# Fachverband Gravitation und Relativitätstheorie (GR)

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## Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal 30.45: 101)

### Plenarvorträge

| | | | | |
|---|---|---|---|---|
| PV I | Di | 11:00–11:45 | 30.95: 001 | **Flavour Physics in the LHC Era** — •Andrzej Buras |
| PV II | Di | 11:45–12:30 | 30.95: 001 | **Testing principles of General Relativity with an eye towards Quantum Gravity** — •Domenico Giulini |
| PV III | Mi | 11:30–12:00 | 30.95: 001 | **Diffraktion bei der Streuung hochenergetischer und stark virtueller Photonen an Protonen bei HERA** — •Günter Wolf |
| PV IV | Mi | 12:00–12:45 | 30.95: 001 | **Der Large Hadron Collider LHC: Beginn einer neuen Ära in der Wissenschaft** — •Rolf Heuer |
| PV V | Mi | 20:00–21:00 | 30.21: 001 | **Von den höchsten Energien zu den kleinsten Teilchen: dem Urknall auf der Spur** — •Thomas Müller |
| PV VI | Do | 11:00–11:45 | 30.95: 001 | **Quantum Field Theory on curved backgrounds and its impact on cosmology** — •Klaus Fredenhagen |
| PV VII | Do | 11:45–12:30 | 30.95: 001 | **Recent Progress in Direct Searches for WIMP Dark Matter** — •Uwe Oberlack |

### Hauptvorträge

| | | | | |
|---|---|---|---|---|
| GR 1.1 | Mo | 14:00–14:45 | 30.45: 101 | **Small-scale structure of spacetime: Simple models and experiments** — •Frans R. Klinkhamer |
| GR 1.2 | Mo | 14:45–15:30 | 30.45: 101 | **The Asymptotic Safety Scenario in Quantum Gravity** — •Frank Saueressig |
| GR 1.3 | Mo | 15:30–16:15 | 30.45: 101 | **Dynamics and diffeomorphism symmetry in discrete quantum gravity** — •Bianca Dittrich |
| GR 7.1 | Mi | 16:45–17:30 | 30.45: 101 | **Loop quantum gravity** — •Carlo Rovelli |
| GR 7.2 | Mi | 17:30–18:15 | 30.45: 101 | **Causal Dynamical Triangulation - A Gateway to Quantum Gravity** — •Renate Loll, Jan Ambjorn, Jerzy Jurkiewicz |
| GR 7.3 | Mi | 18:15–19:00 | 30.45: 101 | **Geometry and Observables in three-dimensional (Quantum) Gravity** — •Catherine Meusburger |
| GR 9.1 | Do | 14:00–14:45 | 30.45: 101 | **Using numerical relativity to explore fundamental physics and astrophysics** — •Luciano Rezzolla |
| GR 9.2 | Do | 14:45–15:30 | 30.45: 101 | **The initial value problem of general relativity** — •David Hilditch |
| GR 16.1 | Fr | 11:00–11:45 | 30.45: 101 | **News from Quantum Gravity Phenomenology** — •Sabine Hossenfelder |
| GR 16.2 | Fr | 11:45–12:30 | 30.45: 101 | **Extra Dimensions in String Cosmology and Phenomenology** — •Marco Zagermann |

### Fachsitzungen

| | | | | |
|---|---|---|---|---|
| GR 1.1–1.3 | Mo | 14:00–16:15 | 30.45: 101 | **Hauptvorträge Montag: Quantengravitation und Quantengravitationsphänomenologie** |
| GR 2.1–2.7 | Mo | 16:45–19:05 | 30.45: 101 | **Quantengravitation und Quantenkosmologie** |
| GR 3.1–3.5 | Di | 14:00–15:40 | 30.45: 101 | **Experimentelle Tests** |
| GR 4.1–4.2 | Di | 15:40–16:20 | 30.45: 101 | **Klassische Allgemeine Relativitätstheorie I** |

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|---|---|---|---|---|
| GR 5.1–5.4 | Di | 16:45–18:05 | 30.45: 101 | **Schwarze Löcher** |
| GR 6.1–6.1 | Di | 18:05–18:25 | 30.45: 101 | **Andere Gebiete** |
| GR 7.1–7.3 | Mi | 16:45–19:00 | 30.45: 101 | **Hauptvorträge Mittwoch: Quantengravitation und Quantengravitationsphänomenologie (gemeinsam mit MP)** |
| GR 8.1–8.6 | Do | 8:30–10:30 | 30.45: 101 | **Kosmologie** |
| GR 9.1–9.2 | Do | 14:00–15:30 | 30.45: 101 | **Hauptvorträge Donnerstag: Klassische Allgemeine Relativitätstheorie** |
| GR 10.1–10.2 | Do | 15:30–16:10 | 30.45: 101 | **Gravitationswellen** |
| GR 11.1–11.3 | Do | 16:45–17:45 | 30.45: 101 | **Numerische Relativitätstheorie** |
| GR 12.1–12.3 | Do | 17:45–18:45 | 30.45: 101 | **Relativistische Astrophysik** |
| GR 13.1–13.2 | Do | 18:45–19:25 | 30.45: 101 | **Klassische Allgemeine Relativitätstheorie II** |
| GR 14.1–14.2 | Fr | 8:30– 9:10 | 30.45: 101 | **Klassische Allgemeine Relativitätstheorie III** |
| GR 15.1–15.4 | Fr | 9:10–10:30 | 30.45: 101 | **Alternative Ansätze** |
| GR 16.1–16.2 | Fr | 11:00–12:30 | 30.45: 101 | **Hauptvorträge Freitag: Quantengravitation und Quantengravitationsphänomenologie** |
| GR 17.1–17.3 | Fr | 12:30–13:30 | 30.45: 101 | **Alternative Ansätze II** |
| GR 18.1–18.1 | Fr | 13:30–13:50 | 30.45: 101 | **Grundlegende Probleme** |
| GR 19.1–19.3 | Mo | 14:00–14:00 | 30.45: 101 | **Poster (permanent)** |

## Plenarvorträge des Symposiums Quantengravitation

Das vollständige Programm dieses Symposiums ist unter SYQG aufgeführt.

| | | | | |
|---|---|---|---|---|
| SYQG 1.1 | Mi | 14:00–14:45 | 30.95: 001 | **Quantum Gravity: General Introduction and Recent Developments** — •Claus Kiefer |
| SYQG 1.2 | Mi | 14:45–15:30 | 30.95: 001 | **Does Quantum Gravity need Strings?** — •Constantin Bachas |
| SYQG 1.3 | Mi | 15:30–16:15 | 30.95: 001 | **Loop Quantum Gravity (LQG)** — •Thomas Thiemann |

## Symposium GHT Dissertationspreis

Das Symposium findet am Dienstag, 8:30–10:30 Uhr, im Hörsaal 30.95: 001 statt. Details zu den Vorträgen werden einige Wochen vor der Tagung auf www.dpg-verhandlungen.de veröffentlicht.

## Begrüßungsabend

Am Dienstag ab 19:30 Uhr findet ein Begrüßungsabend mit Imbiss und Getränken in der Mensa (Gebäude 01.12) statt.

## Mitgliederversammlung Fachverband Gravitation und Relativitätstheorie

Dienstag, den 29. März 2011, 18:30–19:30 Raum 30.54: 101

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

## GR 1: Hauptvorträge Montag: Quantengravitation und Quantengravitationsphänomenologie

Zeit: Montag 14:00–16:15 Raum: 30.45: 101

**Hauptvortrag** GR 1.1 Mo 14:00 30.45: 101

**Small-scale structure of spacetime: Simple models and experiments** — •Frans R. Klinkhamer — Institute for Theoretical Physics, University of Karlsruhe, Karlsruhe Institute of Technology

An elementary discussion of a possible nontrivial small-scale structure of spacetime is presented. Current and future experimental constraints from astroparticle physics are reviewed.

**Hauptvortrag** GR 1.2 Mo 14:45 30.45: 101

**The Asymptotic Safety Scenario in Quantum Gravity** — •Frank Saueressig — Institute of Physics, University of Mainz, D-55099 Mainz, Germany

Asymptotic safety offers the possibility that gravity constitutes a consistent and predictive quantum field theory within Wilsons generalized framework of renormalization. The key ingredient of this scenario is a non-trivial fixed point of the gravitational renormalization group flow which governs the UV behavior of the theory. The fixed point itself thereby guarantees the absence of unphysical UV divergences while its associated finite-dimensional UV-critical surface ensures the predictivity of the resulting quantum theory.

This talk will summarize the evidence for the existence of such a fixed point, which emerged from the flow equation for the effective average action, the gravitational beta-functions in $2 + \epsilon$ dimensions, the 2-Killing vector reduction of the gravitational path-integral and lattice simulations. Possible phenomenological consequences will be discussed in detail.

**Hauptvortrag** GR 1.3 Mo 15:30 30.45: 101

**Dynamics and diffeomorphism symmetry in discrete quantum gravity** — •Bianca Dittrich — AEI, Potsdam, Germany

Diffeomorphism symmetry is the underlying symmetry of general relativity and deeply intertwined with its dynamics. The notion of diffeomorphism symmetry is however often obscured in discrete gravity, which underlies most of the current quantum gravity models. We will propose a notion of diffeomorphism symmetry in discrete models and find that such a symmetry is weakly broken in many models. We will explain the connection to the problem of finding a consistent canonical dynamics for discrete gravity. To overcome these problems we will discuss methods to construct models with exact symmetries via so called perfect actions which involves a renormalization group analysis of the discrete quantum gravity models.

## GR 2: Quantengravitation und Quantenkosmologie

Zeit: Montag 16:45–19:05 Raum: 30.45: 101

GR 2.1 Mo 16:45 30.45: 101

**Dynamik der sphärisch-symmetrischen Schrödinger-Newton-Gleichung** — •André Grossardt[1,2] und Domenico Giulini[1,2] — [1]Centre for Quantum Engineering and Space-Time Research (QUEST), Hannover, Germany — [2]Zentrum für angewandte Raumfahrttechnologie und Mikrogravitation (ZARM), Bremen, Germany

Die Schrödinger-Newton-Gleichung, welche als Modell der semiklassischen Gravitation die Gravitationsselbstwechselwirkung eines quantenmechanischen Wellenpakets beschreibt, wurde von Salzman und Carlip 2006 numerisch untersucht. Unter der Annahme sphärischer Symmetrie soll diesen Autoren zufolge bereits für Massen von einigen tausend atomaren Einheiten ein gravitativ bedingter Kollaps der Wellenfunktion zu beobachten sein, was die Beobachtung in molekülinterferometrischen Experimenten in naher Zukunft in Aussicht stellen würde.

Der von mir präsentierte Versuch, diese Ergebnisse zu reproduzieren, ergab einen Kollaps erst bei um sieben Größenordnungen höheren Massen, was sehr viel besser mit einer naiven analytischen Abschätzung übereinstimmt und den in Aussicht gestellten experimentellen Test in Frage stellt.

GR 2.2 Mo 17:05 30.45: 101

**Quantum gravitational contributions to the CMB anisotropy spectrum** — •Manuel Krämer and Claus Kiefer — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

We derive the primordial power spectrum of density fluctuations in the framework of quantum cosmology. For this purpose, we perform a Born-Oppenheimer approximation to the Wheeler-DeWitt equation for an inflationary universe with a scalar field. In this way we first recover the scale-invariant power spectrum that is found as an approximation in the simplest inflationary models. We then obtain quantum gravitational corrections to this spectrum and discuss whether they lead to measurable signatures in the CMB anisotropy spectrum.

GR 2.3 Mo 17:25 30.45: 101

**Two-point functions in (loop) quantum cosmology** — Gianluca Calcagni[1], •Steffen Gielen[1,2], and Daniele Oriti[1] — [1]Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Am Mühlenberg 1, D-14476 Golm — [2]DAMTP, Centre for Mathematical Sciences, Wilberforce Road, Cambridge CB3 0WA, U.K.

We discuss the path-integral formulation of quantum cosmology with a massless scalar field as a sum-over-histories of volume transitions, with particular but non-exclusive reference to loop quantum cosmology (LQC). Exploiting the analogy with the relativistic particle, we give a complete overview of the possible two-point functions, pointing out the choices involved in their definitions, deriving their vertex expansions and the composition laws they satisfy. We clarify the origin and relations of different quantities previously defined in the literature, in particular the tie between definitions using a group averaging procedure and those in a deparametrized framework. Finally, we draw some conclusions about the physics of a single quantum universe (where there exist superselection rules on positive- and negative-frequency sectors and different choices of inner product are physically equivalent) and multiverse field theories where the role of these sectors and the inner product are reinterpreted.

GR 2.4 Mo 17:45 30.45: 101

**Towards classical geometrodynamics from Group Field Theory hydrodynamics** — Daniele Oriti and •Lorenzo Sindoni — MPI für Gravitationsphysik, Albert Einstein Institute, am Mühlenberg 2, 14476 Golm

We describe the first steps towards identifying the hydrodynamics of group field theories (GFTs) and relating this hydrodynamic regime to classical geometrodynamics of continuum space. We apply to GFT mean field theory techniques borrowed from the theory of Bose condensates, alongside standard GFT and spin foam techniques. The mean field configuration we study is, in turn, obtained from loop quantum gravity coherent states. We work in the context of 2d and 3d GFT models, in euclidean signature, both ordinary and colored, as examples of a procedure that has a more general validity. We also extract the effective dynamics of the system around the mean field configurations, and discuss the role of GFT symmetries in going from microscopic to effective dynamics. In the process, we obtain additional insights on the GFT formalism itself.

GR 2.5 Mo 18:05 30.45: 101

**Spin systems as toy models for emergent gravity** — •Fotini Markopoulou — Perimeter Institute for Theoretical Physics, Waterloo, Canada — Albert Einstein Institute, Golm, Germany — University of Waterloo, Waterloo, Canada

A number of recent proposals for a quantum theory of gravity are based on the idea that spacetime geometry and gravity are derivative concepts and only apply at an approximate level. There are two fundamental challenges to any such approach. At the conceptual level, there is a clash between the "timelessness" of general relativity and emergence. Second, the lack of a fundamental spacetime makes difficult the straightforward application of well-known methods of statistical physics to the problem. We initiate a study of such problems using toy models for emergent geometry and gravity based on evolution of quantum networks with no a priori geometric notions.

In this talk we present two models. The first is a model of emergent (flat) space and matter and we show how to use methods from quantum information theory to derive features such as speed of light from a non-geometric quantum system. The second model exhibits interacting matter and geometry, with the geometry defined by the behavior of matter. This model has primitive notions of gravitational attraction, and exhibits entanglement between matter and geometry and thermalization of the quantum geometry.

GR 2.6 Mo 18:25 30.45: 101

**Einsteins Gleichung - Konsequenz einer Quantenkosmologie** — •Thomas Görnitz — FB Physik, J. W. Goethe-Univ. Frankfurt/M.

Wohl für viele überraschend lässt sich Materie (also die relativistischen Teilchen) als zweite Quantisierung einer abstrakten, bedeutungsfreien Quanteninformation erklären. In Weiterführung von Ideen von v. Weizsäcker sowie von Bekenstein und Hawking wird u. a. eine S^3 als Ortsraum impliziert, für den sich die Plancklänge gruppentheoretisch begründen lässt. Fordert man die Gültigkeit des ersten Hauptsatzes der Thermodynamik, der Planckschen Relation zwischen Energie und Wellenlänge sowie eine ausgezeichnete Geschwindigkeit, so folgt aus dieser Quanteninformation ein kosmologisches Modell, welches gut zu den Beobachtungsdaten passt und das eine physikalische Erklärung für die "Dunkle Energie" und "Dunkle Materie" ermöglicht. Wenn die Beziehungen zwischen dem Energie-Impuls-Tensor in diesem Kosmos und den Veränderungen seiner Metrik, die mit Krümmungstensor und Krümmungsskalar erfasst werden, auch für lokale Schwankungen des Materieinhaltes gelten, dann ergeben sich die Einsteinschen Gleichungen als Beschreibung der lokalen Schwankungen der Geometrie unter dem Einfluss der Materieinhomogenitäten in einem im Wesentlichen homogenen und isotropen Kosmos.

GR 2.7 Mo 18:45 30.45: 101

**Der Quantenzustand des Universums** — •Norbert Sadler — 85540 Haar; Wasserburger Str. 25a

Unter der Annahme, dass sich das Universum lokal in einem virialen Quantenzustand befindet, kann repräsentativ für das gesamte Univ.,der Quantenzustand der mittleren linearen Energiedichte zu (4/9 Protonen/1m) präpariert werden.

Der Quantenzustand in der Eigenwert-Amplitudendarstellung: (4/9)(0,283grav.M.)(0,717dkl.E.)=2(0,045bar.M.)=(4Pi)(Alfa(QED))

Die Zustandsgl. gibt die Beobachtungswahrsch. für 2 kosm. baryon. Entitäten bzw. die zu erwartende lokale helle-phot. Wirklichkeit, innerhalb einer 1m-Distanz, an. Des weiteren gelten folgende QuantenFeldzustände : (2Pi)(0,045)=0,238; (CP Verl.0,0028)(0,717)=(0,045)**2; (CP Verl.)(0,239)=(Alfa/0,283)**2; (4Pi)(CP Verl)=(4/9)/(4Pi)

Es kann gezeigt werden, dass das Gravitationsfeld des Univ. durch Wechselwirkung des dunklen Anteils des 4/9Prot./1m Energiequantes mit dem Expansionsfeld des Universums quantenth. und physikal. generiert wird: 1kg.g(Univ.)=(4/9)(0.239.1kg)c(Hubble)=4/9(p/1m)(c.c)

Der Quantenzustand des Protons im "Higgs-Mechanismus": (2/3)(154,1GeV HiggsB.)(0,045)(0,283)(0,717)=0,938GeV/Prot.

Es kann gezeigt werden, dass die Entwicklung das Univ. bis hin zum Proton dem "Goldenen Schnitt",Phi=1,618 folgt: Phi(Univ.)=0,72/(4/9);Phi(Pr.)=0,938GeV/(0,24x8x0,3GeVQuark)

# GR 3: Experimentelle Tests

Zeit: Dienstag 14:00–15:40 Raum: 30.45: 101

GR 3.1 Di 14:00 30.45: 101

**Elektrostatisches Positionierungssystem** — •Andrea Sondag[1], Marcus Stadtlander[1], Claus Lämmerzahl[1] und Hansjörg Dittus[2] — [1]ZARM, Universität Bremen — [2]DLR Bremen

Im Rahmen des Projekts "Verbesserter Freifalltest des schwachen Äquivalenzprinzips" wurde ein elektrostatisches Positionierungssystem (EPS) entwickelt. Es soll eine zylinderförmige Testmasse möglichst genau in axialer Richtung positionieren und wurde dazu in einem Laborexperiment entwickelt. Anhand erster Tests wurde das System charakterisiert. Der Vortrag gibt einen Überblick über den aktuellen Stand der Entwicklung und die aktuellen Ergebnisse der Charakterisierung des Systems. Wichtige Eigenschaften sind die Positioniergenauigkeit, Positioniergeschwindigkeit, Restgeschwindigkeiten der Testmasse nach der Positionierung sowie die Wiederholgenauigkeit. Dabei spielt der Regler des Systems eine große Rolle. Ein Ausblick zeigt, wie das getestete System weiter verbessert bzw. wie es weiter entwickelt werden kann, um die Testmasse für ein Fallturmexperiment auch in radialer Richtung präzise zu positionieren.

GR 3.2 Di 14:20 30.45: 101

**Towards high precision modeling at the $10^{-20}$ level** — Michael Andres[1], Lothar Banz[1], Adrian Costea[1], •Eva Hackmann[2], Sven Herrmann[2], Claus Lämmerzahl[2], Leo Nesemann[1], Zouhair Nezhi[1], Benny Rievers[2], and Ernst P. Stephan[1] — [1]IfAM, Leibniz Universität Hannover — [2]ZARM, Universität Bremen

In modern high precision experiments optical high-finesse resonators are widely used as a frequency reference for the stabilization of lasers e.g. in optical atomic clocks or in direct tests of special and general relativity. Changes in the optical length of optical resonators are now commonly measured to $10^{-15}$ precision, and new experimental approaches point out that the achievable experimental accuracies may improve down to the level of $10^{-17}$ in the near future. Therefore, the requirements for accurate numerical simulation are increasing constantly. If deformations of the optical length of a resonator in the range of $10^{-15}$ occur, those effects can not be simulated and analyzed any more with standard methods based on double precision data types.

For the development and improvement of high precision resonators and the analysis of experimental data, new methods have to be developed which allow for the needed level of simulation accuracy. Therefore ZARM and IfAM plan the development of new high precision algorithms for the simulation and modeling of thermo-mechanical effects with an achievable accuracy of $10^{-20}$. In this talk we present a test case and identify the problems on the way to this goal.

GR 3.3 Di 14:40 30.45: 101

**High precision numerical modelling of solar radiation and thermal recoil pressure with application to Pioneer 10 and Rosetta** — •Benny Rievers and Claus Lämmerzahl — Zentrum für angewandte Raumfahrttechnologie und Mikrogravitation (ZARM), Universität Bremen, Am Fallturm, 28359 Bremen

For modern space mission a precise knowledge of non-gravitational disturbances acting on the spacecraft orbit can be crucial to the mission success. Among those so called "small forces" the influence of solar radiation pressure (SRP) and thermal recoil pressure (TRP) plays a central role. While SRP is the major non-gravitational disturbance in proximity of Earth and Sun, TRP is dominating for deep space mission with large heliocentric distances. We developed numerical modelling methods for the high precision evalutaion of TRP and SRP. These approaches will be presented and the computation process will be shown exemplarily for the space missions Pioneer 10 and ESAs current deep space mission Rosetta. The results will be discussed with regard to the well known Pioneer and Fly-By anomalies.

GR 3.4 Di 15:00 30.45: 101

**Überprüfung des Newtonschen Gravitationsgesetzes im Grenzfall kleiner Beschleunigungen** — •Sven Schubert[1], Hinrich Meyer[2], Carsten Niebuhr[1], Erich Lohrmann[3], Eberhard Wünsch[1], Alexandre Glazov[1], Bernd Loehr[1] und Wulfrin Bartel[1] — [1]DESY, Hamburg — [2]Universität Wuppertal — [3]Universität Hamburg

Mit einem Pendel-Experiment wird zur Zeit am DESY in Hamburg das Newtonsche Gravitationsgesetz im Grenzfall kleiner gravitativ bedingter Beschleunigungen überprüft. Hintergrund ist die Frage, ob die nach außen hin abflachenden Rotationskurven der Galaxien auf Dunkle Materie zurückzuführen sind oder auf ein Gravitationsgesetz, daß im Bereich kosmischer Skalen vom Newtonschen Gesetz abweicht wie z.B. MOND (Modified Newtionian Dynamics, Milgrom 1983).

Herzstück des Experiments sind zwei Pendel, die zusammen einen Mikrowellenresonator bilden. Dieser Aufbau ermöglicht es, gravitativ bedingte Abstandsänderungen der Pendel bis hinab zu 0.01 nm zu messen. Kleine Testmassen (1 bis 3 kg) sorgen dafür, daß die Pendel Beschleunigungen im Bereich von $10^{-10}$ m/s$^2$ erfahren. Dies simuliert Bedingungen, die weit außerhalb des Zentrums einer Galaxie vorherrschen. Ein auf kosmischen Skalen von Newton abweichendes Gravitationsgesetz könnte somit direkt überprüft werden.

Erste Ergebnisse deuten darauf hin, daß das Newtonsche Gesetz auch bei kleinen Beschleunigungen gültig bleibt.

GR 3.5 Di 15:20 30.45: 101

**Bose-Einstein-Condensates in the gravitational field** — •Zelimir Marojevic and Claus Lämmerzahl — ZARM - Universität Bremen

We are studying numerically the eigenvalue problem for the Gross-Pitaevskii-Equation in a 1D configuration in the gravitational field for various situations. The most simple case is the Gravito-Optical Surface Trap configuration for the Gross-Pitaevskii-Equation with coupling to a homogeneous gravitational field and with a one-sided boundary condition. Characteristic properties of the solutions are investigated with respect to mass, gravitational acceleration and interaction strength. Further 1D configurations like Bose-Einstein Condensates restricted to a parabolic line are also studied.

## GR 4: Klassische Allgemeine Relativitätstheorie I

Zeit: Dienstag 15:40–16:20 Raum: 30.45: 101

GR 4.1 Di 15:40 30.45: 101

**Linearized gravity on type D backgrounds** — Steffen Aksteiner[1,2] and •Lars Andersson[3] — [1]Quest Uni Hannover, Deutschland — [2]Zarm Uni Bremen, Deutschland — [3]MPI, Golm, Deutschland

In this talk I present joint work with Lars Andersson about the field equations of linearized gravity on a Petrov type D background, which includes Kerr spacetime. The Geroch Held Penrose (GHP) formalism is used to derive decoupled equations for all linearized Weyl scalars. The identification of gauge source functions leads to a generalized Regge-Wheeler equation. On Schwarzschild, a derivation of the gauge invariant Regge-Wheeler and Zerilli equation directly from the equation for the spin 0 scalar will be presented.

GR 4.2 Di 16:00 30.45: 101

**Properties of the 1-PN Dedekind ellipsoids** — •Norman Gürlebeck[1] and David Petroff[2] — [1]Institute of Theoretical Physics, Charles University, Prague, Czech Republic — [2]Institute of Theoretical Physics, Friedrich-Schiller-University, Jena, Germany

A changing quadrupole moment leads to gravitational radiation in General Relativity. Does this imply that stationary but non-axisymmetric, isolated systems cannot exist? To learn something about the answer to this question, a post-Newtonian (PN) approximation of the Newtonian triaxial and homogeneous Dedekind ellipsoids is investigated. We shall discuss a generalization of the ansatz used by Chandrasekhar and Elbert (1978), in particular its axisymmetric limit. Contrary to Chandrasekhar & Elbert's ansatz this generalization permits an axially symmetric and rigidly rotating limit (PN Maclaurin spheroids). The additional freedom in the generalized solution can also be used to remove a singularity which occurs in their work. A limit where the Dedekind ellipsoids degenerate to a line mass distribution is also discussed.

## GR 5: Schwarze Löcher

Zeit: Dienstag 16:45–18:05 Raum: 30.45: 101

GR 5.1 Di 16:45 30.45: 101

**Charged Balanced Black Rings in Five Dimensions** — Burkhard Kleihaus, •Jutta Kunz, and Kirsten Schnülle — Universität Oldenburg

We present electrically charged balanced black ring solutions of pure Einstein-Maxwell theory in five dimensions. The solutions are asymptotically flat. Their tension and gravitational self-attraction are balanced by the repulsion due to rotation and electrical charge. We discuss the global and horizon properties of these solutions and show that they satisfy a Smarr relation. We address the phase diagram of these singly rotating black rings.

GR 5.2 Di 17:05 30.45: 101

**Stationary Rotating Black Holes in Dilatonic Einstein-Gauss-Bonnet Theory** — •Burkhard Kleihaus[1], Jutta Kunz[1], and Eugen Radu[2] — [1]University of Oldenburg — [2]School of Theoretical Physics - DIAS, Dublin, Ireland

Kerr black holes in Einstein gravity are known in closed form and well studied. String theory on the other hand suggest higher order curvature corrections to pure Einstein gravity. In the simplest four dimensional model the Gauss-Bonnet (GB) term coupled to the dilaton field is added to the Einstein action, leading to the Einstein-Gauss-Bonnet-dilaton (EGBd) theory. Black holes in EGBd theory may possess new qualitative features. In this talk the influence of the GB term on the properties of stationary rotating black holes is addressed. We show that a generalised Smarr relation holds in EGBd theory. Our results indicate that for EGBd black holes the angular momentum can exceed the extremal limit of the Kerr black hole in pure Einstein gravity. We compare the innermost stable circular orbits of EGBd black holes and Kerr black holes.

GR 5.3 Di 17:25 30.45: 101

**Holographic superconductors and superfluids - effect of back-reaction** — •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

Recently, the gravity-gauge theory correspondence has been used to describe so-called holographic superconductors and superfluids with the help of black holes in Anti-de Sitter space-time. In this talk, I will discuss holographic supercondutors and superfluids away from the probe limit, i.e. taking backreaction of the space-time into account. In the first part of the talk I will present our results for Gauss-Bonnet holographic superconductors in (3+1) dimensions, while the second part will deal with holographic superfluids in (2+1) dimensions where one of the spatial dimensions is compactified.

GR 5.4 Di 17:45 30.45: 101

**Boson shells harboring charged black holes** — •Meike List[1], Burkhard Kleihaus[2], Jutta Kunz[2], and Claus Lämmerzahl[1] — [1]ZARM - Universität Bremen, Am Fallturm, 28359 Bremen — [2]Carl-v.-Ossietzky-Universität Oldenburg, Institut für Physik, 26111 Oldenburg

We consider boson shells in scalar electrodynamics coupled to Einstein gravity. The interior of the shells can be empty space, or harbor a black hole or a naked singularity. We analyze the properties of these types of solutions and determine their domains of existence. We investigate the energy conditions and present mass formulae for the composite black hole-boson shell systems. We demonstrate that these types of solutions violate black hole uniqueness.

## GR 6: Andere Gebiete

Zeit: Dienstag 18:05–18:25 Raum: 30.45: 101

GR 6.1 Di 18:05 30.45: 101

**On the Charge 3 Cyclic Monopoles** — •Victor Enolski — Hanse-Wissenschaftskolleg, Delmenhorst — Institute of Magnetism, Kiev

We study SU(2) BPS monopoles of the charge 3 with spectral curve that respect $C_3$-symmetry. It is of the genus four and taken in the form $\eta^3 + a\eta\zeta^2 + \zeta^6 + b\zeta^3 - 1 = 0$ where $a$ and $b$ are two real parameters.

First we consider the case $a = 0$ and establish that the only curve of this family that yields BPS monopole correspond to tetrahedrally symmetric monopoles. We introduce on this stage several new techniques making use of a factorization theorem of Fay and Accola for theta functions, together with properties of the Humbert variety and higher order hypergeometric relations of Ramanujan. The geometry leads us to a formulation purely in terms of elliptic functions.

Then we are extending this result by continuity to $a \neq 0$ and find (numerically) a curve in parameter $a, b$-plane that produces monopole solutions. To do that a well adapted homology basis is presented enabling the theta functions and monopole data constructed by initial genus four curve to be given in genus two data. The Richelot correspondence and generalize arithmetic-geometric mean is used to solve this genus two curve.

## GR 7: Hauptvorträge Mittwoch: Quantengravitation und Quantengravitationsphänomenologie (gemeinsam mit MP)

Zeit: Mittwoch 16:45–19:00 Raum: 30.45: 101

**Hauptvortrag** GR 7.1 Mi 16:45 30.45: 101

**Loop quantum gravity** — •Carlo Rovelli — Centre de Physique Thèorique, Université de Aix-Marseille, France

I give a general overview of the state of loop quantum gravity, focusing on its covariant version, and of the main results the theory.

**Hauptvortrag** GR 7.2 Mi 17:30 30.45: 101

**Causal Dynamical Triangulation - A Gateway to Quantum Gravity** — •Renate Loll[1], Jan Ambjorn[2], and Jerzy Jurkiewicz[3] — [1]Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands — [2]Niels Bohr Institute, Copenhagen University, Copenhagen, Denmark — [3]Jagiellonian University, Krakow, Poland

The nonperturbative theory of Quantum Gravity constructed using the method of Causal Dynamical Triangulation (CDT) has made considerable progress in explaining the macroscopic structure of spacetime from first (quantum) principles. This includes the "postdictions" that spacetime on large scales is four-dimensional and - in the absence of matter - looks like a de Sitter universe. By contrast, near the Planck scale, spacetime behaves highly non-classically and exhibits two-dimensional features, for which corroborating evidence has meanwhile been found in several other approaches. After summarizing the rationale behind CDT and its main achievements, I will highlight some new results and insights, including CDT's phase structure, which may provide a blueprint for models of dynamical, higher-dimensional geometry, as well as short- and large-scale geometric properties of the dynamically generated quantum universe and their potential implications for quantum cosmology.

**Hauptvortrag** GR 7.3 Mi 18:15 30.45: 101

**Geometry and Observables in three-dimensional (Quantum) Gravity** — •Catherine Meusburger — Fachbereich Mathematik, Bereich AZ, Universität Hamburg, Bundesstraße 55, 20146 Hamburg

Three-dimensionsional gravity serves as a model in which fundamental questions of quantum gravity can be investigated in a fully and rigorously quantised theory. A central question for its interpretation is the relation between the fundamental diffeomorphism invariant observables of the theory and the geometry of the spacetimes. We show how these observables can be related to concrete measurements by observers in terms of lightrays. These measurements allow the observer to fully determine the geometry of the spacetime in finite eigentime.

## GR 8: Kosmologie

Zeit: Donnerstag 8:30–10:30 Raum: 30.45: 101

GR 8.1 Do 8:30 30.45: 101

**Angular Size Test for Galaxies at Low Redshift with SDSS** — •Alexander Unzicker[1] and Karl Fabian[2] — [1]Pestalozzi-Gymnasium München — [2]Geological Survey of Norway, Trondheim

Based on magnitudes and Petrosian radii from the Sloan Digital Sky Survey (DR 7) at low redhift (z <0.2), we perform a test of galaxy size evolution. Since size is obviously correlated to absolute magnitude, the analysis critically depends on the appropriate selection. Several possible artifacts are considered: the Malmquist bias is excluded by using volume-limited samples, and a correction for seeing is applied. We tested also different K-corrections and determined the dependence on the Hubble constant and on other cosmological parameters. We noted a slight increase of average galaxy size with time which is stable across a wide range of luminosities. However, taking into account to the recently discovered luminosity evolution with redshift, the effect is almost reversed. This result raises some questions whether the standard view of galaxy evolution is supported by observations. To facilitate further investigations, the Mathematica code and instructions for data download are publicly available.

GR 8.2 Do 8:50 30.45: 101

**Geodesic motion of test particles in the space-time of cosmic (super)strings** — •Parinya Sirimachan and Betti Hartmann — School of Engineering and Science, Jacobs University Bremen, 28759 Bremen

In this talk I will discuss test particle motion in the space-time of an Abelian-Higgs string and in comparison to that in the space-time of a (p,q)-string, which is a cosmic superstring consisting of p D-strings and q F-strings. The string solutions are solutions to Abelian-Higgs models coupled minimally to gravity and can only be given numerically. The solutions to the geodesic equation can hence also only be given numerically and can be classified according to the test particle's energy, angular momentum and momentum in the direction of the string axis. We find that massive test particles can be attracted and form bound orbits when they are very close to the core of the strings. In the case of Abelian-Higgs strings bound orbits exist only if the gauge boson mass is greater than the Higgs boson mass. This changes for (p,q)-strings which are field-theoretically described by two interacting Abelian-Higgs models. The fact that the p D-strings and the q F-strings form bound states allows for bound orbits of massive test particles for Higgs boson mass larger than gauge boson mass. For both cases, massless test particles can only move on escape orbits. The influence of the string parameters on observable phenomena such as the light deflection and the perihelion shift are also discussed.

GR 8.3 Do 9:10 30.45: 101

**Frame Dependence of Quantum Corrections in Cosmology** — •Christian Steinwachs — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Strasse 77, 50937 Köln, Germany

In the context of cosmological models based on an inflaton field *non-*

*minimally* coupled to gravity, one can remove the non-minimal coupling by performing a conformal transformation of the metric at the price of a more complicated potential.
On a *classical* level this is just a mathematical trick and the two frames – the original Jordan frame and the minimally coupled Einstein frame – are equivalent. The question is now if this still holds at the *quantum* level. We will answer this question for a very general model by calculating and comparing explicitly the corresponding results at the one-loop level. This model is suitable for most of the cosmological applications.

GR 8.4 Do 9:30 30.45: 101

**Quantum theory of fermion preheating** — Jürgen Berges, •Daniil Gelfand, and Jens Pruschke — Institut für Kernphysik, TU Darmstadt, Deutschland

We show that quantum effects dramatically influence the production of fermions during preheating after inflation in the early universe. So far, nonequilibrium fermion production has been mainly investigated using the Dirac equation with coupling to a homogeneous classical inflaton field. We extend this analysis by taking into account quantum corrections including scattering and decay processes, as well as off-shell and memory effects. This is done by using two-particle irreducible (2PI) effective action techniques, which we compare to results from lattice simulations.

GR 8.5 Do 9:50 30.45: 101

**Inflationary Correlation Functions without Infrared Divergencies** — •Mischa Gerstenlauer — Institut für Theoretische Physik, Heidelberg

Inflationary correlation functions are potentially affected by infrared divergences. For example, the two-point correlator of curvature perturbations at momentum $k$ receives corrections $\sim \ln(kL)$, where $L$ is the size of the region in which the measurement is performed. We define infrared-safe correlation functions which have no sensitivity to the size $L$ of the box used for the observation. The conventional correlators with their familiar log-enhanced corrections (both from scalar and tensor long-wavelength modes) are easily recovered from our IR-safe correlation functions. Among other examples, we illustrate this by calculating the corrections to the non-Gaussianity parameter $f_{NL}$ coming from long-wavelength tensor modes. In our approach, the IR corrections automatically emerge in a resummed, all-orders form. For the scalar corrections, the resulting all-orders expression can be evaluated explicitly.

GR 8.6 Do 10:10 30.45: 101

**Fluctuations of cosmic parameters in the local universe** — •Alexander Wiegand and Dominik Schwarz — Fakultät für Physik, Universität Bielefeld, Universitätsstraße 25, D-33615 Bielefeld

Many cosmological observations use measurements in the local universe to determine the global cosmic parameters. As there are pronounced structures on these relatively small scales, the local values are not necessarily representative for the average universe. The talk will address the question how big this cosmic variance still is in the era of deep galaxy surveys, i.e. quantify this fundamental uncertainty in surveys with different geometries. Furthermore, the influence of these fluctuations on the evolution of the local volume will be discussed. As especially the curvature parameter is affected by a relatively large variance, it will finally be shown how this affects other observables.

## GR 9: Hauptvorträge Donnerstag: Klassische Allgemeine Relativitätstheorie

Zeit: Donnerstag 14:00–15:30 Raum: 30.45: 101

**Hauptvortrag** GR 9.1 Do 14:00 30.45: 101

**Using numerical relativity to explore fundamental physics and astrophysics** — •Luciano Rezzolla — Albert Einstein Institute, MPI for Gravitational Physics, Potsdam

Recent years have seen a major progress in numerical relativity and the solution of the simplest and yet among the most challenging problems in classical general relativity: that of the evolution of two objects interacting only gravitationally. I will review the results obtained so far when modelling binaries of black holes or of neutron stars and also discuss the impact these studies have in detection of gravitational-waves, in astrophysics, and in our understanding of general relativity.

**Hauptvortrag** GR 9.2 Do 14:45 30.45: 101

**The initial value problem of general relativity** — •David Hilditch — Theoretical Physics Institute, University of Jena, 07743 Jena, Germany

I will give an overview of general relativity from the point of view of partial differential equations (PDEs). A crucial fact to establish about a given PDE system is whether or not it is well-posed, that is, whether or not unique solutions that depend continuously on given data exist. I will focus in particular on the gauge freedom of general relativity and the freedom it brings to the formulation of the initial value problem. Well-posedness of the initial value problem depends on whether or not the PDE system is in some sense wave-like. I will describe how the wave-like nature of gauge choices can be characterized, and how they may be coupled to the Einstein field equations. I will furthermore highlight the restriction that insisting on a Hamiltonian formulation brings to the system and the relationship between Hamiltonian structure and the PDE properties of the system. Finally I will consider the question: what are the set of gauge conditions that may be coupled to general relativity to form a wave-like PDE system?

## GR 10: Gravitationswellen

Zeit: Donnerstag 15:30–16:10 Raum: 30.45: 101

GR 10.1 Do 15:30 30.45: 101

**Full-analytic frequency-domain gravitational wave forms from eccentric compact binaries to first post-Newtonian order** — •Manuel Tessmer and Gerhard Schäfer — Friedrich-Schiller-Universiät Jena

We provide full-analytical gravitational wave forms for eccentric nonspinning compact binaries of arbitrary mass ratio in the time Fourier domain to first post-Newtonian order in both conservative orbital motion and gravitational wave amplitudes. These amplitudes are given in spherical tensor components. The leading order radiation reaction effects are included to depict the inspiral with the help of the stationary phase approximation. To extend the presented computation to second post-Newtonian order, we present a full-analytical inversion formula of the Kepler equation in harmonic coordinates.

GR 10.2 Do 15:50 30.45: 101

**Time-Delay Interferometry für LISA** — •Markus Otto, Gerhard Heinzel und Karsten Danzmann — Max-Planck Institut für Gravitationsphysik (Albert-Einstein Institut) Hannover und QUEST, Leibniz Universität Hannover

Bei der Detektion von Gravitationswellen mit Hilfe der satellitenbasierten Laser Interferometer Space Antenna (LISA, geplanter Start: 2020) stellt das Laserrauschen die wesentliche Störgröße dar. Durch Time-Delay Interferometry (TDI) kann diese Rauschquelle entfernt werden, während das Gravitationswellensignal erhalten bleibt. Hierzu kombiniert man auf geschickte Art zeitverzögerte Interferometersignale. Um die synthetischen TDI-Variablen zu formen, ist es erforderlich, die gemessenen Datenströme der Satelliten zu digitalisieren. Dies geschieht mit Hilfe eines Analog-Digital-Konverters, welcher wiederum Rauschen in die Daten einkoppelt.

Wir werden in diesem Vortrag einen kurzen Überblick der Prozedur zur Elimination der wesentlichen Rauschquellen geben und anschließend eine geplante TDI-Simulation diskutieren.

## GR 11: Numerische Relativitätstheorie

Zeit: Donnerstag 16:45–17:45 Raum: 30.45: 101

GR 11.1 Do 16:45 30.45: 101

**Motion of test particles in the cosmic string space-time with dark string** — Betti Hartmann[1] and •Valeria Kagramanova[2] — [1]Jacobs University Bremen — [2]Carl von Ossietzky Universität Oldenburg

We study geodesics in the space-time of an Abelian-Higgs string coupled to a dark string. The dark strings are a prediction of dark matter models that could explain the excess of electronic production in the galaxy. The Abelian-Higgs string and the dark string are coupled through the U(1) fields. We investigate the influence of the parameters of the model on the properties of the test particles motion and on the classification of orbits.

GR 11.2 Do 17:05 30.45: 101

**GPU computing for numerical relativity** — •Andreas Weyhausen, Bernd Brügmann, and Jason Grigsby — Theoretisch-Physikalisches Institut, FSU Jena

Numerical Relativity (NR) allows to study physically interesting space times like binary black hole systems by solving Einsteins equations using numerical methods. As this is computationally expensive NR always looks for ways to speed up the simulations. At the moment it is popular in high performance computing to use graphics cards to speed up applications. These have developed from special purpose devices to powerful highly parallel accelerators which outnumber the theoretical peak floating point operations per second performance of CPUs by a factor up to two magnitudes. In my talk I will give an introduction to Numerical Relativity and GPU Computing and I will discuss the question if NR can benefit from using graphics cards.

GR 11.3 Do 17:25 30.45: 101

**Numerical simulations of neutron stars** — •Marcus Thierfelder, Sebastiano Bernuzzi, David Hilditch, and Bernd Brügmann — Theoretisch-Physikalisches Institut, FSU Jena

Numerical relativity simulations are of fundamental importance for the theoretical modelization of the gravitational signal emitted. In this talk we present a new code designed to study binary neutron star mergers in full general relativity. We discuss several tests that validate the code and describe our recent results on the gravitational collapse to black-hole obtained with the puncture gauge. We present preliminary results on the accuracy of the gravitational waves emitted by binary neutron star mergers in our computations.

## GR 12: Relativistische Astrophysik

Zeit: Donnerstag 17:45–18:45 Raum: 30.45: 101

GR 12.1 Do 17:45 30.45: 101

**Asteroseismology with fast rotating neutron stars** — •Gaertig Erich and Kokkotas Kostas — Theoretische Astrophysik, Eberhard Karls Universität Tübingen

We investigate damping and growth times of the quadrupolar f-mode for rapidly rotating stars and a variety of different polytropic equations of state in the Cowling approximation.

This is the first study of the damping/growth time of this type of oscillations for fast rotating neutron stars in a relativistic treatment where the spacetime degrees of freedom of the perturbations are neglected.

We use these frequencies and damping/growth times to create robust empirical formulae which can be used for gravitational wave asteroseismology.

The estimation of the damping/growth time is based on the quadrupole formula and our results agree very well with Newtonian ones in the appropriate limit.

GR 12.2 Do 18:05 30.45: 101

**On magnetars QPOs** — Antonella Colaiuda and •Kostas Kokkotas — Universität Tübingen, Auf der Morgenstelle 10 C, 72076 Tübingen

We study axisymmetric perturbations of neutron star endowed with a strong magnetic field (magnetars), considering the coupled oscillations of the fluid core with the solid crust. We recover discrete oscillations based mainly in the crust and a continuum in the core, while we also discover a class of "discrete Alfvén modes". Our results can explain both the lower and the higher observed quasi periodical oscillations (QPOs) in SGR 1806-20 and SGR 1900+14 and put constrains on the mass, radius and crust thickness of the two magnetars.

GR 12.3 Do 18:25 30.45: 101

**Relativistic accretion processes** — •Philip Peterson[1] and Andrew King[2] — [1]Max-Planck Institute for Gravitational Physics (Albert-Einstein Institute) Hannover and QUEST, Leibniz University Hannover — [2]University of Leicester, Dep. of Physics and Astronomy

Black hole growth is an alien process and there is no intuitive analogy from our daily lives to help us understand it, but under such conditions a lot of interesting physics is going on. This contribution is an overview of some of the peculiarities of episodic black hole accretion, and goes into the effects this has on black hole growth and rotation. Near a rotating black hole the interaction of an accreting disk of gas with the frame dragging effect is discussed, and the consequences of these processes for astrophysics are also briefly covered.

## GR 13: Klassische Allgemeine Relativitätstheorie II

Zeit: Donnerstag 18:45–19:25 Raum: 30.45: 101

GR 13.1 Do 18:45 30.45: 101

**Approximation of the exterior gravitational field of rotating neutron stars** — •Christian Teichmüller[1], Markus B. Fröb[2], and Fabian Maucher[3] — [1]Theoretisch-Physikalisches Institut, University of Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [2]Departament de Física Fonamental, Institut de Ciències del Cosmos (ICC), Universitat de Barcelona, C/Martí i Franquès 1, 08028 Barcelona, Spain — [3]Max Planck Institute for the Physics of Complex Systems, 01187 Dresden, Germany

It was shown that Bäcklund transformations can be used to generate stationary axisymmetric solutions of Einstein's vacuum field equations with any number of constants. We want to use this class of exact solutions to describe the exterior vacuum region of numerically calculated neutron stars. Therefore we study how an Ernst potential given on the rotation axis and containing arbitrary constants can be used to determine the metric everywhere. Afterwards we review two methods to determine those constants from a numerically calculated solution. Finally, we compare the metric and physical properties of our analytic solution with the numerical data and find excellent agreement even for a small number of parameters.

GR 13.2 Do 19:05 30.45: 101

**Next-to-leading order spin-orbit and spin(a)-spin(b) Hamiltonians for arbitrary many gravitating spinning compact objects** — •Johannes Hartung and Jan Steinhoff — Theoretisch–Physikalisches Institut, Friedrich–Schiller–Universität Jena, Max–Wien–Platz 1, 07743 Jena

At the next-to-leading order spin-orbit and spin(a)-spin(b) interaction levels, counted within a post-Newtonian approximation scheme, the complexity of Einstein's general relativity becomes apparent. Due to the nonlinearity of the field equations there appear certain three-body interaction terms in the respective Hamiltonians. In this talk we discuss those gravitational three-body correlations. Afterwards an outline of the derivation of the Hamiltonians mentioned above for arbitrary many compact objects is given. A discussion of the relative strength of the next-to-leading order interaction terms in relation to the leading order ones — via a preliminary analysis of certain special configurations of the three-body system — is provided.

## GR 14: Klassische Allgemeine Relativitätstheorie III

Zeit: Freitag 8:30–9:10 Raum: 30.45: 101

GR 14.1 Fr 8:30 30.45: 101

**Inversion of hyperelliptic integrals of arbitrary genus with application to particle motion in General Relativity** — •Claus Lämmerzahl[1], Victor Z. Enolski[1,2,3], Eva Hackmann[1], Valeria Kagramanova[4], and Jutta Kunz[4] — [1]ZARM, Uni Bremen, Germany — [2]HWK, Delmenhorst, Germany — [3]Institute of Magnetism, Kiev, Ukraine — [4]Uni Oldenburg, Germany

The description of many dynamical problems like the particle motion in higher dimensional spherically and axially symmetric space-times is reduced to the inversion of a holomorphic hyperelliptic integral. The result of the inversion is defined only locally, and is done using the algebro-geometric techniques of the standard Jacobi inversion problem and the foregoing restriction to the $\theta$–divisor. For a representation of the hyperelliptic functions the Klein–Weierstraß multivariable sigma function is introduced. It is shown that all parameters needed for the calculations like period matrices and Abelian images of branch points can be expressed in terms of the periods of holomorphic differentials and theta-constants. The cases of genus two and three are considered in detail. The method is exemplified by particle motion associated with a genus three hyperelliptic curve.

GR 14.2 Fr 8:50 30.45: 101

**Orbits of spinning particles in Schwarzschild- and Kerr-de Sitter space-times** — •Isabell Schaffer and Claus Lämmerzahl — ZARM Uni Bremen, 28359 Bremen

Spinning particles are described within the Mathisson-Papapetrou-Dixon formalism. We calculate the orbits of particles with spin and the corresponding spin motion in Schwarzschild-de Sitter and Kerr-de Sitter space-times, determine the influence of the spin on the orbit, and evaluate the influence of the cosmological constant.

## GR 15: Alternative Ansätze

Zeit: Freitag 9:10–10:30 Raum: 30.45: 101

GR 15.1 Fr 9:10 30.45: 101

**Repulsive gravity model for dark energy** — •Manuel Hohmann — II. Institut für theoretische Physik, Universität Hamburg

We present a multimetric gravity theory containing $N \geq 3$ copies of standard model matter and a corresponding number of metrics. In the Newtonian limit, this theory generates attractive gravitational forces within each matter sector, and repulsive forces of the same strength between matter from different sectors. We apply our theory to cosmology and show that the repulsion between different types of matter may induce the observed accelerating expansion of the universe. In this way dark energy can be explained simply by dark copies of the well-understood standard model. We finally show that our result is consistent with solar system experiments at the post-Newtonian level.

GR 15.2 Fr 9:30 30.45: 101

**Finsler spacetimes and Finsler gravity** — •Christian Pfeifer — II Institut für theoretische Physik Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

Based on the methods of Finsler geometry I introduce the notion of physical Finsler spacetimes which generalize semi-Riemannian spacetime manifolds. On these generalized backgrounds I develop the mathematical tools needed to write down field theory actions. I use these tools to present a theory of Finsler gravity that reduces to general relativity in case the Finsler spacetime is semi-Riemannian, and I discuss matter coupling in this context.

GR 15.3 Fr 9:50 30.45: 101

**Eine Klasse von sphärisch-symmetrischen statischen Finsler-Raumzeiten** — Claus Lämmerzahl und •Volker Perlick — ZARM, Universität Bremen, Am Fallturm, 28359 Bremen

Wir betrachten sphärisch-symmetrische statische Finsler-Raumzeiten, in denen sich die räumliche Metrik als Wurzel aus einem quartischen Term schreiben lässt. Nach Linearisierung der Metrik um die Schwarzschild-Metrik herum untersuchen wir, welche Schranken sich aus den gegenwärtigen Beobachtungen (Lichtablenkung, Periheldrehung, Lichtlaufzeitmessung u.a.) im Sonnensystem für die Finsler-Störung ergeben. Insbesondere diskutieren wir, ob sich im Rahmen eines solchen Finsler-Modells die Pioneer-Anomalie erklären lässt, ohne mit anderen Beobachtungsdaten in Widerspruch zu geraten.

GR 15.4 Fr 10:10 30.45: 101

**Entropy, bio-evolution and the psychological arrow of time** — •Heinrich Päs — TU Dortmund

Physics seems to be almost time symmetric. Apart from small CP violating effects in weak interactions microscopic processes can run backwards just as they can run forward in time. The only difference in macroscopic environments between future and past thus seems to be entropy. If entropy increase is the only measure of time, though, the psychological arrow of time is a most puzzling fact: why do we remember the past, but do not "premember" the future. In this talk we propose a darwinist approach to this problem: in order deal with a situation in the present, individuals premembering the future have to process larger amounts of information due to entropy increase. Species which were developing the necessary physique are thus disfavored in evolution. Thus even if no other source of time asymmetry than macroscopic entropy would be relevant for the psychological arrow of time, the selection processes of biological evolution alone would imply its existence, and thus could be of relevance for the understanding of the phenomenon.

## GR 16: Hauptvorträge Freitag: Quantengravitation und Quantengravitationsphänomenologie

Zeit: Freitag 11:00–12:30 Raum: 30.45: 101

**Hauptvortrag** GR 16.1 Fr 11:00 30.45: 101

**News from Quantum Gravity Phenomenology** — •Sabine Hossenfelder — NORDITA, Roslagstullsbacken 23, 106 91 Stockholm, Sweden

The phenomenology of quantum gravity is a young and lively research field that brings together many areas of physics, both experimental and theoretical. Its purpose is to bridge the gap between current approaches towards a fundamental theory of quantum gravity and observation, with the hope of obtaining experimental guidance for our quest to find the right theory. In this talk I will give a brief overview on the present efforts to construct phenomenological models for quantum gravity, and to test them in astrophysics, cosmology, particle physics and high precision measurements. I will also mention some recent developments and speculate on what directions are promising for further research.

**Hauptvortrag** GR 16.2 Fr 11:45 30.45: 101
**Extra Dimensions in String Cosmology and Phenomenology** — •Marco Zagermann — Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover, Germany

I discuss some of the phenomenologically relevant aspects associated with the presence of extra dimensions in string theory, in particular in the context of cosmological applications. This includes a discussion of the moduli fields of string compactifications as well as the modeling of dark energy and early universe inflation.

## GR 17: Alternative Ansätze II

Zeit: Freitag 12:30–13:30 Raum: 30.45: 101

GR 17.1 Fr 12:30 30.45: 101
**Relativity without Space-Time** — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Present-day physics is governed by two fundamental misconceptions:
1. Relativity is allegedly caused by the properties of space-time
2. Elementary particles are assumed to be point-like, having no internal structure.

By deviating from these assumptions we can correctly reconstruct the results of present-day physics from an adapted model; and in addition we are able to find answers to unsolved problems.

In the announced talk about relativity we will show that relativity can be based on properties of fields and on the structure of particles. The benefits of this approach are:
- The calculations are much simpler than those using space-time
- The results are identical to those of Einstein with respect to experimental findings - including those of General Relativity
- Unresolved issues such as Dark Matter, Dark Energy and Quantum Gravity can be answered
- We gain additional insights in other areas of physics, e.g. particle physics.

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

GR 17.2 Fr 12:50 30.45: 101
**Physik in Literaturform** — •Helmut Hille — Fritz-Haber-Str. 34, 74081 Heilbronn

Dicke Wälzer in einer schwer verständlichen Sprache sind wenig geeignet, das Anliegen der Physik nicht nur dem Laien verständlich zu machen. Ich zeige wie es anders geht, indem ich meine Überlegungen dem Publikum in ihm vertrauter Literaturform und Sprache mitteile. Dazu ist eine große Klarheit der Gedanken erforderlich, sollen Sachverhalte auch durch kurze Texte transparent werden. So lasse ich in einer Szene Faust/Newton letzteren Fausts Frage, was die Welt im Innersten zusammenhält, in von Goethe geliehener Gedichtform kurz und bündig beantworten. In einem anderen Beispiel veranschauliche ich im Feuilletonstil auf einer Seite, was unter Verschränkung und Emergenz zu verstehen ist, wodurch vieles Geschehen vom Mikro- bis zum Makrokosmos verständlich wird. Bleibt noch Zeit, würde ich die Hörer gern noch mit einem meiner eher heiteren Texte bekannt machen, der sich auf die Lage heutiger Physik bezieht.

GR 17.3 Fr 13:10 30.45: 101
**Modifizierte Kepler/Newton-Gravitation – Die Weltpotentialtheorie (WPT)** — •Peter Wolff — www.wolff.ch

Ausgangspunkt sind lokale Symmetrie- und Gaussens Integralsatz-Überlegungen, die schon Kepler zum klassischen $1/R^2$-Schwerkraftgesetz führten. Auf „grosslokalen“ Skalen (Galaxien und grössere Strukturen) gibt es aber enorme Probleme, die man heute meist durch Dunkelmaterie zu lösen versucht.

Für die Gravitation auf grössten Skalen gibt es einen noch wenig bekannten, sehr erklärungsstarken Ansatz: Die **Weltpotentialtheorie (WPT)** zeigt, dass sich die ganz normale, lokale Schwere auf kosmischen Skalen bei Gültigkeit des kosmologischen Prinzips als kosmische Bremskraft manifestiert, die für Licht konstant ist, so dass die kosmischen Schwereerscheinungen im Rahmen der SRT behandelt werden können, womit sich die geometrische ART in der Kosmologie als falsch erweist, weil die ART im Gegensatz zur WPT auf viele hoch spekulative Ad-hoc-Annahmen angewiesen ist, während die WPT zu einem grossskalig statischen All führt, das weder Urknall, Inflation noch dunkle Energie und Materie kennt und nur einen leicht freien Parameter, die mittlere Dichte des Alls $\rho$, aus der sich über $H = \sqrt{\frac{8\pi}{3} G \rho}$ die Hubblekonstante H ergibt.

Unter Einbezug von etwas Heuristik kann die WPT auch die MOND-Artigkeit der Galaxiendynamik (Grössenordnung von Milgroms $a_0$, flache Rotationskurven und Tully-Fisher) im Aussenbereich von Spiralgalaxien erklären.

## GR 18: Grundlegende Probleme

Zeit: Freitag 13:30–13:50 Raum: 30.45: 101

GR 18.1 Fr 13:30 30.45: 101
**A surprisingly close relationship between gravitation and electrostatic interaction** — •Karl Otto Greulich — Fritz Lipmann Institute Beutenbergstr.11 D 07745 Jena

Despite their formal identity, the physical core of gravitation and electrostatic interaction is seen to be quite different. In cosmology, gravitation is thought to have separated from the other forces very early in the history of the universe. When, however, both, the gravitation constant G and the Coulomb constant are expressed in terms of Planck units it turns out that G = k0e2 / (alpha * mPlanck2) and the gravitational force is Kgrav = (1 / alpha) ko e1*e2 / r2 where alpha is the fine structure constant and mPlanck the Planck mass. The charges e1 and e2 can be calculated from the elementary charge e and the masses m1 and m2 which exert the gravitational force as e1 = e *m1 / mPlanck and e2 = e *m2 / mPlanck. Thus it formally appears as if the gravitational force is simply an electrostatic force between (very small) residual charges e1 and e2, which are narrowly correlated with the mass.

Reference K.O. Greulich Expression of the dimensionless constants of nature as function of proton and electron properties Verhandlungen der DPG 3/2006 Gr 303.1 http://www.fli-leibniz.de/www_kog (then click the symbol Phi for physics)

## GR 19: Poster (permanent)

Zeit: Montag 14:00–14:00 Raum: 30.45: 101

GR 19.1 Mo 14:00 30.45: 101
**Buch: Spezielle und Allgemeine Relativitätstheorie** — •Jürgen Brandes — Karlsbad

In [1] werden diskutiert: Die experimentellen Beweise der SRT und GRT, die Lösungen der Paradoxien, die Thesen zum vierdimensionalen Raum-Zeit-Kontinuum der SRT, sowie die Thesen zum gekrümmten, expandierenden und geschlossenen Raum der GRT. 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.* So besteht in der GRT folgende *'Paradoxie'*: Einerseits hat ein im Gravitationsfeld ruhendes Teilchen eine Gesamtenergie kleiner als die Ruheenergie (man muss Energie aufwenden, um es aus dem Feld zu entfernen), andererseits hat das Teilchen im zugehörigen lokalen Inertialsystem eine Gesamtenergie gleich seiner Ruhemasse (egal wo es ruht). In der Lorentz-Interpretation hat beides seine Berechtigung. Daraus ergeben sich experimentell überprüfbare Unterschiede zwischen beiden Interpretationen der GRT.

[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 19.2 Mo 14:00 30.45: 101

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

There are two ways of explaining and formalizing relativity:

A.) The original approach, presented by O. Heaviside and H.A. Lorentz, explains relativistic contraction by means of the well understood behaviour of fields. - This physics-based approach could not be finalized at the time, due to a lack of knowledge about elementary particles.

B.) The geometric method of Einstein, who redefined the formal treatment of space and time.

The approach referred to under A.), currently called the "Neo-Lorentzian" interpretation of relativity, assumes a variable speed of light 'c', Euclidean space and Galilean time. Only the *measured* value of 'c' is constant. - Using our present knowledge of particle physics, this approach is able to fully explain relativity.

The method of Einstein, B.), assumes a truly constant 'c' and therefore has to accept the curvature of space-time in the general case.

Both approaches agree with experimental findings for relativity (SR as well as GR). The Neo-Lorentzian way, however, is considerably easier to understand and to handle, as well as solving additional problems such as inflation, quantum gravity, dark matter, and dark energy.

For further information: www.ag-physics.org

GR 19.3 Mo 14:00 30.45: 101

**Kosmologie ohne Urknall und dunkle Kräfte – Urknall und beschleunigte Expansion: alles nur ein Trugbild müden Lichts** — •Peter Wolff — www.wolff.ch

Ausgangspunkt ist ein endliches und ein potential – entsprechend einem üblichen Grenzwertprozess – unendliches, dynamisches Vollkugelmodell des Alls im Sinne von Newton und Friedmann. Über die physikalisch sehr instruktive Newtonsche Kosmologie und das kosmologische Prinzip gelangen wir zu einer neuen, stabil statischen Kosmologie: **Die Weltpotentialtheorie (WPT)** kann die kosmische Gravitation auf die lokale Schwere zurückführen, die sich auf grössten Skalen als reine Bremskraft manifestiert, deren Quelle die überall gleiche, aktual unendliche Massenschale mit Dichte $\rho_\infty$ ist, die in einem homogenen, unendlichen All mit Dichte $\rho = \rho_\infty$ jeden endlichen Weltbereich mit Dichte $\rho_0 = \rho$ isotrop umschliesst und die – anders als nach Newton und ART – in der WPT nicht vernachlässigt werden darf.

Die WPT-Kosmologie kann ohne Rückgriff auf die ART allein mittels SRT und Einsteins originalem Äquivalenzprinzip von 1907 behandelt werden, woraus die kosmische Rotverschiebung samt Zeitdilatation folgt, die die beschleunigte Expansion der Friedmannmodelle nur vortäuscht. Die Leuchtkraft/Rotverschiebungs-Beziehung kann so mit nur einem einzigen leicht freien Parameter, der mittleren Alldichte $\rho$, die Beobachtungen beschreiben. Die Hintergrundstrahlung ist primär rotverschobenes und „nachthermalisiertes“ Sternenlicht, und mit etwas Heuristik folgt noch die MOND-Artigkeit (Grössenordnung von $a_0$, flache Rotationskurven und Tully-Fisher) der Spiralgalaxiendynamik.