Signal dort mittels zweitem Frequenzkamm mit der Frequenz des Mg Frequenznormals verglichen. Die Gesamtverbindung wird zur Zeit schrittweise aufgebaut und charakterisiert. Wir berichten über den Stand des Projektes.

Q 30.5 Di 16:30 Poster C2

High reflectivity grating waveguide coatings — •Daniel Friedrich[1], Oliver Burmeister[1], Michael Britzger[1], Tina Clausnitzer[2], Frank Brückner[2], Ernst-Bernhard Kley[2], Andreas Tünnermann[2], Karsten Danzmann[1], and Roman Schnabel[1] — [1]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) und Institut für Gravitationsphysik der Leibniz Universität Hannover, Callinstr. 38, 30167 Hannover — [2]Institut für Angewandte Physik der Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena

Thin single-layer grating structures can be used as a high reflectivity, but low thermal noise, alternative to conventional multilayer coatings. Grating waveguide (GWG) coatings should have low mechanical loss due to the reduced coating thickness, resulting in low thermal noise. Since the coating provides the interface between a light field and a mirror device, coating thermal noise is an important design concern for various high precision experiments such as gravitational wave detection. We present concepts and ongoing investigations of different types of GWG's.

Q 30.6 Di 16:30 Poster C2

Testing the Isotropy of the Speed of Light using ULE Optical Resonators — •Christian Eisele[1], Maxim Okhapkin[2], Alexander Yu. Nevsky[1], and Stephan Schiller[1] — [1]Institut für Experimentalphysik, Heinrich-Heine-Universität, 40225 Düsseldorf — [2]Institute for Laser Physics, Novosibirsk, Russia

Modern Michelson-Morley-type experiments with ultra-stable resonators are aiming to measure a possible violation of Lorentz invariance for electromagnetic waves.

We will report about the latest results of our measurements using optical high finesse resonators (F = 190000) orthogonally embedded in a rectangular ULE (ultra low expansion coefficient glass) block. This design gives a certain amount of common mode rejection for several disturbances. A monolithic Nd:YAG laser at 1064 nm is frequency stabilized to the resonance frequencies of the resonators, and the difference frequency between the resonators is measured as a function of the orientation of the cavities in space. To improve the short term frequency stability of the laser system, we use an active vibration isolation system. For active rotation of the setup a highly-accurate air-bearing rotation table is used.

Q 30.7 Di 16:30 Poster C2

Thermal noise limit of the Fabry-Perot cavities used for laser stabilisation at sub-Hz level — •Janis Alnis, Nikolay Kolachevsky, Arthur Matveev, Thomas Udem, and Theodor Hansch — Max Planck Institute of Quantum Optics, 85748 Garching, Germany

Precision optical spectroscopy experiments require lasers with extremely narrow spectral line widths that can be achieved by stabilising the laser to a high-finesse Fabry-Perot (FP) cavity. We have developed two independent external-cavity diode laser systems at 972 nm with 0.5 Hz spectral line width that is limited by the thermal noise properties of the FP cavity spacer and mirrors [1]. The thermal noise limit is reached thanks to a mid-plane mounting of the cavities making them insensitive to ambient vibrations. The line drift is always smaller than 0.5 Hz/s as the cavities are made from Ultra-Low-Expansion (ULE) glass possessing a zero expansion temperature. Our new design with Peltier coolers in vacuum allows us to keep any ULE FP cavity at this particularly advantageous temperature.

With this narrow laser source after amplification and frequency quadrupling to 243 nm we excite the 1S-2S two-photon transition in atomic hydrogen [2]. The diode laser has an unusually long (20 cm) resonator that significantly reduces the high-frequency noise typical to diode lasers and allows efficient doubling of the narrow optical carrier.

References

1. J. Alnis et al., in preparation for Appl. Phys. B.
2. N. Kolachevsky et al., Phys. Rev. A 73, 021801(R) (2006).