Fachverband Gravitation und Relativitätstheorie (GR) gemeinsam mit der Astronomischen Gesellschaft e.V.

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Der Fachverband GR hat sich für diese Frühjahrstagung den Schwerpunkt **analytische und numerische Methoden in der Allgemeinen Relativitätstheorie** gesetzt. Dazu tragen wir mit zwei Plenarvorträgen sowie mehreren Hauptvorträgen bei. Diese Methoden sind wesentlich für das Verständnis der Dynamik von Binärsystemen und werden für die Berechnung von Gravitationswellenformen eingesetzt.

Außerdem wird zusammen mit dem Fachverband Didaktik sowie der Arbeitsgruppe Philosophie der Physik ein Symposium zum Begriff der Masse organisiert.

Darüber hinaus stellt sich die ganze Breite der Forschung auf dem Gebiet der Gravitationsphysik in vielen Kurzvorträgen dar, die von grundlegenden Problemen über mathematische Methoden bis hin zu experimentellen Tests reicht.

Übersicht der Plenar- und Hauptvorträge sowie der Fachsitzungen

(Hörsaal HS 1 und HS 6)

Plenarvorträge

PV I	Mo	11:15–12:00	HS 1	**The gravitational signal of newly born protoneutron stars** — •Valeria Ferrari
PV II	Mo	12:00–12:45	HS 1	**Constraining Cosmic Acceleration** — •Jochen Weller
PV III	Di	8:30– 9:15	HS 1	**Interdisciplinarity in Early Physical Cosmology** — •Helge Kragh
PV IV	Di	9:15–10:00	HS 1	**Progress towards inertial confinement fusion on the National Ignition Facility** — •Siegfried Glenzer
PV V	Di	10:00–10:45	HS 1	**Faserlaser - Stand und Perspektiven** — •Jens Limpert
PV VI	Di	20:00–21:00	Volkshaus	**Galaktische Archäologie** — •Eva Grebel
PV VII	Mi	9:15–10:00	HS 1	**Solar, wind and waves: Natural limits to renewable sources of energy within the Earth system** — •Axel Kleidon
PV VIII	Mi	10:00–10:45	HS 1	**Jenseits unserer Wahrnehmung** — •Michael Vollmer
PV IX	Mi	12:00–12:45	HS 1	**Von der konformen Feldtheorie zu Quantencomputern** — •Werner Nahm
PV X	Do	8:30– 9:15	HS 1	**Voyager 1 at the Boundary of the Heliosphere** — •Edward C. Stone
PV XI	Do	9:15–10:00	HS 1	**Variational concepts in General Relativity** — •Gerhard Huisken
PV XII	Do	10:00–10:45	HS 1	**Effekte der Einsteinschen Gravitationstheorie in Hamiltonscher Formulierung** — •Gerhard Schäfer
PV XIII	Fr	8:30– 9:15	HS 1	**Leistungsabfuhr in Fusionsplasmen** — •Marco Wischmeier

Hauptvorträge

GR 3.1	Di	11:15–12:00	HS 6	**Causal fermion systems: A quantum space-time emerging from an action principle** — •Felix Finster
GR 3.2	Di	12:00–12:45	HS 6	**How to reconstruct a metric by its unparameterized geodesics** — •Vladimir Matveev
GR 11.1	Do	11:15–12:00	HS 6	**Geodesics and their observation in General Relativity** — •Eva Hackmann, Victor Enolski, Valeria Kagramanova, Jutta Kunz, Claus Lämmerzahl
GR 11.2	Do	12:00–12:45	HS 6	**Exploring physics close to the Galactic Center black hole with infrared and submillimeter interferometry** — •Frank Eisenhauer

GR 16.1	Fr	9:15–10:00	HS 6	**Numerical evolution of the Einstein equations to future null infinity** — •Oliver Rinne
GR 16.2	Fr	10:00–10:45	HS 6	**Spherical and cylindrical wormholes in general relativity** — •Kirill Bronnikov

Hauptvorträge des fachübergreifenden Symposiums SYBM

Das vollständige Programm dieses Symposiums ist unter SYBM aufgeführt.

SYBM 1.1	Di	11:00–11:30	HS 3	**Gedankenexperimente zum Äquivalenzprinzip – Ein Zugang zur Allgemeinen Relativitätstheorie** — •Karl-Heinz Lotze
SYBM 1.2	Di	11:30–12:00	HS 3	**Was hat die Philosophie mit der Masse zu tun?** — •Manfred Stöckler
SYBM 1.3	Di	12:00–12:30	HS 3	**Masse und Gravitation: Zum Massebegriff in der Allgemeinen Relativitätstheorie** — •Domenico Giulini
SYBM 1.4	Di	12:30–13:00	HS 3	**The concept of mass in particle physics** — •Georg Weiglein

Hauptvorträge des fachübergreifenden Symposiums SYNU

Das vollständige Programm dieses Symposiums ist unter SYNU aufgeführt.

SYNU 1.1	Do	16:30–17:00	HS 2	**Trends in Numerical Mathematics** — •Wolfgang Hackbusch
SYNU 1.2	Do	17:00–17:30	HS 2	**Challenges in Numerical Astrophysics: Modeling the Formation of Stars** — •Ralf Klessen
SYNU 1.3	Do	17:30–18:00	HS 2	**Black Holes on the Computer** — •Thomas Baumgarte
SYNU 1.4	Do	18:00–18:30	HS 2	**Astrophysical simulations of gas dynamics with ionising radiation transport** — •Jonathan Mackey

Fachsitzungen

GR 1.1–1.8	Mo	14:00–16:00	HS 6	**Schwarze Löcher I**
GR 2.1–2.10	Mo	16:30–19:00	HS 6	**Gravitationswellen I**
GR 3.1–3.2	Di	11:15–12:45	HS 6	**Hauptvorträge: Mathematische Methoden**
GR 4.1–4.8	Di	14:00–16:00	HS 6	**Gravitationswellen II**
GR 5.1–5.7	Di	16:30–18:15	HS 6	**Experimente**
GR 6.1–6.5	Di	18:15–19:30	HS 6	**Klassische Allgemeine Relativitästheorie I**
GR 7.1–7.1	Mi	8:30– 8:45	HS 6	**Schwarze Löcher II**
GR 8.1–8.2	Mi	8:45– 9:15	HS 6	**Kosmologie I**
GR 9.1–9.8	Mi	14:00–16:00	HS 6	**Numerische Relativitätstheorie I**
GR 10.1–10.8	Mi	16:30–18:30	HS 6	**Numerische Relativitätstheorie II**
GR 11.1–11.2	Do	11:15–12:45	HS 6	**Hauptvorträge: Relativistische Astrophysik**
GR 12.1–12.1	Do	14:00–14:15	HS 6	**Relativistische Astrophysik**
GR 13.1–13.7	Do	14:15–16:00	HS 6	**Klassische Allgemeine Relativitätstheorie II**
GR 14.1–14.6	Do	16:30–18:00	HS 6	**Kosmologie II**
GR 15.1–15.2	Do	18:00–18:30	HS 6	**Alternative Ansätze I**
GR 16.1–16.2	Fr	9:15–10:45	HS 6	**Hauptvorträge: Numerische Relativitätstheorie und Wurmlöcher**
GR 17.1–17.2	Fr	11:15–11:45	HS 6	**Grundlegende Probleme I**
GR 18.1–18.3	Fr	11:45–12:30	HS 6	**Quantenfeldtheorie in gekrümmten Raumzeiten**
GR 19.1–19.3	Fr	12:30–13:15	HS 6	**Quantengravitation und Quantenkosmologie I**
GR 20.1–20.1	Fr	14:00–14:15	HS 6	**Quantengravitation und Quantenkosmologie II**
GR 21.1–21.1	Fr	14:15–14:30	HS 6	**Grundlegende Probleme II**
GR 22.1–22.1	Fr	14:30–14:45	HS 6	**Alternative Ansätze II**
GR 23.1–23.10	Fr	14:45–14:45	HS 6	**Poster (permanent)**

Begrüßungsabend

Am Montag findet ab 19:30 Uhr ein informeller Begrüßungsabend mit Imbiss und Getränken in der Mensa am Ernst-Abbe-Platz 8, direkt neben dem Tagungsgebäude, statt.

Mitgliederversammlung Fachverband Gravitation und Relativitätstheorie

Donnerstag, den 28. Februar, 18:30–19:30 HS 6

- 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: Schwarze Löcher I

Zeit: Montag 14:00–16:00 Raum: HS 6

GR 1.1 Mo 14:00 HS 6

Tidally distorted black holes — •Norman Gürlebeck — ZARM, University of Bremen, Germany

Planets, stars and black holes are deformed due to an external gravitational field generated by e.g. a moon or a companion in a binary system. This deformation is in Newtonian theory characterized by the first and second Love numbers. These measure the deformation of the surface and the induced multipole moment produced by a specific external field. Similar definitions were employed in General Relativity in [T. Damour & O. M. Lecian, PRD, **80**,044017 (2009); T. Binnington & E. Poisson, PRD, **80**, 084018 (2009)]. However, these approaches require necessarily some linearizations and approximations. We employ here the source integrals for the asymptotic multipole moments, which we found recently in [N. Gürlebeck, gr-qc/arXiv:1207.4500], to show that the induced multipole moments and, thus, the second Love numbers for static and axially symmetric black holes always vanish, thereby corroborating existing results in the aforementioned papers without resorting to any approximations. Hence, the contributions of the distorted black hole to the asymptotic multipole moments turn out to be exactly those of an undistorted Schwarzschild black hole. This can be seen as a generalization of the no-hair theorem to the case where additional matter is present. Nonetheless, the internal geometry of the horizon changes, which is characterized by the first Love numbers.

GR 1.2 Mo 14:15 HS 6

Gauss-Bonnet solitons and black holes in 5d Anti-de Sitter spacetime — •Sardor Tojiev[1], Betti Hartmann[1], and Yves Brihaye[2] — [1]School of Engineering and Science, Jacobs University Bremen, 28759 Bremen, Germany — [2]Physique-Mathematique, Universite de Mons-Hainaut, 7000 Mons, Belgium

We have studied 5-dimensional solitons and black holes in Gauss-Bonnet gravity coupled to electromagnetic and scalar fields. We find that the presence of the Gauss-Bonnet term has an influence on the pattern of soliton solutions for small enough values of the electric charge. We also present new results for rotating Gauss-Bonnet black holes with and without scalar hair. We find that although solitons cannot be made rotating properly with non-vanishing angular momentum, the hairy black holes can be generalized to rotating solutions characterized by the angular velocity on the horizon. Our numerical results show that some branches of soliton solutions disappear when the Gauss-Bonnet coupling constant is large enough.

GR 1.3 Mo 14:30 HS 6

Black holes, classicalization, dimensional reduction and holography — •Piero Nicolini[1], Jonas Mureika[2], and Euro Spallucci[3] — [1]Goethe University Frankfurt — [2]Loyola Marymount University, Los Angeles — [3]University of Trieste

In this contribution we address two issues related to the black hole classicalization (also known as gravity self completeness) i.e., the recently conjectured black hole semi-classical regime one obtains by compressing particles at transplanckian energies.

We showed that the supposed mechanism of space-time spontaneous dimensional reduction - one experiences by probing the space-time at energies close to the Planck scale - might be in conflict with the expected gravity self completeness. Specifically for (1+1)-dimensional dilaton gravity models black hole formation can occur with no mass lower bound.

In the second part of the talk, we present a new static, neutral, nonrotating black hole metric, admitting an extremal configuration with both mass and radius equalling the Planck units. We identify this object as the space-time fundamental building block, whose interior is physically inaccessible and cannot be probed even during the Hawking evaporation terminal phase. This metric overcomes the difficulties presented in the first part of the talk. Thermodynamics and holographic considerations are presented as a conclusion of the contribution.

GR 1.4 Mo 14:45 HS 6

Van der Waals behavior and gauge/gravity duality — •Antonia Micol Frassino — Frankfurt Institute for Advanced Studies, Goethe University, Frankfurt am Main

We study a specific solution of the Einstein's equations generated by a self–gravitating, anisotropic fluid type matter. We analyse the critical behaviour of this Schwarzschild–like solution in Anti–de Sitter space spacetime showing that exists an extension of the Hawking–Page transition into a van der Waals–like phase diagram. In this analysis we consider the cosmological constant as a dynamical quantity and its variation is included in the first law of black hole thermodynamics. We do explicit calculations in the case of space dimensions $n = 3$. Then we generalize to generic n dimensions.

GR 1.5 Mo 15:00 HS 6

Geometrothermodynamics of Kerr-Newman Black Hole with Cosmological Constant as Thermodynamic Varible — •Mojica Sindy[1] and Larrañaga Alexis[2] — [1]Institut Für Physik, Universität Oldenburg, Germany — [2]Universidad Nacional de Colombia, Colombia, Bogotá

The thermodynamics of the Kerr-AdS black hole is reformulated within the context of the formalism of geometrothermodynamics(GTD), developed by Hernando Quevedo. We use the Quevedo's invariant metric G associated to thermodynamics phase space τ and the metric g corresponding to space of a thermodynamics state of equilibrium ϵ, induced from τ through a Legendre transformation in order to study the possible phase transitions as a divergence of curvature scalar which is compared with the heat capacity. We show is possible find phase transitions. However, considering the cosmological constant like a variable state does not generated a new phase transitions.

GR 1.6 Mo 15:15 HS 6

Orbits around a charged doubly spinning black ring — •Saskia Grunau, Valeria Kagramanova, and Jutta Kunz — Carl von Ossietzky Universität Oldenburg

We analyze the geodesics of test particles and light in the five dimensional charged doubly spinning black ring spacetime. Apparently it is not possible to separate the Hamilton-Jacobi-equation for charged doubly spinning black rings in general, so we concentrate on special cases: null geodesics in the ergosphere and geodesics on the two rotational axes of the charged doubly spinning black ring. We present analytical solutions to the geodesic equations for these special cases. Using effective potential techniques we study the motion of test particles and light and discuss the corresponding orbits

GR 1.7 Mo 15:30 HS 6

Photonenregionen in Raumzeiten kompakter Objekte — •Arne Grenzebach, Claus Lämmerzahl und Volker Perlick — ZARM, Universität Bremen, 28359 Bremen

In diesem Vortrag werden physikalische Effekte untersucht, die mit der Photonenregion der Kerr-Raumzeit verknüpft sind. Grund für diese Überlegungen sind die aktuellen Versuche, den Schatten eines Schwarzen Loches zu beobachten. Unter anderem interessiert hier die Frage, wie sich Photonen im Bereich der Photonenregion akkumulieren. Die Beschreibung der auftretenden Phänomene ist jedoch nicht nur auf Schwarze Löcher ($a \leq m$) beschränkt, sondern eignet sich auch für nackte Singularitäten ($a > m$). Ähnliche Rechnungen können auch für allgemeinere Raumzeiten, für die eine solche Photonenregion existiert, durchgeführt werden, wie z.B. für die Kerr-NUT Raumzeit.

GR 1.8 Mo 15:45 HS 6

Photon distribution near a static black hole — •Dennis Philipp[1] and Volker Perlick[2] — [1]Fachbereich Physik, Universität Bremen, 28359 Bremen — [2]ZARM, Universität Bremen, 28359 Bremen

We consider the distribution of photons in die vicinity of a Schwarzschild black hole. As the initial condition, we assume that at each point of the sphere of radius $r = R$ (for some large R) a monochromatic and isotropic flash of light is emitted at $t = 0$. We use the concepts of kinetic theory, describing the photons in terms of a distribution function on 8-dimensional phase space P with coordinates (x^μ, p_μ). The resulting distribution function, which satisfies Liouville's equation (the collisionless Boltzmann equation), is implicitly given by an equation that involves elliptic integrals. By integration over the momentum space we calculate the distribution function explicitly, in terms of elementary functions, in the limit $t \to \infty$, and we show that it has a singularity at $r = 3m$. We argue that every Schwarzschild black hole in Nature is surrounded by a sphere of very high photon density near $r = 3m$ which could be detrimental to the health of any observer that comes close to it.

GR 2: Gravitationswellen I

Zeit: Montag 16:30–19:00 Raum: HS 6

GR 2.1 Mo 16:30 HS 6

Resolving multiple supermassive black hole binaries with pulsar timing arrays. — •Stanislav Babak — Albert Einstein Institut, Am Muehlenberg 1, D-14476 Golm

Pulsar timing arrays might detect gravitational waves from massive black hole binaries within this decade. The signal is expected to be an incoherent superposition of several nearly-monochromatic waves of different strength. The brightest sources might be individually resolved, and the overall deconvolved, at least partially, in its individual components. We study resolvability of individual sources and estimation of their location on the sky.

GR 2.2 Mo 16:45 HS 6

Equation-of-state dependence of gravitational waves, nucleosynthesis and optical transients from neutron-star mergers — •Andreas Bauswein and Hans-Thomas Janka — Max-Planck-Institut fuer Astrophysik, Garching, Germany

Based on a representative set of relativistic hydrodynamical simulations we discuss the influence of the high-density equation of state on observable features of neutron-star mergers. The dependence of the gravitational-wave emission on the equation of state of neutron-star matter is addressed. On the basis of our survey we point out a novel possibility to determine neutron-star radii from gravitational-wave detections from the postmerger phase of a neutron-star coalescence. The likelihood of an corresponding gravitational-wave observation is estimated. Moreover, nucleosynthesis calculations are presented revealing a robust rapid neutron-capture process in the ejecta of neutron-star collisions. The properties of optical transients which are powered by the radioactive decay of the freshly synthesized elements, are discussed as well.

GR 2.3 Mo 17:00 HS 6

Gravitational-wave measurements from binary black holes and their dependency on waveform models — •Frank Ohme — Cardiff University, Cardiff, United Kingdom — Max-Planck-Institut für Gravitationsphysik, Potsdam/Hannover, Germany

Successfully detecting and interpreting gravitational waves from coalescing black-hole binaries requires a detailed model of the signals to be expected. With a combination of analytical approximations and full-relativistic numerical simulations it only recently became possible to predict the entire signal emitted by an inspiraling and merging binary, even in the complicated case of precessing black hole spins. However, these models are not free of errors, and I will summarize in this talk how to construct state-of-the-art waveform models, how to assess their errors and estimate the impact those may have on actual gravitational-wave measurements.

GR 2.4 Mo 17:15 HS 6

Measuring the spin of compact objects with advanced ground-based gravitational wave detectors — •Alex Nielsen — Max Planck Institut, Hannover

Inspirals of neutron stars and stellar sized black holes are a promising source of gravitational waves for ground-based laser interferometer detectors. The intrinsic spin of these objects is an important astrophysical observable and affects the gravitational wave signal due to general relativity. We discuss some of the issues involved in measuring these spins using the gravitational wave signal and the data analysis techniques that are needed to determine them.

GR 2.5 Mo 17:30 HS 6

GEO600: Gequetschter Gravitationswellendetektor lauscht der Milchstrasse — •Hartmut Grote — MPI für Gravitationsphysik und Leibniz Universität Hannover

Der Deutsch-Britische Gravitationswellendetektor GEO600 ist derzeit das einzige Laser-Interferometer weltweit, welches regelmässig Daten zur Suche nach Gravitationswellen nimmt. Wir geben einen kurzen Überblick über die Szene der erdgebundenen Gravitationswellendetektoren und berichten über die aktuellen Fortschritte bei GEO600. Unter anderem wird bei GEO600 kontinuierlich gequetschtes Licht (bzw. gequetschtes Vakuum) zur Erhöhung der Empfindlichkeit eingesetzt. Also dann: Auf dass Beteigeuze explodieren möge!

GR 2.6 Mo 17:45 HS 6

Einstein@Home all-sky search for periodic gravitational waves in LIGO S5 data — •Paola Leaci — Max Planck Institut fuer Gravitationsphysik

We present results of an all-sky search for periodic gravitational waves in the frequency range [50, 1 190] Hz and with frequency derivative range of $\sim [-20, 1.1] \times 10^{-10}$ Hz s^{-1} for the fifth LIGO science run (S5). The search uses a non-coherent *Hough-transform* method to combine the information from coherent searches on timescales of about one day. Because these searches are very computationally intensive, they have been carried out with the Einstein@Home volunteer distributed computing project. Post-processing identifies eight candidate signals; deeper follow-up studies rule them out. Hence, since no gravitational wave signals have been found, we report upper limits on the intrinsic gravitational wave strain amplitude h_0. For example, in the 0.5 Hz-wide band at 152.5 Hz, we can exclude the presence of signals with h_0 greater than 7.6×10^{-25} at a 90% confidence level. This search is about a factor 3 more sensitive than the previous Einstein@Home search of early S5 LIGO data.

GR 2.7 Mo 18:00 HS 6

Space Interferometry Simulation for LISA — •Andreas Schreiber, Markus Otto, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik, Callinstraße 38, 30167 Hannover

The "Laser Interferometer Space Antenna" (LISA) is a space-borne gravitational wave detector planned for the next decade. LISA aims at the detection of gravitational waves (GW) in the band of 0.1 mHz to 1 Hz. Sources within this band are, e.g., white dwarf and SMBH binaries. However, the detection of GW is disturbed by various noise sources. In particular, these are laser frequency noise, clock noise and displacement noise due to the motion of the satellites.
In our talk, we will present a numerical "Space Interferometry Simulation" (SIS). The simulation consists of models for GW, satellites and their orbits. Moreover, we implemented "Time-Delay Interferometry" (TDI) algorithms to remove the dominant noises listed above. The goal of the simulation is the verification of noise reduction by TDI within a realistic detector model. This talk will give an overview of the simulation and the gravitational wave detection in space, including first results.

GR 2.8 Mo 18:15 HS 6

Time-Delay Interferometry for a flexing LISA constellation — •Markus Otto, Andreas Schreiber, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik, Callinstraße 38, 30167 Hannover

Laser phase noise is the dominant noise source in the on-board measurements of the space-based gravitational wave detector LISA. A well-known data analysis technique, so-called "Time-Delay Interferometry" (TDI), provides synthesized data streams free of laser phase noise. At the same time TDI also removes the next largest noise source: phase fluctuations of the on-board clocks which distort the sampling process. Therefore TDI needs precise information about the spacecraft separations, sampling times and differential clock noises between the three spacecrafts. These are measured using auxiliary modulations on the laser light. Hence, there is a need for algorithms that account for clock noise removal schemes combined with TDI while preserving the gravitational wave signal.
In this talk, we will present the mathematical formulation of the LISA-like data streams and discuss a compliant TDI-algorithm that corrects for both clock and laser noise in the case of a rotating and flexing LISA constellation.

GR 2.9 Mo 18:30 HS 6

Squeezed light for gravitational wave astronomy — •Alexander Khalaidovski, Henning Vahlbruch, Moritz Mehmet, Karsten Danzmann, Hartmut Grote, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany

The measurement sensitivity of the first generation of interferometric gravitational wave (GW) detectors is limited by quantum shot noise at Fourier frequencies above a few hundred Hertz. Future generations of GW observatories will even be limited by quantum noise almost over their entire detection band. A non-classical approach to further improve the signal-to-quantum-noise ratio is based on the injection of squeezed states of light. Such a light field has a characteristic non-classical noise distribution in the field quadratures. Injected from the signal port, the squeezed states replace the vacuum states, thereby reducing the interferometer's quantum noise.

This contribution presents an overview over the field of squeezed-light generation for GW astronomy. The squeezed-light laser that is now operated in GEO 600 is discussed in detail. Prospects for the use of squeezed light in the 2nd and 3rd observatory generations are presented.

GR 2.10 Mo 18:45 HS 6

Two-mode squeezed light for gravitational wave detectors — •Sebastian Steinlechner, Jöran Bauchrowitz, Melanie Meinders, Helge Müller-Ebhardt, Karsten Danzmann, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany

The high-frequency sensitivity of interferometric gravitational-wave detectors is limited by the light's quantum noise, i.e. shot-noise arising from zero-point fluctuations at the detection dark-port. Non-classical, squeezed-light readout can reduce this noise and has been successfully implemented in GEO600 and was recently also tested in LIGO. In the mid-frequency region, the quantum noise is obscured by both thermal noise and parasitic interferences due to scattered light. Here we present a novel quantum-dense interferometer readout scheme, which we implemented in a table-top experiment. This scheme is able to identify and possibly remove parasitic signals, thus increasing the detection sensitivity in frequency bands that were previously not quantum-noise limited.

GR 3: Hauptvorträge: Mathematische Methoden

Zeit: Dienstag 11:15–12:45 Raum: HS 6

Hauptvortrag GR 3.1 Di 11:15 HS 6

Causal fermion systems: A quantum space-time emerging from an action principle — •Felix Finster — Mathematics Department, University of Regensburg, Germany

Causal fermion systems provide a general framework for the formulation of relativistic quantum theory. A particular feature is that space-time is a secondary object which emerges by minimizing an action. The aim of the talk is to give a simple introduction, with an emphasis on conceptual issues. We begin with Dirac spinors in Minkowski space and explain how to formulate the system as a causal fermion system. As an example in curved space-time, we then consider spinors on a globally hyperbolic space-time. An example on a space-time lattice illustrates that causal fermion systems also allow for the description of discrete space-times. These examples lead us to the general definition of causal fermion systems. The causal action principle is introduced. We outline how for a given minimizer, one has notions of causality, connection and curvature, which generalize the classical notions and give rise to a proposal for a "quantum geometry". In the last part of the talk, we outline how quantum field theory can be described in this framework and discuss the relation to other approaches.

Hauptvortrag GR 3.2 Di 12:00 HS 6

How to reconstruct a metric by its unparameterized geodesics — •Vladimir Matveev — Mathematical Institute , University of Jena

We discuss whether it is possible to reconstruct a metric by its unparameterized geodesics, and how to do it effectively. We explain why this problem may be interesting for general relativity. We show how to understand whether all curves from a sufficiently big family are unparameterized geodesics of a certain affine connection, and how to reconstruct algorithmically a generic 4-dimensional metric by its unparameterized geodesics. The algorithm works very effectively if the searched metric is Ricci-flat. We also prove that almost every metric does not allow non-trivial geodesic equivalence, and construct all pairs of 4-dimensional geodesically equivalent metrics of Lorenz signature. If the time allows, I will also explain how this theory helped to solve two mathematical problems explicitly formulated by Sophus Lie in 1882, and the semi-Riemannian two-dimensional version of the projective Lichnerowicz-Obata conjecture. The new results of the talk are based on the papers arXiv:1010.4699, arXiv:1002.3934, arXiv:0806.3169, arXiv:0802.2344, arXiv:0705.3592 joint with Bryant, Bolsinov, Kiosak, Manno, Pucacco, and on an unpublished work with Trautman.

GR 4: Gravitationswellen II

Zeit: Dienstag 14:00–16:00 Raum: HS 6

GR 4.1 Di 14:00 HS 6

Silicon - A potential test mass material for future GW detectors — •Jessica Steinlechner[1], Gerd Hofmann[2], Alexander Khalaidovski[1], Julius Komma[2], Christoph Krüger[1], Christian Schwarz[2], Sebastian Steinlechner[1], Ronny Nawrodt[2], and Roman Schnabel[1] — [1]Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany — [2]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Helmholtzweg 5, 07743 Jena, Germany

Today's gravitational wave (GW) detectors use test mass mirrors made from fused silica and a laser wavelength of 1064 nm. Future GW detectors such as the Einstein Telescope (ET) [1,2] consider cryogenic cooling of the test-masses to reduce their thermal noise. Due to its high mechanical quality factor at low temperatures and a high heat conductivity, silicon is a promising new test-mass material. An important question is whether the optical absorption of silicon is low enough since some of the test masses require the transmission of intense laser radiation. At 1550 nm silicon is expected to show a rather low optical absorption, however, precise absorption coefficients are not known. This talk deals with the absorption characteristics of crystalline silicon at a wavelength of 1550 nm.

[1] M. Punturo et al., Class. Quantum Grav. 27, 194002 (2010).
[2] B. Sathyaprakash et al., Class. Quantum Grav. 29, 124013 (2012).

GR 4.2 Di 14:15 HS 6

Optical properties of silicon — •Julius Komma[1], Gerd Hofmann[1], Christian Schwarz[1], Daniel Heinert[1], Jessica Steinlechner[2], Roman Schnabel[2], Paul Seidel[1], and Ronny Nawrodt[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, D-07743 Jena, Germany — [2]Institut für Gravitationsphysik, Universität Hannover, Callinstraße 38, D-30167 Hannover, Germany

Silicon is the chosen test mass material due to its mechanical and thermal properties for the proposed European gravitational wave detector "Einstein Telescope". For the design of such a detector optical parameters like refractive index, thermo-optic coefficient and absorption play an important role for the calculation of noise and the design of this interferometer. The temperature dependent change of the refractive index causes thermal noise due to thermal fluctuations. Another process induced by the thermo-optic coefficient is thermal lensing.

This contribution gives an overview about the optical properties of silicon. We present the measurement technique of the thermo-optic coefficient and data from 5 to 300 K. Hence estimations of the thermal noise in silicon were done. Furthermore calculations of thermal lensing effects in silicon are shown, especially for the low temperature region in which the Einstein Telescope will be operated.

This work is supported by the German Science Foundation (DFG) under contract SFB Transregio 7.

GR 4.3 Di 14:30 HS 6

Mechanical loss of sapphire at low temperatures — •Gerd Hofmann[1], Julius Komma[1], Christian Schwarz[1], Daniel Heinert[1], Paul Seidel[1], Andreas Tünnermann[2], and Ronny Nawrodt[1] — [1]FSU Jena, Institut für Festkörperphysik, Helmholtzweg 5, D-07743 Jena, Germany — [2]FSU Jena, Institut für Angewandte Physik, Albert-Einstein-Strasse 15, D-07745 Jena, Germany

One crucial limit in the sensitivity of current gravitational wave observatories (GWOs) is given by the thermal noise from the test masses which is directly linked to their temperature and mechanical loss. Current detectors are operated at room temperature with fused silica. The reduction of thermal noise is possible by decreasing the temperature and the mechanical loss. So the next generation of GWOs like the Japanese KAGRA will be operated at cryogenic temperatures. However, fused silica shows a high mechanical loss at cryogenics. Thus new materials especially crystaline ones are required. In this sense sapphire is a promising candidate with low losses at low temperatures.

We present measurements from 5 to 300 K on bulk sapphire as well as sapphire fibers. Data analysis reveals that bulk sapphire is limited in its mechanical loss at lowest temperatures due to Akhiezer damping i.e. the interaction of phonons. In contrast, we found that sapphire fibers mainly follow the theoretical predictions of thermoelastic damping. We further discuss the influence of surface treatment and the supporting structure in detail.

This work is supported by the DFG under contract SFB TR7.

GR 4.4 Di 14:45 HS 6

Silicon surfaces and its impact on gravitational wave detectors — •Christian Schwarz[1], Julius Komma[1], Gerd Hofmann[1], Daniel Heinert[1], Stefanie Kroker[2], Andreas Tünnermann[2], Paul Seidel[1], and Ronny Nawrodt[1] — [1]Institut für Festkörperphysik, FSU Jena, Helmholtzweg 5, D-07743 Jena — [2]Institut für Angewandte Physik, FSU Jena, Albert-Einstein-Strasse 15, D-07745 Jena

Gravitational wave detectors are one of the most precise measurement devices ever developed. Surface conditions can limit the noise performance of these devices effecting their mechanical and thermal properties (e.g. by phonon scattering). In order to change the sample surface different preparation techniques like mechanical polishing, dry and wet etching were used. We present detailed temperature dependent measurements on the mechanical loss ϕ and thermal conductivity κ of small flexures. All measurements were carried out in a temperature range from 5 to 300 K revealing mechanical losses as low as 3×10^{-8} at 10 K.

In order to extract the surface loss parameter we compare our measurements to values known from literature. It can be shown that the surface loss parameter of silicon is significantly smaller than for fused silica.

This work was supported by the German science foundation DFG under contract SFB TR7.

GR 4.5 Di 15:00 HS 6

Thermal noise in grating reflectors — •Daniel Heinert[1], Stefanie Kroker[2], Daniel Friedrich[3], Stefan Hild[4], Iain Martin[4], Ronny Nawrodt[1], Paul Seidel[1], Andreas Tünnermann[2], Sergey Vyatchanin[5], and Kazuhiro Yamamoto[3] — [1]Institut für Festkörperphysik, FSU Jena, 07743 Jena — [2]Institut für Angewandte Physik, FSU Jena, 07745 Jena — [3]Institute for Cosmic Ray Research, The University of Tokyo, Kashiwa, Chiba 277-8582, Japan — [4]SUPA, School of Physics and Astronomy, Institute for Gravitational Research, Glasgow University, Glasgow G12 8QQ, United Kingdom — [5]Faculty of Physics, Moscow State University, Moscow 119991, Russia

The interferometric detection of gravitational waves is crucially limited by the thermal noise of the detector's optical components. Past investigations have identified the high reflective coating layers to show a high mechanical loss. Due to the fluctuation-dissipation theorem they form the dominating noise source in a detector.

A promising alternative to the use of Bragg mirrors can be found in grating reflectors. Such gratings can be designed to exhibit high reflectivities at a specific design wavelength. These structures significantly reduce or even avoid the use of lossy coating materials and thus are expected to show a decreased amount of thermal noise.

In our contribution we present the noise analysis of grating reflectors. We further apply our theory to a 3rd generation gravitational wave detector. Finally, the noise benefit for the use of a grating reflector compared to a conventional layer stack is estimated.

This work is supported by the DFG under contract SFB TR 7.

GR 4.6 Di 15:15 HS 6

Anomalous dynamic back-action in interferometers: beyond the scaling law — •Sergey Tarabrin[1,2], Farid Khalili[3], Klemens Hammerer[1,2], Henning Kaufer[1], and Roman Schnabel[1] — [1]Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstraße 38, 30167 Hannover, Germany — [2]Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover, Germany — [3]Department of Physics, Moscow State University, Moscow 119992, Russia

We analyze dynamic back-action in the signal-recycled Michelson-Sagnac interferometer with a translucent membrane positioned in its arm, operated off dark port, and reveal its 'anomalous' features as compared to the ones of 'canonical' back-action, obtained within the scope of scaling law. Given the finite reflectivity of the membrane, optical damping as a function of detuning acquires (i) non-zero value on resonance and (ii) several stability/instability regions. In the case of absolutely reflecting membrane, corresponding to a pure Michelson interferometer, off-dark-port regime results in several intersecting regions of positive/negative values of optical spring and damping. For a certain region of parameters, stable sets of both effects in a free-mass interferometer with a single laser drive are possible. Our results can find implementations in both cavity optomechanics, revealing new regimes of cooling of micromechanical oscillators, and in the gravitational-wave detectors, revealing the possibility of stable single-carrier optical spring which can be utilized for the reduction of quantum noise.

GR 4.7 Di 15:30 HS 6

Diffraktive Optiken in 2. Ordnung Littrow für zukünftige Gravitationswellendetektoren. — •Christoph Krüger[1], Alexander Khalaidovski[1], Michael Britzger[1], Stefanie Kroker[2], Ernst-Bernhard Kley[2], Andreas Tünnermann[2], Karsten Danzmann[1] und Roman Schnabel[1] — [1]Institut für Gravitationsphysik, Leibniz Universität Hannover und Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany — [2]Institut für Angewandte Physik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

Laserinterferometrische Gravitationswellendetektoren setzen hohe Lichtleistungen ein, um eine möglichst hohe Messgenauigkeit zu erreichen. Für die Detektoren der zweiten Generation ist eine zirkulierende Lichtleistung von vielen hundert Kilowatt geplant. Zur Überhöhung der optischen Leistung werden dabei Fabry-Perot Armresonatoren eingesetzt. Die Restabsorption in den transmittiven Optiken führt schon heute zu einer thermischen Verformung, welche ihrerseits eine Veränderung des Strahlprofils bedingt. Da dieser Effekt nur teilweise kompensiert werden kann, wird er zu einem oberen Limit für die nutzbare Leistung in den künftigen Detektorgenerationen führen. Durch den Einsatz diffraktiver Optiken entfallen die Transmission durch Substrate und die damit verbundenen thermischen Effekte. Im Rahmen des SFB TR7 wurden solche dielektrischen Beugungsgitter hergestellt und charakterisiert. Der Vortrag präsentiert die Charakterisierung eines großformatigen optischen Gitters von 20cm x 20cm und damit in einer für GW-Detektoren verwendbaren Dimension.

GR 4.8 Di 15:45 HS 6

Dynamic tuning for a signal recycled interferometer. — •Dmitry Simakov — Institut für Gravitationsphysik, Leibniz Universität Hannover and
Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstraße 38, 30167 Hannover, Germany

In this work we study a particular method of detection of the chirp signal, the so-called dynamic tuning. The exact simulation of the detector response for the arbitrary signal recycling tuning variation and input signal is performed. Using the response, we calculate the shot noise and prove that it stays white for non-stationary regimes of interferometer operation. This allows us to compute the signal-to-noise ratio of the detection with dynamic tuning. The problem of signal deconvolution is also solved.

GR 5: Experimente

Zeit: Dienstag 16:30–18:15 Raum: HS 6

GR 5.1 Di 16:30 HS 6

Optical grating concepts for future gravitational wave detection — •Stefanie Kroker, Thomas Käsebier, Stefan Steiner, Ernst-Bernhard Kley, and Andreas Tünnermann — Friedrich-Schiller-Universität Jena Institut für Angewandte Physik, Abbe Center of Photonics, Max-Wien-Platz 1, 07743 Jena, Germany

Many experiments in the field of optical high-precision metrology are limited in their sensitivity by the thermal noise of optical components, for example, mirrors or beam splitters. Amorphous coating stacks are known to be a major source for these thermal fluctuations. In this contribution we discuss concepts to realize coating free optical components based on subwavelength resonant high contrast gratings (HCGs). The use of crystalline silicon promises a low level of thermal noise. Beside classical cavity mirrors HCGs can also be used to realize reflective cavity couplers acting as beam splitters for the incident light. Therefore, a large angular tolerance of the HCG reflectors has to be ensured. In order to realize HCGs with such angular broadband reflectivity two approaches are presented. The first makes use of stacking HCGs whereas the second benefits from polarization effects in HCGs with two-dimensional periodicity. For reflective beam splitters these angular broadband reflectors can be combined with either additional superposed lateral (grating duty cycle, ridge positions) or transversal (grating thickness) modulations to provide the subwavelength structures with diffraction orders. The diffraction efficiency can therewith be tuned with the strength of the modulation.

GR 5.2 Di 16:45 HS 6

Experiment zur alternative Gravitationstheorien mit LISA Pathfinder — •Natalia Korsakova[1], Martin Hewitson[1], Chris Messenger[2], B.S. Sathyaprakash[2], Gerhard Heinzel[1] und Karsten Danzmann[1] — [1]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) und Institut für Gravitationsphysik der Leibniz Universität Hannover, Hannover, Deutschland — [2]School of Physics and Astronomy, Cardiff University, Cardiff, UK

Die LISA Pathfinder Mission (LPF) wird Technologie für die Laser Interferometer Space Antenna (LISA) am Lagrange-Punkt L1 demonstrieren. Hauptbestandteil der Mission sind zwei freifallende Testmassen, deren relativer Abstand interferometrisch mit Picometer Genauigkeit bestimmt wird. Damit wird LPF eine noch nie dagewesene Sensitivität für differentielle Beschleunigungen bei Frequenzen um 1 mHz erreichen.

In diesem Vortrag soll eine Verlängerung der LISA Pathfinder Mission diskutiert werden. Diese würde sich die Sensitivität von LPF zu Nutze macht um alternative Gravitationstheorien am Sattelpunkt zwischen Erde und Sonne zu testen. Die hierbei notwendige Datenanalyse wird im Detail Vorgestellt.

GR 5.3 Di 17:00 HS 6

Testing the Theory of Relativity Using Ultra-stable Cryogenic Sapphire Oscillators — •Moritz Nagel[1], Stephen Parker[2], Katharina Möhle[1], Klaus Döringshoff[1], Sylvia Schikora[1], Paul Stanwix[2], Eugene Ivanov[2], Evgeny Kovalchuk[1], Mike Tobar[2], and Achim Peters[1] — [1]Humboldt-Universität zu Berlin, Institut für Physik, AG Optische Metrologie, Newtonstr. 15, 12489 Berlin — [2]School of Physics, The University Of Western Australia, Crawley 6009, Western Australia, Australia

Modern Michelson-Morley-type experiments compare the electromagnetic eigenfrequencies of ultra-stable resonators to scrutinize one of the most fundamental principles of modern physics: Lorentz invariance.

We present details on our currently running Michelson-Morley-type experiment that utilizes two orthogonally aligned cryogenic sapphire microwave oscillators which have a fractional frequency stability in the 10^{-16} regime for integration times from 1 - 100 seconds. The oscillators are being actively rotated on a high-precision air-bearing turntable in the laboratory. This setup will have a sensitivity for signals of Lorentz invariance violations in the 10^{-18} to 10^{-19} regime after one year of continuous operation, representing a 100-fold improvement in such type of experiments.

In a next step we plan to combine these microwave oscillators with a set of ultra-stable cryogenic optical resonators currently being developed to perform an advanced Michelson-Morley-type experiment to investigate simultaneously a multitude of possible Lorentz invariance violations in the 10^{-20} regime.

GR 5.4 Di 17:15 HS 6

Quantum test of the Equivalence Principle: The STE-QUEST mission — •Naceur Gaaloul, Christian Schubert, Ernst Rasel, and the STE-QUEST consortium — Institut für Quantenoptik Leibniz Universität Hannover, Hannover, Germany

STE-QUEST aims for a test of General Relativity through testing the Universality of Free Fall with a dual species atom interferometer on a satellite. This test is based on measuring the differential acceleration of two test bodies assumed to be zero by Einstein's Equivalence Principle (EP). The Eötvös ratio derived from the differential signal will be determined with an accuracy of parts in 10^{15} beyond state-of-the-art precision of 10^{-13} established by lunar laser ranging and torsion balances.

Quantum degenerated ensembles of Rb87 and Rb85 will act as test bodies in the dual species interferometer and would show the first quantum test of the EP. Due to the weightlessness conditions in space these test masses will be simultaneously prepared and interrogated with a free evolution time of 10 s. Within a single cycle of 20 s a shot noise limited sensitivity to accelerations of 3e-12 m/s^2 is anticipated. The simultaneous interferometry is carried out in a double diffraction Mach-Zehnder geometry.

Challenges in this mission lie both in suppressing noise and bias terms as well as in the accommodation to the limited resources of a satellite. In the talk the measurement principle will presented, an overview of the preliminary payload design will be given, and the estimated error budget will be discussed. The STE-QUEST is a proposal for an M3 mission in the frame of the Cosmic Vision program of ESA.

GR 5.5 Di 17:30 HS 6

Vorbereitung der Datenanalyse für die Satellitenmission Microscope — •Stefanie Bremer, Meike List, Benny Rievers, Hanns Selig und Claus Lämmerzahl — ZARM - Universität Bremen, Am Fallturm, 28359 Bremen

Die französische Satellitenmission Microscope hat als Zielsetzung den Test des schwachen Äquivalenzprinzips und die Bestimmung des Eötvös Parameters mit einer Genauigkeit von 1e-15. Der Test wird mithilfe von zwei hoch-genauen kapazitiven Differentialaccelerometern, die jeweils zwei zylindrische Testmassen beinhalten, durchgeführt. Die Bewegung dieser Testmassen im Schwerefeld der Erde wird sehr genau vermessen und das Ergebnis in Zusammenhang mit einer Vielzahl weiterer Faktoren, die das Experiment beeinflussen, interpretiert. Um diese Datenanalyse durchführen zu können, ist die genau Kenntnis des Instruments, der Testmassendynamik und der Wechselwirkungen, die über den Satellitenbus entstehen, Voraussetzung. Zur Vorbereitung der Datenanalyse werden daher Simulationen eingesetzt, die im Vorfeld der Mission bereits die Möglichkeit bieten unterschiedliche Störeffekte künstlich zu erzeugen und deren Auswirkung auf das Messergebnis zu testen. Das ZARM ist Bestandteil des Teams, das die Datenauswertung von Microscope als Erste vornehmen wird. Zu diesem Zweck wird an einem Simulationstool gearbeitet, das den komplexen dynamischen Prozessen sowie allen äußeren Störeinflüssen Rechnung trägt. Der Entwicklungsstand dieses Microscope Simulators wird präsentiert.

GR 5.6 Di 17:45 HS 6

The impact of high precision modeling of non-gravitational forces on the accuracy of gravitational measurements in space — •Benny Rievers, Meike List, Stefanie Bremer, and Claus Lämmerzahl — ZARM, Universität Bremen

The requirements on the knowledge of the perturbations acting on measurement systems in space are increasing constantly. Motivated by this, the Center of Applied Space Technology and Microgravity (ZARM) is developing improved modeling methods for the evaluation and prediction of these effects. For current missions like GRACE, these high precision perturbation models can be used to improve measured data by a better understanding of the sources of the perturbed measurements. For future mission concepts like LISA or GRACE-FO, the same models can be used for an optimization of mission and spacecraft design (with respect to the perturbations) as well as for the generation of mock data, which is needed to qualify the data evaluation techniques used during the respective mission. The importance of the implementation of accurate non-gravitational forces modeling has been demonstrated by ZARM with the interpretation of the Pioneer anomaly as a thermal drag as well as the explanation of anomalous drag effects for the Rosetta mission. In this talk the involved methods will be discussed in detail. Furthermore first results of the evaluation of the dominant non-gravitational forces acting on LISA and the NASA Messenger mission will be shown.

GR 5.7 Di 18:00 HS 6

A covariant approach to the description of a violation of the Weak Equivalence Principle — •Claus Lämmerzahl[1,2], Eva Hackmann[1], and Meike List[1] — [1]ZARM, University Bremen, Germany — [2]IfP, University Oldenburg, Germany

Violations of the Weak Equivalence Principle (WEP) are usually described within the Newtonian framework where masses of different composition couple differently to the gravitational field. Here we develop a covariant formalism and show that violations of the WEP are then described within a kind of bi-metric theory. We describe the consequences of such an ansatz and possible tests of the WEP. Particular features may appear in the strong gravity regime.

GR 6: Klassische Allgemeine Relativitästheorie I

Zeit: Dienstag 18:15–19:30 Raum: HS 6

GR 6.1 Di 18:15 HS 6

Skyrmion-Wormholes — •Burkhard Kleihaus — Universität Oldenburg, Oldenburg, Germany

Skyrmions are solitons stabilized by a topological charge. When minimally coupled to gravity, self-gravitating Skyrmions emerge from the flat space Skyrmion. They exist up to a critical value of the gravitational coupling parameter. Also Skrymion black holes arise, when an event horizon is imposed.

In this talk I will consider gravitating Skyrmions in the context of another kind of solutions of Einstein gravity, namely wormholes. Here the wormhole connects two asymptotically flat universes and is supported by a scalar phantom field. The coupled Einstein and field equations for the metric, the phantom field and the Skyrme field are solved numerically. The properties of the Skyrmion-wormholes are discussed, especially the domain of existence. It will be shown that Skyrmion-wormholes possess an instability mode, and hence are unstable.

GR 6.2 Di 18:30 HS 6

Gravitating vortons as ring solitons in general relativity — Jutta Kunz, •Eugen Radu, and Bintoro Subagyo — Institut für Physik, Universität Oldenburg, Postfach 2503, D-26111 Oldenburg, Germany

The vortons are spinning vortex loops stabilized by the centrifugal force and were proposed more than 20 years ago in the context of the local U(1)xU(1) theory of superconducting cosmic strings of Witten. We present an explicit construction of gravitating vortons in four dimensional general relativity, as solutions of an elliptic boundary value problem. We also discuss their properties and determine their domain of existence. Similar to Q-balls, we shown that the vortons exist only in a limited frequency range. The coupling to gravity gives rise to a spiral-like frequency dependence of the mass and charge of the vortons.

GR 6.3 Di 18:45 HS 6

Local spacetime effects on gyroscope systems — •Christian Pfeifer and Mattias Wohlfarth — Universitaet Hamburg, II Institut fuer theoretische Physik, Hamburg, Deutschland

Guided by the question what exactly is meant when people talk about a rotating spacetime I investigate the transport of initially aligned gyroscopes along different paths, between some initial and final point in spacetime. It turns out that the gyroscopes loose their alignment due to the curvature of spacetime and their relative motion. Sets of aligned gyroscopes can be used to synchronize spatial frames of observers, hence their desynchronization gives rise to a relative rotation of observers. As application we use our findings for a class of observers in Kerr spacetime and suggest a local experiment how these observers are able to determine if their spacetime is described rather by a rotating Kerr or non-rotating Schwarzschild metric.

GR 6.4 Di 19:00 HS 6

Eine direkte Herleitung der Schwarzschildlösung aus der Newtonschen Mechanik mit Hilfe einer linearen Regression — •Hans-Otto Carmesin — Gymnasium Athenaeum, 21680 Stade, Harsefelder Straße 40 — Studienseminar Stade, Bahnhodstraße 5, 21682 Stade

Das Problem: Die Schwarzschildlösung hat viele Anwendungen, aber die übliche Herleitung erfordert die Einstein-Gleichung und deren Lösung. Das ist mathematisch aufwändig und verstellt so den Blick auf den physikalischen Gehalt.

Eine Lösung: Hier wird die Schwarzschildlösung mit Hilfe geometrischer Grundüberlegungen aus der Newtonschen Gravitationstheorie mit Hilfe einer linearen Regression aufgestellt. Die lineare Regression ersetzt eine ähnliche Näherung in niedrigster Ordnung bei der Einführung der Einstein-Gleichung.

Aus der hier entwickelten Schwarzschildlösung kann die Einstein-Gleichung hergeleitet werden. Damit liegt ein einfacher Zugang zur allgemeinen Relativitätstheorie vor.

Es wird über Erfahrungen mit verschiedenen Lerngruppen berichtet.

GR 6.5 Di 19:15 HS 6

GRT - well proven and also incomplete? — •Jürgen Brandes — Karlsbad, Germany

There are two contradictory formulas about the total energy of a particle resting in the gravitational field [1]. From the formulas of radial free fall one gets: $E = mc^2\sqrt{(1-2GM/c^2r)}$. This is at least qualitatively correct since removing the particle from the gravitational field needs energy. Doing this the total energy of the particle becomes $E = mc^2$ and therefore, within the gravitational field it has to be lower. On the other side, there is the equivalence principle. A particle resting in its local inertial system (i.e. the freely falling particle) has a total energy equal to its rest mass: $E = mc^2$. Both of the formula contradict each other. Certainly, they belong to different reference systems with one of them being accelerated, in fact. But: At time point $t = 0$ the free falling particle is also a resting one since its velocity $v = 0$. Only its acceleration $b \neq 0$. Special theory of relativity is applicable and therefore the free falling particle at $t = 0$ as well as an always resting particle at the same position possess identical total energy $E = mc^2$.

This contradiction proves Lorentz interpretation [1] and being so simple proves a 'hardnosed' classical theory of general relativity, too.

[1] J. Brandes, J. Czerniawski: *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen - Einstein- und Lorentz-Interpretation, Paradoxien, Raum und Zeit, Experimente*, 4. Aufl. 2010

GR 7: Schwarze Löcher II

Zeit: Mittwoch 8:30–8:45 Raum: HS 6

GR 7.1 Mi 8:30 HS 6

Highly relativistic particles as an invisible and a large reservoir of mass in the Universe ? — •Karl Otto Greulich — Fritz Lipmann Institute Beutenbergstr.11 D 07745 Jena

At a critical speed given by the Lorenz factor the relativistic mass of a particle corresponds to that of the Planck mass. Above this mass and speed the Schwarzschild radius becomes larger than the de Broglie wavelength, i.e the particle reveals properties of a black microhole * it becomes invisible. For nucleons this is approx. 10 exp19 times of its mass at rest, With the assumption that particles with a potential rest mass of the order of 10 000 Sun masses still have, since the big bang, such a high speed, it can be explained that the major part of the Universes mass appears as *dark*. It also becomes plausible that even today visible mass is generated from virtually the vacuum, simply by decelerating down such fast particles by collisions with slow matter.References: K.O. Greulich J Mod Phys 1, 300 - 302 (2010); K.O. Greulich SPIE Proceedings 8121-15, (2011); for downloads see http://www.fli-leibniz.de/www_kog/ then klick *Physics*

GR 8: Kosmologie I

Zeit: Mittwoch 8:45–9:15 Raum: HS 6

GR 8.1 Mi 8:45 HS 6

Die Entstehung der Zeit als Ursache für den Stop der Inflation des Weltraums — •Kai-Olaf Henkel — Doverkamp 10 22335 Hamburg

Einleitung: Bisher ist der Grund für das abrupte Ende der inflationären Ausdehunung des Weltalls unbekannt. Eine Erklärung liefert eine neue Definition des Begriffs "Zeit". These: Die Zeit resultiert aus der Frequenz der Schwingungen aller massereicher Quanten pro Raumeinheit. Ableitung der These: Die Abweichung eines Lichtstrahls im Gravitationsfeld eines Sterns führt zu dem Schluß das die Zeit der Quotient von Raum und Gravitation ist. Die Gravitation wird durch die Masse des Sterns bestimmt. Für die Masse gilt "Energie durch Quadrat der Lichtgeschwindigkeit". Die Energie wird in der Quantenphysik mit dem Term "Produkt aus Planck'schem Wirkungsquantum und der Frequenz des Quants" beschrieben. Damit gilt die Zeit ist der Quotient aus Raum multipliziert mit dem Quadrat der Lichtgeschwindigkeit und dem Planckschen Wirkungsquantum aller massehaltiger Quanten des Raums multipliziert mit der Frequenz dieser Quanten. Schlußfolgerung: Das Entstehen der Zeit ist an das Vorhandensein des Raums und dem Vorhandensein der Gravitation gebunden. Beweis der These: Das plötzliche Abbremsen der Inflation ist eine Folge des Abspaltens der Gravitation von der Urkraft. Durch den Urknall entstand erst der Raum, als Folge der Entfaltung der Urenergie. Mit dem Abspalten der Gravitation von der Urenergie die Zeit. Damit waren überlichtschnelle Geschwindigkeiten nicht mehr möglich und die inflationsartige Ausbreitung des Raumes wurde beendet.

GR 8.2 Mi 9:00 HS 6

Zustand und Bewertung des Quanten-Kosmos über die E8-Gruppe. — •Norbert Sadler — Wasserburger Str. 25a; 85540 Haar

Durch Anwendung gruppenth. Methoden, insbesondere der E8-Grp., auf den Quanten-Kosmos/Universum wird:(i)die Struktur, (ii) die Energieverteilung, (iii) die spezifischen Massen der Elementarteilchen,(iv)die LHC Ergebnisse aus Sicht der E8-Grp. ermittelt und neu bewertet. Def.: E8 hat 248 Freih.Grade in der Drehung eines 57dim. geom. Objektes und ist selbst 8-dimensional. (i) Die kosm. Srutur-gleich.: 248(Fr.Grd)=1/(5/9 alfa QED); 57(dim. Obj.)=124x(4.13/9); 248(alfa(Gravit.))=(0.283)x(HoXHo);mit Ho=70km/Mpcs und 4/9 =Aufenth. Wahrsch. einer Entität u. 5/9= Entitäten frei. (ii) die Energievert. im Univ.: 4.5% (heller mat.E.)=57x(0.0028;CP-Verl.)x 28.3% (mat. E.); und (2Pi)x4.5% (heller E.)=28.3% (mat. E.); und 71.7% (dunkl. E.)=256 x (0.0028;Cp-Verl.) und die 23.8% (dunkl. mat. E.)=57x alfa(QED)/(5Pi/9). (iii) die Massen der Elementarteilchen: m(Prot.)=57x(alfa(QED))/(4/9)1GeV =(h/4Pi) x sinh57/1s; m(Elektr.)= alfa(QED)/(32x4/9) 1GeV; (iv). Im LHC wurden 248/2=124 "Feynman Pfade" von E8 abgespalten und zwei 57dim.Obj. destabilisiert: 2x(57(1+alfa(QCD)/2))x1GeV =125.4GeV; kein Higgsfeld, sondern das 57dim. geom. Objekt aggregiert zu den stabilen Massen der Elementarteilchen!

GR 9: Numerische Relativitätstheorie I

Zeit: Mittwoch 14:00–16:00 Raum: HS 6

GR 9.1 Mi 14:00 HS 6

Status Report on the Numerical Relativity/Analytical Relativity collaboration — •Ian Hinder — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Potsdam, Germany

I report on the current status of the Numerical Relativity/Analytical Relativity (NR/AR) collaboration. In this project, a collaboration between 14 numerical relativity (NR) and 7 analytical relativity (AR) groups, we aim to use gravitational waveforms from NR simulations of binary black holes to construct accurate analytical templates to be used in the search for gravitational waves with the LIGO and Virgo detectors. I describe our target requirements on waveform length and accuracy, as well as the techniques we use to process the NR data into a form suitable for use with analytical models. Simulations from the first stage, encompassing mostly aligned-spin configurations, are complete, and I present an overview of the numerical results obtained so far.

GR 9.2 Mi 14:15 HS 6

Numerical Relativity in Spherical Polar Coordinates — •Pedro Montero — Max Planck Institute for Astrophysics

Development of numerical relativity codes in spherical polar coordinates has been hampered by the need to handle the coordinate singularities at the origin and on the axis, for example by careful regularization of the appropriate variables. Assuming spherical symmetry and adopting a covariant version of the BSSN equations, Montero and Cordero-Carrión recently demonstrated that such a regularization is not necessary when a partially implicit Runge-Kutta (PIRK) method is used for the time evolution of the gravitational fields. Here we report on an implementation of the BSSN equations in spherical polar coordinates without any symmetry assumptions. Using a PIRK method we obtain stable simulations in three spatial dimensions without the need to regularize the origin or the axis. We perform and discuss a number of tests to assess the stability, accuracy and convergence of the code, namely weak gravitational waves, "hydro-without-hydro" evolutions of spherical and rotating relativistic stars in equilibrium, and single black holes.

GR 9.3 Mi 14:30 HS 6

Black-hole lattices — •Eloisa Bentivegna[1] and Mikolaj Korzynski[2] — [1]Max Planck Institute for Gravitational Physics — [2]Center for Theoretical Physics at the Polish Academy of Sciences

Regular black-hole lattices have recently been proposed as a testbed to investigate the role of small-scale inhomogeneities in spaces that are homogeneous on larger scales. I will present a brief history of the developments in this area and then discuss the construction of black-hole lattices in two cases, characterized by whether the corresponding spacetime contains a time-symmetric spatial hypersurface. Finally, I will illustrate the cosmological relevance of these models by comparing them to the zero-pressure Friedmann-Lemaître-Robertson-Walker class.

GR 9.4 Mi 14:45 HS 6

1+log Trumpet Initial Data in Numerical Relativity — •Tim Dietrich and Bernd Brügmann — Friedrich-Schiller-Universität, Jena, Germany

A key ingredient for reliable numerical simulations is the accurate construction of initial data. One typical method is the puncture approach. When constructing puncture initial data by solving the Hamiltonian constraint, the coordinate singularity requires special attention.

The standard way to treat the pole singularity occurring in wormhole puncture data is not applicable to trumpet puncture data. Therefore, we investigate a new approach based on inverse powers of the conformal factor and present numerical examples for single punctures of the wormhole and 1+log trumpet type. Specifically, we describe a method to solve the Hamiltonian constraint for two 1+log trumpets for given extrinsic curvature with non-vanishing trace and investigate properties of our constructed initial data during binary black hole evolutions.

GR 9.5 Mi 15:00 HS 6

numerical solution of the 2+1 Teukolsky equation on a hyperboloidal and horizon penetrating foliation of Kerr — •Enno Harms, Sebastiano Bernuzzi, and Bernd Brügmann — Theoretical Physics Institute, University of Jena, 07743 Jena, Germany

We present a novel formulation of the Teukolsky equation for generic spin perturbations on the hyperboloidal and horizon penetrating foliation of Kerr proposed recently by Racz and Toth. An additional, spin-dependent rescaling of the field variable can be used to achieve stable, long-term, and accurate time-domain evolutions of generic spin perturbations. As an application we investigate numerically the late-time decays of scalar, electromagnetic, and gravitational perturbations by means of 2+1 evolutions.

GR 9.6 Mi 15:15 HS 6

Spectral time evolution of wave equations on hyperboloidal slices — •Rodrigo Panosso Macedo and Marcus Ansorg — Theoretical Physics Institute - University of Jena, Jena, Germany

We present a new numerical scheme for the time evolution of axisymmetric wave equations around a black hole. The code relies on two features: i) the surfaces of constant time extend all the way towards future null infinity (hyperboloidal slices), which is included in the computational domain by a compactification of the radial coordinate, ii) the wave equations are solved by means of a pseudo-spectral method, which is applied here to both spatial and time directions. The inversion of the resulting dense matrix is efficiently performed with a specifically designed iterative method. We obtain extreme precision of the numerical solution close to machine accuracy, which allows us to study in detail the field's tail, i.e., the decay as an inverse power law in the asymptotic time evolution.

GR 9.7 Mi 15:30 HS 6

Modeling neutron stars using a GR Resistive MHD formalism — •Daniela Alic[1], Kyriaki Dionysopoulou[1], Carlos Palenzuela[2], Luciano Rezzolla[1], and Bruno Giacomazzo[3] — [1]Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Potsdam-Golm, Germany — [2]Canadian Institute for Theoretical Astrophysics, Toronto, Canada — [3]JILA, University of Colorado and National Institute of Standards and Technology, Boulder, USA

We present numerical results obtained with a general-relativistic resistive magnetohydrodynamics (GR-RMHD) version of the Whisky code, using an algebraic Ohm law that accounts for the effects of finite resistivity. The numerical method adopted exploits the properties of Implicit-Explicit Runge-Kutta (RKIMEX) numerical schemes to treat the stiff terms of the equations. We report simulations of magnetized neutron stars both in the Cowling approximation and in dynamical spacetimes. In addition, we present the case of a collapsing star, which provides a very good testbed for numerical codes with dynamical electromagnetic fields in strong gravity and has interesting astrophysical implications. Finally, we show that our results are in good agreement with the perturbative studies of the dynamics of electromagnetic fields in a Schwarzschild background.

GR 9.8 Mi 15:45 HS 6

Initial Data for Eccentric Neutron Star Binaries — •Niclas Moldenhauer and Charalampos Markakis — Friedrich-Schiller Universität, Jena, Germany

We present a way to construct initial data for neutron star binaries on quasi-circular or eccentric orbits. Therefore, a self-consistent field method is used, in which we solve the Einstein constraints in the conformal thin-sandwich approach. A single TOV star can be constructed in this way and afterwards, two such TOV stars are superimposed. Then the method is applied again to minimize the constraint violations and induce tidal deformations.

GR 10: Numerische Relativitätstheorie II

Zeit: Mittwoch 16:30–18:30 Raum: HS 6

GR 10.1 Mi 16:30 HS 6

Simulations of Binary Neutron Star Mergers — •Wolfgang Kastaun — Albert Einstein Institut Golm

The inspiral and merger of binary neutron star systems is one of the most promising sources for current gravitational wave astronomy and also the most likely explanation for short gamma ray bursts. Such events are sensitive to a unique mix of physics, namely general relativity in the strong field regime, nuclear physics at extreme densities and a large temperature range, neutrino physics, and relativistic (Magneto-)Hydrodynamics. Three-dimensional numerical simulations are the only way to map the theoretical unknowns onto observable predictions. In this talk, we will present simulations of non-magnetized binary neutron star mergers done at the AEI, incorporating nuclear physics descriptions of matter at high densities and a fully general relativistic evolution, with focus on the gravitational wave signal and the temperature evolution.

GR 10.2 Mi 16:45 HS 6

Highly eccentric neutron star binaries as revealed by numerical relativity: Properties of their gravitational waves and merger remnants — •Nathan Johnson-McDaniel, Sebastiano Bernuzzi, Marcus Thierfelder, and Bernd Brügmann — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität, Jena, Deutschland

We describe the results of our numerical evolutions of highly eccentric neutron star binaries, focusing on the properties of their gravitational wave signal, accretion disk, and ejecta. On the gravitational wave side, we consider the repeated burst structure from the stars' close encounters and the signal from tidally induced oscillations of the neutron stars, and assess prospects for detection. On the matter side, we consider how the properties of the (in some cases fairly massive) accretion disk and ejecta from the merger relate to potential electromagnetic signals (e.g., short gamma-ray bursts or radio afterglow) and r-process nucleosynthesis. We also discuss how all these properties depend upon the binary's initial conditions and the masses and equation of state of the neutron stars. Finally, we describe our efforts to ensure the accuracy of our simulations.

GR 10.3 Mi 17:00 HS 6

Evolution of magnetized hypermassive neutron stars — •Daniel Siegel, Riccardo Ciolfi, and Luciano Rezzolla — Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Potsdam-Golm, Germany

Differentially rotating hypermassive neutron stars (HMNSs) are metastable configurations which can be formed in the latest stage of binary neutron star mergers. Their eventual collapse produces a spinning black hole surrounded by a hot and thick accretion disk. The dynamics of such a system is of crucial importance, since it could generate the relativistic jets observed in short gamma-ray bursts. By performing simulations of very high resolution, we discuss the influence of magnetic fields on the evolution of HMNSs. In particular, we provide convincing evidence for the occurrence of the *magneto-rotational instability* (MRI), which is responsible for strong magnetic field amplification. Characteristic features of the MRI are discussed and quantities such as the characteristic growth rate and the wavelength of the fastest growing mode are extracted and compared with analytical predictions. We also show the emergence of coherent channel flows and their eventual rearrangement through reconnection.

GR 10.4 Mi 17:15 HS 6

Tidal effects in binary neutron star coalescence — •Sebastiano Bernuzzi — TPi, Jena, Germany

Gravitational waves from coalescing neutron stars carries unique information about the star's equation of state. An accurate theoretical modeling of these systems is of primary importance to extract robust data in a direct detection of gravitational waves.

I will present results about tidal effects in binary neutron star coalescence and their signature in gravitational radiation emitted. In particular, I will discuss the outcome of state-of-art numerical relativity simulations and their comparison with analytical approaches like post-Newtonian method and the effective-onde-body model.

GR 10.5 Mi 17:30 HS 6

A minimax approach to solving for relativistic stellar equilibria — •Charalampos Markakis[1,2], Bernd Brügmann[1], Richard

Price[3], and John Friedman[4] — [1]University of Jena, Germany — [2]University of Southampton, UK — [3]University of Texas - Brownsville, US — [4]University of Wisconsin - Milwaukee, US

Similar methods have been used to construct models of rapidly rotating or binary stars, in Newtonian and relativistic contexts. The choice of method has been based on numerical experiments, which indicate that particular methods converge quickly to a solution, while others diverge. The theory underlying these differences, however, has not been understood. In an attempt to provide a better theoretical understanding, we analytically examine the behavior of different iterative schemes near an exact static solution. We find the spectrum of the linearized iteration operator and show for self-consistent field methods that iterative instability corresponds to unstable modes of this operator. We show that minimizing the maximum eigenvalue accelerates convergence and allows computation of highly compact configurations that were previously inaccessible via self-consistent field methods.

GR 10.6 Mi 17:45 HS 6

Numerical long-term integration of compact binary systems — •Jonathan Seyrich — Numerical Analysis Group, Universitaet Tuebingen, Auf der Morgenstelle 10, 72076 Tuebingen

The two most common descriptions of relativistic binary systems - the Geodesic approximation and the post-Newtonian approach- give rise to equations of motion which have to be integrated numerically. In the investigation for chaos, integrations over very long time ranges are necessary. For this purpose, highly accurate and efficient numerical integration schemes are presented. The best integrators will turn out to be based on Gauss collocation methods.

GR 10.7 Mi 18:00 HS 6

Initial data for perturbed Kerr black holes on hyperboloidal slices — •David Schinkel, Marcus Ansorg, and Rodrigo Panosso Macedo — Theoretisch-Physikalisches Institut, Jena, Germany

We construct initial data corresponding to a single perturbed Kerr black hole in vacuum. These data are defined on specific hyperboloidal slices on which the mean extrinsic curvature K approaches a constant asymptotically. More precisely, we require that K obeys the Taylor expansion $K = K_0 + O(\sigma^4)$ where K_0 is a constant and σ describes a compactified spatial coordinate such that future null infinity (scri+) is represented by $\sigma = 0$. We excise the singular interior of the black hole and assume an apparent horizon as inner boundary of the computational domain. Momentum and Hamiltonian constraints are solved by means of pseudo-spectral methods. We find exponential rates of convergence of our numerical solutions which are planned to be dynamically evolved in a future project.

GR 10.8 Mi 18:15 HS 6

Spinning Q-balls and Boson Stars in Anti-de Sitter Spacetime — Jutta Kunz, Eugen Radu, and •Bintoro Subagyo — Institut für Physik, Universität Oldenburg, Postfach 2503, D-26111 Oldenburg, Germany

We construct spinning Q-balls and boson stars in d dimensional anti-de Sitter spacetime. These are smooth, horizonless solutions for gravity coupled to a complex scalar field with a harmonic dependence on time and an azimuthal angle. We find that a class of solutions with a self-interaction potential has a limit corresponding to static solitons with axial symmetry only. We also discuss an exact solution describing spherically symmetric Q-balls in a fixed AdS background.

GR 11: Hauptvorträge: Relativistische Astrophysik

Zeit: Donnerstag 11:15–12:45 Raum: HS 6

Hauptvortrag GR 11.1 Do 11:15 HS 6

Geodesics and their observation in General Relativity — •Eva Hackmann[1], Victor Enolski[2], Valeria Kagramanova[3], Jutta Kunz[3], and Claus Lämmerzahl[1,3] — [1]ZARM, Universität Bremen, Germany — [2]Institute of Magnetism, NAS Kyiv, Ukraine — [3]Institut für Physik, Universität Oldenburg, Germany

The geodesic equation for the motion of test-particles in General Relativity can be solved by using algebro-geometric methods in a wide range of space-times. In particular, the geodesic equation in the two most basic space-times given by the Schwarzschild and the Kerr metric can be solved in terms of elliptic functions, whereas some more general type D space-times require hyperelliptic functions. Directly related observable effects like the perihelion shift or the bending of light, but also the timing of pulsars, can be expressed in terms of (hyper-)elliptic integrals and functions. Also, the calculation of observational effects in the more general Hořava-Lifshitz gravity benefits from such a description. In this talk, we will present analytic expressions and address computational problems for geodesics and related observations.

Hauptvortrag GR 11.2 Do 12:00 HS 6

Exploring physics close to the Galactic Center black hole with infrared and submillimeter interferometry — •Frank Eisenhauer — Max Planck Institute for extraterrestrial Physics, PO Box 1312, Giessenbachstr., 85741 Garching, Germany

Infrared observations of stellar orbits and the extreme compactness of the central radio source provide compelling evidence that the Galactic Center harbors a supermassive black hole. Given its relative proximity, the Galactic Center is the ideal laboratory for studying the details of such an extreme object. Flares from the black hole have already given first insights to the physical processes close to the last stable orbit. Currently we are witnessing a gas cloud on its way towards the supermassive black hole. The cloud's dynamic evolution and radiation after its peri-passage in 2013 will shed light on the feeding processes and will probe the properties of the accretion flow. Infrared and submillimeter interferometry will soon take the next steps in the Galactic Center research by providing event-horizon scale astrometry and imaging resolution. While the submillimeter interferometry aims at imaging the shadow of the black hole against the surrounding accretion flow, the infrared interferometry with GRAVITY - a new instrument combining the four 8m ESO Very Large Telescopes in Chile - will focus on measuring the motion of matter close to the last stable orbit and on detecting general relativistic effects in the stellar orbits at larger distance.

GR 12: Relativistische Astrophysik

Zeit: Donnerstag 14:00–14:15 Raum: HS 6

GR 12.1 Do 14:00 HS 6

Gravitational Waves from Rotational Instabilities of Neutron Stars — •Kostas Kokkotas — Theoretical Astrophysics, University of Tuebingen, Germany

We will present our recent results on the conditions for the excitation of the rotational instabilities of neutron stars with emphasis to the one of the f-mode. We will also discuss the duration of the unstable phase and the efficiency in the emission of gravitational waves.

GR 13: Klassische Allgemeine Relativitätstheorie II

Zeit: Donnerstag 14:15–16:00 Raum: HS 6

GR 13.1 Do 14:15 HS 6

Post-Newtonian expansion of a rotating disc of charged dust — •Stefan Palenta and Reinhard Meinel — Friedrich-Schiller-Universität Jena

We present an algorithm for obtaining the post-Newtonian expansion of the asymptotically flat solution to the Einstein-Maxwell equations describing a rigidly rotating disc of dust with constant specific charge. Explicit analytic expressions can be obtained up to fifth order. The results are used for a physical discussion of interesting limiting cases.

GR 13.2 Do 14:30 HS 6

Zur Problematik der Wahl eines geeigneten Koordinatensystems für die Periastrondrehung der Bahn eines Testteilchens im Kerr-Feld in post-Newtonscher Näherung — •Steven Hergt[1], Abhay Shah[2] und Gerhard Schäfer[1] — [1]TPI, FSU Jena, Max-Wien-Platz 1, 07743 Jena — [2]Benoziyo Center for Astrophysics, Weizmann Institute of Science, P.O. Box 26, Rehovot 76100 Israel

Wir geben einen kurzen Überblick über die Methode aus Phys. Rev. D 85, 044049 (2012) zur Berechnung der Periastrondrehung und vergleichen unser Ergebnis mit Formel (107), welche nicht das Standard-post-Newtonsche-Resultat widerspiegelt. Mögliche Gründe werden erörtert und es wird eine abweichende, aber physikalisch besser interpretierbare Definition der Periastrondrehung in einem der Dynamik angepassten Koordinatensystem mit sog. Hill-Variablen entworfen.

GR 13.3 Do 14:45 HS 6

Die Kerr-Metrik in ADM-Koordinaten bis zur quadratischen Ordnung im Kerr-Spin — Jan Sperrhake, •Johannes Hartung und Gerhard Schäfer — Theoretisch-Physikalisches Institut, FSU Jena, Deutschland

Der ADM-Formalismus hat sich in der Vergangenheit als sehr erfolgreich zur Behandlung von Binärsystemen mit rotierenden Komponenten (kurz: mit Spin) erwiesen. Er wurde vor kurzem (2008-2011) von Punktmassen auf die lineare Ordnung in den Einzelspins ausgedehnt. Zum Teil wurde er auch auf die quadratische Ordnung in den Einzelspins erweitert (um 2007/2008). Dies wurde jedoch noch nicht systematisch durchgeführt. Die Umeichung der Kerr-Metrik in ADM-Koordinaten soll nun dazu genutzt werden, den ADM-Formalismus auf quadratischer Ordnung in den Einzelspins weiter auszubauen. Zum Einen kann die entstehende Metrik direkt in Ausdrücke für die Hamiltonfunktion eines Testspins in einem äußeren Gravitationsfeld einfließen und somit einen ersten Test für den systematisch auf diese Ordnung erweiterten ADM-Formalismus und die dort abgeleiteten Hamiltonfunktionen darstellen. Ebenso können dadurch bei der vorgenannten Erweiterung des ADM-Formalismus die Limites der Kopplungskonstanten aus einem Wirkungszugang für den Fall des stationären Kerr-Lochs fixiert werden. Aus diesen Gründen ist die vorliegende Studie ein wichtiger erster Schritt zur Behandlung von "finite-size"-Effekten bei rotierenden kompakten Objekten in der Astrophysik und Gravitationswellenastronomie.

GR 13.4 Do 15:00 HS 6

Lie-Transformationen und deren Verwendung zur Lösung von Bewegungsgleichungen für kompakte Binärsysteme unter Spin-Bahn-Wechselwirkung — •Manuel Tessmer[1], Jan Steinhoff[2] und Gerhard Schäfer[1] — [1]Friedrich-Schiller-Universität Jena — [2]Universidade Técnica de Lisboa

Kompakte Binärsysteme mit rotierenden Komponenten (kurz: mit Spin) besitzen aufgrund ihrer Ausstrahlungscharakteristik von Gravitationswellen (GW) besondere Bedeutung für die GW-Astronomie.

In der Literatur existieren Algorithmen, welche Bewegungsprobleme mit periodischen Anteilen, wie sie z.B. auch durch die Spin-Bahn-Kopplung bei Begleitsternen ungleicher Massen entstehen, vereinfachen. Wir stellen eine modifizierte Lösungsmethode für speziell diese Aufgabe vor, welche die Schwierigkeiten, die in der Literatur auftreten, per Konstruktion nicht aufweist. Zusätzlich stellen wir kanonische Variablen für den Spin vor, die eine einfache geometrische Bedeutung haben und im Grenzfall verschwindender Spins in die bekannten Hill-Variablen übergehen. Wir wenden diese Methode unter Verwendung der neuen Variablen für Kreisbahnen bis zur nächst-führenden Ordnung der Spin-Bahn-Kopplung an.

GR 13.5 Do 15:15 HS 6

Are non-Kerr spacetimes integrable? — •Georgios Lukes-Gerakopoulos — Theoretical Physics Institute, Friedrich-Schiller-Universität Jena, D-07743 Jena, Germany

The only known axisymmetric and stationary vacuum solution of the Einstein equation which corresponds to integrable system is the Kerr spacetime. However, in the last few years there were attempts to find Carter-like constants in non-Kerr spacetimes, i.e. in spacetimes that are axisymmetric and stationary perturbations of the Kerr spacetime. In this talk we are going to discuss whether the Carter constant is unique or not and the implications of this issue.

GR 13.6 Do 15:30 HS 6

Action-Angle Variables and KAM Theory in General Relativity — •Daniela Kunst[1], Volker Perlick[1], and Claus Lämmerzahl[1,2] — [1]Center of Applied Space Technology and Microgravity (ZARM), University of Bremen — [2]University of Oldenburg

Dynamical systems can be described by the Hamiltonian formalism providing the description of the evolution of the system with time. Roughly speaking, they can be classified into integrable and non-integrable systems, where the integrable ones are rather special cases. Nevertheless, it is useful to study such systems since many non-integrable systems can be characterised as a perturbation affecting an integrable system. Using the characteristic property of the foliation of the phase space into n-dimensional tori for integrable systems with n degrees of freedom, it is possible to draw conclusions about the dynamics and the stability behaviour of perturbed integrable systems. This method is based on the classical Kolmogorov-Arnold-Moser Theorem which states that under certain non-degneracy conditions for the integrable Hamiltonian the preservation but slight deformation of particular tori and of the corresponding regular motion is ensured in the perturbed system.

In this talk I present the calculation of action-angle variables in general relativity, in particular for Schwarzschild and Kerr spacetime. Moreover, I discuss the non-degeneracy condition for the unperturbed Hamiltonian in Schwarzschild and give and outlook for the application of KAM Theory to general relativistic systems.

GR 13.7 Do 15:45 HS 6

Microlensing by an Ellis wormhole — •Volker Perlick[1] and Maciej Bobrowski[1,2] — [1]ZARM, Universität Bremen, 28359 Bremen — [2]Physics Department, University of Wroclaw, Poland

The Ellis wormhole, first discussed by American physicist Homer Ellis in 1973, is the best known example of a static traversable wormhole of the Morris-Thorne class. We use the exact lens map for spherically symmetric and static spacetimes for writing all lensing features explicitly in terms of elliptic integrals, for light sources and observers at arbitrary radius value r_S and r_O, respectively. On the basis of these formulas we discuss the microlensing properties of the Ellis wormhole, i.e., the light curve (magnification as a function of time) for a moving light source.

GR 14: Kosmologie II

Zeit: Donnerstag 16:30–18:00 Raum: HS 6

GR 14.1 Do 16:30 HS 6

The effects of warm dark matter on the large scale structure in the universe — •Katarina Markovic — University Observatory Munich

Warm Dark Matter (WDM) is a generalisation of the standard Cold Dark Matter model in the sense that it does not assume dark matter particles to be absolutely cold. In the simplest models all dark matter is made of the same particles, which started out in thermal equilibrium and cooled to effectively become cold today. If such particles have masses of the order of a keV or less, they leave an observable imprint on the dark matter density field. At late times, the perturbations in the matter density field become non-linear. This means that they cannot be described perturbatively any longer. For this reason, N-body simulations are a good way to understand the formation of non-linear structure. Simulating WDM can be a challenge, because unlike CDM, it's relatively large thermal velocities can introduce unwanted Poisson noise on small scales. With better computing resources nowadays it has become possible to examine WDM cosmologies with simulations. This talk will present results of such simulations together with the halo model and discuss how to calculate non-linear corrections to the matter power spectrum, which describes the matter density field today. It will also discuss the possibility of constraining the dark matter particle mass using measurements of large scale structure, like cosmic shear or galaxy clustering.

GR 14.2 Do 16:45 HS 6

Newtonian N-body simulations are compatible with cosmological perturbation theory — •Thomas Haugg, Stefan Hofmann, and Michael Kopp — LMU Munich

We elaborate on the recent claim (Flender & Schwarz 2012) that Newtonian N-body simulations of collisionless Dark Matter in a LambdaCDM background are inaccurate on scales larger than 10 Mpc due to general relativistic effects at the linear level. We find that at the 10 Mpc scale these effects are indeed important, however are well known as gravitational lensing. At even larger scales all relativistic corrections can in general become equal in size. Using Bardeen variables we give a dictionary for how to use Newtonian N-body simulation data to correctly evaluate these general relativistic terms at all scales where linear perturbation theory applies, in particular at scales larger than 10 Mpc up to arbitrary large scales.

GR 14.3 Do 17:00 HS 6

The trajectories of photons in an averaged space time — •Samae Bagheri — Uni Bielefeld D6-136, Universitätsstr. 25, 33615 Bielefeld

The present state of the Universe is neither homogeneous nor isotropic on scales smaller than 100 Mps. By taking the principal assumption of spatial homogeneity and isotropy on the largest scales, the averaging of local inhomogeneities can lead to dynamical effects on the evolution of the Universe. There are a number of averaging procedures that have been introduced in order to study this subject. We will describe two of the main schemes that can deal with inhomogeneities. One is Buchert's averaging which only scalar quantities are averaged and second is Zalaletdinov's averaging. The later allows tensor quantities to be averaged, as well as scalars. As the next step, we will discuss about the motion of photons in an averaged geometry within the context of the geodesic equation. All conclusions about cosmological data are based on the trajectories of photons. We consider the case of a null geodesic in the FLRW background space time. After averaging we obtain a smoothed out geometry with averaged metric. By doing so, we aim to pose the question of what trajectories photons follow in the averaged geometry.

GR 14.4 Do 17:15 HS 6

Dark energy emerging from gravitationally effective vacuum fluctuations — •Bruno Deiss — Institut für Theoretische Physik, Universität Frankfurt

In this contribution I present a new model that provides a natural UV cut-off, beyond which vacuum fluctuations decouple from expanding space-time, i.e., decouple from gravity. The model relies on two assumptions: firstly, virtual fluctuations are subjected to the overall expansion of space during their limited lifetime; secondly, space-time has a *process-related* discrete structure, which means that only *changes* of length-scales and time-scales are constraint by a minimal scale. The derived effective vacuum energy density is found to be closely related to the critical cosmic energy density, thus helping to solve the cosmological constant problem as well as the coincidence problem.

GR 14.5 Do 17:30 HS 6

Minkowski functionals of the Sloan Digital Sky Survey — •Alexander Wiegand[1], Thomas Buchert[2], and Matthias Ostermann[3] — [1]Albert Einstein Institut, Golm — [2]CRAL, Lyon — [3]LMU, München

In this talk, we present the results of our analysis of the structure in the Galaxy distribution of the Sloan Digital Sky Survey, that we performed with the help of Minkowski functionals. With the discovery of larger and larger coherent structures, it is worthwhile to test the consistency of the observations with the standard models of structure formation. In particular we use the boolean grain model, that allows a very precise and robust comparison. In addition, the Minkowski functionals in this model may be analytically related to a series of the (higher order) correlation functions of the distribution. This allows us to quantify the influence of higher order clustering beyond the simple two point correlations. Comparing the Minkowski functionals to a set of N-body simulations we find a small, but significant deviation of the observed structure from the simulated one.

GR 14.6 Do 17:45 HS 6

Resimulating the local universe — •Steffen Hess — Leiniz Institut f. Astrophysik Potsdam

Within a Lambda-CDM model we are using a combined approach consisting of an iterative reconstruction based on non-linear Lagrangian Perturbation Theory and a fully non-linear N-body simulation we are able to re-simulate the matter density in the local universe with unprecedented correlation with the galaxy distribution in the 2MASS redshift survey.

GR 15: Alternative Ansätze I

Zeit: Donnerstag 18:00–18:30 Raum: HS 6

GR 15.1 Do 18:00 HS 6

Observer space of Finsler spacetimes — •Manuel Hohmann — Teoreetilise Füüsika Labor, Füüsika Instituut, Tartu Ülikool

Two different ideas to generalize our classical picture of spacetime in an observer dependent fashion will be briefly reviewed. The first idea is Finsler geometry, where the Lorentzian metric of spacetime depends on the four-velocity of an observer. The second idea is a lift of general relativity from a Lorentzian manifold to the space of observers, i.e., future timelike unit tangent vectors. It will be shown that these approaches are closely related. Constructions to obtain an observer space from a Finsler spacetime and vice versa will be discussed.

GR 15.2 Do 18:15 HS 6

Gravity - Based on Lorentzian Relativity — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

In order to explain relativity, Einstein used a geometric method for the required physical calculations. Contrary to general opinion, Einstein was not the original inventor of this method, which was in fact developed about 100 years before him. The method was later given up because it turned out not to be helpful in understanding physics and to have intricate mathematical implications. However, it has now achieved high acclamation in connection with Einstein's name.

We will show that relativity can be led back from geometrization to physics. The benefits of this approach are that it is easier to grasp and has a stronger relationship with the other branches of physics. Special relativity and general relativity (i.e. gravity) can be understood and treated using classical physics and school-level mathematics to produce exactly the same results as Einstein in almost all applications. At the same time, unresolved problems like dark energy and quantum gravity can be solved.

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

GR 16: Hauptvorträge: Numerische Relativitätstheorie und Wurmlöcher

Zeit: Freitag 9:15–10:45 Raum: HS 6

Hauptvortrag GR 16.1 Fr 9:15 HS 6

Numerical evolution of the Einstein equations to future null infinity — •Oliver Rinne — Albert-Einstein-Institut

In numerical simulations of isolated systems, one usually adopts the Cauchy formulation of general relativity and foliates spacetime by spacelike hypersurfaces that are truncated at a finite distance. Boundary conditions must be imposed so that the resulting initial-boundary value problem is well posed and, ideally, the artificial boundary is transparent to gravitational radiation. However, the latter is only defined unambiguously at future null infinity (Scri+) and so a far more elegant solution is to include Scri+ in the numerical domain. This can be accomplished by a conformal transformation of the metric combined with a compactifying coordinate transformation. With Vince Moncrief we have developed a constrained ADM-like formulation of the Einstein equations on hypersurfaces of constant mean curvature approaching Scri+. Although the equations contain terms that are formally singular at Scri+, these can nevertheless be evaluated in a regular way. Numerical results based on this formulation include evolutions of perturbed vacuum axisymmetric black holes and studies of late-time power-law tails of scalar and Yang-Mills fields coupled to the Einstein equations in spherical symmetry.

Hauptvortrag GR 16.2 Fr 10:00 HS 6

Spherical and cylindrical wormholes in general relativity — •Kirill Bronnikov — Center for Gravitation and Fundamental Metrology, VNIIMS, Ozyornaya 46, Moscow 119361, Russia — Institute of Gravitation and Cosmology, PFUR, ul. Miklukho-Maklaya 6, Moscow 117198, Russia

After a brief review of the current situation in wormhole physics, some recent results will be presented concerning wormhole models with spherical and cylindrical symmetries in general relativity. Among them are (i) some new wormhole models with electric and/or magnetic charges (and closely related regular black hole models, the so-called black universes); (ii) results on the stability of static, spherically symmetric wormholes; (iii) the existence conditions and properties of cylindrical wormholes with and without rotation. It has been shown, in particular, that rotation, representing a vortex gravitational field, can provide a cylindrical wormhole geometry without violating the standard energy conditions, but the main problem is that such geometries are not asymptotically flat. The latter is a necessary requirement if a wormhole should be seen as a local object by distant observers like ourselves. We try to solve this problem by matching the wormhole throat region with flat-space regions in a rotating reference frame. The junctions comprise thin shells co-rotating with the whole configuration, and their physical properties are analyzed.

GR 17: Grundlegende Probleme I

Zeit: Freitag 11:15–11:45 Raum: HS 6

GR 17.1 Fr 11:15 HS 6

Gravitational Quadrupole Contributions to the Equations of Motion of Compact Objects — •Jan Steinhoff — CENTRA, Instituto Superior Técnico, Avenida Rovisco Pais 1, 1049-001 Lisboa, Portugal

Compact objects in general relativity approximately move along geodesics of spacetime. Corrections due to spin (dipole), quadrupole, and higher multipoles were derived, e.g., by Mathisson, Papapetrou, and Dixon long ago. We discuss how Dixon's quadrupole can be related to astrophysical objects like neutron stars or black holes. In particular, we investigate quadrupole deformation due to spin and tidal interactions. Further, an inclusion of oscillation modes of the object via the quadrupole is considered. For this purpose the Newtonian case is reviewed and formulated in a novel manner. Problems for an extension to the general relativistic case and a tentative solution are discussed.

GR 17.2 Fr 11:30 HS 6

Covariant equations of motion for test bodies in nonminimal coupling theories — •Dirk Puetzfeld — ZARM, Universitaet Bremen

We present covariant equations of motion for a wide class of gravitational theories with nonminimal coupling. Our findings generalize and correct previous results in the literature and allow for a systematic test of such theories by means of multipolar test bodies.

GR 18: Quantenfeldtheorie in gekrümmten Raumzeiten

Zeit: Freitag 11:45–12:30 Raum: HS 6

GR 18.1 Fr 11:45 HS 6

Quantization of submanifold embeddings — Dorothea Bahns[1], Katarzyna Rejzner[2], and •Jochen Zahn[1] — [1]Courant Research Centre "Higher Order Structures", Universität Göttingen — [2]II. Institut für Theoretische Physik, Universität Hamburg

We describe a perturbative quantization of the embedding of d-dimensional submanifolds into n-dimensional Minkowski space, based on suitable generalizations of the Nambu-Goto action. We use tools from perturbative algebraic quantum field theory, quantum field theory on curved spacetimes, and the Batalin-Vilkovisky formalism. The resulting theory is perturbatively non-renormalizable, but well-defined as an effective theory, i.e., there are no anomalies, for any dimension d, n. In particular there is no critical dimension for the case of string theory ($d = 2$).

GR 18.2 Fr 12:00 HS 6

On dynamical mass generation in Euclidean de Sitter space — •Paul Moch[1,2] and Martin Beneke[1,2] — [1]Physik Department T31, Technische Universität München — [2]Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen University

We consider the perturbative treatment of a minimally coupled, massless, self-interacting scalar field in Euclidean de Sitter space. Generalizing the work of Rajaraman, we obtain the dynamical mass $m^2 \propto \sqrt{\lambda} H^2$ of the scalar for non-vanishing Lagrangian masses and the first perturbative quantum correction in the massless case. We introduce the rules of a systematic perturbative expansion, which treats the zero-mode non-perturbatively, and goes in powers of $\sqrt{\lambda}$. The infrared divergences of the massless free field theory are self-regulated by the zero-mode dynamics. Thus, in Euclidean de Sitter space the interacting and massless scalar field is just as well-defined as the massive field. We then show that the dynamical mass can be recovered from the diagrammatic expansion of the self-energy and a consistent solution of the Schwinger-Dyson equation. This requires the summation of a divergent series of loop diagrams of arbitrarily high order. We note that the value of the long-wavelength mode two-point function in Euclidean de Sitter space agrees at leading order with the stochastic treatment in Lorentzian de Sitter space, in any number of dimensions.

GR 18.3 Fr 12:15 HS 6

Quantum simulation of curved spaces in optical lattices containing topological defects — •Nikodem Szpak — Fakultät für Physik, Universität Duisburg-Essen

We discuss the possibility of quantum simulation of relativistic fields living in curved spaces realized in optical lattices loaded with ultracold atoms. In some regime their dynamics can be described by the Hubbard model which can be mapped onto a discrete version of a relativistic quantum field theory. Manipulation of the laser beams can lead to the emergence of curvature and torsion in an artificial Riemann-Cartan geometry. We give examples of several lattice geometries and discuss the properties of the emerging curved spaces with their field theoretic effects, like scattering on curvature centers and birefringence on torsion lines. Since the interaction of quantum fields with curvature or torsion is very difficult to observe in real experiments the proposed table-top analog model can be very instructive.

GR 19: Quantengravitation und Quantenkosmologie I

Zeit: Freitag 12:30–13:15 Raum: HS 6

GR 19.1 Fr 12:30 HS 6

Singularity avoidance in quantum cosmology — Mariam Bouhmadi-López[1], Claus Kiefer[2], and •Manuel Krämer[2] — [1]Instituto de Estructura de la Materia, IEM-CSIC, Serrano 121, 28006 Madrid, Spain — [2]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

One of the aims of a theory of quantum gravity is to resolve the singularities appearing in general relativity. In this talk we give an overview of how singularities are avoided in quantum-cosmological models that are dominated by dark energy. We show how one can model universes with different kinds of singularities by choosing specific types of a generalized Chaplygin gas and we present our recent results on how to resolve a certain sub-class of these singularities in a quantum-cosmological approach based on the Wheeler–DeWitt equation.

GR 19.2 Fr 12:45 HS 6

The Schrödinger-Newton equation as a model for self-gravitating quantum systems — •André Grossardt[1,2] und Domenico Giulini[1,2] — [1]Zentrum für angewandte Raumfahrttechnologie und Mikrogravitation (ZARM), Universität Bremen — [2]Institut für theoretische Physik, Leibniz Universität Hannover

The time-dependent Schrödinger-Newton equation can be considered as a model for the gravitational self-interaction of a quantum system. We motivate this model as the non-relativistic limit of a gravitationally interacting relativistic field. Namely, we show that the Schrödinger-Newton equation can be derived in a WKB-like expansion in 1/c from the Einstein-Klein-Gordon and Einstein-Dirac system.

GR 19.3 Fr 13:00 HS 6

Supersymmetric Q-balls and boson stars in (d+1) dimensions — Betti Harmann and •Jürgen Riedel — Jacobs University, Bremen

We construct supersymmetric Q-balls and boson stars in $(d+1)$ dimensions. These non-topological solitons are solutions of a scalar field model with global $U(1)$ symmetry. We apply in our work a scalar field potential that appears in gauge-mediated supersymmetry (SUSY) breaking in the minimal supersymmetric extension of the Standard Model (MSSM).

We study the asymptotically flat solutions of such solitons. We show that for our choice of the potential gravitating, asymptotically flat boson stars exist in $(2+1)$ dimensions. We observe that the behaviour of the mass and charge of the asymptotically flat solutions at maximal frequency depends strongly on the number of spatial dimensions. We also find that boson stars with arbitrarily large values of the mass and charge exist for $d \geq 5$ and exhibit some new features. We can also draw conclusions about the stability of these objects with respect to the decay into Q free bosons. In particular we find that the "thick-wall limit" Q-balls are always unstable in flat space-time.

GR 20: Quantengravitation und Quantenkosmologie II

Zeit: Freitag 14:00–14:15 Raum: HS 6

GR 20.1 Fr 14:00 HS 6

Quantum Gravity: Cosmology and Its Relations to Particle Physics — •Claus Birkholz — Seydelstr. 7, D-10117 Berlin

In QG, elementary particles and our universe are subject to identical equations. Motion in bent space-time is uniquely determined by Casimir operators - geodesics and the variation principle are dispensable.

Irreducibility is slicing our world into bent universes orthogonal to each other. Dark Energy reveals as a quantum effect on cosmic scale; it is the agent of physics to execute the ”background independence” of mathematics. As one of its immediately related properties, the quark confinement of particle physics had been shown to result. The cosmological ”constant” reveals to be an inverse particle propagator.

”Cosmic master equations” (allowing to calculate the interior of black holes) show the ”big bang” not to be the start of our universe; its radius is given by Dark Energy reproducing cosmic inflation. Tiny Dark Matter masses execute gravity, but, due to the non-compactness of space-time, they are not well localizable - in accord with experiment.

Unsaturated ”valence” quanta act as condensation germs binding saturated quantum pairs out of Dark Matter as their non-valence parts: massive elemenmtary particles, then, are precipitating as droplets out of Dark Matter.

GR 21: Grundlegende Probleme II

Zeit: Freitag 14:15–14:30 Raum: HS 6

GR 21.1 Fr 14:15 HS 6

Ergänzung des Dritten Keplerschen Gesetzes — •Klaus Maibaum — Collenberg, Deutschland

Seine Ergänzung durch die Raumzeit-Krümmungs-Konstante 1/(pi/3)^2 führt zur universellen Form T^2/a^3=1 für alle Zentripetalsysteme. a^3=(2* Wurzel pi^2/6)^3= 2,56509966^3= 16,87767926 =T^2(mit Umlaufbahn 2r pi / Kreisbahngeschwindigkeit (v= Wurzel r * 1/g^2, mit Gleichsetzung von r=g!)) =((2* Wurzel pi^2/6) * 2pi / Wurzel (2* Wurzel pi^2/6 * 4*(pi^2/6)* 1/(pi/3)^2))^2 = ((2,56509966 *2 pi / Wurzel 2,56509966 * 6,57973627 * 0,911890652))^2 = 16,87767926. Der zentrale Eulersche Grenzwert der Reihe der reziproken Quadratzahlen Summe pi^2/6 spiegelt das Gravitationsfeld über seine gesamte Ausdehnung wider. Für die großen Halbachsen ist der absolute mathematische Betrag für die Gesamt-Wurzel aus Summe pi^2/6 einzusetzen: in Anlehnung an trigonometrische Funktionen mit Wurzel -1 zur Lösung kubischer Gleichungen, weil auch die Perihelbewegung den Raum erweitert (offene Rosettenbahn). Das Rechenwerk stellt den neutral definierten Ideal-Kosmos einer vierdimensionalen Raumzeit zur Einsteinschen Allg. Relativitätstheorie dar und definiert das Zusammenspiel von v, g, r, T, E, letztlich m, M und G = die Raumzeit-Krümmungs-Konstante selbst. Es erzeugt eine Quantelung des Bahndrehimpulses für Planetenbahnen und verleiht der stationären Schrödinger-Gleichung erstmals einen Zeitbezug. Jene hat bei der Erweiterung um 2(r)*4(g)=.../8(*m*L^2) Pate gestanden, auch bei der Anpassung von g 6,57973627 (*0,911890652) auf 6 = natürliche n für ganzzahlige Vielfache.

GR 22: Alternative Ansätze II

Zeit: Freitag 14:30–14:45 Raum: HS 6

GR 22.1 Fr 14:30 HS 6

Review of equations of Special Relativity consequences — •Shukri Klinaku — University of Prishtina

According to the theory of special relativity (TSR) in relative motion we have the length contraction, the time dilatation, the mass increasing and addition of velocities that can't reach the velocity of light c. For each of these TSR consequences an equation and special explanation exist. These equations will be reviewed in this paper. The review poses three questions. The first, on which quantity depend these consequences? Second, should all of these consequences depend on the same quantity? Third, what is the physical meaning of these consequences if we read (interpret) their equations in right way? This paper has found the answers: equations that express the TSR consequences does not reflect all quantities on which they depend; review of these equations shows that all consequences do not depend on same quantity; and finally, the answer to the third question is: according to the TSR the reading (interpretation) of the equations that express the TSR consequences is voluntary, i.e. it is non-scientific.

GR 23: Poster (permanent)

Zeit: Freitag 14:45–14:45 Raum: HS 6

GR 23.1 Fr 14:45 HS 6

New materials for low noise measurements — •Gerd Hofmann[1], Christian Schwarz[1], Julius Komma[1], Daniel Heinert[1], Paul Seidel[1], Andreas Tünnermann[2], and Ronny Nawrodt[1] — [1]FSU Jena, Institut für Festkörperphysik, Helmholtzweg 5, D-07743 Jena, Germany — [2]FSU Jena, Institut für Angewandte Physik, Albert-Einstein-Strasse 15, D-07745 Jena, Germany

High precision applications like length measurements in gravitational wave oberservatories, laser stabilization, or micro-mechanical systems often suffer from disturbances due to thermal noise. There are two ways to overcome this problem, lowering the temperatures or the mechanical loss in the system. Silicon, sapphire, and gallium arsenide as crystaline materials are of great interest in these communities but not yet fully characterized.

We present a comparision of silicon, sapphire, and gallium arsenide in a wide temperature range from 5 to 300 K. Our measurements on silicon bulk samples show a peak in the mechanical loss around 120 K. A potential loss mechanism is discussed. We further show that Sapphire exhibits a low temperature limit according to the interaction of phonons i.e. Akhiezer damping. In gallium arsenide illumination with light in the visible range increases the mechanical loss. At low temperatures a hysteresis like behaviour can be observed. We link this with the creation of electrons and their interaction with acoustic phonons.

This work is supported by the DFG under contract SFB TR7.

GR 23.2 Fr 14:45 HS 6

Mechanical loss of ion-implanted tantala layers — •Bastian Walter, Julius Komma, Gerd Hofmann, Christian Schwarz, Daniel Heinert, Paul Seidel, Claudia Schnohr, and Ronny Nawrodt — Institut für Festkörperphysik, FSU Jena, Helmholtzweg 5, D-07743 Jena

The sensitivity of future gravitational wave detectors will be limited by Brownian thermal noise of the optical components. One approach is to utilize low mechanical loss materials for the substrates and coatings as well as cryogenic temperatures. However, high performance dielectric layers for high-reflectivity coatings - like tantala or silica - show large mechanical losses and thus high Brownian thermal noise at low temperatures due to their amorphous nature. It was found that co-doping of tantala layers with titania significantly reduces the mechanical loss and thus the Brownian thermal noise.

We present detailed studies of the mechanical loss of post-deposition ion-implanted tantala coatings and of the influence of heat treatments. These measurements give evidence that it is possible to reduce the mechanical loss of the tantala layers by ion-implantation.

This work is supported by the German science foundation DFG under contract SFB TR7.

GR 23.3 Fr 14:45 HS 6

Optical absorption of silicon around the fundamental band gap at low temperatures — •Philip Pastrik, Julius Komma, Gerd Hofmann, Christian Schwarz, Daniel Heinert, Paul Seidel, and Ronny Nawrodt — Institut für Festkörperphysik, FSU Jena, Helmholtzweg 5, D-07743 Jena

Silicon is a promising candidate material for the test masses of future gravitational wave detectors operated at cryogenic temperatures. Any optical absorption will introduce heat into the detector's substrates and, thus, should be minimized. For this reason a laser wavelength of 1550 nm is used with an energy well below the fundamental band gap of silicon. Nevertheless, multiple phonon processes will even lead to an absorption at 1550 nm and can influence the working temperature of the detector.

We studied the optical absorption of silicon near its band gap in a wide temperature range from 5 K to 300 K. In their fine structure these measurements reveal information on the emission and absorption of phonons. We also report a strong temperature dependence of these effects. Thus our results will be valuable for a systematic understanding of the absorption in silicon at 1550 nm.

This work is supported by the German science foundation DFG under contract SFB TR7.

GR 23.4 Fr 14:45 HS 6

Optical absorption measurements of silicon at 1550 nm — •Julius Komma[1], Gerd Hofmann[1], Christian Schwarz[1], Daniel Heinert[1], Jessica Steinlechner[2], Roman Schnabel[2], Paul Seidel[1], and Ronny Nawrodt[1] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Helmholtzweg 5, D-07743 Jena, Germany — [2]Institut für Gravitationsphysik, Universität Hannover, Callinstraße 38, D-30167 Hannover, Germany

Silicon is a common material for semiconductors and because of many applications in integrated circuits or devices like solar cells object of many investigations. In the last few years it became also - together with sapphire - one of the most interesting materials for the usage as a bulk material for optics in low noise applications like cryogenic gravitational wave detectors. The desired wavelength in such detectors is 1550 nm because of the low absorption. For this wavelength and the intended low temperatures in the region around 20 K there exists no measured data for the optical absorption in silicon.

We present a comparison of different measurement methods. One is based on the deflection of a probe laser beam due to the creation of a thermal lens created by the absorbed light. Another method is the thermal absorption measurement where the temperature rise of a sample of silicon is measured. Advantages, problems and accuracies of this two methods will be discussed.

This work is supported by the German Science Foundation (DFG) under contract SFB Transregio 7.

GR 23.5 Fr 14:45 HS 6

Monolithic silicon grating reflectors - Current status, chances and challenges for future gravitational wave detection — •Stefanie Kroker, Thomas Käsebier, Stefan Steiner, Ernst-Bernhard Kley, and Andreas Tünnermann — Friedrich-Schiller-Universität Jena Institut für Angewandte Physik, Abbe Center of Photonics, Max-Wien-Platz 1, 07743 Jena, Germany

In order to enhance the sensitivity of future gravitational wave detectors (GWDs), particularly the Brownian coating thermal noise of the optical components in the GWD has to be reduced. Besides an improvement of well-established highly reflective amorphous multilayer stacks two alternative approaches are under investigation: crystalline coatings based on $Al_xGa_{1-x}As$ or $Al_xGa_{1-x}P$ and monolithic resonant high-contrast gratings made of crystalline silicon. We discuss possibilities and current achievements of silicon reflectors with respect to feasible reflectance, spectral, angular bandwidth and thermal noise. To optimize the optical performance of the gratings we evaluate the impact of structure deviations on the maximum specular reflectance. It is distinguished between an enhanced transmittance and scattered light. Both result from fabrication processes, whereas the latter might severely disturb the signal in a GWD. It is found, that different parts of the grating structure exhibit significant differences in their sensitivity concerning structural imperfections. These results allow the optimization of fabrication for an improved optical performance. Concluding we compare the current status of crystalline coatings and silicon reflectors for applications in future gravitational wave detectors.

GR 23.6 Fr 14:45 HS 6

Book: Special and general theory of relativity — •Jürgen Brandes — Karlsbad

Exact and comprehensible are discussed [1]: The experimental proofs of relativity theory, the solutions of the paradoxes, the theses of the four-dimensional space-time-continuum of special relativity as well as the theses of curved, expanding and closed spacetime of general relativity. Included are the general relavistic solution variant of the twin paradox and the paradoxies of BELL, EHRENFEST and SAGNAC.

The so-called LORENTZ-interpretation was initiated by LORENTZ, POINCARÉ, BELL, SEXL and many others. It connects EINSTEIN's principle of relativity with the concept of a three-dimensional space and a one-dimensional time

An important point in [1] concerns energy conservation. Within NEWTON's theory there is a negative gravitational potential, on account of the famous relation $E = mc^2$ this means negative masses. Negative masses don't exist. Neither NEWTON's nor EINSTEIN's theory are able to explain the meaning of the negative energy of particles resting in the gravitational field. In spite of this, in certain limiting cases there exist contradictious formulas of total energy. In both of the cases LORENTZ-interpretation gives a clear, experimentally verifiable answer.

[1] J. Brandes, J. Czerniawski: *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen - Einstein- und Lorentz-Interpretation, Paradoxien, Raum und Zeit, Experimente*, VRI: 2010

GR 23.7 Fr 14:45 HS 6

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

The Michelson-Morley experiment has at the first glance given the impression that 'c' is a constant in relation to any system. However, at the second glance this constancy turns out to be pure measurement result.

H. Lorentz had pointed out that this apparent constancy is the result of well understood field behaviour. Einstein accepted this as a viable explanation, but he disliked it as it made an ether necessary, which he didn't want. He insisted in a theory with a constant 'c' with respect to any system. To achieve this, he had to assume a variation of space and time depending on the actual conditions of motion.

Einstein extended this principle about 'c' to gravitational fields. Even though it can be directly measured that 'c' is reduced there, Einstein again stated its constancy and explained the measurement result as a change of space-time (which is not directly measurable).

It is logically possible to transform Einstein's equations based on a constancy of 'c' and a variable space-time into a model, where space and time are fixed as always assumed but 'c' variable. This results in a much more straight understanding of physics with predominantly similar results as with Einstein.

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

GR 23.8 Fr 14:45 HS 6

The Question of Dark Energy — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Dark energy is considered to be one of the great mysteries in present-day physics. From measurements of the motion of type Ia supernovae, it is deduced that the universe is undergoing accelerated expansion. To explain this acceleration, it is assumed that the universe is filled with some type of ("dark") energy.

To shed light on this problem, we will give a survey of the concepts currently being discussed by the physics community. Furthermore, we will present an alternative solution which is on the one hand very straightforward and simple, but on the other hand contradicts some common assumptions of present-day physics, particularly regarding relativity. We will discuss to what extent these conflicts are critical in that they may exclude an otherwise viable solution.

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

GR 23.9 Fr 14:45 HS 6

Why Current Field Theories Are Doomed to Failure — •Claus Birkholz — Seydelstr. 7, D-10117 Berlin

Current field theories developed historically, in a bottom-up way. By appending one balcony after the other to old conceptions, the grand direction seems to have got lost meanwhile. This poster is outlining another, a top-down procedure starting with the most fundamental group-theoretical implications on general relativity (GR) and on quantum field theories (QFT's). Thus, it stopped systematically to preclude physics from answering the great questions.

Field theories are demonstrated to tumbling from one inconsistency to the next one, culminating in the "standard model", which is fitting hosts of parameters without scrutinizing if there is no better system to be fitted.

The most obvious example is quantum gravity, whose installation of a fully quantized GR failed since a century by the only reason that a bent space-time has not yet been accepted to be the simple result of a non-linear condition (2nd-order SU(2,2)-Casimir) leaving untouched the superposition principle of linear quantum theories.

And QFT's are suffering under their ignorance of (Kronecker-) singlets.

GR 23.10 Fr 14:45 HS 6

Die große Vereinigung der Kräfte ist geschafft. — •Dieter Grosch — Seyferthstr 25 06618 Naumburg

In Newtons Gravitationstheorie findet man vergeblich die nach seinem 3. Axiom notwendige Antigravitation Meine *Dynamischen Gravitationstheorie*, vorgetragen auf der DPG-Tagung 2007 (1), schließt diese Lücke, indem sie die Fliehkraft, die man heute als Scheinkraft bezeichnet, zur realen abstoßenden elektrischen Ladung als Antigravitation macht. Leider hat Coulomb diesen Schluss noch nicht gezogen, weshalb man nach 250 Jahren diese Lücke immer noch nicht schließen konnte In meinem Poster ist nun beschrieben, dass Bewegung einer Masse zur Erzeugung einer elektrischen Ladung führt, so wie es meine Theorie vorhersagt Daraus ergibt sich, das die gesamte Physik dann nur noch eine einzige Konstante, die der Masse eines *Elementaren Teilchens* mit 2,78E-28 kg, benötigt Das beschriebene, und beim Besuch selbst durchführbare, Experiment beweist die in der Theorie gemachte Behauptung und bestätigt damit, das elektrische Ladung Antigravitation ist, und alle Erscheinungsformen der Natur nur unterschiedliche Verhältnisse zwischen Gravitation und Antigravitation, also unterschiedliche Bewegungszustände, darstellen (1) www.grosch.homepage.t-online.de