Fachverband Gravitation und Relativitätstheorie (GR)

Claus Lämmerzahl
ZARM, Universität Bremen
Am Fallturm
28359 Bremen
claus.laemmerzahl@zarm.uni-bremen.de

Für die diesjährige Frühjahrstagung hat der Fachverband GR als Schwerpunktthema die **Physik Schwarzer Löcher** ausgewählt. Zu diesem Thema tragen wir mit einem Plenarvortrag, einem Vortrag im gemeinsamen Symposium sowie mit vielen Haupt- und Kurzvorträgen bei. Dabei wird eine Sitzung mit Hauptvorträgen zu diesem Thema gemeinsam mit dem Fachverband Mathematische Physik durchgeführt.

Diese Tagung beginnen wir aber mit zwei Hauptvorträgen zur Kosmologie und der Supernova Ia Entfernungsbestimmung, mit denen wir den im letzten Jahr vergebenen **Nobelpreis** würdigen.

Abgesehen von diesen Schwerpunktthemen 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 Hauptvorträge und Fachsitzungen

(Hörsaal ZHG 002)

Plenar- und Abendvorträge

PV I	Di	11:00–11:45	ZHG 011	**LHC Highlights** — •Gregor Herten
PV II	Di	11:45–12:30	ZHG 011	**Klassen starr rotierender relativistischer Sterne im Gleichgewicht** — •Marcus Ansorg
PV III	Mi	11:30–12:30	ZHG 011	**The Mysteries of Cosmology** — •Michael Turner
PV IV	Mi	19:00–20:00	ZHG 009	**Dem Higgs Boson auf der Spur – aktuelle Ergebnisse des Large Hadron Colliders** — •Arnulf Quadt
PV V	Do	11:00–11:45	ZHG 011	**On the Mathematical Structure of Scattering Amplitudes** — •Marcus Spradlin
PV VI	Do	11:45–12:30	ZHG 011	**Die fehlenden 95%: Theorie und Phänomenologie der dunklen Materie und dunklen Energie** — •Joachim Kopp

Hauptvorträge

GR 1.1	Mo	14:00–14:45	ZHG 002	**Cosmology from Large-Scale Structure Surveys: Status and Challenges** — •Jens Niemeyer
GR 1.2	Mo	14:45–15:30	ZHG 002	**Type Ia Supernovae: Models, and their Implication for Cosmology** — •Wolfgang Hillebrandt
GR 6.1	Di	14:00–14:45	ZHG 002	**Constructive proof of the Kerr-Newman black hole uniqueness** — •Reinhard Meinel
GR 6.2	Di	14:45–15:30	ZHG 002	**Black Holes in Gauge/Gravity Correspondence** — •Veronika Hubeny
GR 11.1	Mi	16:45–17:15	ZHG 002	**On the Consistency of Classical and Quantum Supergravity Theories** — •Thomas-Paul Hack, Mathias Makedonski, Alexander Schenkel
GR 11.2	Mi	17:15–17:45	ZHG 002	**Analytical approach to the geodesic equations in General Relativity** — Victor Enolski, Eva Hackmann, •Valeria Kagramanova, Jutta Kunz, Claus Lämmerzahl
GR 11.3	Mi	17:45–18:15	ZHG 002	**Black holes in su(N) Einstein-Yang-Mills theory: hair, fur and superconducting horizons** — •Elizabeth Winstanley
GR 11.4	Mi	18:15–18:45	ZHG 002	**Bidifferential calculus and integrable PDEs in General Relativity** — •Folkert Müller-Hoissen
GR 14.1	Do	14:00–14:45	ZHG 002	**Black Holes in Higher Dimensions** — •Eugen Radu

GR 14.2	Do	14:45–15:30	ZHG 002	**Stable Wormhole Solutions in Dilatonic Einstein-Gauss-Bonnet Theory** — •Panagiota Kanti, Burkhard Kleihaus, Jutta Kunz
GR 14.3	Do	15:30–16:15	ZHG 002	**Blackfolds as fluids and materials** — •Niels Obers
GR 19.1	Fr	11:00–11:45	ZHG 002	**Accretion onto Sagittarius A* at the Center of the Milky Way** — •Andreas Eckart
GR 19.2	Fr	11:45–12:30	ZHG 002	**Probing the nature of gravity with radio pulsars** — •Norbert Wex

Fachsitzungen

GR 1.1–1.2	Mo	14:00–15:30	ZHG 002	**Hauptvorträge Kosmologie**
GR 2.1–2.2	Mo	15:30–16:10	ZHG 002	**Kosmologie I**
GR 3.1–3.3	Mo	16:40–17:40	ZHG 002	**Kosmologie II**
GR 4.1–4.4	Mo	17:40–19:00	ZHG 002	**Klassische Allgemeine Relativitätstheorie**
GR 5.1–5.6	Di	8:30–10:30	ZHG 002	**Schwarze Löcher – Lösungen I**
GR 6.1–6.2	Di	14:00–15:30	ZHG 002	**Hauptvorträge Schwarze Löcher I**
GR 7.1–7.2	Di	15:30–16:10	ZHG 002	**Schwarze Löcher – Lösungen II**
GR 8.1–8.4	Di	16:40–18:00	ZHG 002	**Schwarze Löcher – Bahnen**
GR 9.1–9.3	Mi	8:30– 9:30	ZHG 002	**Alternative Allgemeine Relativitätstheorie I**
GR 10.1–10.2	Mi	9:30–10:10	ZHG 002	**Quantengravitation und Quantenkosmologie I**
GR 11.1–11.4	Mi	16:45–18:45	ZHG 002	**Hauptvorträge Schwarze Löcher und Felder (gemeinsam mit MP)**
GR 12.1–12.4	Do	8:30– 9:50	ZHG 002	**Alternative Allgemeine Relativitätstheorie II**
GR 13.1–13.2	Do	9:50–10:30	ZHG 002	**Schwarze Löcher – Lösungen III**
GR 14.1–14.3	Do	14:00–16:15	ZHG 002	**Hauptvorträge Schwarze Löcher II**
GR 15.1–15.6	Do	16:45–18:45	ZHG 002	**Quantengravitation und Quantenkosmologie II**
GR 16.1–16.2	Do	18:45–19:25	ZHG 002	**Grundlegende Probleme**
GR 17.1–17.2	Fr	8:30– 9:10	ZHG 002	**Quantenfeldtheorie**
GR 18.1–18.4	Fr	9:10–10:30	ZHG 002	**Gravitationswellen**
GR 19.1–19.2	Fr	11:00–12:30	ZHG 002	**Hauptvorträge Relativistische Astrophysik**
GR 20.1–20.3	Fr	12:30–13:30	ZHG 002	**Relativistische Astrophysik**
GR 21.1–21.4	Fr	14:00–15:20	ZHG 002	**Numerische Relativitätstheorie**
GR 22.1–22.3	Fr	15:20–16:20	ZHG 002	**Experimentelle Tests**
GR 23.1–23.1	Fr	16:20–16:40	ZHG 002	**Alternative Ansätze**
GR 24.1–24.4	Mo	14:00–14:00	ZHG 002	**Poster (permanent)**

Plenarvorträge des Symposiums Supersymmetrie

Das vollständige Programm dieses Symposiums ist unter SYSY aufgeführt.

SYSY 1.1	Mi	14:00–14:35	ZHG 011	**Supersymmetrie zwischen TeV-Skala und GUT-Skala** — •Wilfried Buchmüller
SYSY 1.2	Mi	14:35–15:10	ZHG 011	**Suche nach Supersymmetrie am LHC** — •Johannes Haller
SYSY 1.3	Mi	15:10–15:45	ZHG 011	**Black Holes in String Theory** — •Mirjam Cvetic
SYSY 1.4	Mi	15:45–16:20	ZHG 011	**Superstrings, Gauge Theory and Supermagnets** — •Volker Schomerus

Begrüßungsabend

Am Dienstag findet ab 19:30 Uhr ein Begrüßungsabend mit warmen Buffet im 1. Stock der Zentralmensa statt.
Ab 21:00 Uhr gibt es im Foyer der Zentralmensa den Einstein-Slam.

Abendvortrag

Am Mittwoch um 19:00 Uhr gibt es einen öffentlichen Abendvortrag im Hörsaal 009 des Zentralen Hörsaalgebäudes.
Am Mittwoch um 19:45 Uhr wird das Theaterstück „Kopenhagen" im Deutschen Theater Göttingen dargeboten. Im Anschluss an das Stück findet eine Diskussionsrunde zur Verantwortung der Wissenschaft statt.

Mitgliederversammlung Fachverband Gravitation und Relativitätstheorie

Dienstag, den 28. Februar 2012, 18:10–19:30 Uhr, im Raum ZHG 002

- Eröffnen und Festsetzen der endgültigen Tagesordnung
- Bericht des Vorsitzenden
- Wahl des Vorsitzenden des FV
- Wahl des Beirats des FV
- Vergangene Aktivitäten
- Zukünftige Aktivitäten
- Dissertationspreis
- Denkschrift
- Büchertisch
- Verschiedenes

GR 1: Hauptvorträge Kosmologie

Zeit: Montag 14:00–15:30 Raum: ZHG 002

Hauptvortrag GR 1.1 Mo 14:00 ZHG 002
Cosmology from Large-Scale Structure Surveys: Status and Challenges — •Jens Niemeyer — Göttingen University, Göttingen, Germany

Complementing measurements of supernova distances and anisotropies in the cosmic microwave background, large galaxy surveys have become important tools for exploring the geometry and matter-energy content of the universe. The next generation of galaxy surveys may potentially open a new window on neutrino masses and the physics of inflation. I will summarize the current status and discuss some challenges for theory and simulations.

Hauptvortrag GR 1.2 Mo 14:45 ZHG 002
Type Ia Supernovae: Models, and their Implication for Cosmology — •Wolfgang Hillebrandt — MPI für Astrophysik, Garching, Germany

Because calibrated light curves of Type Ia supernovae (SNe Ia) have become a major tool to determine the local expansion rate of the Universe and the nature of the Dark Energy, considerable attention has been given to models of these events over the past years. In this talk recent progress in modeling SNe Ia by means of 3-dimensional hydrodynamic simulations as well as several of the still open questions are addressed. It will be shown that the new models have considerable predictive power which allows us to study observable properties such as light curves and spectra without adjustable non-physical parameters. This is a necessary requisite to improve our understanding of the explosion mechanism and to settle the question of systematic uncertainties in their role as distance indicators for cosmology. In particular, we describe the modeling of SNe Ia as thermonuclear explosions of Chandrasekhar-mass white dwarfs. However, because recent observations of nearby SNe Ia indicate that these explosion models alone cannot explain their diversity alternative scenarios are also discussed together with their consequences for supernova cosmology.

GR 2: Kosmologie I

Zeit: Montag 15:30–16:10 Raum: ZHG 002

GR 2.1 Mo 15:30 ZHG 002
Backreaction in the relativistic Zel'dovich approximation — •Alexander Wiegand[1], Thomas Buchert[2], and Charly Nayet[2] — [1]Fakultät für Physik, Universität Bielefeld, Deutschland — [2]Centre de Recherche Astrophysique de Lyon, Frankreich

Zel'dovich's approximation is in Newtownian cosmology a practical tool to investigate the evolution of mildly nonlinear regions of the Universe. Its extension to the relativistic case is important for the investigation of the backreaction of inhomogeneities on the evolution history of spatial domains of the Universe. This talk presents a Lagrangian framework that allows for a one to one correspondence of Newtownian and general relativistic quantities and provides a perturbative backreaction model, together with domain-dependent quantitiative estimates of the backreaction effect.

GR 2.2 Mo 15:50 ZHG 002
Cosmic radio dipole measurement with Lofar — •Matthias Rubart — Fakultät Physik, Universität Bielefeld, 33615 Bielefeld, Germany

The velocity of our galaxy has been inferred using the CMB dipole anisotropy. An independent verification of this velocity is crucial to exclude any intrinsic CMB dipole term. One way to do this is by using catalogues of radio galaxies. The Low Frequency Array (Lofar) will be able to provide such a catalogue with sufficient number of sources. All estimators that have been in use to determine this radio dipole term in existing radio surveys require an almost complete sky coverage. Since Lofar will mainly map the northern hemisphere an adjustment to those estimators is needed. In this talk an overview of existing dipole estimations as well as an outlook for future measurements will be given. The focus thereby lies on surveys produced by Lofar.

GR 3: Kosmologie II

Zeit: Montag 16:40–17:40 Raum: ZHG 002

GR 3.1 Mo 16:40 ZHG 002
Bulk Viscous Universes — •Hermano Velten — Fakultät für Physik, Bielefeld Universität, Bielefeld, Germany

In this contribution we model Cold Dark Matter (CDM) as a non-ideal fluid. Ideal (or perfect) fluids are assumed to be dissipationless. On the other hand, real fluids display dissipative properties. In our model the CDM has an intrisic bulk viscous pressure given by Eckart's formula $p_v = -3H\xi$, where $3H$ is the expansion scalar and ξ is the coefficient of bulk viscosity. We explore scenarios where i) the Universe is dominated by the viscous dark fluid (VDF) and ii) only the CDM component of the ΛCDM model behaves as a VDF. We constrain the background dynamics of these models using current astronomical data and we discuss the structure formation process in these scenarios (giving particular attention to the integrated Sachs-Wolfe effect).

GR 3.2 Mo 17:00 ZHG 002
Anatomy of bispectra in general single-field inflation — modal expansions — •Jan Grieb and Thorsten Battefeld — Institut für Astrophysik, Göttingen, Deutschland

Non-Gaussianities are an important probe of the interactions in the very early universe. This work discusses bispectra of single-field inflationary models described by general Lorentz invariant Lagrangians that are at most first order in field derivatives, including the fast-roll models investigated by Noller and Magueijo. We identify the least correlated basic contributions to the general shape and show quantitatively which templates provide a good approximation. Future comparison with CMB observations requires modal techniques for these non-separable bispectra. In the context of this work, we provide a modal expansion employing the formalism by Fergusson et al.

Truncated polynomial modal expansions have restrictions, which we highlight using an example with slow convergence. The particular shape originates from particle production during inflation (common in trapped inflation) and entails both localized and oscillatory features. We show that this shape can be recovered efficiently using a Fourier basis.

GR 3.3 Mo 17:20 ZHG 002
Dynamical cancellation of an arbitrary cosmological constant by vector fields — •Emelyanov Viacheslav — KIT, ITP, Karlsruhe, Germany

The cosmological constant problem (CCP) has two aspects. Firstly, the theoretical estimates of the cosmological constant (CC) and observational data are significantly different. Secondly, one needs to explain its small, but nonzero value. The first CCP motivates us to find a dynamical adjustment mechanism that will compensate the vacuum energy and bring it down to cosmologically acceptable levels. In this talk I would like to present a particular vector model realizing this approach.

GR 4: Klassische Allgemeine Relativitätstheorie

Zeit: Montag 17:40–19:00 Raum: ZHG 002

GR 4.1 Mo 17:40 ZHG 002

Stable Phases of Boson Stars — •Burkhard Kleihaus, Jutta Kunz, and Stefanie Schneider — Universität Oldenburg

We analyze the physical properties of boson stars, which possess counterparts in flat space-time, Q-balls. Applying a stability analysis via catastrophe theory, we show that the families of rotating and nonrotating boson stars exhibit two stable regions, separated by an unstable region. Analogous to the case of white dwarfs and neutron stars, these two regions correspond to compact stars of lower and higher density. Moreover, the high density phase ends when the black hole limit is approached. Here another unstable phase is encountered, exhibiting the typical spiralling phenomenon close to the black hole limit. When the interaction terms in the scalar field potential become negligible, the properties of mini boson stars are recovered, which possess only a single stable phase.

GR 4.2 Mo 18:00 ZHG 002

Cartan geometrodynamics — •Derek Wise — Institut für Theoretische Physik III, Uni. Erlangen-Nürnberg, Staudtstr. 7/B2, 91058 Erlangen, Germany

The MacDowell-Mansouri formulation of gravity is based on broken de Sitter symmetry. Geometrically, this is best understood in terms of Cartan geometry, in which breaking symmetry from a group G to a group H plays the role of describing geometry relative to the geometry of the homogeneous space G/H [arxiv:gr-qc/0611154]. After explaining these geometric ideas, I explain a related formulation for Hamiltonian gravity, in which an observer field spontaneously breaks Lorentz symmetry to give "Cartan geometrodynamics": a system of evolving spatial Cartan geometries [arxiv:1111.7195]. Thanks to Cartan's "method of equivalence", this can be viewed as a link between geometrodynamics in the metric sense implemented by ADM and the connection dynamics of the Ashtekar formulation.

GR 4.3 Mo 18:20 ZHG 002

Ist die Klassische Allgemeine Relativitätstheorie unvollständig? — •Jürgen Brandes — Karlsbad

Aktuelle Probleme der Allgemeinen Relativitätstheorie liegen im Bereich hoher Energie. So in der Simulation von Supernovae (außer Typ Ia) und im sog. fireball-Modell für Gammaburster. Mögliche Ursache dafür ist die Unbestimmtheit der Teilchenenergie in Gravitationsfeldern, die aus einer einfachen Überlegung folgt [1]:

Einerseits hat ein im Gravitationsfeld ruhendes Teilchen eine Energie kleiner als seine Ruhemasse (es muss Energie aufgewendet werden, um das Teilchen aus dem Feld zu entfernen), andererseits hat dieses Teilchen im zugehörigen Lokalen Inertialsystem eine Energie gleich seiner Ruhemasse (Äquivalenzprinzip). Zum Zeitpunkt $t = 0$ lasse man das ruhende Teilchen frei fallen. Zu diesem Zeitpunkt hat es die Geschwindigkeit $v = 0$ und ruht sowohl im Lokalen Inertialsystem als auch im globalen Bezugssystem (das System, in dem der Stern und der Beobachter ruhen, bzw. das r, t-Koordinatensystem der Schwarzschildmetrik). Da zum Zeitpunkt $t = 0$ beide Bezugssysteme am Ort des ruhenden Teilchens zusammenfallen und die unterschiedliche Beschleunigung noch keine Bedeutung hat, muss das Teilchen zwei verschiedene Energien haben - eine kleiner und eine gleich seiner Ruhemasse. Oder anders: Obwohl die Gesamtenergie des ruhenden Teilchens kleiner ist als seine Ruhemasse, hat die am Ort des Teilchens *gemessene* Gesamtenergie den Wert der Ruhemasse.

[1] J. Brandes, J. Czerniawski: *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen*, 4. Aufl. 2010

GR 4.4 Mo 18:40 ZHG 002

Relativity Acceleration's Cosmographicum and its Radar Photon Surfings – A Euclidean Diminishment of Minkowski Spacetime — •Brian Coleman — BC Systems (Erlangen)-Velchronia, Moyard, County Galway, Irland

A geometric treatment of the Gudermann function - the inverse sine of the hyperbolic tangent - uncovers a hemispherical asymptotic curve which conforms to the familiar relativistic parameters of the constant-thrust rocket. This 'hemix universe-line' constitutes a uniformly accelerating particle's comoving frames counterpart to the single frame world-line. String increment symmetry and assumed regularity of expansion together infer that the intersection of a hemixgenerated 'curl' helicoid with a 'proxy' comoving frame linear helicoid, epitomizes the stretching of a massless string joining two identical fixed-thrust rockets - Bell's string paradox. Physically vindicated by its trajectories of photons whose radar times are analytically shown to indeed vary, the cosmographicum's 'hemicoid universe-surface' illustrates emitted and reflected photon/string 'surfings', affirms the string's expansion ratio as $\sqrt{1 + v^2/c^2}$, elucidates a variant of the 1909 Ehrenfest rotating ring paradox, and yields a uniform acceleration metric space-time interval. Minkowski spacetime, though valid for accelerating particles, is thereby revealed as inappropriate for extended accelerating objects.

GR 5: Schwarze Löcher – Lösungen I

Zeit: Dienstag 8:30–10:30 Raum: ZHG 002

GR 5.1 Di 8:30 ZHG 002

Gravitational objects in the presence of a minimal length — Piero Nicolini[1], •Alessio Orlandi[2], and Euro Spallucci[3] — [1]Frankfurt Institute for Advanced Studies (FIAS) and Institut fur Theoretische Physik, u Johann Wolfgang Goethe-Universitaet, Frankfurt am Main, Germany — [2]Dipartimento di Fisica, Universita' di Bologna and INFN, Sezione di Bologna, Italy — [3]Dipartimento di Fisica, Universita' di Trieste and INFN, Sezione di Trieste, Italy

In this contribution I will present a new family of gravitational objects representing gravitational matter shells. The key feature of these geometries is the presence of a minimal length. The latter can be implemented by considering an effective stress tensor, whose time-time component is governed by higher momentum of the Gaussian distribution. By solving Einstein equations, one finds that the resulting geometries describe singularity-free black holes with no, one or two horizons. By studying the Hawking temperature, I will show how the inclusion of the minimal length improves usual problems of terminal phase of the evaporation. Finally I will mention further developments in the direction of brane world black holes.

GR 5.2 Di 8:50 ZHG 002

Phenomenology of quantum gravity black holes — •Piero Nicolini[1], Jonas Mureika[2], Euro Spallucci[3], and Elizabeth Winstanley[4] — [1]Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [2]Loyola Marymount University, Los Angeles, CA, USA — [3]Università di Trieste and INFN, Sezione di Trieste, Trieste, Italy — [4]The University of Sheffield, Sheffield, United Kingdom

In this contribution we present a new scenario for the production and the evaporation of microscopic black holes in the presence of a quantum gravity induced fundamental length. After a brief analysis of the existing families of quantum gravity improved black hole geometries, we focus on their common thermodynamic behavior, namely the presence of a phase transition to a positive heat capacity cooling down in the final stages of the evaporation even in the non-rotating, neutral case. This fact has important repercussions of the evaporation spectra in terms of new profiles of grey body factors. Quantum gravity black holes would emit soft particles mainly on the brane, a distinctive signatures in marked contrast to results obtained with classical metrics. Then we present a first step in modeling black hole production in a post-semiclassical limit, by employing an effective ultraviolet cut off. We show that the new cross sections approach the usual "black disk" form at high energy, while they differ significantly near the fundamental scale. If this behavior is confirmed by all the class of quantum gravity black holes, such novel phenomenology is beyond the reach of current accelerators experiments, but is still potentially observable in ultra-high energy cosmic ray collisions.

GR 5.3 Di 9:10 ZHG 002

A scalar condensation instability of hyperbolic black holes in Anti-de Sitter space-time — •Betti Hartmann[1] and Yves Brihaye[2] — [1]School of Engineering and Science, Jacobs University Bremen, 28759 Bremen — [2]Faculte de Sciences, Universite de Mons, 7000 Mons, Belgium

In this talk, I will discuss the stability of static, hyperbolic Gauss-Bonnet black holes in (4+1)-dimensional Anti-de Sitter (AdS) space-time against scalar field condensation. This instability occurs when the black holes are close to extremality. The resulting solutions are *hairy* black holes that are labelled by the number of nodes of the scalar field function.

GR 5.4 Di 9:30 ZHG 002

Black Holes in Einstein-Gauss-Bonnet Theory — Yves Brihaye[1], Burkhard Kleihaus[2], •Jutta Kunz[2], and Eugen Radu[2] — [1]University of Mons, Belgium — [2]University of Oldenburg

We construct rotating black hole and black ring solutions in Einstein-Gauss-Bonnet theory in five spacetime dimensions, corresponding to the generalization of the Myers-Perry black holes and the Emparan-Reall black rings. These black holes are asymptotically flat and possess a regular horizon. We discuss the physical properties of these black holes and study their dependence on the Gauss-Bonnet coupling constant α.

GR 5.5 Di 9:50 ZHG 002

Spinning black strings in $d = 5$ Einstein-Gauss-Bonnet theory — Jutta Kunz[1], Eugen Radu[1], and •Bintoro Anang Subagyo[1,2] — [1]Institut für Physik, Universität Oldenburg, — [2]Jurusan Fisika, Institut Teknologi Sepuluh Nopember, Surabaya 60111, Indonesia

We construct new uniform black string solutions in Einstein-Gauss-Bonnet theory for $d = 5$ dimensions. Our solutions are rotating and approach asymptotically the four dimensional Minkowski-space times a circle. The solutions are constructed by solving numerically the equations of the model. We discuss the properties of these black objects, in particular the dependence on the Gauss-Bonnet coupling constant α.

GR 5.6 Di 10:10 ZHG 002

Bidifferential calculus approach to solutions of the Ernst equations — Aristophanes Dimakis[1], •Nils Kanning[2], and Folkert Müller-Hoissen[3] — [1]Department of Financial and Management Engineering, University of the Aegean, Chios, Greece — [2]Institute for Mathematics and Institute for Physics, Humboldt University, Berlin, Germany — [3]Max-Planck-Institute for Dynamics and Self-Organization, Göttingen, Germany

The "bidifferential calculus framework" (see also the talk by Folkert Müller-Hoissen) provides an abstract formulation of many features of "integrable" partial differential and difference equations. A special solution generating method in this framework has been used to construct in particular "multi-soliton" solutions of various integrable equations. Recently this result has been applied to the Ernst equations (arXiv:1106.4122), which are the central part of the stationary axially symmetric Einstein vacuum and Einstein-Maxwell equations. Based on this work, we present a derivation of the multi-Kerr-NUT solutions and their electrically and magnetically charged generalizations, the multi-Demiański-Newman spacetimes.

GR 6: Hauptvorträge Schwarze Löcher I

Zeit: Dienstag 14:00–15:30 Raum: ZHG 002

Hauptvortrag GR 6.1 Di 14:00 ZHG 002

Constructive proof of the Kerr-Newman black hole uniqueness — •Reinhard Meinel — Theoretisch-Physikalisches Institut der Universität Jena

A new proof of the uniqueness of the Kerr-Newman black hole solutions amongst asymptotically flat, stationary and axisymmetric electrovacuum spacetimes surrounding a connected Killing horizon is given by means of an explicit construction of the corresponding complex Ernst potentials on the axis of symmetry. This construction, which makes use of the inverse scattering method, also works in the case of a degenerate horizon.

Reference: arXiv:1108.4854

Hauptvortrag GR 6.2 Di 14:45 ZHG 002

Black Holes in Gauge/Gravity Correspondence — •Veronika Hubeny — Durham University, Durham, UK

I will give a brief overview of the role of black holes in the gauge/gravity correspondence, focusing on the gravitational highlights and understanding achieved to date.

GR 7: Schwarze Löcher – Lösungen II

Zeit: Dienstag 15:30–16:10 Raum: ZHG 002

GR 7.1 Di 15:30 ZHG 002

Critical regions in Lovelock space-times — •Keno Eilers, Burkhard Kleihaus, and Jutta Kunz — Institut für Physik, Carl-von-Ossietzky-Universität Oldenburg

Black Strings in Gauss-Bonnet theory are known to exhibit critical solutions, which limit their domain of existence. For positive Gauss-Bonnet coupling constant α, the critical solution is reached for a minimal radius of the string, at a finite mass, temperature, and curvature. For negative α, on the other hand, a critical solution with a curvature singularity is encountered. Black Holes in "maximal" Lovelock gravity theories exhibit analogous critical solutions.

Here we show that this behavior is typical for Gauss-Bonnet and Lovelock theories, by studying the phase diagrams of black objects for a rather big variety of such theories.

GR 7.2 Di 15:50 ZHG 002

Two-body equilibrium configurations involving one extreme black hole in the electrovacuum case — •Ivan Cabrera Munguia and Claus Lämmerzahl — ZARM, University Bremen, Germany

The present work fills in the final gap in the search and description of different equilibrium states in the two-body systems consisting of one extreme and one non-extreme components. In the 'extreme-non-extreme' case of charged spinning masses we obtain, by making use of an appropriate exact solution of the Einstein-Maxwell equations and solving numerically the corresponding balance equations, the first examples of the 'extreme-hyperextreme' equilibrium configurations characterized by positive Komar masses of both Kerr-Newman constituents. Furthermore, we demonstrate that equilibrium in the 'extreme-subextreme' stationary electrovac systems is also possible, but it requires negative mass of one of the constituents. In the electrostatic case which admits a purely analytic treatment we give a rigorous proof of the non-existence of the 'extreme-non-extreme' equilibrium configurations in the framework of the double-Reissner-Nordström solution. At the same time, the electrostatic equilibrium between an extreme and a subextreme black holes can be achieved in the uniform external field, provided the two constituents form a specific dihole with zero net charge and the mass of the subextreme black hole greater than that of the extreme one.

GR 8: Schwarze Löcher – Bahnen

Zeit: Dienstag 16:40–18:00 Raum: ZHG 002

GR 8.1 Di 16:40 ZHG 002

Analytische Lösungen der Bewegungsgleichungen in Kerr-Newman Raumzeiten — •Hongxiao Xu[1], Eva Hackmann[2] und Claus Lämmerzahl[3] — [1]Uni Bremen, Bremen — [2]ZARM, Universität Bremen, Am Fallturm, 28359 Bremen — [3]ZARM, Universität Bremen, Am Fallturm, 28359 Bremen, und Institut für Physik, Universität Oldenburg, 26111 Oldenburg

In diesem Vortrag werden die vollständigen Lösungen der Bewegungsgleichungen von geladenen zeitartigen Testteilchen in Kerr-Newman-Raumzeiten mit Hilfe der Weierstraßschen Elliptischen Funktionen $\wp$, ζ und σ präsentiert. Dazu werden zunächst die möglichen Bahnen anhand der radialen und latitudinalen Gleichungen charakterisiert und mögliche Bahnkonfigurationen in Energie-Impuls-Bifurkationsdiagrammen dargestellt. Die Abhängigkeit der Bifurkationslinien von den restlichen Raumzeit- und Testteilchenparameter wird ebenfalls untersucht. Dies gestattet weiter Vergleiche mit anderen Raumzeiten (Schwarzschild, Reissner-Nordström, Kerr). Schließlich werden die Bewegungsgleichungen explizit gelöst, und einige für Kerr-Newman-Raumzeiten typische Bahnen graphisch dargestellt.

GR 8.2 Di 17:00 ZHG 002

Geodesic Motion in Black Ring Space-Times — •Saskia Grunau[1], Valeria Kagramanova[1], Jutta Kunz[1], and Claus Lämmerzahl[1,2] — [1]Carl von Ossietzky Universität Oldenburg — [2]ZARM, University Bremen

We present analytical solutions of the geodesic equations of test particles and light in five dimensional black ring space-times for special cases, since it does not appear possible to separate the Hamilton-Jacobi-equation for black rings in general. Based on the study of the polynomials in the equations of motion we characterize the motion of test particles and light and discuss the associated orbits. We compare the motion around singly spinning black rings, doubly spinning black rings and charged supersymmetric black rings.

GR 8.3 Di 17:20 ZHG 002

Analytical solution of the geodesic equations in Myers-Perry spacetimes — •Stephan Reimers und Valeria Kagramanova — Carl von Ossietzky Universität Oldenburg 26111 Oldenburg

Myers-Perry space-times represent the higher dimensional generalizations of the Kerr space-time. We analytically solve the geodesic equations in Myers-Perry space-times with equal angular momenta. The analytical solutions of the geodesic equations are given in terms of elliptic Weierstraß functions. With the complete set of analytical solutions we study the motion of test particles and light and derive analytical expressions for the observables.

GR 8.4 Di 17:40 ZHG 002

Detailed discussion and visualization of circular orbits in the extreme Reissner-Nordstrom dihole metric — •Andreas Wünsch[1], Thomas Müller[2], and Günther Wunner[1] — [1]1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany — [2]Visualisierungsinstitut der Universität Stuttgart, 70569 Stuttgart, Germany

The extreme Reissner-Nordstrom dihole metric is a special case of the Majumdar-Papapetrou solution (of the Einstein-Maxwell equations), where the electromagnetic repulsion between two static, extreme Reissner-Nordstrom black holes is compensated by their gravitational attraction. We determined all circular orbits of neutral test particles (timelike and lightlike) using the effective potential formalism. The first-person view of a particle on a circular orbit, realized using four-dimensional general-relativistic ray tracing, depicts the image a virtual camera would actually produce. Here, we concentrate on the geometric distortion due to the dihole metric on the visual appearance of orbiting objects. The extreme Reissner-Nordstrom dihole metric yields a simple and instructive example of multi-black-hole system for a detailed exploration of the geodesic structure and the visual appearance of orbiting objects.

GR 9: Alternative Allgemeine Relativitätstheorie I

Zeit: Mittwoch 8:30–9:30 Raum: ZHG 002

GR 9.1 Mi 8:30 ZHG 002

Die Verbindungen des Energiegleichgewichts einer Masse im Erdorbit mit der Hintergrundstrahlung und dem Standardmodel — •Erhard Schulz — Erhard Schulz, Wiesenstrasse 32, D-01987 Schwarzheide, Germany

Planck beschreibt das Gleichgewicht in [Ver.d.D.Ph.Ges.1900] wie folgt: Wir betrachten E als zusammengesetzt aus einer ganz bestimmten Anzahl endlich gleicher Teile und bedienen uns dazu der Naturkonstanten h. Jede Energie besteht somit aus dem Vielfachen des elementaren Energiequantums (h.1Hz). Dieses Quant bewegt sich deshalb als reines Photon oder als reines Roton mit Lichtgeschwindigkeit. Sie bilden die dunkle Energie. Gleichgewicht zwischen zwei Systemen entsteht, wenn sie unterschiedliche Bewegungszustände haben und Energie austauschen. Sichtbar ist nur die Energiesumme aus reinen Photonen und reinen Rotonen. Reine Photonen und reine Rotonen sind eindimensionale Strings. Ihre Energie liegt auf einer geschlossenen Plancklänge. Für das Gleichgewicht im Gravitationsfeld[Fr = vvm, mit F = Kraft, r = Abstand zum Erdmittelpunkt, v = Geschwindigkeit und m = Masse], die Hintergrundstrahlung und das Standardmodell werden die Photonen-Rotonen-Darstellungen abgeleitet. In den Randzonen von Gleichgewichtszuständen, wie in Atomen, Galaxien und des Universums bilden sich Rotonenkrusten, die so stark werden können, so dass kein reales Photon das System verlassen kann. Zeit und Raum erhalten durch das Quantum eine neue Form. Siehe: http://gisela43ch.wordpress.com.

GR 9.2 Mi 8:50 ZHG 002

The universality of the s p e c i f i c Planck charge and its role for gravitation. — •Karl Otto Greulich — Fritz Lipmann Institut Beutenbergstr 11 07745 Jena

Gravitation between two Planck masses mPl is quantitatively the same as electrostatic interaction of two Planck charges qPl=e/SQRT alpha. When the specific charge of the formal Planck particle, rhoPl=qPl/mPl, is assigned to a n y mass m, the resulting charge qm=(e/SQRT alpha)(m/mPl)allows to correspondingly calculate any gravitational force by electrostatics. The specific charge rhoPl turns out to be SQRT(G/k0) where G is the gravitation- and k0 the Coulomb constant, i.e. it describes similarly, but simpler than the dimensionless gravitation factor gamma, the ratio between gravitation and electrostatics. Thus, the specific charge of the Planck particle has a fundamental physical core. As a side result, simple expressions for the fine structure constant alpha and the gravitation factor gamma are given: alpha=re*me, gamma=re/mp, where the electron and proton quantities r and m are expressed as multiples of the corresponding Planck units.

References: K.O. Greulich 2011 SPIE Proceedings 8121-15, for a download see http://www.fli-leibniz.de/www_kog/ then klick *Physics*

GR 9.3 Mi 9:10 ZHG 002

Maximalwert einer hypothetischen Photonenmasse — •Friedrich Siems — Allensbach

Mit den Mitteln der speziellen Relativitaetstheorie und unter Verwendung der Rotverschiebung des Lichts naher Galaxien wird der Maximalwert der Ruhemasse eines hypothetischen Photons errechnet, das sich mit $v < c$ fortbewegt, wobei die massebedingte Vergroesserung seiner Wellenlaenge in Konkurrenz zur Rotverschiebung durch den Dopplereffekt tritt. Wie zu erwarten ist dieser Maximalwert proportional zur Lichtfrequenz, also zur Energie des Photons, und liegt für den sichtbaren Bereich bei etwa $m = 5 \cdot 10^(- 16)[eV/c^2]$. Eine hypothetische Photonenmasse ist demnach um etwa 14 Groessenordnungen kleiner als die derzeit gehandelten Werte für die Neutrinomassen.

GR 10: Quantengravitation und Quantenkosmologie I

Zeit: Mittwoch 9:30–10:10 Raum: ZHG 002

GR 10.1 Mi 9:30 ZHG 002

General Relativity Consistently Unified with Quantum Theory Giving Conformal Quantum Gravity in Operator Notation + Dark Energy — •Claus Birkholz — Seydelstr. 7, D-10117 Berlin

This unification is achieved by group theory. The group SU(2,2) is identified to be the fully quantized covering group of (an extended form of) GR:

(1) Its linear generators yield quantum theory,
(2) its non-linear Casimir operators create curvature,
(3) irreducibility provides background independence.

Dark energy results as a byproduct of the commutation relations of the (non-linear) space-time operators. By the number 3 of Casimir operators in an SU(2,2), the equations of motion in GR are fixed to have three components (3-dimensionality of motion).

A maximal set of commuting generators defining the "quantization axis" of GR is given by the triplet L3 (spin), Q3 (CMS-space), P0 (energy).

GR 10.2 Mi 9:50 ZHG 002

Von der kosmischen Energiedichte zur Quantengravitation. — •Norbert Sadler — Wasserburger Str. 25a, 85540 Haar

Unter Berücksichtigung der Energieverteilung des Universums wird eine neue topologisch-physikalische Deutung der Gravitation und der Vereinheitlichung der 4 Naturkräfte aufgezeigt. So kann gezeigt werden, dass die Energiedichte der Materie und der dunklen Energie auf dem "Thales Halbkreis" durch Falten, Strecken und Abwickeln identifiziert werden kann. Der "Thales Kreis" ist dazu als ein linearer Planck -Oszillator zu betrachten. Durch Strecken des Halbkreises mit (Pi/2-1)=2x(0.283) über den Durchmesser wird die Materiedichte zu 28.3% identifiziert und an den Rändern mit (2Pi)x(0.045 baryon. E.)=(0.283) zyklisch kompaktiert. Die Dunkle Energie wird über eine 2fache Zykloiden Abwicklung 4x(4x(0.045))=(0.717) dynamisch identifiziert. Die 28.3% Materiedichte und der Wert des Hubbleparameters (69.9km/Mpcs) sind die relativen Fehler 1/Wurzel(Pi) und 1/Wurzel(Pi/l(Pl.)). Die CD-Wechselwirkung mit (0.239) dkl. Mat.E. vereinheitlicht die 4 Naturkräfte: Alfa(QCD)x(0.239)x(l(Pl.))=4Pi x Alfa(Gravitation)x1m mit 4Pi x Alfa(QCD)=(0.717+0.239)xAlfa(W-Boson) und AlfaQCD/QED=8/3. Die Feldst. des Univ. resultiert aus der totalen Wechselwirkung der Energiedichten mit der Planckmasse:(1kg i.Univ.Feld)= (0.045x0.239x0.283)x(m(Pl.))x(1m/1s**2).

GR 11: Hauptvorträge Schwarze Löcher und Felder (gemeinsam mit MP)

Zeit: Mittwoch 16:45–18:45 Raum: ZHG 002

Hauptvortrag GR 11.1 Mi 16:45 ZHG 002

On the Consistency of Classical and Quantum Supergravity Theories — •Thomas-Paul Hack[1], Mathias Makedonski[2], and Alexander Schenkel[3] — [1]II Institute for Theoretical Physics, University of Hamburg — [2]Department of Mathematical Sciences, University of Copenhagen — [3]Department of Stochastics, University of Wuppertal

It is known that pure N=1 supergravity in d=4 spacetime dimensions is consistent at a classical and quantum level, i.e. that in a particular gauge the field equations assume a hyperbolic form - ensuring causal propagation of the degrees of freedom - and that the associated canonical quantum field theory satisfies unitarity. It seems, however, that it is yet unclear whether these properties persist if one considers the more general and realistic case of N=1, d=4 supergravity theories including arbitrary matter fields. We partially clarify the issue by introducing novel hyperbolic gauges for the gravitino field and proving that they commute with the resulting equations of motion. Moreover, we review recent partial results on the unitarity of these general supergravity theories and suggest first steps towards a comprehensive unitarity proof.

Hauptvortrag GR 11.2 Mi 17:15 ZHG 002

Analytical approach to the geodesic equations in General Relativity — Victor Enolski[2,3,4], Eva Hackmann[4], •Valeria Kagramanova[1], Jutta Kunz[1], and Claus Lämmerzahl[4] — [1]Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26111 Oldenburg — [2]Hanse-Wissenschaftskolleg (HWK), 27733 Delmenhorst, Germany — [3]Institute of Magnetism, 36-b Vernadsky Blvd, Kyiv 03142, Ukraine — [4]ZARM, Universität Bremen, Am Fallturm, ZARM, Universität Bremen, Am Fallturm, D-28359 Bremen, German

The motion of test particles and light is of great importance for the investigation of the physical properties of gravitational fields since only matter and light can be observed. There are two main methods to solve the geodesic equations: analytical and numerical. Analytical solutions deliver an exact solution of the equations of motion, have arbitrary accuracy and allow to investigate the properties of the motion and hence of the gravitating body itself in detail. In this talk we present the analytical solution of the geodesic equation in many well-known black hole space-times. In particular, in the Plebanski-Demianski space-time of generalized black holes. The solution is expressed in terms of the Weierstrass' elliptic or Abelian hyperelliptic functions. That depends on the degree of difficulty of the considered problem and on the number of parameters characterizing the black hole and the test particle. We integrate differentials of all three kind with arbitrary genus of the underlying polynomial curve. We also present the analytical expressions for the observable quantities such as perihelion shift for planetary orbits and light deflection for escape orbits of photons.

Hauptvortrag GR 11.3 Mi 17:45 ZHG 002

Black holes in su(N) Einstein-Yang-Mills theory: hair, fur and superconducting horizons — •Elizabeth Winstanley — Consortium for Fundamental Physics, School of Mathematics and Statistics, The University of Sheffield, Hicks Building, Hounsfield Road, Sheffield. S3 7RH United Kingdom

Black hole solutions of general relativity coupled to an su(N) Yang-Mills gauge field have been studied for over 20 years. In this talk we focus on black holes in Einstein-Yang-Mills theory in four-dimensional, asymptotically anti-de Sitter space, with a negative cosmological constant. We emphasize three aspects of these black holes:

(a) the existence of stable black holes in anti-de Sitter space with abundant Yang-Mills hair;
(b) how these hairy black holes may be characterized by non-Abelian charges at infinity;
(c) planar black holes with superconducting horizons.

Hauptvortrag GR 11.4 Mi 18:15 ZHG 002

Bidifferential calculus and integrable PDEs in General Relativity — •Folkert Müller-Hoissen — Max-Planck-Institute for Dynamics and Self-Organization, Bunsenstrasse 10, D-37073 Göttingen

The "bidifferential calculus approach" to integrable partial differential (and difference) equations allows to deduce substantial results, e.g. methods to generate exact solutions, on an abstract level. Once a "bidifferential calculus formulation" of some equation is at hand, these general results can be evaluated in the concrete case. A special result in this framework, with a surprisingly simple proof, has recently been shown (joint work with Aristophanes Dimakis and Nils Kanning) to reproduce in particular the multi-Kerr-NUT and multi-Demianski-Newman families of solutions of the Ernst equations, governing stationary axisymmetric vacuum and electrovacuum space-times in General Relativity. We present an introduction to the underlying structures and methods of bidifferential calculus, and delegate a more detailed discussion of the case of the Ernst equations to the talk by Nils Kanning at this meeting.

GR 12: Alternative Allgemeine Relativitätstheorie II

Zeit: Donnerstag 8:30–9:50 Raum: ZHG 002

GR 12.1 Do 8:30 ZHG 002

Methode zur Messung der Bewegung gegen das Gravitationsfeld und Vorstellung eines Gravitationsmodels, das ohne dunkle Materie auskommt. — •Karl-Herbert Darmer — Meyertwiete 7, 22848 Norderstedt

Es soll eine Methode dargestellt werde mit der man die Bewegung zum Gravitationsfeld in Richtung und Geschwindigkeit messen kann. Diese ergibt sich aus dem Verhalten der Uhren im Global Positioning System, dem negativen Ausgang des Michelson-Morley-Experiments und den Lorenztransformationen. Mit dieser Messung kann man K und K' unterscheiden.

Zwei Ringe rotieren parallel mit unterschiedlicher Geschwindigkeit. Welche Gravitationstheorie kann eindeutig sagen in welchem Ring eine Zentrifugalkraft gemessen wird und warum überhaupt eine Zentrifugalkraft in einem der beiden Ringe gemessen werden muß?

Es soll ein Gravitationsmodell vorgestellt werden, aus dem dies eindeutig hervorgeht. Mit diesem könnte sich auch die Flyby-Anomalie erklären lassen und für den Zusammenhalt der Spiralgalaxien könnte auf die dunkle Materie verzichtet werden.

Ausführlicher unter www.darmer.de/physik/physik.html

GR 12.2 Do 8:50 ZHG 002

Gravitational waves in multmetric gravity — •Manuel Hohmann — II. Institut für theoretische Physik, Universität Hamburg

We discuss the propagation of gravitational waves in a class of multimetric gravity theories containing $N \geq 2$ copies of standard model matter and a corresponding number of metrics. We show that within these theories the propagation velocity of gravitational waves equals the speed of light, and that two to six polarizations of gravitational waves may exist. Finally, we discuss the emission of gravitational waves by binary systems and relate our results to the upcoming gravitational wave experiments.

GR 12.3 Do 9:10 ZHG 002

Gravity underlying matter beyond the standard model — •Frederic P. Schuller — Max-Planck-Institut für Gravitationsphysik, Golm, Deutschland

Superluminal neutrinos, if indeed observed, force one to forsake Lorentzian geometry as the spacetime structure. But only a severely restricted class of tensor fields can provide an alternative classical spacetime geometry. Their precise structure and kinemantics are determined already by the requirements that the geometry be able to carry predictive matter field equations, be time-orientable and allow for an observer-independent distinction of positive and negative particle energies. Lorentzian metrics, on which general relativity and the standard model of particle physics are built, present just the simplest such tensorial spacetime geometry, and incidentally the only one that does not implement superluminal particles in perfectly causal fashion.

The problem to find the gravitational dynamics for general tensorial spacetime geometries satisfying the above minimum requirements can be reformulated as a system of linear partial differential equations, in the sense their solutions present the actions for the corresponding spacetime geometry. This opens the possibility to formulate the search for alternative classical theories of gravity in general—and in particular for gravity compatible with superluminal matter—as a well posed mathematical task.

GR 12.4 Do 9:30 ZHG 002

Gravity for Finsler spacetime — •Christian Pfeifer — II Institut f. theoretische Physik, Uni Hamburg

I present an action based theory of gravity for Finsler spacetime including matter coupling. Its consistency with general relativity will be demonstrated. For spherical symmetry I present a first order solution of the Finsler gravity vacuum equation beyond metric geometry. This solution is a refinement of the linearised Schwarzschild metric from general relativity. Effects of this refinement in the solar system will be discussed.

GR 13: Schwarze Löcher – Lösungen III

Zeit: Donnerstag 9:50–10:30 Raum: ZHG 002

GR 13.1 Do 9:50 ZHG 002

Ein Quasar mit ungeklärter interner Dynamik — •Jan Preuss und Alexander Unzicker — Pestalozzi-Gymnasium München

Wir analysierten Quasarspekteren aus dem SDSS-Katalog und suchten nach Exemplaren, bei denen die Narrow-Line-Region (NLR) gegenüber der Broad-Line-Region (BLR) verschoben ist. Neben zwei ungewöhnlichen Exemplaren, die über die charakteristische OIII-Linie identifiziert wurden und bereits in der Literatur bekannt waren, fanden wir einen weiteren Quasar, der zusätzlich eine feine Doppelstruktur in der OIII-Linie aufweist. Zudem scheint die breite H-Beta-Linie doppelt vorzukommen. Die optische Aufnahme und Photometrie zeigt dagegen keine Besonderheiten. Die Annahme anisotroper Gravitationswellenabstrahlung, die für andere anomale Quasarspektren plausibel war, liefert hier keine vollständige Erklärung, so dass die Beschaffenheit dieses Objektes noch ungeklärt ist.

GR 13.2 Do 10:10 ZHG 002

Holographic Approach to Screening and Running Coupling in Strongly Coupled Plasmas — •Konrad Schade[1,2] and Carlo Ewerz[1,2] — [1]Institut für Theoretische Physik, Uni Heidelberg, Philosophenweg 16, D-69120 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, D-64291 Darmstadt, Germany

We use the AdS/CFT correspondence to study the screening distance and free energy of quark-antiquark pairs in strongly coupled, nonconformal plasmas at finite temperature. There, the screening distance of nonconformal plasmas is always larger than the corresponding conformal value that can be computed in the dual gravity theory of $\mathcal{N} = 4$ super Yang-Mills. We conjecture that this behaviour is true for an even larger class of theories.

Furthermore, a running coupling is computed that allows us to study a large class of nonconformal, strongly coupled plasmas and the results are in good agreement to Lattice QCD results.

GR 14: Hauptvorträge Schwarze Löcher II

Zeit: Donnerstag 14:00–16:15 Raum: ZHG 002

Hauptvortrag GR 14.1 Do 14:00 ZHG 002

Black Holes in Higher Dimensions — •Eugen Radu — Institut für Physik, Oldenburg University, Germany

We review recent progress in understanding black hole solutions of higher-dimensional vacuum gravity. The properties of these solutions can differ significantly from those of black holes in four dimensions, since neither the uniqueness theorem, nor the staticity theorem or the topological censorship theorem generalize to higher dimensions. General results and open problems are discussed throughout. Special attention is paid to solutions with non-spherical event horizon topologies. The properties of the recently discovered non-perturbative black ring solutions in more than five dimensions are also discussed.

Hauptvortrag GR 14.2 Do 14:45 ZHG 002

Stable Wormhole Solutions in Dilatonic Einstein-Gauss-Bonnet Theory — •Panagiota Kanti[1], Burkhard Kleihaus[2], and Jutta Kunz[2] — [1]University of Ioannina, Physics Department, Division of Theoretical Physics, Ioannina, GR 45110, Greece — [2]Institut fur Physik, Universitat Oldenburg, D-26111 Oldenburg, Germany

As is well-known, wormhole solutions arising in the context of General Relativity, are non-traversable: they are unstable under small perturbations, and their 'throat' opens and closes so quickly that not even a light signal can pass through. In this talk, we present wormhole solutions that arise in the context of the four-dimensional dilatonic Einstein-Gauss-Bonnet theory, a simple gravitational theory that follows from superstring theory. These solutions have their throat kept open by a localised matter distribution that respects all energy conditions imposed by physics, and admit particle trajectories that start from one side of the wormhole spacetime and exit from the other. In addition, our solutions do not possess any horizons, are stable under small radial perturbations and their throat can be arbitrarily large. We discuss additional properties of these solutions such as their domain of existence, the generalised Smarr relation they satisfy and the magnitude of the acceleration and tidal forces that a traveler crossing the wormhole would feel.

Hauptvortrag GR 14.3 Do 15:30 ZHG 002

Blackfolds as fluids and materials — •Niels Obers — Niels Bohr Institute, University of Copenhagen, Denmark

I will review the blackfold approach, which is an effective worldvolume theory capturing the dynamics of thin black branes. I will show how the method can be applied to construct, in the blackfold limit, numerous novel stationary, possibly charged, black holes in higher dimensions, both in vacuum gravity as well as supergravities. It furthermore provides insights into the dynamical stability of black objects under long wavelength perturbations. In particular, the approach shows that black branes possess both fluid as well as material properties, corresponding to intrinsic and extrinsic perturbations respectively, and I will discuss the associated response coefficients.

GR 15: Quantengravitation und Quantenkosmologie II

Zeit: Donnerstag 16:45–18:45 Raum: ZHG 002

GR 15.1 Do 16:45 ZHG 002

SUSY Q-Balls and Boson Stars in Anti-de Sitter space-time — •Jürgen Riedel — School of Engineering and Science Jacobs University Bremen 28759 Bremen, Germany

Q-balls and boson stars are non-topological solitons that have been intensively studied and their properties are well established for a variety of scalar potentials. More recently a supersymmetric (SUSY) potential has been considered for Q-ball and boson star models in the context of the supersymmetric extension of the Standard Model [1,2]. Moreover, it has been proposed that such soliton models can be interpreted as Bose-Einstein condensates of glueballs within the context of the Anti-de Sitter/Conformal Field Theory (AdS/CFT) correspondence [3].

We solve the Klein-Gordon equation for the SUSY Q-balls in AdS background numerically and study the solutions in detail. In particular the mass M and charge Q of the Q-balls in AdS background are calculated.

[1] E. Copeland and M. Tsumagari, Phys.Rev. D 80 025016 (2009) [2] L. Campanelli and M. Ruggieri, Phys. Rev. D 77 (2008), 043504; L. Campanelli and M. Ruggieri, Phys. Rev. D 80 (2009) 036006 [3] G.T. Horowitz and B. Way, Complete phase diagrams for holographic superconductor/insulator systems, JHEP 1011:011, 2010 [arXiv:1007.3714v2]

GR 15.2 Do 17:05 ZHG 002

Decoherence in loop quantum cosmology with fermions — Claus Kiefer and •Christian Schell — Institut für Theoretische Physik, Universität zu Köln

Loop quantum cosmology employs triads of two different orientations. The theory allows them to occur in an arbitrary superposition. Here we show how such a superposition is rendered unobservable by decoherence - the irreversible interaction with an "environment". Since a suitable environment must be able to distinguish between the two orientations, we introduce fermions for its description. Solving the total difference equation numerically and integrating out the fermions, we obtain the reduced density matrix for the triads. We discuss the degree of decoherence described by it and focus on the relevance of our results for interpretational issues in loop quantum cosmology.

GR 15.3 Do 17:25 ZHG 002

Quantum gravitational effects for cosmological perturbations — •Manuel Krämer and Claus Kiefer — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

We discuss cosmological perturbations in the framework of canonical quantum gravity. We use a model for an inflationary universe with a perturbed scalar field and obtain the power spectrum for these perturbations by means of a semiclassical approximation to the Wheeler-DeWitt equation. We calculate quantum gravitational corrections to the power spectrum and discuss the appearance of unitarity-violating correction terms.

GR 15.4 Do 17:45 ZHG 002

Spontaneous breaking of Lorentz symmetry for canonical gravity — •Steffen Gielen[1,3] and Derek Wise[2] — [1]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Am Mühlenberg 1, 14476 Golm — [2]Institut für Theoretische Physik III, Universität Erlangen-Nürnberg, Staudtstr. 7/B2, 91054 Erlangen — [3]Perimeter Institute for Theoretical Physics, 31 Caroline St. N., Waterloo, Ontario, Canada N2L 2Y5

In Hamiltonian formulations of general relativity, in particular Ashtekar variables which serve as the classical starting point for loop quantum gravity, Lorentz covariance is a subtle issue which has been the focus of some debate, while at the same time being crucial with regard to possible experimental tests. After reviewing the sources of difficulty, we present a Lorentz covariant formulation in which which we generalise the notion of a foliation of spacetime usually used in the Hamiltonian formalism to a field of "local observers" which specify a time direction only locally. This field spontaneously breaks the local SO(3,1) symmetry down to a subgroup SO(3), in a way similar to systems in condensed matter and particle physics. The formalism is analogous to that in MacDowell-Mansouri gravity, where SO(4,1) is spontaneously broken to SO(3,1). We show that the apparent breaking of SO(3,1) to SO(3) is not in conflict with Lorentz covariance. We close by outlining other possible applications of the formalism of local observer, especially with regard to phenomenology of quantum gravity.

GR 15.5 Do 18:05 ZHG 002

Fluctuations of spacetime and hyperfine structure of the hydrogen atom — •Ertan Göklü[1], Juan Israel Rivas[2], and Abel Camacho[2] — [1]ZARM-Universität Bremen, Am Fallturm, 28359 Bremen — [2]Universidad Autónoma Metropolitana–Iztapalapa, Apartado Postal 55–534, C.P. 09340, México, D.F., México

We consider the consequences of the presence of metric fluctuations upon the properties of a hydrogen atom. Particularly, we introduce these metric fluctuations in the corresponding effective Schrödinger equation and deduce the modifications that they entail upon the hyperfine structure related to a hydrogen atom. We will find the change that these effects imply for the ground state energy of the system and obtain a bound for its size comparing our theoretical predictions against the experimental uncertainty reported in the literature.

GR 15.6 Do 18:25 ZHG 002

What happens inside a black hole? — •Thomas Görnitz — Goethe-Univ. Frankfurt/M

The interior solution for a black hole is normally understood as a problem of classical general relativity. Such a view is carried by the questionable notion that quantum theory is necessary only for very small space regions. Therefore it is often argued that for real black holes, which are much larger than the atoms, the use of quantum theory is superfluous for its description. A simple argument from quantum theory shows that such a concept may be incorrect, because a restriction of the spatial extent of a system - putting it into a box - results in a change of its ground state. The only really impenetrable boxes in the universe are the horizons of the black holes. Therefore it is unphysical to postulate inside of a black hole the same vacuum as outside. By avoiding this, the unphysical singularity in the centre of the black hole disappears, and the interior solution goes over into a Friedman-Robertson-Walker-cosmos. To show that, one has to work with the protyposis, abstract and absolute quantum bits, as the elementary entities of the universe. Doing this, also the entropy of the black holes does follow in a simple and straightforward way.

GR 16: Grundlegende Probleme

Zeit: Donnerstag 18:45–19:25 Raum: ZHG 002

GR 16.1 Do 18:45 ZHG 002

On supplementary conditions in general relativistic multipolar approximation schemes — •Dirk Puetzfeld — ZARM, Universitaet Bremen

Multipolar approximation techniques play an important role in the description of the motion of extended bodies in General Relativity. All currently known approximation schemes require the specification of a so-called "supplementary condition" beyond the lowest multipolar order. In this talk we review the most common supplementary conditions. In particular, we focus on their interpretation in the context of different multipolar approximation schemes, as well as the conceptual problems which arise with their introduction.

GR 16.2 Do 19:05 ZHG 002

The Origin of Gravity - by Lorentzian Relativity — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Einstein based his theory of relativity on so-called 'principles'. These are assumed to be basic rules of nature which cannot be traced back to more fundamental facts. - However, it can be shown that Einstein's principles can in fact either be traced back further (accompanied by a better understanding of physics in general), or have in the meantime been falsified.

One of Einstein's fundamental principles is the constancy of the speed of light 'c'. The logical conflicts with geometry or with observations in gravitational fields that follow from this are dealt with by assuming curved 4-dimensional space-time which even looks different to different observers.

By adopting the fundamental assumption of H. Lorentz that relativistic phenomena are not a consequence of new principles but can be deduced from known physical processes, we can find an easier way to explain relativity including gravity, while at the same time giving us a better understanding of other areas of physics such as field theory and particles. General relativity turns out to be workable at a school level with similar results to those of Einstein, but avoiding the logical paradoxes inherent in Einstein's approach.

We also find answers to the great open problems of present-day physics such as Dark Energy, Dark Matter, and Quantum Gravity.

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

GR 17: Quantenfeldtheorie

Zeit: Freitag 8:30–9:10 Raum: ZHG 002

GR 17.1 Fr 8:30 ZHG 002

A new approach to a unified force — •Jürgen Kässer — Ahornweg 5 D31199 Diekholzen

The assumption is presented that the true structure of the world is a six dimensional (6D) Euclidian space in which our 4D world is embedded properly. Because of the local isomorphism of SO(6) and SU(4) physics developed for this space crystallizes as being very symmetric with only one force and no gravity. Analyzing how this 6D physics can be interpreted by a 4D observer it emerges that the transition seems to be something like a universal remedy. It shows that the result allows formulating our known physics. It gives reason why quantum physics is a probabilistic theory, can explain quarks as transformed 6D symmetry, can deduct our three forces from the one 6D force, can introduce particle mass in the Lagrange density and can implement gravity. The paper presents a structural description. To achieve quantitative results mathematical problems have to be overcome.

GR 17.2 Fr 8:50 ZHG 002

A sheet of graphene - quantum fields in a discrete curved space — •Nikodem Szpak — Fakultät für Physik, Universität Duisburg- Essen

Hubbard-like Hamiltonian systems describing quantum fields in a discrete space, known from optical lattices or crystalline materials like graphene, offer a fascinating possibility for studying and simulating the impact of non-trivial geometries (e.g. curved graphene sheets) on the quantum fields living in it. Despite existing analogies between deformations and defects in the lattice systems and curvature and torsion in the differential geometry, the correspondence is still incomplete and the language allowing for effective calculations is still lacking. We will report on progress in this direction.

GR 18: Gravitationswellen

Zeit: Freitag 9:10–10:30 Raum: ZHG 002

GR 18.1 Fr 9:10 ZHG 002

Time-Delay Interferometry and clock noise removal for LISA — •Markus Otto — Centre for Gravitational Physics Hannover and QUEST, 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. Time-Delay Interferometry (TDI) provides synthesized data streams free of laser phase noise while preserving the gravitational wave signal. At the same time TDI also removes fluctuations of the on-board clocks that distort the sampling process. TDI needs precise information about the spacecraft separations, sampling times and differential clock noise between the three spacecraft. These are measured using auxiliary modulations on the laser light.

In our talk, we will discuss a compliant algorithm that corrects for both clock and laser noise in the case of a rotating, non-breathing LISA constellation. Furthermore, we will consider the absolute order of laser frequencies forming the beatnote at the photodetectors. As an outlook, we will shortly discuss an optical setup to verify the TDI algorithm in the experiment.

GR 18.2 Fr 9:30 ZHG 002

eLISA / NGO – ein Gravitationswellendetektor im All — •Peter Aufmuth — Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover.

In ihrem 2010 veröffentlichten Zehnjahresprogramm hat das Board on Physics and Astronomy den Nachweis von Gravitationswellen durch die Weltraummission LISA („Laser Interferometer Space Antenna") zu einem der wichtigsten astrophysikalischen Projekte der nächsten Dekade erklärt. Ursprünglich gemeinsam von ESA und NASA geplant, mußte sich die NASA Anfang 2011 aus finanziellen Gründen aus der Vorbereitung von LISA zurückziehen. Die Mission soll nun unter dem Namen eLISA / NGO („evolved LISA / New Gravitational wave Observatory") von der ESA allein durchgeführt werden. Durch eine Reskalierung des ursprünglichen Konzepts werden Kosten eingespart ohne den wissenschaftlichen Nutzen der Mission wesentlich zu verringern. In dieser Form gehört eLISA / NGO zu den Missionen der L-Klasse der ESA („Cosmic Vision 2015 – 2025“), deren Start für Anfang der 2020er Jahre vorgesehen ist.

GR 18.3 Fr 9:50 ZHG 002

Maximum elastic deformations of relativistic stars — •Nathan K. Johnson-McDaniel[1,2] and Benjamin J. Owen[2] — [1]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität, Jena, Deutschland — [2]Institute for Gravitation and the Cosmos, Center for Particle and Gravitational Astrophysics, The Pennsylvania State University, University Park, PA, USA

Deformed neutron stars are a prominent potential source of gravitational waves, and there are active searches for these waves by the LIGO/Virgo collaboration. It is thus of considerable interest to know the maximum deformation that could be obtained for various models of neutron stars. We present here the first general relativistic calculations of such maximum quadrupoles in the case of elastic deformations. We consider the standard case of the quadrupoles generated by crustal deformations, and the somewhat more speculative case of quadrupoles generated by deformations of the hadron-quark mixed phase in hybrid stars, where we use our recent calculation of the shear modulus. In both cases, we find relativistic suppressions of the maximum quadrupole, compared with the standard, Newtonian calculations; these suppressions can be as large as a factor of 6 for the crustal quadrupoles of massive, compact stars. But even with the suppressions, maximally strained hybrid stars can still sustain quadrupoles large enough that they could have been detected in recent LIGO/Virgo searches (assuming that the large breaking strain recently calculated for the crust is applicable to the mixed phase in the core).

GR 18.4 Fr 10:10 ZHG 002

Mind the resonances — •Georgios Lukes-Gerakopoulos for the Pierre Auger-Collaboration — Theoretical Physics Institute, University of Jena, 07743 Jena, Germany

Though, the ergodic motion is the most prominent effect of a non-integrable system, the frequency spectrum of the ergodic motion corresponds to noise. However, the resonances of the intrinsic frequencies of a non-integrable system produces interesting non-linear phenomena which could be detected during a gravitational wave analysis. I will present these resonance phenomena for different types of "bumpy" black holes and I will indicate how these phenomena can be observed.

GR 19: Hauptvorträge Relativistische Astrophysik

Zeit: Freitag 11:00–12:30 Raum: ZHG 002

Hauptvortrag GR 19.1 Fr 11:00 ZHG 002

Accretion onto Sagittarius A* at the Center of the Milky Way — •Andreas Eckart — I. Physikalisches Institut, Universität zu Köln; Zuelpicher Str. 77; 50937 Köln

The super-massive 4 million solar mass black hole (SMBH) SgrA* shows flare emission from the millimeter to the X-ray domain. Near-infrared polarimetry shows signatures of strong gravity that are statistically significant against randomly polarized red noise. This allows us to derive spin and inclination information of the SMBH. A detailed analysis of the flares in the framework of a Synchrotron Self Compton (SSC) mechanism shows that a scenario in which the infrared flares are explained by synchrotron emission and the associated X-ray flares are produced via SSC emission can also explain the variability spectrum observed in the sub-millimeter radio domain. The light curves suggest in many cases that the mm flare emission follows the NIR emission with a delay of 1.5 - 2 hours indicating that adiabatic expansion of a plasma of relativistic electrons is at work. A detailed analysis of the infrared light curves allow us to address the accretion phenomenon in a statistical way. The analysis shows that the flare amplitudes are dominated by a single state power law. SgrA* also allows us to study the interaction of the SMBH with the immediate interstellar and gaseous environment of the central stellar cluster. It appears that through infrared imaging of the central few arcseconds one can study both inflow and outflow phenomena linked to the SgrA* black hole. SgrA* will also be compared to nuclei of nearby galaxies and to higher luminosity extragalactic active nuclei.

Hauptvortrag GR 19.2 Fr 11:45 ZHG 002

Probing the nature of gravity with radio pulsars — •Norbert Wex — Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany

Nearly four decades have passed since the discovery of the first radio pulsar in a binary system by Joseph Taylor and Russell Hulse. The most well-known use of this precise "cosmic clock" has been its role in tests of gravity theories, in particular in the (indirect) verification of the existence of gravitational waves.

Since then, additional binary pulsars have been discovered, allowing us to test different aspects of gravity. A particularly interesting system in this respect is the so-called "Double Pulsar", a unique system where two active radio pulsars orbit each other in less than 2.5 hours.

Currently there are efforts to find the first pulsar orbiting a black hole. This would complement the pulsar gravity tests in a unique way. The ultimate laboratory would be a pulsar in a tight orbit around the supermassive black hole in the centre of our Galaxy.

In addition to gravity tests with the binary motion of pulsars, there is presently a world wide effort for a direct detection of nano-Hz gravitational waves from supermassive black hole binaries, using an array of pulsars with very high rotational stability.

After a short introduction to pulsars and pulsar timing, I will summarise some of the more recent gravity tests with binary pulsars, outline the potential of a pulsar-black hole system which is yet to be discovered, and highlight some aspects of using pulsars as a gravitational wave detector.

GR 20: Relativistische Astrophysik

Zeit: Freitag 12:30–13:30 Raum: ZHG 002

GR 20.1 Fr 12:30 ZHG 002

Observables for bound orbital motion in axially symmetric space-times — •Eva Hackmann[1] and Claus Lämmerzahl[1,2] — [1]ZARM, Universität Bremen — [2]Institut für Physik, Universität Oldenburg

The periastron shift and the Lense-Thirring effect of bound orbital motion in a general axially symmetric space-time given by Plebański and Demiański are analyzed. We also define a measure for the conicity of the orbit and give analytic expressions for the observables in terms of hyperelliptic integrals and Lauricella's F_D function. For an interpretation of these analytical expressions, we perform a post-Schwarzschild and a post-Newton expansion of these quantities. This clearly shows the influence of the different space-time parameters on the considered observables and allows to characterize Kerr, Taub-NUT, Schwarzschild-de Sitter, or other space-times.

GR 20.2 Fr 12:50 ZHG 002

Analytical timing formula for a pulsar orbiting a Schwarzschild black hole — Eva Hackmann[1], Claus Lämmerzahl[1,2], •Viktoriya Morozova[1,3,4], and Volker Perlick[1] — [1]ZARM, University Bremen, Am Fallturm, 28359 Bremen, Germany — [2]Institute for Physics, University Oldenburg, 26111 Oldenburg, Germany — [3]Institute of Nuclear Physics, Ulughbek, 100214,Tashkent, Uzbekistan — [4]Albert-Einstein-Institute, Golm

The analytical formula describing the arrival of periodic signals coming from a pulsar orbiting a Schwarzschild black hole is presented. The novelty of our approach consists in using general relativistic solutions in terms of Weierstrass elliptic functions for exact description of the pulsar motion as well as light ray propagation in the vicinity of Schwarzschild black hole in application to the pulsar timing problem. From the obtained formula any order of relativistic approximation can be derived.

GR 20.3 Fr 13:10 ZHG 002

On spherical lightlike geodesics in the Kerr spacetime — •Volker Perlick — ZARM, Universität Bremen, 28359 Bremen

It is known that the Kerr spacetime admits spherical lightlike geodesics, i.e., lightlike geodesics that stay on a sphere $r =$constant in standard Boyer-Lindquist coordinates. In this talk I will present pictures that show the region filled by these spherical lightlike geodesics, for the black-hole case ($a^2 \le m^2$) and for the naked-singularity case ($a^2 > m^2$), and I will discuss the relevance of this "photon region" for gravitational lensing. In the second part of the talk I will investigate the behaviour of the photon region under perturbations of the Kerr spacetime and I will discuss, thereupon, the question of how to distinguish strongly naked singularities from weakly naked singularities; this distinction was introduced by Shwetketu Virbhadra for spherically-symmetric and static spacetimes and is generalised here.

GR 21: Numerische Relativitätstheorie

Zeit: Freitag 14:00–15:20 Raum: ZHG 002

GR 21.1 Fr 14:00 ZHG 002

Conservation laws and evolution schemes in geodesic, hydrodynamic and magnetohydrodynamic flows — •Charalampos Markakis[1,2], Koji Uryu[3], Eric Gourgoulhon[4], and Jean-Philippe Nicolas[5] — [1]Theoretical Physics Institute, University of Jena, Germany — [2]Department of Physics, University of Wisconsin - Milwaukee, USA — [3]Department of Physics, University of the Ryukyus, Okinawa, Japan — [4]LUTh, Paris Observatory, Meudon, France — [5]Department of Mathematics, University of Western Brittany, Brest, France

Carter, Arnold and others have shown that the elements of a perfect barotropic fluid obey particle-like laws of motion that can be expressed in covariant form and derived from simple variational principles. This framework can accommodate neutral or poorly conducting charged fluids. We extend this framework to perfectly conducting fluids via the Bekenstein-Oron description of ideal MHD. This allows one to cast the ideal MHD equations into a circulation-preserving hyperbolic form. In this framework, conserved circulation integrals, such as those of Alfven, Kelvin and Bekenstein-Oron, emerge simply as special cases of the Poincare-Cartan integral invariant of Hamiltonian systems. Such scheme can be used to evolve oscillating stars or radiating binaries with magnetic fields in numerical relativity.

Synge and Lichnerowicz have further shown that barotropic fluid flow may be represented as geodesic flow in a conformally related manifold. By extending the notion of a metric to allow for Finsler geometries, we generalize this result to ideal MHD.

GR 21.2 Fr 14:20 ZHG 002

Constraint Damping for the Z4 formulation of general relativity — •Andreas Weyhausen, David Hilditch, and Sebastiano Bernuzzi — TPI Friedrich-Schiller-Universität Jena

The Z4 formulation of general relativity provides a built-in damping scheme which promises to damp away constraint violations during free evolution. In this talk I present the results of a numerical study on the damping system in Z4c, a conformal decomposition of Z4. I will discuss the effect of the damping on low-frequency and on high-amplitude perturbations of flat space-time as well as on the long-term dynamics of puncture and compact star initial data in the context of spherical symmetry.

GR 21.3 Fr 14:40 ZHG 002

Self-gravitating Bose-Einstein-Condensates — Kris Schroven[1], Betti Hartmann[2], •Claus Lämmerzahl[1], and Meike List[1] — [1]ZARM, University Bremen — [2]Jacobs-University Bremen

Self-gravitating quantum systems serve as model for a variety of issues like Boson stars, gravitationally induced decoherence, or quasi-classical Einstein equations. Here we are considering self-gravitating Bose-Einstein-Condendates which are described by the Newton–Gross–Pitaevskii equation. We solve these equations for stationary spherically symmetric configurations and discuss the dependence of the solutions and their energy from the particle number and the value of the non-linearity parameter. Also higher energy states will be presented. We close with an outlook describing possible issues which can be discussed within this formalism.

GR 21.4 Fr 15:00 ZHG 002

Multiple Solutions of the Gross-Pitaevskii-Equation in a gravitational field — •Zelimir Marojevic and Claus Lämmerzahl — Center of Applied Space Technology and Microgravity, Bremen

A new numerical method is used to treat the problem of a Bose-Einstein-Condensate in 3D trapped by a gravitational field along the axial direction and by a harmonic trap along the radial direction. We call this setup gravito-optical surface trap. This new algorithm gives us access to excited states, which belong to monkey type saddle points of the Lagrangian. In order to find a measure for gravitational acceleration the emerging pattern for different parameter sets are studied.

GR 22: Experimentelle Tests

Zeit: Freitag 15:20–16:20 Raum: ZHG 002

GR 22.1 Fr 15:20 ZHG 002

Spectroscopy of Gravity — Hartmut Abele[1], Thomas Bittner[1], Gunther Cronenberg[1], Hanno Filter[1], Peter Geltenbort[2], •Tobias Jenke[1], Hartmut Lemmel[1], and Martin Thalhammer[1] — [1]Atominstitut TU Wien, Wien, Österreich — [2]Institut Laue-Langevin, Grenoble, Frankreich

This talk is about a test of the Newtons Inverse Square Law of Gravity at micron distances by quantum interference with ultra-cold neutrons deep into the theoretically interesting regime.

The method is based on a new resonance spectroscopy technique related to Rabi spectroscopy, but it has been adapted to gravitationally bound quantum systems. By coupling such a quantum system to mechanical vibrations, we observe resonant transitions, devoid of electromagnetic interaction.

As Newtonian gravity and hypothetical Fifth Forces evolve with different phase information, the experiment has the potential to test the equivalence principle and Newtons gravity law at the micron scale. This experiment can therefore test speculations on large extra dimensions of sub-millimetre size of space-time or the origin of the cosmological constant in the universe, where effects are predicted in the interesting range of this experiment and might give a signal in an improved setup.

GR 22.2 Fr 15:40 ZHG 002

Thermal recoil analysis of the Pioneer 10 spacecraft — •Benny Rievers and Claus Lämmerzahl — Centre of Applied Space Technology and Microgravity (ZARM), University of Bremen

Since the upcoming of investigations of the so called Pioneer Anomaly (PA), a constant unexplained residual Doppler shift of the deep space probes Pioneer 10 and Pioneer 11, many theories on the origin of the effect have been proposed and tested without success. It has soon be suggested to investigate the thermal effects, since only a small fraction of the available thermal energy is sufficient to cause a recoil in the magnitude of the anomaly. However, the constancy of the effect and simple model calculations seemed to contradict a thermal source. At the Centre of Applied Space Technology and Microgravity (ZARM) new high precision modeling methods for the assessment of thermal recoils acting on spacecraft have now been developed and utilized for a detailed thermal analysis of the complete Pioneer 10 mission. The analysis, which includes the detailed interior and exterior configuration of the craft as well as the available telemetry data shows that the observed residual effect can completely be reconstructed as a thermal recoil resulting from anisotropic heat radiation. For one part of the mission this result has already been confirmed independently and new analysis of longer Doppler data sets by NASA also favour a thermal explanation of the PA. In the talk, the modelling methods based on Finite Elements and raytracing as well as the robustness of the results will be discussed in detail.

GR 22.3 Fr 16:00 ZHG 002

Störkraftanalyse für die MICROSCOPE-Mission — •Meike List, Stefanie Bremer, Benny Rievers und Claus Lämmerzahl — ZARM, Universität Bremen

Das Ziel des französischen Raumfahrtprojektes MICROSCOPE ist die experimentelle Überprüfung des schwachen Äquivalenzprinzips mit einer Genauigkeit von $\eta = 10^{-15}$. Das Experiment wird voraussichtlich 2016 auf einer erdnahen Umlaufbahn an Bord eines Kleinsatelliten der CNES-μ-Sat-Line durchgeführt. Das französische Institut ONERA entwickelt und baut die hochgenauen Differential-Accelerometer, mit deren Hilfe die angestrebte Messgenauigkeit erreicht werden soll.

Das ZARM verfügt über das Erstzugriffsrecht auf die Missionsdaten. Für die Datenanalyse sowie die In-Orbit-Kalibrierungsphasen des Satelliten werden am ZARM umfangreiche Simulationen der verschiedenen Störeinflüsse durchgeführt. Hierzu wird die Simulationssoftware HPS verwendet, welche in Kooperation mit dem DLR Institut für Raumfahrtsysteme entwickelt wird.

Über den aktuellen Stand des Projekts wird im Rahmen des Vortrags berichtet.

GR 23: Alternative Ansätze

Zeit: Freitag 16:20–16:40 Raum: ZHG 002

GR 23.1 Fr 16:20 ZHG 002

Review of the relationship between the Galileo principle and the velocity of light — •Shukri Klinaku — University of Prishtina, Sheshi Nëna Terezë, Prishtinë, Kosovo

In the part of physics called "classical mechanics" the Galileo's principle of relativity is accepted by all. But, according to the theory of special relativity (TSR) this principle can't be applied for the light. By analyzing several experiments (Fizeau's experiment, Michelson's experiment, de Sitter's observation and Alväger's experiment) in this paper it will be concluded that the reliance of TSR's postulates in those experiments is unsustainable. The essence of the reviewing of these experiments is that some of them do not have the same conditions as the motion to which refers the Galileo principle (Fizeau's experiment, the de Sitter's observation and the Alväger's experiment) and in some of them the Galileo principle is not applied correctly (Michelson's experiment). In this paper it is also concluded that the light obeys to the Galileo principle like all other bodies. Finally, an idea is proposed for conducting an experiment which will prove that the velocity of light is not constant in all reference frames.

GR 24: Poster (permanent)

Zeit: Montag 14:00–14:00 Raum: ZHG 002

GR 24.1 Mo 14:00 ZHG 002

qBounce - a realization of the Quantum Bouncer with ultra-cold neutrons — Hartmut Abele[1], Thomas Bittner[1], •Gunther Cronenberg[1], Hanno Filter[1], Peter Geltenbort[2], Tobias Jenke[1], Kevin Mitsch[1], and Martin Thalhammer[1] — [1]Atominstitut TU Wien, Wien, Österreich — [2]Institut Laue-Langevin, Grenoble, Frankreich

We present the observation of a quantum bouncing ball in the gravitational field of the Earth. Quantum states in the Earth's gravitational field can be observed, when ultra-cold neutrons fall under gravity.

In our previous experiment in collaboration with the Institute Laue-Langevin/Grenoble, the lowest stationary quantum state of neutrons in the Earth's gravitational field was clearly identified. In the new experiment qBounce, we use this technique to prepare a neutron in the ground state and then to let it fall and bounce off a neutron mirror. Oscillations in time similar to the harmonic oscillator system described by Glauber states have been observed. Such a quantum particle bouncing in a linear gravitational field is known as the quantum bouncer. The motivation of this activity is also the investigation of quantum phases and quantum decoherence. For that matter we have developed position-sensitive neutron detectors with an extra-high spatial resolution.

GR 24.2 Mo 14:00 ZHG 002

Buch: Spezielle und Allgemeine Relativitätstheorie — •Jürgen Brandes — Karlsbad

Exakt und allgemeinverständlich werden diskutiert [1]: Die experimentellen Beweise der Relativitätstheorie, die Lösungen der Paradoxien, die Thesen zum vierdimensionalen Raum-Zeit-Kontinuum der Speziellen Relativitätstheorie, sowie die Thesen zum gekrümmten, expandierenden und geschlossenen Raum der Allgemeinen Relativitätstheorie. Enthalten sind die allgemein-relativistische Lösungsvariante der Zwillingsparadoxie und die Paradoxien von BELL, EHRENFEST und SAGNAC.

Die sogenannte LORENTZ-Interpretation wurde von LORENTZ, POINCARÉ, BELL, SEXL und vielen Anderen initiiert. Sie verbindet das EINSTEINsche Relativitätsprinzip mit der Vorstellung eines dreidimensionalen Raumes und einer eindimensionalen Zeit.

Ein wichtiger Punkt in [1] ist *die Energieerhaltung.* In der NEWTONschen Theorie gibt es ein negatives Gravitationspotenzial, wegen $E = mc^2$ bedeutet das negative Masse. Negative Massen gibt es nicht. Weder die NEWTONsche Theorie noch die EINSTEIN-Interpretation können erklären, was die negative Energie von im Feld ruhenden Teilchen bedeutet. Die LORENTZ-Interpretation gibt eine klare, experimentell überprüfbare Antwort.

[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 24.3 Mo 14:00 ZHG 002

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

At first glance, the Michelson-Morley experiment seems to suggest that 'c' is constant in relation to any system. However, at second glance this constancy turns out to be purely a result of the measuring procedure.

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

Einstein extended this principle about 'c' to gravitational fields. Even though it can be shown by direct measurement that 'c' is reduced in such a field, Einstein again asserted that it is constant and explained the result of the measurement through a change in space-time (which is not directly measurable).

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

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

GR 24.4 Mo 14:00 ZHG 002

Rydberg Atom in Gravity — •Aniket Agrawal — Indian Institute of Technology Delhi, New Delhi, India

Recently, Chiao predicted the quantum incompressibility of a falling Rydberg atom. A Hydrogen-like atom was considered in a very high n, l=m=n-1 state to calculate the effects of tidal gravitational forces on these states. The high values of quantum numbers ensure that gravitational effect is measurable on the *stretch* state. We consider a similar atom and derive the energy of a particular level under the influence of Newtonian gravity. A change in the frequency of observed transition is predicted for a freely falling Hydrogen atom. This change is calculated both in Newtonian gravity and in curved space.

We see that the change in energy of the electron under gravity also depends on its principal quantum number. Thus there will be a shift in the frequency of the photon emitted by an electron making an ordinary transition from the state n=100, l=99, m=99 to the state n=99,l=98,m=98. Though this shift is quite less to be observed on Earth, it is measurable in satellites in a highly elliptical orbit about the earth, by spectroscopic methods. A similar result was derived by Chiao recently using a different argument. We conclude that the effect described by Chiao will be masked to a very large extent by the effect calculated above. Such perturbations might be important in emission spectra of white dwarfs and neutron stars.