GR 202 Experimentelle Tests

Zeit: Dienstag 14:00–16:00 Raum: K

Hauptvortrag

GR 202.1 Di 14:00 K

A modern Michelson-Morley experiment using ultrastable optical resonators — •Achim Peters — Humboldt-Universität zu Berlin, Institut für Physik, Hausvogteiplatz 5-7, 10117 Berlin

This talk will present a modern version of the classic Michelson-Morley experiment testing the isotropy of light propagation and thus the foundations of Special Relativity. From a modern perspective, this measurement is one out of a more general class of experiments investigating the validity of Lorentz-Invariance in the light of new theoretical approaches — such as string theory or loop quantum gravity — suggesting small violations.

The experiment itself is performed by monitoring the resonance frequency of an optical resonator continuously rotating on a precision turntable, making it possible to achieve a sensitivity at the $\Delta c(\theta)/c \sim 10^{-16}$ level for a direction dependent variation of the speed of light. I will analyze the experimental results in the context of modern test theories and discuss the potential for improvements in sensitivity by up to three orders of magnitude.

GR 202.2 Di 14:40 K

Lorentz invariance violation in higher order electrodynamics — •Dennis Lorek and Claus Lämmerzahl — ZARM, University of Bremen

The low energy limit of, e.g., loop quantum gravity suggests that the effective Maxwell equations contain beside an arbitrary constitutive tensor also higher derivatives. The consequences based on an ordinary linear constitutive tensor have already been discussed extensively. Here we consider violations of Lorenz invariance which may come in through higher orders of derivatives. We present a general scheme for the influence of these higher order terms on the propagation of light and on the solution for point charges. This results in a modified, non–homogeneous dispersion relation, which is also predicted by non–commutative approaches, and in modifications of the energy levels in hydrogen atoms due to the additional appearance of electric multipole fields. A comparison with experiments yields estimates on the Lorentz violating terms.

GR 202.3 Di 15:00 K

Exact deformation of cavities by means of the gravitational gradient — •Eva Hackmann und Claus Lämmerzahl — Zarm, Uni Bremen

For high precision experiments in space the elastic deformation of optical resonators by the means of the gravitational gradient has to be considered. Therefore question on the solution of the basic equilibrium equation of the theory of elasticity and thus to the solution of the biharmonic equation in three variables under certain boundary conditions arises. In order to estimate the dimension of the error of the numerical result an analytical solution is desirable. Different approaches to obtain such a solution depending on the boundary conditions are presented here.

GR 202.4 Di 15:20 K

Quantenzustände ultrakalter Neutronen im Gravitationsfeld der Erde — •Claude Krantz und Hartmut Abele — Physikalisches Institut, Philosophenweg 12, 69120 Heidelberg, Deutschland

In unserem Experiment an der Neutronenquelle des Instituts Laue-Langevin (Frankreich) werden seit einigen Jahren gebundene Quantenzustände im Gravitationsfeld der Erde beobachtet. Auf Längenskalen von wenigen Mikrometern wird dabei das Verhalten von ultrakalten Neutronen untersucht, die über einem reflektierenden Spiegel frei fallen. In dem aus Spiegel und Schwerfeld entstehenden Potential besetzen die Neutronen nach den Gesetzen der Quantenmechanik ein diskretes Zustandsspektrum. Obwohl die untersten Energieeigenwerte nur einige Pico-eV betragen, ist es möglich, das System derart zu präparieren, dass nur der Grundzustand und die nächsten benachbarten Niveaus besetzt und damit Quanteneffekte beobachtbar werden, die vom klassischen Rahmen abweichen.

Mit Hilfe höchstauflösender Neutronendetektoren ist es nun gelungen, die Höhenverteilung der Teilchen über dem Spiegel direkt zu messen, also das Betragsquadrat der Wellenfunktion im Ortsraum abzubilden. Es zeigt sich, dass die Messdaten der quantenmechanischen Erwartung entsprechen, durch ein rein klassisches Modell aber nicht reproduziert werden können.

GR 202.5 Di 15:40 K

String-Motivated Torsion Effects on Spin Precession — •Thorsten Feldmann[1], Robert Graham[1], Axel Pelster[1], and Urs Schreiber[2] — [1]Fachbereich Physik, Universität Duisburg-Essen, Universitätsstraße 5, 45117 Essen, Germany — [2]Zentrum für mathematische Physik, Bundesstraße 55, Universität Hamburg, D-20146 Hamburg, Germany

In the low-energy limit string theory predicts that Einstein's gravitation theory is modified by the occurrence of the Kalb-Ramond and the dilaton field. At first, we show that all these string-inspired gravitational fields can be considered as constituents of a Riemann-Cartan differential geometry. Then we analyze in detail how a constant torsion tensor, induced by a Kalb-Ramond field, modifies the equations of motion of a classical particle with spin in a flat space-time, leading, for instance, to a precession of a myon spin in a storage facility. Such effects might be candidates for an explanation of the current discrepancy between the predictions of the standard model of elementary particle physics for the anomalous magnetic moment of the myon and the recent precision measurements at Brookhaven National Laboratory.