Fachverband Gravitation und Relativitätstheorie (GR)

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Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal A214)

Plenarvorträge

PV I	Di	11:00–11:45	Audimax	**Kosmologie, Krümmung, und Quantenfelder** — •Stefan Hollands
PV II	Di	11:45–12:30	Audimax	**On the topology of the Universe.** — •Frank Steiner
PV III	Mi	11:00–11:45	Audimax	**Proton Structure - the impact of HERA** — •Robin Devenish
PV IV	Mi	11:45–12:30	Audimax	**Der Large Hadron Collider: Stand und Perspektiven** — •Felicitas Pauss
PV V	Mi	20:00–21:00	Audimax	**Expedition ins Innerste der Materie und zum Anfang unseres Universums** — •Wolfgang Hollik
PV VI	Do	11:00–11:45	Audimax	**Kinderleukämie und Kernkraftwerke?** — •Herwig Paretzke

Hauptvorträge

GR 3.1	Di	9:00– 9:45	A214	**Massive binary black holes and superkicks** — •Stefanie Komossa
GR 3.2	Di	9:45–10:30	A214	**Die Satellitenmission GRACE - Hochgenaue Gravitationsfeldbestimmung der Erde** — •Torsten Mayer-Gürr
GR 6.1	Mi	8:30– 9:15	A214	**Relativistic Figures of Equilibrium** — •David Petroff
GR 6.2	Mi	9:15–10:00	A214	**The inner Cauchy horizon of axisymmetric and stationary black holes with surrounding matter** — •Marcus Ansorg
GR 8.1	Do	8:30– 9:10	A214	**Superstrings and Cosmology** — •Dieter Lüst
GR 8.2	Do	9:10– 9:50	A214	**Anti-de Sitter black holes dual to thermal quantum field theories** — •Johanna Erdmenger
GR 8.3	Do	9:50–10:30	A214	**Cosmic and superconducting strings** — •Betti Hartmann

Fachsitzungen

GR 1.1–1.3	Mo	17:00–18:00	A214	**Grundlegende Probleme und allgemeiner Formalismus**
GR 2.1–2.4	Mo	18:00–19:20	A214	**Quantengravitation und Quantenkosmologie**
GR 3.1–3.2	Di	9:00–10:30	A214	**Hauptvorträge Dienstag**
GR 4.1–4.7	Di	14:00–16:20	A214	**Klassische Allgemeine Relativitätstheorie I**
GR 5.1–5.4	Di	16:45–18:05	A214	**Klassische Allgemeine Relativitätstheorie II**
GR 6.1–6.2	Mi	8:30–10:00	A214	**Hauptvorträge Mittwoch**
GR 7.1–7.7	Mi	16:45–19:05	A214	**Schwarze Löcher**
GR 8.1–8.3	Do	8:30–10:30	A214	**Hauptvorträge Donnerstag**
GR 9.1–9.2	Do	11:45–12:25	A214	**Numerische Relativitätstheorie I**
GR 10.1–10.3	Do	12:25–12:34	Dekanatsgang	**Poster**
GR 11.1–11.3	Do	14:00–15:00	A214	**Numerische Relativitätstheorie II**
GR 12.1–12.4	Do	15:00–16:20	A214	**Gravitationswellen I**
GR 13.1–13.2	Do	16:45–17:25	A214	**Gravitationswellen II**
GR 14.1–14.6	Do	17:25–19:25	A214	**Experimente zur Gravitation I**
GR 15.1–15.2	Fr	8:30– 9:10	A214	**Experimente zur Gravitation II**
GR 16.1–16.4	Fr	9:10–10:30	A214	**Kosmologie I**
GR 17.1–17.5	Fr	11:00–12:40	A214	**Kosmologie II**

GR 18.1–18.3	Fr	12:50–13:50	A214	**Alternative klassische Gravitation**

Plenarvorträge des Symposiums Komplexität

Das vollständige Programm dieses Symposiums ist unter SYKO aufgeführt.

SYKO 1.1	Mo	13:00–13:35	A140	**Chaoticity and Complexity** — •Andreas Knauf
SYKO 1.2	Mo	13:35–14:10	A140	**The LHC-Project: Complexity in High Energy Physics** — •Thomas Lohse
SYKO 1.3	Mo	14:10–14:45	A140	**Structure Formation in Astrophysics - From Cosmology to Planets** — •Wolfgang Hillebrandt
SYKO 1.4	Mo	15:05–15:40	A140	**The Scaling Laws of Human Travel: Tracking Dollars for New Approaches to Epidemic Modeling** — •Theo Geisel
SYKO 1.5	Mo	15:40–16:15	A140	**Challenges of Complexity in Natural, Technical and Economic Sciences** — •Klaus Mainzer

Plenarvorträge des Symposiums Das Dunkle Universum

Das vollständige Programm dieses Symposiums ist unter SYDU aufgeführt.

SYDU 1.1	Mi	14:00–14:45	Audimax	**Astrophysikalische Beobachtungen von Dunkler Materie und Dunkler Energie** — •Marek Kowalski
SYDU 1.2	Mi	14:45–15:30	Audimax	**Dark Matter in the Laboratory** — •Laura Covi
SYDU 1.3	Mi	15:30–16:15	Audimax	**Kosmische Beschleunigung** — •Dominik J. Schwarz

Begrüßungsabend

Am Dienstag, den 10. März, findet ab 19:30 Uhr ein Begrüßungsabend mit warmen Buffet im Lichthof des Hauptgebäudes statt.

Mitgliederversammlung Fachverband Gravitation und Relativitätstheorie

Dienstag, den 10. März 18:15–19:15 Hörsaal A214

- Eröffnung und Festsetzung der endgültigen Tagesordnung
- Verlesen und Genehmigung des Protokolls der letzten Mitgliederversammlung
- Bericht des Vorsitzenden
- Vergangene Aktivitäten
- Zukünftige Aktivitäten
- Dissertationspreis
- Denkschrift
- Büchertisch
- Verschiedenes

GR 1: Grundlegende Probleme und allgemeiner Formalismus

Zeit: Montag 17:00–18:00 Raum: A214

GR 1.1 Mo 17:00 A214

On the initial-value problem of Maxwell's equations — •Volker Perlick — Physics Department, Lancaster University, UK

I present some new results on the initial-value problem for Maxwell's equations. Throughout, Maxwell's equations are considered in metric-free form, with a local but otherwise arbitrary constitutive law. This setting covers standard Maxwell theory on a general-relativistic space-time and many alternative theories as special cases. The general results are illustrated with applications to the Born-Infeld nonlinear electrodynamic theory. Among other things, I present a new proof of the known fact that the Born-Infeld initial-value problem is well-posed.

GR 1.2 Mo 17:20 A214

The physics of higher order equations of motion — •Patricia Rademaker and Claus Lämmerzahl — ZARM, University Bremen, 28359 Bremen

On the classical level interactions are explored through the observation of the dynamics of particles. The basic underlying assumption in that scheme is that Newton's second law holds. We relax the validity of this axiom by assuming higher order time derivatives in the equation of motion. We discuss the physics emerging from such higher order equations of motion and derive the structure of interactions which can be deduced from a gauge principle. One main result is that modifications in the particle motion due to higher order derivatives induce a zitterbewegung. As a consequence the main motion resulting from the second order equation of motion is rather robust against such modifications. Higher order equations of motion also allow for a more general structure of interactions. In particular, this approach also serves as a novel scheme to introduce the Riemannian space-time metric on a gauge level. We confront this general scheme with experimental data.

GR 1.3 Mo 17:40 A214

Averaged Gravity — •Juliane Behrend — Institut für Theoretische Physik, Universität Ulm

The fact that an adequate description of gravitational dynamics on cosmological scales should be given by an average over Einstein's equations is currently receiving considerable attention. Finding an accurate theory of averaged gravity is difficult since we lack a suitable averaging procedure for tensor quantities in general relativity. In this talk I will discuss in depth various approaches to such a procedure and address remaining problems that need to be overcome to find a viable averaged theory.

GR 2: Quantengravitation und Quantenkosmologie

Zeit: Montag 18:00–19:20 Raum: A214

GR 2.1 Mo 18:00 A214

Classical and quantum gravitational collapse in the Lemaitre-Tolman-Bondi model with positive cosmological constant — •Anne Franzen[1], Sashideep Gutti[2], and Claus Kiefer[1] — [1]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Strasse 77, 50937 Köln, Germany — [2]Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai 400 005, India

We develop the canonical theory of gravitational collapse for the Lemaitre-Tolman-Bondi model with a positive cosmological constant.

We present the classical canonical formalism and adress the boundary terms in the action. Quantizing the constraints we obtain the Wheeler-deWitt equation. Employing a lattice regularization, we derive exact solutions to all quantum constraints.

We employ these solutions and a general relation between dust time and Killing time to derive the Hawking temperature at the cosmological horizon and at the black hole horizon of the Schwarzschild-de Sitter spacetime. We obtain approximate Planck spectra near the horizons.

GR 2.2 Mo 18:20 A214

Von der Quanteninformation zur Gravitation — •Thomas Görnitz — FB Physik, Goethe-Univ. Frankfurt/M.

Seit vielen Jahren suchen sehr viele gute Theoretiker mit großem Nachdruck einen Weg von der Allgemeinen Relativitätstheorie zur Quantentheorie, ohne dass bisher ein wirklich zufriedenstellender Durchbruch erzielt werden konnte. Daher erscheint es angebracht, einen Schritt zurückzutreten und zu schauen, ob sich das Tor nicht nach der anderen Richtung öffnet. Es gibt neben dem ausgebliebenen Erfolg wissenschaftstheoretische Argumente, die gegen eine Quantisierung der ART sprechen, z.B., das Unikat "Universum" als eine von unendlich vielen Lösungen einer allgemeinen Gleichung beschreiben zu wollen. Aus einer abstrakten Theorie der Quanteninformation lässt sich mit Hilfe des ersten Hauptsatzes eine Kosmologie ableiten, die frei von den bekannten "kosmologischen Problemen" ist, die gut zu den empirischen Daten passt, die eine plausible Erklärung für die dunkle Energie gibt und bei der die lokalen Abweichungen von der homogenen und isotropen Raumzeit den Einsteinschen Gleichungen genügen.

GR 2.3 Mo 18:40 A214

Metric fluctuations and decoherence — •Ertan Göklü[1], Claus Lämmerzahl[1], and Heinz-Peter Breuer[2] — [1]ZARM-Universität Bremen, Am Fallturm, 28359 Bremen — [2]Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg i.Br.

Recently a model of metric fluctuations has been proposed which yields an effective Schrödinger equation for a quantum particle with a modified inertial mass, leading to a violation of the weak equivalence principle. The renormalization of the inertial mass tensor results from a local space average over the fluctuations of the metric over a fixed background metric. Here, we demonstrate that the metric fluctuations of this model lead to a further physical effect, namely to an effective decoherence of the quantum particle. We derive a quantum master equation for the particle's density matrix, discuss in detail its dissipation and decoherence properties, and estimate the corresponding decoherence time scales. By contrast to other models discussed in the literature, in the present approach the metric fluctuations give rise to a decay of the coherences in the energy representation, i.e., to a localization in energy space.

GR 2.4 Mo 19:00 A214

Quantengasladungen als Gravitationsursache — •Manfred Böhm — Telphykas, Solitudestr. 389, 70499 Stuttgart

Von den Gestirnen mitgeführte Quantengase (Quanten-"Äther") sind Ursache der Gravitation als Wechselwirkungen schwingender Quantenladungen aufeinander (Hertzsche Dipole).

Die Materiequantenwelt besteht aus den Festquanten und den Urquanten. Die Massendichte der Festquanten liegt ganz grob um den Faktor eine Million höher als die des Neutrons.

Während sich Funk und Licht mittels transversaler EM-Schwingungen ausbreiten, wirkt die Gravitation über nicht abschirmbare Spektren longitudinaler EM-Schwingungen.

Quanten-Drehimpulse und -Impulse werden durch die Festquanten ermöglicht, die auch zu Neutrinos führen. Ihre Energie ist abhängig von den inertialen Geschwindigkeiten (Omega, v) und von der absoluten Temperatur (K).

"Zeitdilatation" und "Raumkrümmung" können auf die von den Gestirnen mitgeführten Quantengase und deren infolge der Gravitation variable Moldichten gegründet werden, die zu entsprechenden Krümmungen und Längenänderungen von Lichtbahnen - also auch zu Laufzeitänderungen - führen.

Abschließend werden drei Experimente zum Nachweis der Materiequanten vorgeschlagen und technische Nutzungsmöglichkeiten angegeben.

GR 3: Hauptvorträge Dienstag

Zeit: Dienstag 9:00–10:30 Raum: A214

Hauptvortrag GR 3.1 Di 9:00 A214

Massive binary black holes and superkicks — •Stefanie Komossa — Max-Planck-Institut für extraterrestrische Physik, München

There is now growing evidence that supermassive black holes (SMBHs) reside at the centres of many galaxies, and that the black holes' presence and growth is intimately linked with the formation and evolution of galaxies. Accreting supermassive black holes are the power source of quasars, the most luminous long-lived objects in the universe. Since galaxies are merging frequently with each other throughout the history of the universe, supermassive binary black holes will form frequently at their cores. Recent numerical relativity simulations predict that coalescing SMBHs may receive kick velocities up to several 1000 km/s due to anisotropic emission of gravitational waves, leading to long-lived oscillations of the SMBHs in galaxy cores and even black hole ejections from their host galaxies. The presence of these "kicks" and "superkicks" has a wide range of exciting astrophysical implications which only now start being explored. I will summarize these, together with recent observations that point to the presence of massive binary black holes and superkicks.

Hauptvortrag GR 3.2 Di 9:45 A214

Die Satellitenmission GRACE - Hochgenaue Gravitationsfeldbestimmung der Erde — •Torsten Mayer-Gürr — Institut für Geodäsie und Geoinformation, Universität Bonn

Mit Hilfe der Satellitenmission GRACE kann seit über 6 Jahren das statische und zeitvariable Schwerefeld der Erde sehr präzise vermessen werden. Die Kenntnis des Schwerefeldes ist für viele Anwendungen in der Geophysik von großer Bedeutung, sie wird aber auch für die Bestimmung relativistischer Effekte mit Hilfe von erdbezogenen Satelliten benötigt.

Dieser Vortrag gibt einen Einblick über die in Bonn verwendete, auf Integralgleichungen basierende, Auswertungsmethode von GRACE-Daten. Dabei wird insbesondere auf die Faktoren eingegangen, welche die Genauigkeit der Lösung limitieren. Diese umfassen zum einen das prinzipiell schlecht gestellte Problem zum anderen aber auch praktische Probleme, wie die Genauigkeit der verwendeten Hintergrundmodelle und die daraus resultierenden Aliasing-Effekte.

GR 4: Klassische Allgemeine Relativitätstheorie I

Zeit: Dienstag 14:00–16:20 Raum: A214

GR 4.1 Di 14:00 A214

Dedekind-like Configurations in Relativity — •Norman Gürlebeck[1] and David Petroff[2] — [1]Institute of Theoretical Physics, Prague, Czech Republic — [2]Theoretisch-Physikalisches Institut, Jena, Germany

Because a changing quadrupole moment leads to gravitational radiation in Einstein's theory of gravity, one might suppose that stationary but non-static and non-axisymmetric, isolated systems cannot exist. In Newtonian theory, the triaxial, homogeneous Dedekind ellipsoids are classical figures of equilibrium whose shape remains unchanged in an inertial frame due to internal motions. In this talk, I shall discuss the possibility of using Dedekind ellipsoids as a basis for finding non-axisymmetric figures of equilibrium in General Relativity.

GR 4.2 Di 14:20 A214

Rotierende Flüssigkeitsringe — •Stefan Horatschek und David Petroff — Theoretisch-Physikalisches Institut, Jena

Es wird ein analytisches Verfahren zur Behandlung von rotierenden Flüssigkeitsringen im Gleichgewicht präsentiert. Das Verfahren basiert auf einer Entwicklung um den Grenzfall dünner Ringe, bei dem der Querschnitt kreisförmig wird. Die Ergebnisse werden mit numerischen Lösungen verglichen.

GR 4.3 Di 14:40 A214

Are gravitational waves essentially linear? — •Nikodem Szpak — Albert-Einstein-Institut, Max-Planck-Institut für Gravitationsphysik, Golm

Einstein equations are obviously nonlinear while nonlinear wave equations, in general, have the property that also in the weak-field regime the propagating waves experience a nonlinear self-interaction and thus deviate from the linear approximation. We analyze how the special geometric structure of the Einstein equations determines the behavior of small amplitude gravitational waves and to what extent they behave as linear waves.

GR 4.4 Di 15:00 A214

Kosmologische Expansion und lokale Systeme — •Matteo Carrera[1] und Domenico Giulini[2] — [1]Physikalisches Institut, Albert-Ludwigs-Universität, Hermann-Herder-Str. 3, 79104 Freiburg — [2]Albert-Einstein-Institut, Am Mühlenberg 1, 14476 Golm

Die heutigen kosmologischen Messungen sind mit einem Bild eines sich beschleunigt expandierenden Universums verträglich. Im Vortrag wird die Frage untersucht, inwieweit die kosmologische Expansion auf kleinen Skalen (verglichen mit den kosmologischen) spürbar ist.

Es werden einige alte und neuere exakte Lösungen der Eintein'schen Gleichungen vorgestellt, die die idealisierte Situation von einer Inhomogeneität in einer kosmologischen Raumzeit modellieren. Dabei werden wir uns auf sphärisch symmetrische Raumzeiten spezialisieren und von deren besonders netten geometrischen Struktur gebrauch machen, die beispielsweise erlaubt, nützliche quasilokale Massendefinitionen einzuführen.

GR 4.5 Di 15:20 A214

Analytic solutions of the geodesic equation in higher dimensional static spherically symmetric space–times — Eva Hackmann[1], •Valeria Kagramanova[2], Jutta Kunz[2], and Claus Lämmerzahl[1] — [1]ZARM, Universität Bremen, Am Fallturm, D–28359 Bremen — [2]Institut für Physik, Universität Oldenburg, D–26111 Oldenburg

We present the complete analytical solutions of the geodesic equation of massive test particles in higher dimensional Schwarzschild, Schwarzschild–(anti)de Sitter, Reissner–Nordström and Reissner–Nordström–(anti-)de Sitter space–times. Using the Jacobi inversion problem restricted to the theta divisor the explicit solution is given in terms of Kleinian sigma functions. The derived orbits depend on the structure of the roots of the characteristic polynomials which depend on the particle's energy and angular momentum, on the mass and the charge of the gravitational source, and the cosmological constant. We discuss the general structure of the orbits and show that due to the specific dimension–independent form of the angular momentum and the cosmological force a rich variety of orbits can emerge only in four and five dimensions. We present explicit analytical solutions for orbits up to 11 dimensions. A particular feature of Reissner–Nordström space–times is that bound and escape orbits traverse through different universes.

GR 4.6 Di 15:40 A214

Geodesic equation in Kerr-de Sitter spacetimes — •Eva Hackmann and Claus Lämmerzahl — ZARM, Universität Bremen

Recently, a method for analytically solving the geodesic equation in Schwarzschild-de Sitter spacetime has been developed [Phys. Rev. Lett. 100, 171101 (2008), Phys. Rev. D 78, 024035 (2008)]. The solution ansatz utilizes the theory of hyperelliptic functions and is based on a limiting case of Jacobi's inversion problem in two complex dimensions. In its final form, the solution is given in terms of Kleinian sigma functions. We present our efforts for a generalisation of this method to the equation of motion in Kerr-de Sitter spacetimes.

GR 4.7 Di 16:00 A214

Motion of spinning particles — •Andreas Resch and Claus Lämmerzahl — ZARM, University Bremen, 28359 Bremen

In this talk the equations of motion of a rigid test body in General Relativity will be reviewed. We discuss the Mathisson-Papapetrou-Dixon equations for the pol-dipole particle and present the equations of motion both in PPN approximation and in Schwarzschild space–time. The equations in the latter case are integrated by a numeric solver. As expected, the solutions show deviations from the geodesic motion. The possible impact on the Flyby anomaly is discussed.

GR 5: Klassische Allgemeine Relativitätstheorie II

Zeit: Dienstag 16:45–18:05 Raum: A214

GR 5.1 Di 16:45 A214

Gravitating Sphaleron-Antisphaleron Systems — Rustam Ibadov[1], Burkhard Kleihaus[2], Jutta Kunz[2], and •Michael Leissner[2] — [1]Department of Theoretical Physics and Computer Science, Samarkand State University, Samarkand, Uzbekistan — [2]Institut für Physik, Universität Oldenburg, D-26111 Oldenburg, Germany

The configuration space of the bosonic sector of Yang-Mills-Higgs theory possesses non-trivial topology. This gives rise to a plethora of unstable classical solutions, such as the Klinkhamer-Manton sphaleron. Representing a saddlepoint of the energy functional between two topologically inequivalent vacua, its existence permits processes, which violate baryon number conservation.

We here present new solutions to Einstein-Yang-Mills-Higgs theory, representing gravitating sphaleron-antisphaleron pairs, chains and vortex rings. In these static axially symmetric solutions, the Higgs field vanishes on isolated points on the symmetry axis, or on rings centered around the symmetry axis.

GR 5.2 Di 17:05 A214

Motion of extended bodies in the theory of general relativity — •Isabell Schaffer and Claus Lämmerzahl — ZARM, Universität Bremen, Am Fallturm, D-28359 Bremen

The geodesic equation in General Relativity holds for ideal point particles only. If e.g. intrinsic angular momentum is associated with a particle, the particle must have an extension, to avoid physical inconsistency. Moreover, spin and mass quadrupole couple to the curvature of spacetime. As a consequence, the equations of motion will be modified. For the description of these extended bodies with spin the Mathisson–Papapetrou formalism can be used (MP–formalism) which we will apply on a particle in a Kerr–de Sitter background space time. The equations of the MP-formalism have to be completed by a supplementary condition. We want to apply different supplementary conditions which are mainly used in literature on a Kerr–de Sitter spacetime and discuss the different effects. The results of this analysis may be useful in the description of satellite dynamics oder binary systems of stars.

GR 5.3 Di 17:25 A214

Interaktive Visualisierung in der Allgemeinen Relativitätstheorie — •Thomas Müller und Frank Grave — Visualisierungsinstitut der Universität Stuttgart

Die Visualisierung in der Relativitätstheorie ermöglicht uns Einblicke in die Natur von Raum und Zeit, die uns aus unserer Alltagserfahrung vollkommen fremd sind. Sie dient hierbei nicht nur dazu, die Relativitätstheorie einer breiten Öffentlichkeit zugänglich zu machen, sondern kann auch als wichtiges pädagogisches Hilfsmittel in Schule und Studium eingesetzt werden. Während die Effekte der Speziellen Relativitätstheorie relativ einfach in eine interaktive Simulation umgesetzt werden können, sind die Effekte der Allgemeinen Relativitätstheorie bisher nur durch aufwendige mathematische Rechnungen zu veranschaulichen. Im Falle einfacher Geometrien ist jedoch eine interaktive Visualisierung mit Hilfe analytischer Lösungen der Geodätengleichungen möglich. Die notwendigen theoretischen Grundlagen werden anhand der Schwarzschild-, der Morris-Thorne-, sowie der Gödel-Raumzeit diskutiert. Im Anschluss ist eine kurze Vorführung möglich.

GR 5.4 Di 17:45 A214

The Schwarzschild solution and its implications for gravitational waves — •Stephen J. Crothers — P.O. Box 1546, Sunshine Plaza, 4558, Queensland, Australia

The so-called Schwarzschild solution is not Schwarzschild's solution. The quantity r in the so-called Schwarzschild solution has never been rightly identified by the physicists. The said quantity r is in fact the inverse square root of the Gaussian curvature of a spherically symmetric geodesic surface in the spatial section, not in itself a distance in that manifold. It is easily proven that there is only one singularity associated with Schwarzschild spacetime. The standard removal of the singularity at r = 2m is, in a very real sense, removal of the wrong singularity. Consequently, there are no black holes associated with the field equations Ric = 0 and therefore no related gravitational waves. It is also shown that Ric = 0 violates Einstein's Principle of Equivalence. This has major implications for gravitational waves.

GR 6: Hauptvorträge Mittwoch

Zeit: Mittwoch 8:30–10:00 Raum: A214

Hauptvortrag GR 6.1 Mi 8:30 A214

Relativistic Figures of Equilibrium — •David Petroff — Theoretisch-Physikalisches Institut, Jena, Germany

Motivated by the desire to model celestial bodies, a great deal of impressive work in Newtonian gravity concerned itself with self-gravitating fluids in equilibrium. Contributors to the field include some of the most illustrious names in physics and mathematics and a seminal book on the subject, "Ellipsoidal Figures of Equilibrium", was written by Chandrasekhar in 1969.

In this talk, I will discuss the analogous problem in general relativity. The analytic treatment of a small number of important limiting cases will be presented, but also numerical methods for dealing with the general problem. The application of these methods to exemplary situations will allow us to understand many interesting features of such figures of equilibrium and determine some of their generic properties.

Hauptvortrag GR 6.2 Mi 9:15 A214

The inner Cauchy horizon of axisymmetric and stationary black holes with surrounding matter — •Marcus Ansorg — Albert-Einstein-Institut, 14476 Golm

We investigate the interior of regular axisymmetric and stationary black holes surrounded by matter and find that for non-vanishing angular momentum of the black hole the space time can always be extended regularly up to and including an inner Cauchy horizon. We provide an explicit relation for the regular metric at the inner Cauchy horizon in terms of that at the event horizon. As a consequence, we obtain the universal equality $(8\pi J)^2 = A^+ A^-$ where J is the black hole's angular momentum and A^- and A^+ denote the horizon areas of inner Cauchy and event horizon, respectively. We also find that in the limit $J \to 0$ the inner Cauchy horizon becomes singular.

GR 7: Schwarze Löcher

Zeit: Mittwoch 16:45–19:05 Raum: A214

GR 7.1 Mi 16:45 A214

Asymptotically flat charged rotating dilaton black holes in higher dimensions — Ahmad Sheykhi, •Masoud Allahverdizadeh, Yosof Bahrampour, and Majid Rahnama — shahid bahonar kerman university,kerman,iran

We find a class of asymptotically flat slowly rotating charged black hole solutions of Einstein*Maxwelldilaton theory with arbitrary dilaton coupling constant in higher dimensions. Our solution is the correct one generalizing the four-dimensional case of Horne and Horowitz [J.H.Horne, G.T. Horowitz, Phys. Rev. D 46 (1992) 1340]. In the absence of a dilaton field, our solution reduces to the higher-dimensional slowly rotating Kerr-Newman black hole solution. The angular momentum and the gyromagnetic ratio of these rotating dilaton black holes are computed. It is shown that the dilaton field modifies the gyromagnetic ratio of the black holes.

GR 7.2 Mi 17:05 A214

Rotating Einstein-Maxwell-Dilaton Black Holes — Burkhard Kleihaus[1], •Jutta Kunz[1], Francisco Navarro-Lerida[2], and Jan Viebahn[3] — [1]Universität Oldenburg — [2]Universidad Complutense de Madrid — [3]Universität Kiel

We construct numerically asymptotically flat rotating black holes in Einstein-Maxwell-dilaton theory in 4 and higher dimensions for arbitrary dilaton coupling constant. We focus on higher odd dimensions and equal angular momenta, where the angular dependence can then be treated explicitly. We discuss the global and horizon properties of these black holes and compare to the Einstein-Maxwell and Kaluza-Klein cases. In 4 dimensions the black holes can carry both electric and magnetic charge, giving rise to counterrotating horizons beyond a critical value of the dilaton coupling strength.

GR 7.3 Mi 17:25 A214

Charged black objects in Kaluza-Klein theory — •Eugen Radu, Burkhard Kleihaus, and Jutta Kunz — Universität Oldenburg

We construct charged static black strings and $p-$brane solutions in a theory of gravity in $D-$dimensions coupled with a dilaton and an antisymmetric form by using a Harrison-type transformation. The seed vacuum solutions we use correspond to uplifted Kaluza-Klein black strings and black holes in $D-p$ dimensions. We argue that the thermodynamics of these solutions can be derived from those of the vacuum configurations. New charged nonuniform black strings rotating in a single plane are studied in a perturbative approach for $D=5,6$ dimensions.

GR 7.4 Mi 17:45 A214

The power of Poincaré invariance concerning black hole binary interaction — •Steven Hergt, Gerhard Schäfer, and Jan Steinhoff — FSU Jena, TPI, Max-Wien Platz 1, Germany

The fulfillment of the space-asymptotic Poincaré algebra is used to derive new higher-order-in-spin interaction Hamiltonians for binary black holes in the Arnowitt-Deser-Misner canonical formalism almost completing the set of the formally second post-Newtonian order spin-interaction Hamiltonians involving nonlinear spin terms.

GR 7.5 Mi 18:05 A214

Hamiltonians from the Stress-Energy Tensor — •Jan Steinhoff, Steven Hergt, and Gerhard Schäfer — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität, Max-Wien-Platz 1, 07743 Jena, Germany

We show how Hamiltonians for spinning black holes can be derived from the stress-energy tensor. The Hamiltonians fits into the canonical formalism of Arnowitt, Deser, and Misner and are given in their transverse-traceless gauge. All post-Newtonian next-to-leading order spin effects up to quadratic order in spin for binary black holes are presented in Hamiltonian form.

GR 7.6 Mi 18:25 A214

Lorentz-Verletzung und Schwarze Löcher — Gerold Betschart, •Elisabeth Kant und Frans R. Klinkhamer — Institut für Theoretische Physik, Universität Karlsuhe

Es werden Schwarze Löcher in der lorentz-verletzenden modifiezierten Maxwell-Theorie diskutiert. Besondere Aufmerksamkeit gilt möglicherweise auftretenden multiplen Ereignishorizonten und Implikationen für den zweiten Hauptsatz der Thermodynamik Schwarzer Löcher.

GR 7.7 Mi 18:45 A214

Fuzzy Black Holes — •Peter Schupp — Jacobs–Universität Bremen

The quantization of the geometry of classical black hole solutions, e.g. as a toy model for the study of quantum gravitational effects, leads to discrete "fuzzy" geometries. We discuss some examples in 3 and 4 dimensions with space-time and space-space noncommutativity.

GR 8: Hauptvorträge Donnerstag

Zeit: Donnerstag 8:30–10:30 Raum: A214

Hauptvortrag GR 8.1 Do 8:30 A214

Superstrings and Cosmology — •Dieter Lüst — Max-Planck-Institute for Physics, Föhringer Ring 6, 80805 München und Ludwig-Maximilians-Universität, Arnold-Sommerfeld-Center, Theresienstrasse 37, 80333 München

Abstract: Superstrings as a unified theory of particles and forces contain gauge interactions as well as gravitational interactions. Hence superstrings should also provide some microscopic understanding about the physics of the early universe. In this talk I will discuss several aspects of superstring cosmology:
(i) String inflation
(ii) Dark energy from strings
(iii) The multiverse picture
(iv) Strings and singularities - physics around the big bang.

Hauptvortrag GR 8.2 Do 9:10 A214

Anti-de Sitter black holes dual to thermal quantum field theories — •Johanna Erdmenger — Max-Planck-Institut für Physik, München

We discuss the duality between classical gravity in an Anti-de Sitter black hole background and quantum field theory at finite temperature. This duality arises from string theory in a particular saddle point approximation. Using this duality, it is possible to calculate observables for strongly coupled plasmas which are similar to the quark-gluon plasma studied at heavy-ion colliders. In particular, it is possible to describe the dynamical behaviour of mesons (quark-antiquark bound states) in the plasma by embedding additional hypersurfaces (D-branes) into the black hole background. A geometrical first-order phase transition appears which is interpreted as meson melting. Moreover, results for meson spectral functions at finite density are presented within this approach. We also comment on the description of non-equilibrium field theory with a collapsing matter shell in Anti-de Sitter space.

Hauptvortrag GR 8.3 Do 9:50 A214

Cosmic and superconducting strings — •Betti Hartmann — School of Engineering and Science, Jacobs University Bremen, 28759 Bremen

Cosmic strings are the topological defect that seems most important from the point of view of cosmological applications, especially since it is now believed that cosmic strings might be linked to the fundamental strings of String theory. The reason are so-called brane world scenarios which allow to lower the fundamental Planck scale down to the TeV scale. Newly developed inflation scenarios (e.g. hybrid inflation) almost always predict the production of strings at the end of inflation. The objects formed are so-called D- and F-strings, where D stands for Dirichlet and F for fundamental. Also bound states of these F- and D-strings, so-called p-q-strings are possible. Recently, field theoretical models have been developed that describe such objects. In the first part of my talk, I will discuss the "zoo" of cosmic strings available and also mention their gravitational properties. In the second part of my talk I will concentrate on *superconducting strings*. These are current- and charge-carrying strings, which can have an additional internal structure in the form of bosonic or fermionic fields. This internal structure can lead to the formation of vortons, i.e. loops of cosmic string that are balanced against gravitational collapse by a non-vanishing angular momentum. I will discuss an equation of state describing superconducting strings that has recently been confirmed numerically.

GR 9: Numerische Relativitätstheorie I

Zeit: Donnerstag 11:45–12:25 Raum: A214

GR 9.1 Do 11:45 A214

Using curvature invariants for wave extraction in numerical relativity — •Oliver Elbracht[1] and Andrea Nerozzi[2] — [1]Institut für Theoretische Physik und Astrophysik, Julius-Maximilians-Universität, Am Hubland, 97074 Würzburg, Germany — [2]Institut für Angewandte Mathematik, Friedrich-Schiller-Universität, Ernst-Abbe-Platz 2, 07743 Jena, Germany

We present a new expression for the Weyl scalar Ψ_4 that can be used in numerical relativity to extract the space-time gravitational wave content. The formula relies upon the identification of transverse tetrads, namely the ones in which $\Psi_1 = \Psi_3 = 0$. It is well known that tetrads with this property always exist in a general Petrov type I space-time. A sub-class of these tetrads naturally converges to the Kinnersley tetrad in the limit of Petrov type D space-time. However, the transverse condition fixes only four of the six parameters coming from the Lorentz group of transformations applied to tetrads. Here we fix the tetrad completely, in particular by giving the expression for the spin-boost transformation that was still unclear. The value of Ψ_4 in this optimal tetrad is given as a simple function of the two curvature invariants I and J.

GR 9.2 Do 12:05 A214

Zoom whirl orbits of black holes — •Roman Gold — TPI, FSU Jena, Germany

For several years research on the binary black hole problem has focused on quasi-circular (minimally eccentric) orbits because of the circularizing effect of gravitational radiation in a binary system.

Allowing significant eccentricity reveals an interesting region of the parameter space of the GR two-body problem: zoom whirl orbits. These orbits are loosely defined as the behaviour of two bodies that approach each other on very eccentric trajectories, move (or "whirl") around each other several times very closely in a nearly circular orbit and then eventually merge or separate. These events produce some of the most intense gravitational wave signals in black hole binaries and therefore may provide an upper bound on the radiated energy for two equal mass Schwarzschild black holes.

I show results from numerical studies of the Einstein equation in vacuum for these zoom whirl orbits including the orbital dynamics, the extracted waves and the radiated energy.

GR 10: Poster

Zeit: Donnerstag 12:25–12:34 Raum: Dekanatsgang

GR 10.1 Do 12:25 Dekanatsgang

A Variable Speed of Light Theory of Gravity Based on Ideas of Dirac, Sciama and Dicke — •Alexander Unzicker — Pestalozzi-Gymnasium München

Though the contributions to cosmology originating from the above named researchers seem abandoned today, their basic ideas can be combined. We analyze Dirac's article on the large number hypothesis (1938), Sciama's proposal of realizing Mach's principle (1953), and Dicke's scalar theory of gravitation with a variable speed of light (1957). The description of curvature by a refractive index given in the latter is extended to matter waves using de Broglies relation for phase velocities. Thus Sciama's hypothesis on the gravitational constant G, a quantitative version Mach's principle, is recovered. Applied to cosmology, this model satisfies Dirac's large number hypotheses (LNH). While Dicke's proposal in first approximation agrees with the classical tests of GR, the cosmological redshift arises from a shortening of measuring rods rather than an expansion of space. The speed of light turns out to be the increase of the horizon R. A related discussion is given in arxiv:0708.3518.

GR 10.2 Do 12:25 Dekanatsgang

Is the Speed of Light 'c' a True Constant? — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Einstein has - in his structure-based theory of relativity - stated that the speed of light 'c' is a true constant under all circumstances. The physical community has accepted this in spite of the problems arising from this paradigm; see the deadlock situation of present physics (e.g. Quantum Gravity).

The constancy of the speed of light has 3 aspects:

1.) Is 'c' the same for an observer in motion or at rest?

Einstein says: YES – Lorentz says: NO; only the ¿measured¡ 'c' is constant resulting from the contraction of measuring rods and the desynchronization of clocks during motion.

2.) Is 'c' the same inside and outside a gravitational field?

Einstein says: YES – We say: NO; 'c' is reduced in a gravitational field as the direct measurement tells us; the apparent curvature of space is in truth a refraction effect caused by the variation of 'c'

3.) Was 'c' a constant during the development of the universe?

Einstein says: YES – Magueijo says: NO; if we accept an (adapting) decrease of 'c', we can avoid the inflation in cosmology and the landscape of 10^{100} universes.

Note that the alternative approaches mentioned above yield the same mathematical results as the traditional version of Einstein, to the extent as they are confirmed by experiments.

Further information: www.ag-physics.org/relat and /gravity

GR 10.3 Do 12:25 Dekanatsgang

Special Relativity Derived from the Structure of Matter — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Historically, the phenomena of relativity gave us a great chance for a better understanding of the structure of matter. Some of the founders of SR like H. Lorentz proceeded on this >physical< way.

This chance, however, was given away when Einstein presented a theory, which solved the relativity related problems with an abstract concept of space and time, without any relation to matter. We can excuse Einstein by the fact that at his time there was only a limited knowledge about matter.

Stimulated by the deadlock in present physics, we should re-develop the process of understanding relativity. We should use the contraction of fields (Lorentz) rather than the contraction of space; and as well the slow down of elementary oscillators (Ziegler, Schrödinger) rather than the dilation of time.

This presentation will demonstrate for the example of dilation, how much our physical understanding will profit, if we return to a >physical< understanding of such phenomena.

We arrive at the same mathematics like with Einstein (= Lorentz Transformation). And we win a theory of relativity which is so easy to comprehend, that it can be taken into physics lessons at school.

And we find an easily understandable mechanism that explains the increase of mass at motion and the mass-energy-relation, without any use of abstract principles.

Further information: www.ag-physics.org/relat

GR 11: Numerische Relativitätstheorie II

Zeit: Donnerstag 14:00–15:00 Raum: A214

GR 11.1 Do 14:00 A214

Apparent Horizon Finding — •Norbert Lages — Friedrich-Schiller-Universität Jena, Deutschland

First a brief summary is given of why Apparent Horizons or more generally Marginally Trapped Surfaces (MOTs) are interesting in numerical Relativity.

Special methods are explained for how to find MOTs in axisymmetry and MOTs in arbitrary (conformally flat) spacetimes. I will present a method to extract the eigenvalues of a Newton-type iteration procedure and its possible applications to improve Apparent Horizon finding.

GR 11.2 Do 14:20 A214

Numerical black hole initial data with low eccentricity based on post-Newtonian orbital parameters — Benny Walther, Bernd Brügmann, and •Doreen Müller — Theoretisch-Physikalisches Institut, FSU Jena

We present our implementation of an algorithm for finding initial data for numerical black hole binary simulations resulting in quasi-circular orbits with initial separations of about $10\,M$, where M is the total mass of the two black holes. Our method uses direct parameters from an analytical approach relying on a Hamiltonian formulation with post-Newton approximated Hamiltonian and radiation reaction term. We compare the use of different Hamiltonians and energy fluxes that can be found in the literature and measure the eccentricity of the resulting orbits where a low eccentricity is our measure of success. Our procedure allows us to obtain as low eccentricities as previously achieved with a PN integration procedure for equal mass non-spinning binaries. In addition, we obtain low eccentricities for the unequal mass case and for spinning binaries compared to previously used PN techniques.

GR 11.3 Do 14:40 A214

Finding Event Horizons in Multiple Black Hole Simulations — •Marcus Thierfelder, Bernd Brügmann, and Pablo Galaviz — Theoretical Physics Institute, University of Jena, Germany

We present results of two event horizon finder schemes for full 3D numerical simulations. Both algorithms evolve null surfaces backwards in time. One of them uses a level-set algorithm to describe full 3D event horizons which was first used by Peter Diener. The other is based on a direct 2D parametrisation of the event horizon for simulations with planar symmetry. Both codes can handle numerical spacetimes which are created by the BAM code. We discuss results for the simulation of the inspiral and collision of three black holes.

GR 12: Gravitationswellen I

Zeit: Donnerstag 15:00–16:20 Raum: A214

GR 12.1 Do 15:00 A214

On the ability of adiabatic circular inspiral templates to capture inspiral gravitational waves from compact binaries having tiny orbital eccentricities — •Manuel Tessmer and Achamveedu Gopakumar — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universitaet Jena, Deutschland

We probe the ability of various types of post-Newtonian(PN)-accurate circular templates to capture inspiral gravitational-wave (GW) signals from compact binaries having orbital eccentricities. The GW signals are constructed by adapting the phasing formalism, available in T. Damour, A. Gopakumar, and B. R. Iyer, [Phys. Rev. D 70, 064028 (2004)], employing the orbital energy and the time-eccentricity to describe the orbital evolution. Using the fitting factor estimates, we show that circular templates, based on the adiabatic TaylorT1, complete adiabatic TaylorT1 and TaylorT4 approximants are unable to capture our GW signals from compact binaries having tiny residual orbital eccentricities. However, the 2PN-order circular inspiral templates based on the recently introduced TaylorEt approximant are found to be both effectual and faithful in capturing GWs from inspiralling compact binaries having moderate eccentricities and we provide physical explanations for our observations.

GR 12.2 Do 15:20 A214

Time Delay Interferometry — •Markus Otto, Gerhard Heinzel und Karsten Danzmann — AEI Hannover

Bei der Detektion von Gravitationswellen mit Hilfe eines Interferometers ungleicher Armlängen stört vordergründig das Rauschen der Laser. Um diesem Problem Abhilfe zu schaffen, kann man das Werkzeug der zeitverzögerten Interferometrie (Time Delay Interferometry, kurz TDI) benutzen. Kern des Verfahrens ist es, durch geschickte Kombinationen von zeitverzögerten Datenströmen das Laserrauschen herauszurechnen. Mit Hilfe von TDI ist es möglich, einen Detektor wie LISA (Laser Interferometer Space Antenna) als mehrere Detektoren gleichzeitig anzusehen, in denen einerseits das Laserrauschen eliminiert oder andererseits das Signal der Gravitationswelle herausgerechnet wurde, so dass eine Abschätzung des Rauschmodells möglich wird. Das Verfahren TDI wird im Vortrag ausführlich vorgestellt und anhand von LISA in der Näherung eines statischen Detektors diskutiert.

GR 12.3 Do 15:40 A214

Irdische Interferometer an der Schwelle zu Himmlischer Physik — •Hartmut Grote — MPI für Gravitationsphysik und Leibniz-Universität Hannover

Derzeit gibt es fünf Standorte von Laser-Interferometrischen Gravitationswellendetektoren auf der Erde, und zwar in den USA (zwei), in Italien, Deutschland und Japan.

Der Vortrag gibt einen Überblick über die momentanen Aktivitäten der einzelnen Projekte und der Pläne für die nächsten Jahre. 2007 ging eine zweijährige Messphase zu Ende, und erste astrophysikalische Ergebnisse sind da! Gegenwärtig werden mehrere der Detektoren in ihrer Empfindlichkeit verbessert, um ab Mitte 2009 erneut in den Weltraum zu horchen. Von einer zweiten Generation von Detektoren wird ab ca. 2014 eine um den Faktor zehn gesteigerte Empfindlichkeit erwartet. Damit lässt sich ein tausendfach größeres Volumen belauschen, und eine direkte Messung von Gravitationswellen kann somit Routine werden...

GR 12.4 Do 16:00 A214

LISA Phasemeter Development: Digital Phase-Lock Loop (DPLL) analysis — Iouri Bykov, Joachim Kullman, Juan Jose Esteban, Antonio Francisco Garsia Marin, •Gerhard Heinzel, and Karsten Danzmann — Max-Planck Institut für Gravitatiionsphysik, Callinstr. 38, 30167 Hannover

The gravitational wave detector LISA (Laser Interferometer Space Antenna) aims to detect and observe in detail gravitational waves from astronomical sources. One of the most important key technology development issues of the LISA-mission is the interferometric readout of the main science measurement. We discuss a mathematical model of the core of the system (DPLL) which was developed and is used for phase measurement system (PMS) tuning. We also present the status of our work on the LISA Phasemeter Hardware, based on the extra large FPGA (main processor unit) and demonstrate the performance of the PMS in laboratory conditions.

GR 13: Gravitationswellen II

Zeit: Donnerstag 16:45–17:25 Raum: A214

GR 13.1 Do 16:45 A214

Mock Data Challenges for LISA Pathfinder — •Anneke Monsky[1], Gudrun Wanner[1], Miquel Nofrarias[1], Ingo Diepholz[1], Martin Hewitson[1], Gerhard Heinzel[1], Adrien Grynagier[2], Mauro Hueller[3], Luigi Ferraioli[3], Stefano Vitale[3], and Karsten Danzmann[1] — [1]Albert Einstein Institut, Max Planck Institut fuer Gravitationsphysik, Institut fuer Gravitationsphysik Universitaet Hannover, Callinstr 38, 30167 Hannover — [2]Institut für Flugmechanik und Flugregelung. 70569 Stuttgart — [3]Università di Trento, I-38050 Povo (Italy)

LISA Pathfinder is an ESA space mission designed to test critical technologies for the joint ESA/NASA mission LISA (Laser Interferometer Space Antenna). The main mission goal of the LISA Technology Package (LTP) aboard LISA Pathfinder is the verification of free-fall between two test masses with an accuracy of about $3 \times 10^{-14}\,\mathrm{m\,s^{-2}} / \sqrt{\mathrm{Hz}}\,[1 + (\mathrm{f}/3\,\mathrm{mHz})^2]$ in a measurement bandwidth (MBW) between 1 mHz and 30 mHz.

The data analysis of the LISA Technology Package (LTP) will comprise a series of discrete experiments, each focussing on a particular noise measurement or characterisation of the instrument in various operating modes. Each of these experiments must be analysed and planned in advance of the mission because the results of a given experiment will have an impact on those that follow. As such, a series of Mock Data Challenges (MDCs) will be developed and carried out with the aim of preparing the analysis tools and optimising the various planned analyses.

GR 13.2 Do 17:05 A214

LISA onboard ranging and data communication capabilities — •Juan Jose Esteban Delgado, Antonio Garcia Marin, Iouri Bykov, Johannes Eichholz, Joachim Kullmann, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) and Universität Hannover. Callinstrasse 38 30167 Hannover, Deutschland

The Laser Interferometer Space Antenna (LISA) is a joint ESA and NASA mission to detect and observe gravitational waves from low-frequency sources. LISA consists of three spacecraft separated by 5 million kilometers forming an equilateral triangle and communicated via three bidirectional laser links. The primary quantity to be measured is the relative pathlength variation between the free-floating test masses onboard two different spacecraft by means of heterodyne interferometry with picometer sensitivity.

Due to relative movements between the spacecraft, the interferometer arms are unequal and time-varying. Therefore, to achieve the necessary interferometric sensitivity, the absolute distance between the spacecraft has to be measured. To this end, the LISA lasers must be phase modulated with pseudo-random noise sidebands, which also enable data transfer between the satellites.

This work presents a modulation scheme with submeter ranging accuracy and several kilobytes data rate. Its functionality was already demonstrated in a software simulation and in a FPGA-based hardware implementation. The next step will be an optical experiment with LISA representative hardware.

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.

GR 15: Experimente zur Gravitation II

Zeit: Freitag 8:30–9:10 Raum: A214

GR 15.1 Fr 8:30 A214

Testing Finslerian space-times — •Claus Lämmerzahl — ZARM, University Bremen, 28359 Bremen

Finsler geometry is a generalization of Riemannian geometry with a generalized concept of a distance. In some cases effective theories resulting from quantum gravity scenarios are related to Finslerian concepts. Such generalized space–time structures allow for (i) a metric induced violation of Lorentz invariance which is beyond scenarios introducing just additional background fields, and (ii) a modification of the equations of motion of particles. Though the universality of free fall is valid, gravity cannot be transformed away in Finslerian space-times. We develop a test theory for describing Finslerian deviations from Riemannian space-times and confront it with tests of Lorentz invariance in the photon as well as in the matter sector, and with observations of satellite and planetary orbits.

GR 15.2 Fr 8:50 A214

Verbesserter Freifalltest des schwachen Äquivalenzprinzips — •Andrea Sondag[1], Claus Lämmerzahl[1], Hansjörg Dittus[2], Frank Löffler[3] und Wolfgang Vodel[4] — [1]ZARM Universität Bremen — [2]DLR Bremen — [3]PTB Braunschweig — [4]FSU Jena

Das von der DFG geförderte Projekt "Verbesserter Freifalltest des schwachen Äquivalenzprinzips" ist ein Experiment in Kooperation mit der PTB und der FSU zum Test des schwachen Äquivalenzprinzips mit einer Genauigkeit von 10^{-13}. Während der 4,7 Sekunden Fallzeit im Bremer Fallturm soll die differentielle Beschleunigung von speziellen Testmassen mit Hilfe von SQUID-Sensoren gemessen werden. Diese Aufgabe stellt hohe Anforderungen an den Versuchsaufbau: Kryotauglichkeit, Vakuumtauglichkeit, Abschirmung vor magnetischen Feldern, präzise Fertigung, geeignete Materialauswahl und Materialbearbeitung sowie eine genaue Positionierung der Testmasse. Dieser Vortrag berichtet vom aktuellen Stand des Experimentes am ZARM Universität Bremen.

GR 16: Kosmologie I

Zeit: Freitag 9:10–10:30 Raum: A214

GR 16.1 Fr 9:10 A214

Ist die Topologie des 3-Torus durch die WMAP-Daten ausgeschlossen? — •Sven Lustig — Institute of Theoretical Physics, Ulm, Germany

In einem mehrfach zusammenhängenden Universum werden sogenannte gepaarte Kreise in der kosmischen Mikrowellenhintergrundstrahlung vorausgesagt. Diese gepaarten Kreise sollten im Idealfall ein ähnliches Verhalten zeigen und darum durch eine entsprechende Suche in einer vollständigen Himmelskarte der kosmischen Mikrowellenhintergrundstrahlung entdeckbar sein. In diesem Vortrag sollen die aktuellen Untersuchungen zur Kreissuche präsentiert werden und die Frage, wie weit z.B. die Unsicherheiten in den Daten durch die Milchstraße und weitere Vordergrundquellen Konsequenzen für die Resultate der Kreissuche in den WMAP-Daten haben.

GR 16.2 Fr 9:30 A214

Skalenmaße und der CMB — •Holger Stefan Janzer — Institut für Theoretische Physik, Universität Ulm, Deutschland

Skalenmaße spielen eine höchst tragende Rolle in der Deutung der Strukturen des CMBs. So gewinnt man mit dem Winkelleistungspektrum beispielsweise Rückschlüsse auf die kosmologischen Parameter. Für die Betrachtung größter Skalen ist hingegen die Zweipunktkorrelationsfunktion ein aussagekräftiges Maß.

Insgesamt trifft das Standardmodell die Observation beeindruckend gut und doch zeichneten sich in der Vergangenheit immer wieder Anomalien ab. Dabei belasten Vordergrund, experimentbedingte Begebenheiten und modellabhängige Unsicherheiten zusätzlich die Ergebnisse, was in diesem Beitrag offenbart wird. Spezielles Augenmerk liegt hier auf der Zweipunktkorrelationsfunktion, sowie auf einer verallgemeinerten Betrachtung dieses Maßes.

GR 16.3 Fr 9:50 A214

Cosmological constant from decoherence — •Friedemann Queisser — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, D-50937 Köln

Yokoyama proposed the interesting idea to explain the small nonvanishing cosmological constant from the fact that the universe might not be in its ground state but rather in a false vacuum with nonvansishing vacuum energy. This idea is also motivated by recent ideas in string theory were a large 'landscape' of local minima is discussed. Based on this idea we investigated the influence of decoherence on this quantum tunneling process to explain the localization and the classical appeareance of the cosmological constant. Furthermore we also investigated the suppression of the tunneling rate due to system-environment-interaction.

GR 16.4 Fr 10:10 A214

Structure formation with renormalisation-group techniques — •Klaus Klingmüller, Martin Beneke, and Johannes Braun — Institut für Theoretische Physik E, RWTH Aachen, 52056 Aachen

We review a new method to study non-linear effects in the formation of large scale structure, which has been presented by Matarrese and Pietroni [1]. In this approach, generating functionals for the correlation functions in Fourier space are constructed and their dependence on a cut-off applied to the initial power spectrum is studied. The resulting differential equations resemble renormalisation-group equations from quantum field theory and statistical physics and can be integrated to obtain the power spectrum at redshifts and length scales inaccessible to perturbation theory. We discuss the approximations used in [1] and possible future applications such as the computation of the bispectrum.

[1] S. Matarrese and M. Pietroni, JCAP 0706 (2007) 026

GR 17: Kosmologie II

Zeit: Freitag 11:00–12:40 Raum: A214

GR 17.1 Fr 11:00 A214

The Concordance Model and its Dissonances — •Alexander Unzicker — Pestalozzi-Gymnasium München

'Cosmologists are often in error, but never in doubt' (L.D.Landau)

The majority of physicists agrees upon that cosmological data ist best described by the Friedmann-Lemaitre model with the currently accepted ΛCDM -paradigm. An increasing number of results however does not fit into the model, such as galactic dynamics, large-scale-structure formation and the coincidence problem. Using further free parameters without having established the nature or dark matter and dark energy is questionable from a methodological point of view - the danger of introducing epicycles. It seems thus worthwhile to review the direct evidence for conventional theories of gravity without assuming its validity a priori. Anomalies like Pioneer and Flyby in the solar system are particulary unsettling because nothing else but the sucess of general relativity in this range can justify the huge extrapolation we perform when considering galactic and cosmological scales. The most crucial point however is the regime of weak accelerations which play a role in most of the anomalous observations. A related discussion is given in gr-qc/0702009.

GR 17.2 Fr 11:20 A214

Cosmology and four-dimensional manifolds — •Torsten Asselmeyer-Maluga[1] and Helge Rosé[2] — [1]Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin — [2]FhG FIRST, Kekulestr.7, 12489 Berlin

By using the standard model of cosmology, we study possible models for the 4-manifold representing the history since the big bang. The current analysis of the WMAP data by Luminet et.al. (Nature 425 p.593ff, 2003),seem to imply that the spatial component is a compact 3-manifold. We will show that the main restriction of the 4-manifold is the existence of a smooth structure on it. Then we single out an attractive model for the 4-manifold which is the simplest, possible model. The topological model admits at least one phase transition which can be interpreted as inflation. A topological interpretation of the dark energy is also discussed.

GR 17.3 Fr 11:40 A214

Proof that Dark Energy Can Scale Like Matter; Full Determination of Dark Energy, Radiation, and Matter Components at Recombination and in the Present Epoch — •Christopher Pilot — Maine Maritime Academy, Castine, USA

We prove that dark energy can scale like matter, starting from the assumption that $\rho_{1\mathrm{matter}}$ equals 3 x $\rho_{1\mathrm{radiation}}$, which is what is actually observed in the WMAP CMB at recombination. We find that $\Omega_{1\mathrm{radiation}}$ equals 7.2 percent, $\Omega_{1\mathrm{matter}}$ equals 21.7 percent and $\Omega_{1\mathrm{darkenergy}}$ equals 71.1 percent if $\rho_{\mathrm{darkenergy}}$ scales as ρ_{matter} where matter includes atomic and dark matter. In the present epoch this leads unequivocally to $\Omega_{0\mathrm{radiation}}$ equals .007%, $\Omega_{0\mathrm{matter}}$ equals 23.4% and $\Omega_{0\mathrm{darkenergy}}$ equals 76.6% where radiation consists of blackbody photons and neutrinos. If there is no scaling in the dark energy component, then we find that $\rho 1/\rho 0 = 4.04 \times 10^8$; with matter-like scaling for dark energy we predict for the ratio of critical densities $\rho 1/\rho 0 = 1.40 \times 10^9$.

GR 17.4 Fr 12:00 A214

Kosmologie ohne Scheuklappen — •Helmut Hille — Fritz-Haber-Str. 34, 74081 Heilbronn

Ohne die Beachtung des Grund-Satzes vom Erhalt der Energie kann es m.E. keine solide Physik und Kosmologie geben. Aus diesem Grund-Satz ergibt sich, dass das Universum keine Grenzen in Raum und Zeit haben kann und dass unser Kosmos nur einer von vielen ist, der aus einer Megaexplosion zusammenströmender Materie hervorging. So sahen es auch bereits antike Denker z.B. Anaximander aus Milet (um 611-545): „Der Ursprung der seienden Dinge ist das Unbegrenzte. Denn aus diesem entstehe alles und zu diesem vergehe alles. Weshalb auch unbeschränkt viele Welten produziert werden und wieder zu jenem [Unbegrenzten] vergehen, aus dem sie entstehen." Oder wie ich es in heutiger Sprache sage: „Die Kosmen kommen und gehen, doch die Energie, das Universum bleibt." Ich zeige, wie unter diesen Prämissen sich eine Kosmologie von selbst ergibt, in der die Gravitation ein emergentes Phänomen der durch die Megaexplosion verschränkten Materie ist.

GR 17.5 Fr 12:20 A214

Die Pioneer-Anomalie, der experimentelle Nachweis der Dunklen Materie im interstellaren Raum — •Norbert Sadler — Wasserburger Str. 25a ; 85540 Haar

Die beobachtete negative Beschleunigung ,-a(Pioneer), zum Zentrum des Sonnensystems wird durch den Dunklen-Anteil der virialen Materie des Universums verursacht.Durch Anwendung des Virialsatzes auf die lineare, mittlere Materiedichte des Univ.,von 4/9 Protonenmassen auf 1m, kann die Anomalie verstanden und -a(Pioneer) analytisch berechnet werden

E(Halo lin.Dichte)=(dunkl.vir.Mat.Ant.%)*a(Pion.)*1kg*1m E(Halo lin.Dichte)=4Pi*(4/9 Prot.)*c**2

(dunkl.vir.Mat.Ant.%)=3*6*SQRT(CP-Verletzung)=95,56% -a(Pioneer)=8,79*10**-10 m/s**2

Die viriale Materie des Univ.unterliegt der raumzeitlichen Expansion, wobei sich der dunkle, viriale Mat.Anteil über -a(Pionneer) gravitativ von der Expans. abkoppelt und zum interstellaren, reaktiven Gravitationsfeld generiert. Das kosmische Gravitationsgesetz lautet: (Halo d. vir.Mat.)*g(Univ.)=(dunkl.vir.%-Mat.Ant.)*a(Pion.) mit g(Univ.)=6,674*10**-11 m/s**2.

GR 18: Alternative klassische Gravitation

Zeit: Freitag 12:50–13:50 Raum: A214

GR 18.1 Fr 12:50 A214

The Origin of Gravity — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Einstein's relativity is a structural theory, and so also his gravity. Einstein has based it on assumptions about space and time. But, following Heisenberg, physics should use only such quantities which can be directly observed. This is not the case for the parameters 'space' and 'time'.

To change from a structural to a physical understanding, we should in General Relativity replace 'curvature of space' by 'change of the speed of light c', as it is in practise already done by cosmologists. The results of the according derivations are very close to the ones of Einstein, but much easier to visualise, and they avoid the well known paradoxes. The equivalence principle is for the first time not only stated, but proven from physical basics. And there is a good potential to understand open questions like Dark Matter, Dark Energy; Quantum Gravity becomes obsolete.

The main difference to current physics is the understanding, that gravity is not the force no. 4 but a feeble side effect of other forces.

Further Information: www.ag-physics.org/gravity

GR 18.2 Fr 13:10 A214

Was ist Ruhemasse? — •Manfred Geilhaupt — HS-Niederrhein, Mönchengladbach, Deutschland

oder was hätte Albert Einstein aus der Sicht der ART sonst noch dazu sagen können?

Die Allgemeine Relativitätstheorie in Verbindung mit der Thermodynamik ist in der Lage, die Ruhemasse als zeitlichen Mittelwert (Effektivwert) des Elektrons sowie die Feinstrukturkonstante als Folge des zweiten Hauptsatzes zu deduzieren.

Die Lösung der (Einsteinschen) Bewegungsgleichung für ein *ruhendes* Elektron liefert eine periodische skalare Funktion r(t), welche in der Lage ist, sowohl die Welleneigenschaft des Elektrons als auch die Teilcheneigenschaft zu erklären. Ferner ist es nunmehr möglich, das Doppelspaltexperiment (als Jahrhundertexperiment eingestuft) einzelner Elektronen zu verstehen.

Illustrationen der mathematischen Lösung und Einsteins Kommentare ergeben einen Einstieg in seine Gedankenwelt, Ruhemasse verstehbar zu machen. Das ist möglich, wenn die Prinzipientheorien ART und TD miteinander verbunden werden. Jede Theorie für sich ist dazu nicht in der Lage.

GR 18.3 Fr 13:30 A214

Antigravitation durch gegenläufige Präzession — •Peter Kümmel — Amselweg 15 c; 21256 Handeloh

Werden zwei identische, homogene Massen als Kreisel mit gleicher Drehzahl gegenläufig rotiert, entsteht "Künstlicher Schwerpunktversatz". Beim Steigern der Versatzwerte sind a) der Rotationsmassendichte und b) den Drehzahlen Grenzen gesetzt. Mehrfach ineinander verschachtelte, gegenläufig rotierte Präzessions-Vorrichtungen mit den entsprechenden elektrischen Antrieben erfordern größeren Kraftaufwand. Sie dienen aber gleichzeitig zur Verstärkung der Schwerpunkt-Versatzwerte. Präzessionserscheinungen verursachen Lagerreibungen. Dennoch zeitigen erhöhte Präzessionswiderstände Ergebnisse, die mit vergrößerter Massendichte vergleichabr sind. Die zusätzliche Kraftinvestition gegen präzessive Widerstände vergrößern die Resultate der Antigravitation. Vgl. Ref.-Nr. ISBN: 3-921 291-05-4