

GRAVITATION UND RELATIVITÄTSTHEORIE (GR)

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 ÜBERSICHT DER HAUPTVORTRÄGE UND FACHSITZUNGEN
 (Hörsaal TU BH262)

Hauptvorträge

GR 1.1	Fr	10:15	(TU BH262)	Quantum Gravity – General Introduction and Recent Developments, <u>Claus Kiefer</u>
GR 2.1	Fr	11:00	(TU BH262)	Chronology Protection and Topological Censorship: Does physics allow wormholes and closed timelike curves? , <u>John Friedman</u> , Atsushi Higuchi
GR 5.1	Fr	16:30	(TU BH262)	Zur Geschichte der einheitlichen Feldtheorie: Einsteins erfolglose Jahre, <u>Hubert Gönnner</u>
GR 8.1	Sa	08:30	(TU BH262)	Angular Momentum in General Relativity, <u>Gernot Neugebauer</u>
GR 8.2	Sa	09:15	(TU BH262)	Exploring the mathematical structure of gravitational fields, <u>Helmut Friedrich</u>
GR 8.3	Sa	10:30	(TU BH262)	Gravitational waves, <u>Bernard Schutz</u>
GR 14.1	Di	10:15	(TU BH262)	Dark Matter and Galaxy Formation, <u>Joseph Silk</u>
GR 14.2	Di	11:00	(TU BH262)	Kosmische Schwarze Löcher - vom Kollaps massereicher Sterne zu Milliarden von Sonnenmassen, <u>Max Camenzind</u>
GR 14.3	Di	11:45	(TU BH262)	Gravitational Lensing as a Powerful Astrophysical Tool: MACHOs, Multiple Quasars and Einstein Rings, <u>Joachim Wambsganss</u>
GR 17.1	Mi	10:15	(TU BH262)	Is the velocity of light really constant? – The experimental status of Lorentz invariance, <u>Claus Lämmerzahl</u>
GR 17.2	Mi	11:00	(TU BH262)	Was Einstein right? , <u>Clifford M. Will</u>
GR 17.3	Mi	11:45	(TU BH262)	The first double pulsar - A unique laboratory to test general relativity, <u>Michael Kramer</u>

Fachsitzungen

GR 1	Quantengravitation	Fr	10:15–11:00	TU BH262	GR 1.1–1.1
GR 2	Wurmlöcher und Zeitreisen	Fr	11:00–11:45	TU BH262	GR 2.1–2.1
GR 3	Supersymmetrie, SYM	Fr	11:45–12:30	TU BH262	GR 3.1–3.3
GR 4	Quantengravitation – Loops	Fr	14:00–16:00	TU BH262	GR 4.1–4.8
GR 5	Einstein und vereinheitlichte Feldtheorie	Fr	16:30–17:15	TU BH262	GR 5.1–5.1
GR 6	Quantengravitation – Kanonische Quantisierung, Geometrie, Schrödinger-Newton	Fr	17:15–18:15	TU BH262	GR 6.1–6.4
GR 7	Einstein-Yang-Mills-Higgs	Fr	18:15–19:00	TU BH262	GR 7.1–7.3
GR 8	Gravitationswellenastronomie	Sa	08:30–11:15	TU BH262	GR 8.1–8.3
GR 9	Gravitationswellen – Mathematisch-Numerische Grundlagen	Sa	11:15–12:30	TU BH262	GR 9.1–9.5
GR 10	Gravitationswellen – Quellen	Sa	14:00–16:00	TU BH262	GR 10.1–10.8
GR 11	Gravitationswellen – Detektoren	Sa	16:00–16:30	TU BH262	GR 11.1–11.2

GR 12	Grundlagen und allgemeiner Formalismus	Mo 17:00–17:45	TU BH262	GR 12.1–12.3
GR 13	Alternative Zugänge	Mo 17:45–19:00	TU BH262	GR 13.1–13.5
GR 14	Gravitation im Universum	Di 10:15–12:30	TU BH262	GR 14.1–14.3
GR 15	Experimentelle Tests	Di 14:00–16:00	TU BH262	GR 15.1–15.8
GR 16	Klassische ART und Kosmologie	Di 16:30–18:00	TU BH262	GR 16.1–16.6
GR 17	Relativitätstheorie im Experiment	Mi 10:15–12:30	TU BH262	GR 17.1–17.3
GR 18	Postersitzung	Fr 14:00–19:00	Poster TU BH	GR 18.1–18.13

Weitere Hinweise

Im Rahmen des Festakts am Sonntag, 6.3.2005 spricht C. W. Francis Everitt um 15:30 an der Humboldt-Universität über *Space, Einstein & Technology: The NASA-Stanford Gravity Probe B Mission*.

Der Fachverband **Gravitation und Relativitätstheorie** beteiligt sich am Symposium SYET *Physik und Erkenntnistheorie* Mo. 10:00–12:00, 13:30–17:00, BH262.

Am Samstag und Dienstag werden in den Kaffeepausen verschiedene Visualisierungen zur Relativitätstheorie gezeigt.

Mitgliederversammlung des Fachverbands Gravitation und Relativitätstheorie

Di 18:00–19:00 BH262

Vorläufige Tagesordnung

Eröffnung und Festlegung der endgültigen Tagesordnung

Verlesung und Genehmigung des Protokolls der letzten MV

Bericht über vergangene Aktivitäten

Bericht Frauendiener über SFB-Sommerschule in Golm

Zukünftige Aktivitäten

Büchertisch

Verschiedenes

Gäste sind willkommen!

Fachsitzungen

– Haupt-, Kurzvorträge und Posterbeiträge –

GR 1 Quantengravitation

Zeit: Freitag 10:15–11:00

Raum: TU BH262

Hauptvortrag

GR 1.1 Fr 10:15 TU BH262

Quantum Gravity – General Introduction and Recent Developments — •CLAUS KIEFER — Institut für Theoretische Physik, Universität zu Köln

One of the biggest open problems in physics is the consistent unification of quantum theory with general relativity, resulting in a theory of “quantum gravity”. Such a theory would have an important bearing on the physics of the early universe and the understanding of black holes.

In my talk I give a general introduction to the motivations for and the problems of quantum gravity. I shall then briefly describe the main approaches – quantum general relativity and string theory – and their main applications. I shall end with an overview of recent results and current research, dealing with such issues as the microstructure of spacetime and black-hole entropy.

Ref.: C. Kiefer, *Quantum Gravity* (Oxford University Press 2004).

GR 2 Wurm Löcher und Zeitreisen

Zeit: Freitag 11:00–11:45

Raum: TU BH262

Hauptvortrag

GR 2.1 Fr 11:00 TU BH262

Chronology Protection and Topological Censorship: Does physics allow wormholes and closed timelike curves? — •JOHN FRIEDMAN¹ and ATSUSHI HIGUCHI² — ¹University of Wisconsin-Milwaukee, USA — ²Department of Mathematics, University of York, UK

Vacuum solutions to the classical Einstein equations generically include black holes and white holes, wormholes (and a countably infinite set of 3-dimensional topological structures); closed timelike curves (particle paths that loop back in time), and time-nonorientable geometries. A path-integral formalism allows smooth topology change; and light-cone fluctuations lead to a microscopic foam of closed timelike curves, unless

one a priori demands global causality. What then enforces the euclidean topology and strict causality of ordinary experience?

Work of the past fifteen years shows that, on scales large enough to ignore the quantum fluctuations of geometry, classical or semiclassical fields prevent exotic topological and causal structures. Positive energy forces topological structures to collapse in a light-crossing time. It also prevents the formation of closed timelike curves in local regions. At the boundary of a region of closed timelike curves, quantum fields become singular; and unitarity of interacting fields is lost.

Because these mechanisms do not rely on an ordinary Planck-scale topology and causal structure, they leave open the possibility of topology change and causality violation on the smallest scales.

GR 3 Supersymmetrie, SYM

Zeit: Freitag 11:45–12:30

Raum: TU BH262

GR 3.1 Fr 11:45 TU BH262

Plane-wave matrix theory as toy model for N=4 Super-Yang-Mills — •THOMAS KLOSE — Max-Planck-Institute für Gravitationsphysik, Am Mühlenberg 1, 14476 Potsdam

Plane-wave matrix theory (PWMT) is the conjectured microscopic definition of M-theory on a plane-wave, and an important and interesting theory in its very own right. In this talk, however, we look upon PWMT as toy model for N=4 supersymmetric Yang-Mills theory (SYM) and its role in the AdS/CFT correspondence.

We sketch how the PWMT is obtained as a consistent truncation of SYM on a three-sphere. Within their common domain, PWMT and SYM are classically completely equivalent and quantum mechanically to at least third order of perturbation theory. The recent interest in the spectrum of conformal dimensions and the conjectured integrability of SYM are issues which may now be easily studied within PWMT. The advantage of this approach is the computationally much simpler quantum mechanical nature of the matrix theory. We obtain novel 4-loop results of PWMT and hence are able to make new predictions for SYM.

GR 3.2 Fr 12:00 TU BH262

Higher-Loop Integrability of Planar $\mathcal{N} = 4$ SYM — •VIRGINIA DIPPPEL — Max-Planck Institut für Gravitationsphysik, Albert-Einstein-Institut, Am Mühlenberg 1, 14476 Potsdam, Germany

The celebrated AdS/CFT Correspondence conjectures a duality between certain string and gauge theories, e.g. type II B superstring theory on an $AdS_5 \times S^5$ background and 4-dim. $\mathcal{N} = 4$ SYM theory. On a kinematical level the two theories are indeed identical. However, in order to truly test the correspondence, one has to compare the dynamics of gauge and string theory. On the string side the discovery of a σ -model allowed to use very powerful techniques, that come along with integrable models, in order to calculate the energies of so called semiclassical string states.

These semiclassical strings are conjectured to be dual to very long, local, gauge invariant SYM operators. Thus, we expect the gauge theory to be integrable as well. Indeed a description of planar $\mathcal{N} = 4$ SYM in terms of an integrable super spin chain was found at the one-loop level. In this talk we are going to investigate subsectors of this theory in which the integrability extends to higher orders in the coupling constant. We will also comment on the mismatch between the gauge and the string side that was observed at three-loop order in this context.

GR 3.3 Fr 12:15 TU BH262

Supersymmetry, exact Foldy-Wouthuysen transformation and gravity — •SEBASTIAN HEIDENREICH, THORALF CHROBOK, and HORST-HEINO v. BORZESZKOWSKI — Institut für Theoretische Physik PN7-1, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

The Dirac particle in general space-time metrics is considered and the Dirac Hamiltonian in Newman-Penrose formalism is constructed. To get the physical meaning of the Dirac Hamiltonian it is necessary to perform the Foldy-Wouthuysen transformation. In most cases this transformation exists only in approximative form. Here we show that for supersymmetric Dirac Hamiltonians depending not explicitly on time the exact Foldy-Wouthuysen transformation can always be constructed.

Further we give some criterions for spin coefficients such that the accompanying Dirac Hamiltonian is supersymmetric. These criterions are fulfilled by the class of static axisymmetric space-time metrics.

Recently Obukhov [1] constructed a different exact Foldy-Wouthuysen transformation for the subclass of conform-stationary space-time metrics and calculated the Dirac-Hamiltonian in Foldy-Wouthuysen representation. We show that the expansion series in orders of $1/mc^2$ of our Dirac Hamiltonian and Obukhov's one coincide.

[1] Y. N. Obukhov, *Phys. Rev. Lett.* **86**, 2001, 192

GR 4 Quantengravitation – Loops

Zeit: Freitag 14:00–16:00

Raum: TU BH262

GR 4.1 Fr 14:00 TU BH262

Spherically Symmetric Quantum Geometry — •MARTIN BOJOWALD — Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, Am Mühlenberg 1, 14476 Potsdam

Loop Quantum Gravity provides a framework for quantum geometry which can be probed by studying symmetric configurations in the theory. Properties of quantum black holes can be understood by employing spherical symmetry which will be reviewed here. This leads to non-trivial tests of the full theory, as well as several physical applications to be discussed in more detail in the talk by Rafal Swiderski.

GR 4.2 Fr 14:15 TU BH262

Spherically Symmetric Quantum Geometry II — •RAFAL SWIDERSKI and MARTIN BOJOWALD — Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, Am Mühlenberg 1, 14476 Golm

One of the open questions in the loop approach to the quantization of General Relativity is whether the theory has the correct classical limit. We investigate this issue in the context of spherically symmetrically reduced Loop Quantum Gravity. In addition, we discuss some applications of our symmetry reduced model to isolated horizons.

GR 4.3 Fr 14:30 TU BH262

Quantum Dynamics of Loop Quantum Gravity — •THOMAS THIEMANN — AEI and PI

We report on the current status of the quantum dynamics of Loop Quantum Gravity.

GR 4.4 Fr 14:45 TU BH262

An alternative Quantisation of the Flux Operator in Loop Quantum Gravity — •KRISTINA GIESEL^{1,2} and THOMAS THIEMANN^{1,2} — ¹Albert-Einstein Institut für Gravitationsphysik, Am Mühlenberg 1, 14476 Golm — ²Perimeter Institute for Theoretical Physics, 31 Caroline Street, Waterloo, Ontario N2L 2Y5, Canada

We will introduce an alternative way of quantising the flux operator that is usually used in Loop Quantum gravity (LQG). For this purpose we will use the same quantisation procedure that was used in quantising the Hamiltonian Constraint of LQG. In comparing the action of the alternative flux operator with the one of the usual flux operator, we can verify whether this quantisation procedure leads to the expected result.

GR 4.5 Fr 15:00 TU BH262

Singularities of General Relativity in the Framework of Loop Quantum Gravity — •JOHANNES BRUNNEMANN — Max Planck Institut fuer Gravitationsphysik, Am Muehlenberg 1, D-14476 Golm

A quantum theory of gravity is expected to solve one of the main problems of General Relativity: the occurrence of singularities, such as the big bang.

Recently, remarkable progress has been made in understanding symmetry reduced cosmological models within the program of Loop Quantum Cosmology (*LQC*), leading to striking results like the absence of a big bang singularity in these quantum-cosmologies .

One might worry, however, that the performed symmetry reductions could be too restrictive and therefore one should look at the full theory of Loop Quantum Gravity (*LQG*) in order to check the obtained results.

In this talk I will give an overview of what can be said about the (dis)appearance of classical singularities within the **full theory**, *LQG*, and show possible connections to the results within *LQC* .

GR 4.6 Fr 15:15 TU BH262

The physical Hilbert space of loop quantum cosmology — •KEVIN VANDERSLOOT, KARIM NOUI, and ALEJANDRO PEREZ — Institute for Gravitational Physics and Geometry, Department of Physics, Pennsylvania State University, University Park, PA 16802, USA

Loop quantum cosmology currently lacks a physical inner product. Without it, wave functions can not be interpreted in terms of probability and it is not clear which states are physical (those with finite physical norm). We discuss the group averaging/path integral technique applied to loop quantum cosmology as a method of calculating the physical inner product. A simplified model of loop quantum cosmology is presented in which the physical inner product can be calculated explicitly. The implications for standard loop quantum cosmology are discussed.

GR 4.7 Fr 15:30 TU BH262

Partial and Complete Observables for General Relativity — •BIANCA DITTRICH — Max-Planck-Institute for Gravitational Physics, Golm and Perimeter Institute, Waterloo

We will generalize the concept of partial and complete observables introduced by Rovelli to constrained systems with an arbitrary number of first class constraints, in particular general relativity. Different methods to calculate complete observables will be presented and applied to examples.

GR 4.8 Fr 15:45 TU BH262

Gibt es eine rein differentialtopologische Interpretation von Spin-Foam-Modellen? — •TORSTEN ASSELMAYER-MALUGA — FhG FIRST, Kekulestr. 7, 12489 Berlin

Ausgehend von einem Ansatz zur Klassifikation von Differentialstrukturen auf 4-Mannigfaltigkeiten über virtuell flache Bündel wird eine Beziehung zu den Spin-Foam-Modellen hergestellt. Dabei steht die Äquivalenz zwischen Differentialstruktur und Triangulation der 4-Mannigfaltigkeit im Mittelpunkt. Zwei nicht-äquivalente Triangulationen implizieren zwei unterschiedliche Differentialstrukturen und zwei unterschiedliche Spin-Foam-Modelle. Die Konsequenzen dieses Ansatzes werden diskutiert. Insbesondere läßt sich daraus der Kontinuum-Limes des Spin-Foam-Modells konstruieren.

GR 5 Einstein und vereinheitlichte Feldtheorie

Zeit: Freitag 16:30–17:15

Raum: TU BH262

Hauptvortrag

GR 5.1 Fr 16:30 TU BH262

Zur Geschichte der einheitlichen Feldtheorie: Einsteins erfolgreiche Jahre — •HUBERT GÖNNER —

Verschiedene Ansätze zu einer einheitlichen theoretischen Darstellung von Elektromagnetismus und Gravitation, eventuell sogar mit Einschluss

der Schrödingerschen Wellenmechanik, in den 20er und 30er Jahren des 20sten Jahrhunderts werden vorgestellt. Als Hauptakteure treten auf: Cartan, Eddington, Einstein, Kaluza und Weyl. Einstein fokussiert Jahre seiner Forschung auf das Ziel einer einheitlichen Feldtheorie, ohne grundlegende und weiterführende Ideen beisteuern zu können.

GR 6 Quantengravitation – Kanonische Quantisierung, Geometrie, Schrödinger-Newton

Zeit: Freitag 17:15–18:15

Raum: TU BH262

GR 6.1 Fr 17:15 TU BH262

Quantum gravitational collapse and Hawking radiation — ●CARSTEN WEBER — Institut für Theoretische Physik, Universität zu Köln, 50937 Köln

Within the framework of canonical quantization, we discuss the Lemaitre-Tolman-Bondi model of gravitational collapse. We recover Hawking radiation from the wave functional and investigate whether singularities can be avoided in the quantum theory.

GR 6.2 Fr 17:30 TU BH262

Effective Action from Geometrical Formulation of Quantum Mechanics — ●AURELIANO SKIRZEWSKI — MPI für Gravitationsphysik, Am Mühlenberg 1, 14476 Golm, Germany

In order to get quantum corrections to the classical equations of motion for an arbitrary system such as a cosmological model, we explore a point of view in which the Hermitian inner product of the Hilbert space of the quantum system induces a symplectic structure and a metric in an infinite dimensional projective space [gr-qc/9706069]. The procedure is suggested when realizing that the quantum phase space is a bundle over the classical one and that the space of functions on this submanifold can be preserved under the action of the quantum Hamiltonian's vector field once certain assumptions are made. We review the general framework and discuss examples to compare with the usual effective action's procedure.

GR 6.3 Fr 17:45 TU BH262

s-Wellen-Lösungen der Mehrteilchen-Newton-Schrödinger-Gleichung — ●MARKUS KNAPP und GÜNTER WUNNER — 1. Institut für Theoretische Physik, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart

Die Newton-Schrödinger-Gleichung ist ein von Penrose [1] vorgeschlagener Ansatz, um die Rückwirkung der Gravitation auf quantenmechanische Zustände zu beschreiben. Sie stellt ein System zweier gekoppelter nichtlinearer Differentialgleichungen dar. Die Entartung ver-

schränkter quantenmechanischer Mehrteilchenzustände kann durch gravitative Selbstwechselwirkung aufgehoben werden, wobei diese dann in die Eigenfunktionen der Newton-Schrödinger-Gleichung kollabieren. Dieses System wurde bereits für das radialsymmetrische Einteilchen-Problem von verschiedenen Gruppen (z.B. [2]) numerisch behandelt. Wir haben diese Einteilchen-Gleichung analog zu [3] auf mehrere Teilchen erweitert, und dann mit Hilfe eines dem Hartree-Verfahren ähnlichen Algorithmus die zugehörigen Eigenfunktionen und Energieeigenwerte bestimmt. Als Ansatz dienten dabei radialsymmetrische Produkte aus Einteilchenwellenfunktionen.

[1] R. Penrose, *Gen. Rel. Grav.* **28** (1996), 581[2] I. M. Moroz, R. Penrose, P. Tod, *Class. Quant. Grav.* **15** (1998), 2733[3] K. R. W. Jones, *Aust. J. Phys.* **48** (1995), 1055

GR 6.4 Fr 18:00 TU BH262

Semiklassische Lösungen der Newton-Schrödinger-Gleichung — ●DANIEL GREINER und GÜNTER WUNNER — 1. Institut für Theoretische Physik, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart

Die Newton-Schrödinger-Gleichung stellt ein System nichtlinearer gekoppelter Differentialgleichungen dar, das von Penrose [1] als ein einfacher Ansatz für den klassischen Grenzfall einer Theorie der Quantengravitation vorgeschlagen wurde. Die Eigenfunktionen können als Basis einer „objektiven Zustandsreduktion“ verschränkter Quantenzustände dienen. Alternativ zu vorhandenen numerischen Lösungen (z.B. [2]) des radialsymmetrischen Problems kann ein semiklassisches Verfahren – in unserem Fall eine WKB-Näherung, ähnlich zum Vorgehen in [3] – verwendet werden, um die Quantisierung der Energieniveaus im Grenzfall großer Quantenzahlen zu bestimmen und zu prüfen, ob, wie numerische Rechnungen nahelegen, bei der Bohr-Sommerfeld-Quantisierung nichtlinearer Schrödinger-Gleichungen eine Renormierung des Planckschen Wirkungsquantums \hbar erforderlich ist.

[1] R. Penrose, *Gen. Rel. Grav.* **28** (1996), 581

[2] S. Epple, Universität Stuttgart, Diplomarbeit (2003)

[3] C. Hartmann, Universität Osnabrück, Diplomarbeit (1999)

GR 7 Einstein-Yang-Mills-Higgs

Zeit: Freitag 18:15–19:00

Raum: TU BH262

GR 7.1 Fr 18:15 TU BH262

Platonic Sphalerons in the Presence of a Dilaton Field — ●KARI MYKLEVOLL, BURKHARD KLEIHAUS, and JUTTA KUNZ — Universität Oldenburg

When gravity is coupled to non-Abelian gauge theories a number of interesting phenomena arise, such as gravitationally bound monopoles. Since the coupling of gravity to Yang-Mills or Yang-Mills-Higgs theory has a very similar effect concerning the existence of classical solutions as the coupling to a scalar dilaton, we construct sphaleron solutions with discrete symmetries in Yang-Mills-Higgs-dilaton theory. We consider this study as a first step to obtain self-gravitating objects with only discrete symmetries. Related to rational maps of degree N , these platonic sphalerons can be assigned a Chern-Simons number $Q = N/2$. We present sphaleron solutions with degree $N = 1 - 4$, possessing spherical, axial, tetrahedral and cubic symmetry. For all these sphalerons two branches of solutions exist, which bifurcate at a maximal value of the dilaton coupling constant.

GR 7.2 Fr 18:30 TU BH262

Gravitating Monopole-Antimonopole Chains and Vortex Rings — ●BURKHARD KLEIHAUS, JUTTA KUNZ, and YASHA SHNIR — University of Oldenburg

We construct monopole-antimonopole chain and vortex solutions in Yang-Mills-Higgs theory coupled to Einstein gravity. The solutions are static, axially symmetric and asymptotically flat. They are characterized by two integers (m, n) where m is related to the polar angle and n to the

azimuthal angle. Solutions with $n = 1$ and $n = 2$ correspond to chains of m monopoles and antimonopoles. Here the Higgs field vanishes at m isolated points along the symmetry axis. Larger values of n give rise to vortex solutions, where the Higgs field vanishes on one or more rings, centered around the symmetry axis. When gravity is coupled to the flat space solutions, a branch of gravitating monopole-antimonopole chain or vortex solutions arises, and bifurcates at a maximal value of the coupling constant with a second branch of solutions. This second branch has no flat space limit. Instead in the limit of vanishing coupling constant and thus vanishing Higgs field, it either ends in known Einstein-Yang-Mills solutions or, for $m > 4$, $n > 4$, it ends in new Einstein-Yang-Mills solutions, and, in this case, further branches of solutions appear.

GR 7.3 Fr 18:45 TU BH262

Rotating Black Holes with Monopole Hair — ●JUTTA KUNZ¹, BURKHARD KLEIHAUS¹, and FRANCISCO NAVARRO-LERIDA² — ¹University of Oldenburg — ²Universidad Complutense de Madrid

We study rotating black holes in Einstein-Yang-Mills-Higgs theory. These black holes emerge from static black holes with monopole hair when a finite horizon angular velocity is imposed. At critical values of the horizon angular velocity and the horizon radius, they bifurcate with embedded Kerr-Newman black holes. The non-Abelian black holes possess an electric dipole moment, but no electric charge is induced by the rotation. We deduce that gravitating regular monopoles possess a gyroelectric ratio $g_{el} = 2$.

GR 8 Gravitationswellenastronomie

Zeit: Samstag 08:30–11:15

Raum: TU BH262

Hauptvortrag

GR 8.1 Sa 08:30 TU BH262

Angular Momentum in General Relativity — ●GERNOT NEUGEBAUER — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität, Jena, Max-Wien-Platz 1, 07743 Jena

Spin phenomena play an important role in the analysis of astrophysical sources of gravitational radiation (neutron stars, binaries, black holes). This talk is meant to review some recent work on the spin-spin interaction of black holes, (parametric) collapse phenomena, and collisions of rotating disks.

Hauptvortrag

GR 8.2 Sa 09:15 TU BH262

Exploring the mathematical structure of gravitational fields — ●HELMUT FRIEDRICH — Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, Am Mühlenberg 1, 14476 Potsdam

Exploring the mathematical structure of gravitational fields, described in general relativity by solutions to Einstein's field equations, has been a central activity in the field since the beginning of theory. In spite of an impressive progress and a number of surprises there are still important questions to be answered. We discuss the development and the basic open problems of mathematical relativity and review some of the more recent results.

Hauptvortrag

GR 8.3 Sa 10:30 TU BH262

Gravitational waves — ●BERNARD SCHUTZ — Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, Am Mühlenberg 1, D-14476 Golm, Germany

GR 9 Gravitationswellen – Mathematisch-Numerische Grundlagen

Zeit: Samstag 11:15–12:30

Raum: TU BH262

GR 9.1 Sa 11:15 TU BH262

The why and how of treating infinite domains in numerical relativity — ●SASCHA HUSA — MPI für Gravitationsphysik / Albert Einstein Institut

This talk discusses the problem of treating essentially infinite domains in the numerical modelling of isolated systems, in particular systems emitting gravitational radiation. After a brief discussion of physical, mathematical and practical issues in different approaches toward dealing with isolated systems in numerical relativity, I focus on the status of the conformal approach, where infinite domains are treated via conformal compactification. While this approach utilizes a complex mathematical formalism, the basic physical ideas are quite simple to understand, and can be summarized as trying to factor out the known falloff behaviour at large distances. The aim is to avoid ambiguities arising from artificial boundaries, and to avoid having to deal with very large or very small quantities related to the asymptotic falloff of the computational quantities. Finally, I review the current status of the AEI group regarding construction of initial data and time evolution.

GR 9.2 Sa 11:30 TU BH262

Stabilität und die Propagation der Zwangsbedingungen — ●TILMAN VOGEL¹ und JÖRG FRAUENDIENER² — ¹Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Am Mühlenberg 1, 14476 Golm — ²Institut für Astronomie und Astrophysik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen

Ein typisches Problem der numerischen Relativitätstheorie ist das instabile Verhalten der Simulationen. Bereits auf kurzen Zeitskalen werden dabei Zwangsbedingungen derart verletzt, dass die physikalischen Eigenschaften der Lösung völlig zerstört werden.

Zwei Quellen werden dafür verantwortlich gemacht, die mit der Formulierung des Anfangsrandwertproblems zusammenhängen: (i) Inkonsistente Randbedingungen können unphysikalische Daten in das Simulationsgebiet einstrahlen. (ii) Kleine (numerisch unvermeidbare) Verletzungen der Zwangsbedingungen in den Anfangsdaten können Instabilitäten der Evolutionsgleichungen auslösen. Diese Problem, das ebenfalls bereits Teil der Kontinuumsformulierung ist, wird hier genauer betrachtet.

Es wird skizziert, wie für solche Störungen in geeigneter Näherung eine Stabilitätsanalyse durchgeführt werden kann. Es wird gezeigt, dass die Stabilität wesentlich von der gewählten Eichung, insbesondere der Wahl der Blätterung abhängt. Als Beispiel werden Ergebnisse für die Bianchi-Gleichung $\nabla_a C^a_{bcd} = 0$ präsentiert.

[1] Jörg Frauendiener and Tilman Vogel: *On the stability of constraint propagation*, gr-qc/0410100

GR 9.3 Sa 11:45 TU BH262

Diskrete Differenzialformen in der numerischen ART — ●RONNY RICHTER — Auf der Morgenstelle 10, 72076 Tübingen

In diesem Vortrag wird beschrieben, wie die Methode der Diskreten Differenzialformen zur Diskretisierung der Cartan-Formulierung der ART benutzt werden kann. Dabei wird allgemein auf Diskrete Differenzialformen eingegangen, die Cartan-Formulierung der ART vorgestellt und am Beispiel kugelsymmetrischer Systeme ein konkretes numerisches Schema entwickelt.

GR 9.4 Sa 12:00 TU BH262

Analytic solution to post-Newtonian accurate ‘Kepler Equation’ — ●MARIA HANEY and ACHAMVEEDU GOPAKUMAR — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

Keplerian type parametric solution to post-Newtonian (PN) accurate equations of motion for compact binaries will be required to realize gravitational wave astronomy.

We derive analytic solution to the PN accurate ‘Kepler Equation’ present in the third post-Newtonian accurate generalized quasi-Keplerian parametrization describing the orbital motion of a compact binary moving in an eccentric orbit, recently obtained by Memmesheimer, Gopakumar, and Schäfer.

Possible applications of our results will also be discussed.

GR 9.5 Sa 12:15 TU BH262

A double-domain spectral method for black hole excision data — ●MARCUS ANSORG — Albert-Einstein-Institut, Golm

In this talk, a new spectral method to compute binary black hole initial data numerically is presented. The method solves a system of elliptic partial differential equations in the exterior of two excised spheres. At the surface of these spheres, boundary conditions need to be imposed. As such, the method can be used to construct arbitrary initial data corresponding to binary black holes with specific boundary conditions valid at their apparent horizons. After a description of the method, current initial data formulations such as the thin-sandwich approach together with boundary conditions derived from the isolated horizon framework are discussed.

GR 10 Gravitationswellen – Quellen

Zeit: Samstag 14:00–16:00

Raum: TU BH262

GR 10.1 Sa 14:00 TU BH262

Stationary Ring–Black Hole Systems — ●DAVID PETROFF¹ and MARCUS ANSORG² — ¹Theoretisch-Physikalisches Institut, FSU Jena — ²Max-Planck-Institut für Gravitationsphysik (AEI), Golm

An axially symmetric, stationary spacetime containing a Black Hole surrounded by a ring of matter is constructed numerically. Because of the extremely high accuracy of the numerical solutions obtained, it is possible to solve for critical configurations and study subtle properties of these solutions that would otherwise be difficult to resolve. After a brief discussion of the numerical methods, these subtleties will be illuminated.

GR 10.2 Sa 14:15 TU BH262

Rotierende Ringe in der allgemeinen Relativitätstheorie — ●HORATSCHEK STEFAN¹, MARCUS ANSORG² und THOMAS FISCHER³ — ¹Theoretisch-Physikalisches Institut, FSU Jena — ²Max-Planck-Institut für Gravitationstheorie (AEI), Golm — ³Institut für Angewandte Mathematik, FSU Jena

In diesem Vortrag werden selbstgravitierende, starr rotierende ideale Flüssigkeitskonfigurationen mit toroidaler Topologie (ohne Zentralkörper) im Rahmen der Einsteinschen Gravitationstheorie diskutiert. Neben polytropen Zustandsgleichungen mit verschiedenen Polytropenindizes wird das ideale vollständig entartete Neutronengas als Materiemodell betrachtet. Wie für die homogenen sogenannten „relativistischen Dyson-Ringe“ erhalten wir für eine vorgegebene maximale innere Energie-Massendichte Konfigurationen mit beliebig großen gravitativen und baryonischen Massen. Darüberhinaus weisen alle untersuchten Klassen toroidaler Flüssigkeitskörper einen kontinuierlichen Übergang zu einem extremen Kerr-black-hole auf.

GR 10.3 Sa 14:30 TU BH262

Kompakte Sterne als Quellen für Gravitationswellen — ●MATTHIAS HANAUSKE — Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, Frankfurt am Main

Rotierende, quadrupoldeformierte kompakte Sterne, Kollisionen von kompakten Sternen oder kollabierende kompakte Sterne stellen mögliche Quellen für Gravitationswellen dar. Die meisten der numerisch erzielten, theoretischen Vorhersagen der emittierten Gravitationswellen solcher Systeme benutzen ein realitätsfremdes Modell der Materie. Wenn man ernsthaft beabsichtigt eine Vorhersage einer möglicherweise in Zukunft detektierten Gravitationswelle zu machen, so sollte man keine einfachen polytropen Zustandsgleichungen bei numerischen Berechnungen verwenden.

GR 10.4 Sa 14:45 TU BH262

Probing oscillations with spectral methods - Towards a 2D simulation for rapidly rotating neutron stars — ●ERICH GAERTIG — Institut für Astronomie und Astrophysik der Universität Tübingen

In this talk I will give a brief overview about the current status of my work, which is part of the SFB/TR07. The final goal is to solve the linearized Einstein-equations for small perturbations on rotating neutron stars. In a very first step, all disturbances in the metric potentials are neglected which simplifies the problem significantly. As a consequence, only the relativistic hydrodynamic equations have to be considered and no gravitational waves are emitted.

A numerical code has been written that utilizes a highly accurate background model for polytropic equations of state and makes use of spectral methods for spatial differentiation. For time-evolution itself, an explicit Runge-Kutta 4th-order scheme is implemented.

GR 10.5 Sa 15:00 TU BH262

Eigenmodes of axisymmetric neutron stars in relativistic perturbation theory — ●STRATOS BOUTLOUKOS — Universität Tbingen

We perform perturbation theory on rapid-rotating neutron stars by

use of the relativistic Cowling approximation and compute their eigenfrequencies. We are able to calculate for the first time the complete spectrum of axisymmetric oscillations, including, the important for gravitational-wave detection, r-modes. The frequency window is determined and various eigenfunctions are shown. The results are compared with previous studies.

GR 10.6 Sa 15:15 TU BH262

Constructing ready to use search templates for compact binaries moving in inspiralling eccentric orbits — ●GOPAKUMAR ACHAMVEEDU — Theoretisch-Physikalisches Institut, Friedrich-Schiller-University, Max-Wien-Platz 1, 07743 Jena, Germany

I describe a program, currently ongoing in Jena under SFB/TR7, *Gravitationswellenastronomie*, to construct highly accurate search templates for gravitational wave signals emitted by compact binaries moving in inspiralling eccentric orbits. These templates will be required to do astronomy with gravitational wave interferometers and the square kilometre array.

GR 10.7 Sa 15:30 TU BH262

Post-Newtonian accurate parametric solution to the dynamics of spinning compact binaries in eccentric orbits: The leading order spin-orbit interaction — ●CHRISTIAN KÖNIGSDÖRFFER and ACHAMVEEDU GOPAKUMAR — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität, Max-Wien-Platz 1, 07743 Jena, Germany

We derive Keplerian-type parametrization for the solution of post-Newtonian (PN) accurate conservative dynamics of spinning compact binaries moving in eccentric orbits. The PN accurate dynamics that we consider consists of the third PN accurate conservative orbital dynamics influenced by the leading order spin effects, namely the leading order spin-orbit interactions. The orbital elements of the representation are explicitly given in ADM-type coordinates. Our parametric solution is applicable in the following two distinct cases: (i) the binary consists of equal mass compact objects, having two arbitrary spins, and (ii) the binary consists of compact objects of arbitrary mass, where only one of them is spinning with an arbitrary spin. As an application of our parametrization, we present gravitational wave polarizations, whose amplitudes are restricted to the leading quadrupolar order, suitable to describe gravitational radiation from spinning compact binaries moving in eccentric orbits. The present parametrization will be required to construct ‘ready to use’ reference templates for gravitational waves from spinning compact binaries in inspiralling eccentric orbits. Finally, we note that our parametrization provides the first step in deriving a fully second PN accurate ‘timing formula’, that may be useful for the radio observations of relativistic binary pulsars like J0737-3039.

GR 10.8 Sa 15:45 TU BH262

Do we really need search templates for gravitational waves from compact binaries moving in inspiralling eccentric orbits ? — ●WEN LINQING¹, ALESSANDRA BUONANNO², and ACHAMVEEDU GOPAKUMAR³ — ¹Max Planck Institut für Gravitationsphysik Albert-Einstein-Institut Am Muehlenberg 1D-14476 Golm Germany — ²groupe de Gravitation et Cosmologie (GRACO), IAP ,98bis Boulevard ARago, 75014 Paris, France — ³Theoretisch-Physikalisches Institut, FSU, Max-Wien-Platz 1, 07743 Jena, Germany

Gravitational waves from compact binaries moving in inspiralling eccentric orbits are plausible sources of gravitational radiation for ground-based interferometric detectors, especially for detectors with good sensitivity at low frequency, such as VIRGO and Advanced LIGO. By using as target signals the current, most accurate post-Newtonian waveforms for inspiralling eccentric binaries, we evaluate the loss in signal-to-noise ratio if post-Newtonian templates for compact binaries in quasi-circular orbits were used. We explore how the loss in signal-to-noise depends on initial eccentricity, individual masses and post-Newtonian orders

GR 11 Gravitationswellen – Detektoren

Zeit: Samstag 16:00–16:30

Raum: TU BH262

GR 11.1 Sa 16:00 TU BH262

Auswertung der ersten gemeinsamen Messungen der laserinterferometrischen Gravitationswellendetektoren — ●PETER AUFMUTH^{1,2} und KARSTEN DANZMANN^{1,2} — ¹Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, D-30167 Hannover — ²Institut für Atom- und Molekülphysik, Universität Hannover, Callinstr. 38, D-30167 Hannover

Seit einigen Jahren sind vier große laserinterferometrische Gravitationswellendetektoren in Betrieb: TAMA300 (Japan), GEO600 (Deutschland) und LIGO (zwei Detektoren in den USA). Alle Anlagen arbeiten in der LIGO Scientific Collaboration (LSC) zusammen, um gemeinsam Daten aufzunehmen, auszuwerten und zu publizieren. Die Empfindlichkeit der Detektoren wird laufend verbessert. Bisher sind drei gemeinsame Meßzeiten von einigen Wochen Dauer mit wechselnder Beteiligung durchgeführt worden. Bei der Auswertung der Daten liegt der Schwerpunkt auf der Suche nach Signalen von Pulsaren, Supernovae und kompakten Binärsystemen sowie nach einer stochastischen Hintergrundstrahlung. Als neueste Ergebnisse werden verbesserte Obergrenzen und Abschätzungen präsentiert.

GR 11.2 Sa 16:15 TU BH262

Tuning GEO600 for best detection of specific signals — ●HANS-PETER NOLLERT — Universität Tübingen, Theoretische Astrophysik, Auf der Morgenstelle 10, 72076 Tübingen

The resonance frequency of the signal recycling cavity of the GEO600 interferometric gravitational wave detector can be changed during operation at a rate up to the order of kHz per second. If the spectrum of a signal is known, the resonance frequency can be adjusted to obtain the largest possible signal-to-noise ratio, or to optimize the detection of certain parts of the spectrum which are considered most interesting for reasons of astrophysics.

This can be done even while the signal is being detected. A prime candidate for such a procedure is the signal of a close compact binary system consisting of neutron stars and/or black holes. The resonance frequency of the signal recycling cavity could be matched to the changing frequency over time of such a system. We discuss the potential and the limitations of this approach, and also consider other signal types as alternatives.

GR 12 Grundlagen und allgemeiner Formalismus

Zeit: Montag 17:00–17:45

Raum: TU BH262

GR 12.1 Mo 17:00 TU BH262

Riemannian light cone from vanishing birefringence in pre-metric vacuum electrodynamics — ●CLAUS LÄMMERZAHL¹ and FRIEDRICH W. HEHL² — ¹ZARM, Univ. Bremen, Am Fallturm, 28359 Bremen — ²Inst. Theor. Physics, Univ. of Cologne, Zùlpicher Str. 77, 50923 Köln

We consider premetric electrodynamics with a local and linear constitutive law for the vacuum. Within this framework, we find quartic Fresnel wave surfaces for the propagation of light. If we require (i) the Fresnel equation to have only real solutions and (ii) the vanishing birefringence in vacuum, then a Riemannian light cone is implied. No proper Finslerian structure can occur. This consideration is generalized to dynamical equations of any order. One important consequence of that is that for vanishing birefringence an anisotropy of the velocity of light can only be experienced by comparing properties of the velocity of light with properties of solids which description is mainly based on the Dirac equation. (Published in Phys.Rev. D 70, 2004)

GR 12.2 Mo 17:15 TU BH262

Die affine Gravitationstheorie im Multimomentum-Formalismus – Erhaltungsgrößen und lokaler Hamilton-Formalismus — ●STEPHAN SPENLING — Institut für Theoretische Physik PN7-1, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Zur Formulierung der Lagrange-Dichte der affinen Gravitationstheorie wird allein der Zusammenhang auf der Weltmannigfaltigkeit benötigt. Da in diesem Setting die Weltmannigfaltigkeit nicht folierbar ist, wird diese Theorie im Multimomentum-Formalismus behandelt. Dabei werden die

Zwangsbedingungen bestimmt, Erhaltungsgrößen hergeleitet und eine lokale Hamiltonfunktion konstruiert.

GR 12.3 Mo 17:30 TU BH262

Relativity theory approach to rigorous justification of the Fermi acceleration mechanism and the law of entropy increase — ●LEV PUSTYL'NIKOV — Universität Bielefeld, Fakultät für Physik, BiBoS, D-33501 Bielefeld, Germany

On the basis of taking account of relativistic effect the following physical problem are in essence solved:(i) the problem posed by Fermi of explaining the origin of high energy particles in the cosmic space, on the basis of the statistics of mechanical collisions of particles and macroobjects moving periodically in the cosmos, and (ii) the problem posed in the days of Clausius, Boltzmann, and Gibbs, of justifying the law of entropy increase in statistical physics. The rigorous investigation of these problems were carried out for relativistic versions of the Fermi-Ulam model ([1]), the Poincare model ([2]) and the generalized billiards ([4]).

[1]. L.D.Pustyl'nikov, "A new mechanism for particle acceleration and relativistic analogue of the Fermi-Ulam model", Theoret.Math.Phys.77(1),(1988). [2]. L.D.Pustyl'nikov, "Poincare model, rigorous justification of the second element of thermodynamics from mechanics, and the Fermi acceleration mechanism", Russ.Math. Surves 50 (1), (1995), 145-189. [3]. L.D.Pustyl'nikov, "On the mechanism for the origin of irreversibility, and the unbounded growth of energy in a model of statistical mechanics", Theoret. and Math. Phys.,86 (1991), 82-89. [4].M.V.Deryabin, L.D.Pustyl'nikov, "Exponential attractors in generalized relativistic billiards", Commun.Math.Phys.,248, N3,(2004), 527-552.

GR 13 Alternative Zugänge

Zeit: Montag 17:45–19:00

Raum: TU BH262

GR 13.1 Mo 17:45 TU BH262

Licht und Gravitation — ●KLAUS FRÖHLICH — ALS, Paracelsusweg 12, 30655 Hannover

In der Gravitationstheorie treten unendliche nicht renormierbare Kräfte auf. Es wird eine Theorie der Gravitation vorgestellt, in der keine unendlichen Kräfte auftreten:

Gravitation hat zwei Arten von Ladung. Sie erhalten die Namen Epi- und Hypo- Gravitation. Gleichnamige Ladungen der Gravitation stoßen sich ab, verschiedenamige Ladungen ziehen sich an.

Licht hat eine longitudinale Komponente, die Träger der Gravitation ist. Licht ist eine elektro-magnetisch-gravitative Welle.

Überprüfbar: Voraussage: Gravitationswellen sind Longitudinalwellen.

Sie haben ihre Wirkung in Ausbreitungsrichtung. Die z.Zt. verbreitete Theorie versucht, Gravitation durch Quadropolwellen zu erklären. Quadropolwellen haben ihre Wirkung senkrecht zur Ausbreitungsrichtung.

GR 13.2 Mo 18:00 TU BH262

Zum Kraftlinienverlauf ausgehend vom Massenschwerpunkt — ●PETER KÜMMEL — Amselweg 15 c, 21256 Handeloh

Um Erscheinungen des künstlichen oder natürlichen Schwerpunktversatzes zu erkennen, sind eindeutige geometrische Grundlagen der unsichtbaren und dreidimensionalen Feldwirkungen nachzuweisen. Diese grundsätzlichen Fundamente der Gravitationswissenschaft wurden in der Lehrbuch-Physik leider vernachlässigt. Der vorliegende Beitrag soll

Übersicht auf 1. die neuen "Gravitationsfeld-Strukturgesetze schwerer Massen", kurz: GSGH mit den Paragraphen 1 bis 21 und 2. die neuen "Gravitationsfeld-Strukturgesetze rotierender Massen", kurz: GSGR mit den Paragraphen 1-13 geben.

GR 13.3 Mo 18:15 TU BH262

Mach's Principle and a Variable Speed of Light — ●ALEXANDER UNZICKER — Pestalozzi-Gymnasium München

Dirac's great number hypothesis (1938), the numerical coincidence $G/c^2 = R_u/M_u$ (R_u and M_u denoting the mass and radius of the universe) remains one of the big mysteries of physics.

Sciama (MNRAS 113, p. 35ff, 1953) developed the more plausible hypothesis $c^2/G = \sum m_i/r_i$, which may be seen as a quantitative proposal for Mach's principle, according to which gravitation has its origin in the presence of all other masses in the universe.

While Sciama's developed a gravitational potential $-c^2$, he did not discuss the obvious consequence of a spatial variation of the speed of light as the origin of gravitation. Such a variation was, by the way Einstein's own idea in 1911 while developing general relativity and does therefore not contradict the relativity principle (Einstein Ann.Phys 38 (1912), 355-69; see also Ranada, gr-qc/0410120).

As a new proposal, the gravitational potential $-c_0^2 \log \sum m_i/r_i$ is discussed, particularly what additional assumptions are needed to fulfill the classical tests of GR. Moreover, it is shown that such an approach yields a theoretical motivation of the equivalence principle.

GR 13.4 Mo 18:30 TU BH262

The Origin of Gravity: A Refraction Process — ●ALBRECHT GIESE — Taxusweg 15, 22605 Hamburg

The phenomena of GR can - as well as those of SR - be derived from processes internal to elementary particles.

From astronomical observations we know that the speed of light is re-

duced in a gravitational field. On the other hand, from classical optics it follows that the track of a light-like particle, which moves in a medium with variable c , is subject to a refraction process. This already explains correctly the famous deflection of photons passing the sun, no factor of 2 is missing!

Also the internal oscillation of an elementary particle, which according to Dirac/Schrödinger goes on at the speed of light, is subject to this refraction process. That is why a free moving elementary particle is accelerated towards the gravitational source. The mathematical deduction yields the correct gravitational acceleration. This process also explains why all objects are subject to the same acceleration. So, the necessity of an equivalence principle becomes obsolete.

This approach further gives the reason for the attracting-only nature of gravitation, and it offers an explanation for Dark Matter.

For further info: www.ag-physics.org/gravity

GR 13.5 Mo 18:45 TU BH262

Spezielle und allgemeine Relativitätstheorie - intolerant und deshalb unwissenschaftlich? — ●JÜRGEN BRANDES — Danziger Str. 65 D-76307 Karlsbad

Spezielle und allgemeine Relativitätstheorie (SRT + GRT) sind elegant und vielfältig experimentell bestätigt, eine Alternative zu diskutieren, wäre Zeitverschwendung. Ja, das ist nachvollziehbar.

Aber: SRT + GRT verschweigen ihre Mängel und verhindern damit eine ERWEITERUNG beider Theorien [1]. So darf man mit SEXL die These vertreten, dass in Gravitationsfeldern Maßstäbe kontrahiert werden. Das ist eine PHYSIKALISCHE Deutung einer gekrümmten Raumzeit und ein Puzzleteil, Quantenmechanik (3-dim. Raum) und ART (gekrümmte Raumzeit) miteinander zu vereinen.

[1] J. Brandes, Die relativistischen Paradoxien und Thesen zu Raum und Zeit - Interpretationen der speziellen und allgemeinen Relativitätstheorie. VRI-Verlag 2001.

GR 14 Gravitation im Universum

Zeit: Dienstag 10:15–12:30

Raum: TU BH262

Hauptvortrag

GR 14.1 Di 10:15 TU BH262

Dark Matter and Galaxy Formation — ●JOSEPH SILK — Astrophysics, Denys Wilkinson Building, Keble Road, Oxford OX1 3RH, UK

Dark matter presents a challenge for gravitational theory. It is best attacked in two ways; by studying the confrontation of structure formation with observation and by direct and indirect searches. In this review, I will focus on those aspects of dark matter that are relevant for understanding galaxy formation, and describe the outlook for detecting the most elusive component, non-baryonic dark matter.

Hauptvortrag

GR 14.2 Di 11:00 TU BH262

Kosmische Schwarze Löcher - vom Kollaps massereicher Sterne zu Milliarden von Sonnenmassen — ●MAX CAMENZIND —

Der Gravitationskollaps massereicher Sterne erzeugt die bizarrsten Objekte des Universums – rotierende Schwarze Löcher. Es handelt sich dabei um so kompakte Objekte, dass innerhalb des Ereignishorizontes nicht mal mehr Licht entkommen kann. Das Jahr 1963 war entscheidend im Verständnis dieser Objekte: Roy Patrick Kerr fand die exakte Lösung der Einstein-Gleichungen für rotierende Schwarze Löcher, und zur gleichen Zeit wurden diese Objekte als eigentliche Energiequelle der Quasare postuliert. Schnell rotierende Schwarze Löcher enthalten so viel Rotationsenergie, dass sie mittels magnetischer Kopplung an heisses Plasma die gesamte Energetik der Quasare erklären können. Dabei spielt die Physik der Ergosphäre eines rotierenden Schwarzen Lochs eine wesentliche Rolle. Dank moderner Beobachtungsmethoden ist die Existenz stellerer Schwarzer Löcher erhärtet worden, und auf der anderen Seite wurde die Existenz supermassereicher Schwarzer Löcher in den Zentren von Galaxien nachgewiesen. Unsere Milchstrasse bildet in dieser Hinsicht keine

Ausnahme. Schwarze Löcher in den Zentren von Galaxien wachsen bereits im frühen Universum zu ihrer heutigen Masse an. Die Frage dieses Wachstums ist zur Zeit Gegenstand intensiver Forschung.

Hauptvortrag

GR 14.3 Di 11:45 TU BH262

Gravitational Lensing as a Powerful Astrophysical Tool: MACHOs, Multiple Quasars and Einstein Rings — ●JOACHIM WAMBSGANSS — Astronomisches Rechen-Institut und Universität Heidelberg, Heidelberg

In 1919, the deflection of light was measured at the solar limb during a total eclipse. This detection quantitatively confirmed the prediction of General Relativity (and initiated Einstein's fame). In 1979, the first phenomenon of a "double quasar" was detected and explained as an optical illusion, a consequence of strong light deflection by gravity. In the 25 years since, many more gravitational lensing phenomena have been discovered, e.g. giant luminous arcs: highly distorted images of background galaxies; microlensing: time-variable magnification background sources due to intervening stars or dark matter objects ("MACHOs") along the line of sight. Even a few "Einstein rings" were discovered, circular images of background galaxies which occur for perfect alignment between lens and source. Weak lensing has been used for measuring the total mass and the mass distribution in galaxy clusters, and "cosmic shear" measurements are currently being refined in order to get better constraints to the cosmological model.

In the talk, the basics of gravitational lensing are explained with many illustrations, the current state-of-the-art in astrophysics and cosmology is demonstrated, and occasional historic reminiscences are intermingled, in particular regarding Einstein's contributions.

GR 15 Experimentelle Tests

Zeit: Dienstag 14:00–16:00

Raum: TU BH262

GR 15.1 Di 14:00 TU BH262

Will gravity reveal other worlds? — ●MARTIN DOMINIK — University of St Andrews, School of Physics & Astronomy, North Haugh, St Andrews, KY16 9SS, United Kingdom

The deflection of light originating from stars in the Galactic Bulge caused by the gravitational field of a foreground star surrounded by a planetary system yields an observable brightening which can reveal planets with masses as low as Earth. Unlike any other technique used in the hunt for extra-solar planets, this effect, known as 'microlensing', probes planetary systems that are similar to our own around the most common types of stars at galactic distances. Currently, it is the only technique able to pick up a signal of a planet that may harbour life, while a Jupiter-like planet has already been detected. The successful operation of ground-based telescope networks such as PLANET (Probing Lensing Anomalies NETwork) has demonstrated the feasibility of nearly-continuous round-the-clock high-precision photometric monitoring with on-line data reduction. The sensitivity of this campaign was reflected in the provision of the first significant abundance limits for planets around M dwarfs. The strongly enhanced capabilities of a UK-operated 2m-robotic-telescope network which is under construction will allow the discovery of planets on an industrial scale, including a few Earth-mass planets within five years of operation. However, a proper characterization of such 'other worlds' would require the deployment of a space-based microlensing mission.

GR 15.2 Di 14:15 TU BH262

Are the active and passive electric charges equal? — ●CLAUS LÄMMERZAHN¹, ALFREDO MACIAS², and HOLGER MÜLLER³ — ¹ZARM, Univ. Bremen, Am Fallturm, 28359 Bremen, Germany — ²Physics Dpt., UAM-I, Mexico D.F., Mexico — ³Physics Dpt., Stanford Univ., Stanford, CA 94305-4060, USA

While the question of a hypothetical difference of the active and passive gravitational mass has been analyzed theoretically and tested by laboratory experiments and confronted with astrophysical observations, nothing similar seems to exist for the electric analogue. Though there is no experimental result which is in disagreement with the current Maxwell theory which always tacitly assumes the equality of active and passive charges, we discuss here theoretical and experimental consequences of a hypothetical difference between the active and passive electric charge. As in gravity, a self-acceleration of the center-of-mass of a bound system is a consequence of a difference between active and passive charges. However, this of no use for an experimental search since because of the short timescale of atomic phenomena this effect immediately cancels out. Therefore other schemes than those invented for the gravitational domain has to be looked for. Here we describe a scheme which uses the difference of "active" and "passive" neutrality and current high precision tests of the neutrality of atoms and molecules. Also other schemes are discussed.

GR 15.3 Di 14:30 TU BH262

The Pioneer Anomaly - Evident Effect or just an Error? — ●HANSJÖRG DITTUS¹, CLAUD LÄMMERZAHN¹, SLAVA G. TURYSHEV², JOHN D. ANDERSON², and MICHAEL M. NIETO³ — ¹ZARM, Universität Bremen — ²Jet Propulsion Laboratory, Pasadena CA, U.S.A. — ³LANL, Univ. of California, Los Alamos, NM, U.S.A.

Analysis of the radio-metric tracking data from the Pioneer 10/11 spacecraft (launched 1972/73) at distances between 20 and 70 astronomical units (AU) from the Sun has consistently indicated the presence of an anomalous, small, constant Doppler frequency drift. The drift can be interpreted as being due to a constant acceleration of $a_p = (8.74 \pm 1.33) \cdot 10^{-8} \text{ cm/s}^2$ directed towards the Sun. After Jupiter and Saturn encounters, the two spacecraft followed escape hyperbolic orbits near the plane of the ecliptic to opposite sides of the solar system. Up to now, no satisfactory explanation of the anomalous acceleration has been found. The inability to explain the anomalous acceleration of the Pioneer spacecraft with standard physics has contributed to the growing discussion about its origin. Although the most obvious explanation would be that there is a systematic origin to the effect, perhaps generated by the spacecraft themselves from excessive heat or propulsion gas leaks, none has been found; that is, no unambiguous, onboard systematic has been discovered. In fact, attempts to find a convincing explanation using such a mechanism have not succeeded. We like to discuss the present situation

and will report on latest results.

GR 15.4 Di 14:45 TU BH262

Tests of Lorentz invariance using hydrogen molecules — ●HOLGER MÜLLER¹, SVEN HERRMANN², ALEJANDRO SAENZ², ACHIM PETERS² und CLAUD LÄMMERZAHN³ — ¹Physics Dept., Stanford University, Stanford, CA94305; email: holgerm@stanford.edu — ²Institut für Physik, Humboldt-Universität zu Berlin, Hausvogteiplatz 5-7, 10117 Berlin, Germany — ³ZARM, Universität Bremen, Am Fallturm, 28359 Bremen, Germany

We discuss the consequences of Lorentz violation (as expressed within the Lorentz-violating extension of the standard model) for the hydrogen molecule, which represents a generic model of a molecular binding. Lorentz-violating shifts of electronic, vibrational and rotational energy levels, and of the internuclear distance are calculated. This offers the possibility of obtaining improved bounds on Lorentz invariance by experiments using molecules.

GR 15.5 Di 15:00 TU BH262

Elastische Verformung von optischen Resonatoren — ●SILVIA SCHEITHAUER¹, CLAUD LÄMMERZAHN¹, HANSJÖRG DITTUS¹, STEPHAN SCHILLER² und ACHIM PETERS³ — ¹ZARM, Uni Bremen, Am Fallturm, 28359 Bremen — ²Institut für Experimentalphysik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf — ³Institut für Physik, Humboldt Universität, 10117 Berlin

In zukünftigen Experimenten zur SRT und ART werden immer häufiger optische Resonatoren Verwendung finden, u.a. auch in der geplanten OPTIS Satellitenmission. In einen optischen Resonator werden Laserstrahlen eingekoppelt, wodurch man hochgenau optische Frequenzen definieren kann (Lichtuhr). Diese Frequenz ist abhängig vom Verhältnis der Lichtgeschwindigkeit und der Resonatorlänge. Will man z.B. die Konstanz der Lichtgeschwindigkeit testen, muss die Resonatorlänge mit derselben Größenordnung stabil sein. Störungen der Resonatorform induzieren Frequenzschwankungen, die das Messergebnis verfälschen. Neben thermischen Gradienten sowie Restbeschleunigung und -rotation spielen bei neuen Experimenten auch Gravitationsgradienten eine wichtige Rolle. Da diese prinzipiell nicht eliminierbar sind, müssen sie bestimmt und aus dem Messsignal herausgerechnet werden. – In diesem Vortrag sollen theoretische und numerische Untersuchungen des Elastizitätsverhaltens optischer Resonatoren und die Größenordnung des Einflusses des Gravitationsgradienten präsentiert werden.

GR 15.6 Di 15:15 TU BH262

Ein verbessertes Michelson-Morley-Experiment mit kryogenen optischen Resonatoren und einem Präzisionsdrehtisch — ●SVEN HERRMANN¹, ALEXANDER SENGER¹, EVGENY KOVALCHUK¹, HOLGER MÜLLER² und ACHIM PETERS¹ — ¹Institut für Physik, Humboldt Universität zu Berlin, Hausvogteiplatz 5-7, 10117 Berlin — ²Physics Department, Stanford University, Stanford CA, 94305

Das Michelson-Morley-Experiment stellt seit jeher einen der wichtigsten Prüfsteine der speziellen Relativitätstheorie dar. Seit seiner ersten Durchführung 1881 wurde die Messgenauigkeit stetig weiter verbessert. Gegenwärtig kann eine Anisotropie der Lichtgeschwindigkeit mit $\Delta c/c = (2,6 \pm 1,7) \cdot 10^{-15}$ ausgeschlossen werden. Dieses Limit stammt aus einer von uns durchgeführten Messung, bei der die Frequenzen zweier Nd:YAG-Laser, stabilisiert auf durch die Erdrotation gedrehte Hoch-Finesse-Resonatoren, über ein Jahr hinweg miteinander verglichen wurden (H. Müller et al., PRL 91:020401 (2003)).

In diesem Beitrag präsentieren wir nun eine verbesserte Version des Experiments, welche eine Steigerung der Genauigkeit um mindestens 1 Größenordnung ermöglichen sollte. Dieser Fortschritt beruht vor allem auf dem Einsatz eines Drehtisches zur aktiven Rotation des Aufbaus. Weitere Verbesserungen, u.a. der Einsatz von Resonatoren höherer Finesse, lassen eine zusätzliche Steigerung der Genauigkeit erwarten.

Es werden erste Ergebnisse der neuen Messungen mit einem Drehtisch präsentiert und der Einfluss der verschiedenen mit der Drehung einhergehenden systematischen Effekte wird diskutiert.

GR 15.7 Di 15:30 TU BH262

Numerische Modellierung der MICROSCOPE Mission — •HANNS SELIG, HANSJÖRG DITTUS und CLAUSS LÄMMERZAHL — ZARM, Uni-Bremen, Am Fallturm, 28359 Bremen

Das Ziel des französischen Raumfahrtprojektes MICROSCOPE ist die experimentelle Überprüfung des schwachen Äquivalenzprinzips mit einer Genauigkeit von $\eta = 10^{-15}$. Das Experiment wird im Jahr 2008 in einer erdnahen Umlaufbahn auf einem Kleinsatelliten der CNES- μ -Sat-Line durchgeführt. Die Messgenauigkeit wird mit Hilfe von hochgenauen kapazitiven Differential-Accelerometern erreicht, die von dem französischen Institut ONERA entwickelt und gebaut werden. Das ZARM verfügt neben den französischen Partnerinstituten über das Erstzugriffsrecht auf die Missionsdaten. Für die Missionsdatenanalyse und für die In-Orbit Kalibrationsphasen des Satelliten werden am ZARM umfangreiche Missionsmodellierungen durchgeführt, die für die missionsbegleitende Datenanalyse eine entscheidende Bedeutung haben. Sowohl die verschiedenen Störeinflüsse als auch die verschiedenen Regelkreise zur Steuerung des Satellitenexperiments können mit dem Modell simuliert werden. Über den aktuellen Stand wird im Rahmen des Vortrages berichtet.

GR 15.8 Di 15:45 TU BH262

Sagnac Effect of Gödel's Universe — E. KAJARI¹, R. WALSER¹, W. P. SCHLEICH¹, and A. DELGADO² — ¹Abteilung für Quantenphysik, Universität Ulm, 89069 Ulm, Germany — ²Departamento de Física, Universidad de Concepción, Casilla 160-C, Concepción, Chile

A Sagnac interferometer serves as a measuring device for any kind of rotation, either due a rotation of the reference frame or the curvature of spacetime. In General Relativity coordinates have no physical meaning any more and so the question arises, how to express the Sagnac effect in terms of observable quantities. For this purpose, we choose proper time delays of light rays as our measurable quantities. In this context, we compare the Sagnac effect on a circular light path for a rotating reference frame in Minkowski spacetime with an analogous experiment performed by a resting observer in Gödel's spacetime [1]. Surprisingly, we find for both cases nearly the same quantitative result, although the two underlying spacetime structures differ significantly [2].

[1] K. Gödel, Rev. Mod. Phys. **21**, 447 (1949)[2] E. Kajari, R. Walser, W. P. Schleich, A. Delgado, Gen. Rel. Grav. **36**, 2289 (2004)

GR 16 Klassische ART und Kosmologie

Zeit: Dienstag 16:30–18:00

Raum: TU BH262

GR 16.1 Di 16:30 TU BH262

Light propagation in electrodynamics with nonminimal curvature coupling — •YURI OBUKHOV — Inst. Theor. Physics, University of Cologne, 50923 Koeln

The propagation of electro-dynamical waves in curved spacetime is discussed in the framework of the Fresnel approach. The general analysis of the extensions of the Maxwell-Lorentz theory with the Lagrangians including the nonminimal curvature coupling terms is presented. As the direct applications we study the birefringence effect of the light propagation in the gravitational fields of compact objects. Observational consequences are derived.

GR 16.2 Di 16:45 TU BH262

Stationär axialsymmetrische Staubscheiben um Schwarze Löcher — •CHRISTIAN KLEIN — MPI für Mathematik in den Naturwissenschaften, Inselstr. 22-26, 04103 Leipzig

Wir diskutieren exakte Lösungen der stationär axialsymmetrischen Einstein-Gleichungen, die Lochscheiben aus druckloser Materie um rotierende Schwarze Löcher beschreiben. Im statischen Fall lassen sich unendlich ausgedehnte Scheiben allgemein behandeln. Im stationären Fall können entsprechende Lösungen auf partiell degenerierten Riemannschen Flächen konstruiert werden.

GR 16.3 Di 17:00 TU BH262

Light deflection in the post-linear gravitational field of bounded point-like masses — •MICHAEL BRÜGMANN and GERHARD SCHÄFER — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena

The light deflection in the post-linear gravitational field of two bounded point-like masses is treated. Both the light source and the observer are assumed to be located at infinity in an asymptotically flat space. The equations of light propagation are explicitly integrated to the second order in G/c^2 . The deflection angle takes a particularly simple form for a light ray originally propagating orthogonal to the orbital plane of the binary. It is shown that the expression obtained for the angle of light deflection is fully equivalent to the expression obtained by Kopeikin and Schäfer up to the order given there. Application of the formulae for the deflection angle to the binary pulsar PSR 1534+12 shows that the corrections to the Einstein angle and the Epstein-Shapiro light deflection are of the order 10^{-2} and 10^{-7} arcsec respectively.

GR 16.4 Di 17:15 TU BH262

Quasinormal mode expansion and the exact solution of the Cauchy problem for wave equations — •NIKODEM SZPAK — Institut für Theoretische Physik, J.W.Goethe Universität Frankfurt, 60054 Frankfurt/Main

Solutions for a class of wave equations with effective potentials are obtained by a method of a Laplace-transform. Quasinormal modes appear naturally in the solutions only in a spatially truncated form, their coefficients are uniquely determined by the initial data and are constant only in some region of spacetime – in contrast to normal modes. This solves the problem of divergence of the usual expansion into spatially unbounded quasinormal modes and a contradiction with the causal propagation of signals. It also partially answers the question about the region of validity of the expansion. Results of numerical simulations are presented. They fully support the theoretical predictions.

GR 16.5 Di 17:30 TU BH262

Scherungsfreie, ideale Fluide in der Allgemeinen Relativitätstheorie — •THORALF CHROBOK — Institut für Theoretische Physik PN7-1, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Es werden einige allgemeine Resultate für rotierende, expandierende und scherungsfreie Raumzeiten mit idealer Flüssigkeit abgeleitet. Allerdings besagt eine Reihe von Theoremen für Spezialfälle die Nichtexistenz derartiger Raumzeiten im Rahmen der Allgemeinen Relativitätstheorie. Dies führte zur Formulierung der *shear-free fluid conjecture* durch Ellis. Eine Anzahl von weiteren Spezialfällen wird bewiesen und deren physikalische Bedeutung diskutiert.

GR 16.6 Di 17:45 TU BH262

Einfluss der globalen Topologie des Universums auf die Anisotropie der kosmischen Mikrowellenhintergrundstrahlung — •MARTIN HENNEMANN und GÜNTER WUNNER — 1. Institut für Theoretische Physik, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart

Die ersten Ergebnisse der Durchmusterung der kosmischen Mikrowellenhintergrundstrahlung (CMB) durch den Satelliten WMAP bestätigen das durch die Analyse der Temperaturfluktuationen auf großen Skalen festgestellte niedrige Quadrupolmoment des Winkelleistungsspektrums und die sehr schwache Korrelation der Fluktuationen [1]. Das kann als Hinweis auf eine nichttriviale Topologie des Universums betrachtet werden. Ein Ansatz zur Erklärung [2] geht von einem hyperbolischen, kompakten Universum aus, in dem es eine untere Grenze für die Wellenzahl möglicher Moden gibt. Die Simulation des CMB für dieses Modell reproduziert die Beobachtungen besser als das global flache "best fit"- Λ CDM-Modell. Wir analysieren diesen Ansatz und untersuchen mögliche Erweiterungen.

[1] C.L. Bennett, astro-ph/0302208

[2] R. Aurich, astro-ph/0403597

GR 17 Relativitätstheorie im Experiment

Zeit: Mittwoch 10:15–12:30

Raum: TU BH262

Hauptvortrag

GR 17.1 Mi 10:15 TU BH262

Is the velocity of light really constant? – The experimental status of Lorentz invariance — •CLAUS LÄMMERZAHL — ZARM, University of Bremen, Am Fallturm, 28359 Bremen

Lorentz invariance is one of the pillars of modern physics. It is not only a frame for all other physical theories, for the standard model as well as for Einstein's General Relativity, but also reached the level of a daily life application (navigation, time standard, geodesy, Earth sciences, climate research). Being of such an importance, the experimental basis has to be as strong as possible. In this talk, after a short introduction to basic notions of relativity and the identification of meaningful measurable quantities, we review the present status of laboratory tests of Lorentz invariance. This includes the tests of properties of light propagation which are covered by the famous Michelson–Morley, Kennedy–Thorndike, and Ives–Stilwell experiments, as well as tests of properties of matter which explore the maximum velocity of massive particles or probe the isotropy of quantum particles as has been done in Hughes–Drever experiments. Furthermore, the available test theories, kinematical as well as dynamical test theories, for describing and comparing various experiments of Lorentz invariance are outlined. Finally, we mention hypothetical violations of Lorentz invariance which follow from various approaches towards a theory of quantum gravity and discuss possible consequences and the experimental search for corresponding effects.

Hauptvortrag

GR 17.2 Mi 11:00 TU BH262

Was Einstein right? — •CLIFFORD M. WILL — McDonnell Center for the Space Sciences, Department of Physics, Washington University, St. Louis, USA

We review the experimental evidence for Einstein's general relativ-

ity. Tests of the Einstein Equivalence Principle support the postulates of curved spacetime, while solar-system experiments strongly confirm weak-field general relativity. The Binary Pulsar provides tests of gravitational-wave damping and of strong-field general relativity. We describe ongoing and future experiments, such as the Stanford Gyroscope Experiment, a satellite test of the Equivalence principle, and tests of gravity at short distance to look for extra spatial dimensions. Recently, operational laser interferometric gravitational-wave observatories, and a future space interferometer, may provide new tests via the properties of gravitational waves. We also discuss how general relativity is important in daily life.

Hauptvortrag

GR 17.3 Mi 11:45 TU BH262

The first double pulsar - A unique laboratory to test general relativity — •MICHAEL KRAMER — Jodrell Bank Observatory, University of Manchester, Jodrell Bank, Macclesfield, SK11 9DL, UK

The first ever double pulsar, discovered by our team last year, consists of two pulsars, one with period of only 22 ms and the other with a period of 2.8 sec. This binary system with an orbital period of only 2.4 hr provides a truly unique laboratory for relativistic gravitational physics. The observations of both pulsars, orbiting each other with orbital speeds exceeding 1 Million km/hr, already allow us to perform the most stringent tests of general relativity in the strong field limit, exceeding the precision tests done with the Hulse-Taylor binary pulsar. In the future, it promises to even allow us the detection of effects of second Post-Newtonian order, and probably the direct measurement of a neutron star's moment of inertia. In this contribution I report on the discovery of this exciting system and its applications in tests of theories of gravity. I will present the latest results such as the detection of gravitational wave damping and will also demonstrate the double pulsar's use as a superb tool to study relativistic plasma physics under extreme conditions.

GR 18 Postersitzung

Zeit: Freitag 14:00–19:00

Raum: Poster TU BH

GR 18.1 Fr 14:00 Poster TU BH

Dynamische Begründung der Lorentz-Transformation — •DIETER SUISKY¹ und PETER ENDERS² — ¹Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin — ²Siemens AG, Berlin

Einstein hat die Lorentz-Transformation erstmals physikalisch begründet, nämlich mit Hilfe einer „Umdeutung“ der Galilei-Newtonschen Kinematik zur speziell-relativistischen (Relativitätsprinzip, Konstanz der Lichtgeschwindigkeit, Umdefinition der Gleichzeitigkeit). Als Ergänzung hierzu stellen wir eine *dynamische* Begründung der Lorentz-Transformation vor. Sie beruht auf der Eulerschen Weiterentwicklung der Newtonschen Axiomatik. Bekanntlich kann die Newtonsche Kinematik und Mechanik nicht verallgemeinert, sondern höchstens „umgedeutet“ (Heisenberg, 1925) werden. Das liegt daran, daß nicht nur die Zustandserhaltung, sondern auch die Zustandsveränderung axiomatisch festgelegt wird. Letzteres ist nach Euler nicht notwendig. Damit sind andere als die Newtonschen Bewegungsgesetze möglich, *ohne* die Axiomatik (vor allem die Energieerhaltung) anzutasten. Insbesondere kann die in der Gleichung $dv(t) = F/Mdt$ (v - Geschwindigkeit, Zustandsvariable bei Euler; F - äußere Kraft; M - konstante träge Masse des betrachteten Körpers) enthaltene Forderung fallengelassen werden, daß die Zustandsänderung dv unabhängig vom Zustand v sei. Dann ergibt sich als eine verallgemeinerte Grundlage der Dynamik die Beziehung $d[f(v)v] = F/Mdt$. Die Funktion $f(v)$ wird aus Invarianzforderungen zu $f(v) = (1 - v^2/c^2)^{-1/2}$ bestimmt. Die resultierende Bewegungsgleichung ist nicht mehr Galilei-, sondern Lorentz-invariant.

GR 18.2 Fr 14:00 Poster TU BH

A post Newtonian accurate gauge invariant analysis tool for general relativistic numerical simulations — •GOPAKUMAR ACHAMVEEDU and GERHARD SCHÄFER — Theoretisch-Physikalisches Institut, FSU, Max-Wien-Platz 1, 07743 Jena, Germany

We describe the construction of a post-Newtonian (PN) accurate *gauge invariant analysis tool*, which should be able to compare, with error bars, numerically created and evolved binary configurations with the related

PN descriptions. The only requirement for any meaningful comparison is that the numerical generation and subsequent evolution of the compact binary should be done in a regime, where the PN dynamics (3.5PN accurate) holds good.

GR 18.3 Fr 14:00 Poster TU BH

Special Relativity - Explained by Particle Physics — •ALBRECHT GIESE — Taxusweg 15, 22605 Hamburg

In the beginning there was the Michelson-Morley Experiment. It has - in contrary to the statement of many textbooks - in no way proven that an ether does not exist. Hendrik Lorentz has presented the calculation that fields contract during motion. As a consequence, all kinds of objects contract, and so does the Michelson apparatus. The null-result is inevitable.

Lorentz, though, could not explain why temporal processes slow down in motion. This gave Einstein the opportunity to present his 'brute force' concept that space and time themselves are changing with motion.

In the meantime, however, (i.e. Dirac/Schrödinger 1928/30) we have learnt that elementary particles perform an internal oscillation at the speed of light. From this fact follows immediately that the oscillation, which is the time base in our world, slows down in motion at the Lorentz factor γ . So, this relativistic phenomenon, too, is explained - by the use of particle physics without any need of such extensive assumptions about space and time as Einstein has made.

The relativistic increase of mass in motion as well as the mass-energy equivalence are consequences of this approach.

For further info: www.ag-physics.org/relat

GR 18.4 Fr 14:00 Poster TU BH

Laser Astrometric Test of Relativity — •HANSJÖRG DITTUS¹, CLAUD LÄMMERZAHL¹, SLAVA G. TURYSHEV², MICHAEL SHAO², YEKTA GURSEL², and KENNETH L. NORDTVEDT, JR.³ — ¹ZARM, Universität Bremen — ²Jet Propulsion Laboratory, Pasadena CA, U.S.A. — ³Northwest Analysis, Bozeman MT, U.S.A.

The Laser Astrometric Test of Relativity (LATOR) is a large scale

European – U.S. Michelson–Morley–type experiment designed to considerably improve tests of General Relativity. The primary objective of the LATOR experiment will be to measure differential deflection of laser light by solar gravity to an accuracy of 0.1 pico-radians. The mission architecture uses a light triangle formed by laser ranging between two small spacecrafts placed on heliocentric orbits and a laser transceiver station built on the International Space Station (ISS). Using independent time-series of highly accurate measurements of the Shapiro time-delay, LATOR will perform a variety of precision tests of gravity. With target precision at the level of the effects of the 2.5 post-Newtonian order, e.g. (beside many other tests) a measurement of the Eddington parameter γ with an accuracy of 1 part in 10^9 (ca. 30,000 better than obtained with the Cassini spacecraft) will be available. The key element of the experiment is a redundant geometry optical truss provided by the long-baseline (ca. 100 m) fibre-coupled optical interferometer on the ISS. The interferometer will perform differential astrometric measurements of the laser light sources on the two spacecrafts as their line-of-sight pass behind the sun. We will discuss the mission concept and improvements of accuracy expected for different tests.

GR 18.5 Fr 14:00 Poster TU BH

Testing Lorentz invariance with matter filled cavity oscillators — ●HOLGER MÜLLER — Physics Department, Stanford University, Stanford, CA 94305, email: holgerm@stanford.edu

We consider the use of matter filled cavities for tests of Lorentz invariance in the framework of the standard model extension. The influence of Lorentz violation on the speed of light c along the cavity axis, the cavity length L as defined by a solid, and the index of refraction n combine to a shift $\delta\nu$ of the cavity's resonance frequency $\nu = mc/(2nL)$ (where m is a constant mode number). A test of Lorentz violation would search for such shifts connected to Lorentz boosts or rotations of the cavity (e.g., due to Earth's rotation).

Compared to vacuum cavities, the change in n makes such experiments sensitive to additional Lorentz violation coefficients from the photon and fermion sector. Moreover, a large index of refraction is found to enhance its own sensitivity to the coefficients. Thus, matter filled cavities offer the possibility to obtain sharper and/or more detailed bounds on Lorentz violation. From experiments that have already been performed, we derive the first bounds on some electron coefficients and improved bounds on photon and electron coefficients. The bounds for several of them are below 10^{-15} . We also discuss how these bounds may be further improved in dedicated experiments and using optimized materials.

GR 18.6 Fr 14:00 Poster TU BH

Visualisierung speziell- und allgemeinrelativistischer Effekte — ●REGINE FRANK¹, THOMAS MÜLLER¹, DANIEL WEISKOPF² und MICHAEL ZADLOUKAL¹ — ¹Institut für Astronomie und Astrophysik, Theoretische Astrophysik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen — ²Institut für Visualisierung und interaktive Systeme (VIS), Universität Stuttgart, Universitätsstraße 38, 70569 Stuttgart

In der Relativitätstheorie muß grundsätzlich zwischen dem Messen und dem Sehen von schnell bewegten Objekten unterschieden werden. Wir stellen anhand der Erde die Effekte der Speziellen und Allgemeinen Relativitätstheorie vor, die für die Visualisierung wesentlich sind. Ausgehend von der Lorentz-Kontraktion, wird durch Hinzunahme des Licht-Laufzeiteffekts, des Doppler- und des Search-Light-Effekts schrittweise das Bild entwickelt, das ein Betrachter tatsächlich sehen würde. Der Unterschied zu einer Vermessung des Objekts wird dabei deutlich. Ebenfalls am Bild der Erde werden die allgemeinrelativistische Lichtablenkung sowie die gravitative Rotverschiebung diskutiert und die zur Berechnung verwendeten relativistische Ray-Tracing-Methoden vorgestellt.

GR 18.7 Fr 14:00 Poster TU BH

Black Hole Excision with Multiple Grid Patches — ●JONATHAN THORNBURG — MPI für Gravitationsphysik, Albert-Einstein-Institut, Am Mühlenberg 1, D-14476 Golm

When using black hole excision to numerically time-evolve a black hole spacetime with no continuous symmetries, most 3 + 1 finite differencing codes use a Cartesian grid. It's difficult to do excision on such a grid, because the natural $r = \text{constant}$ excision surface must be approximated either by a very different shape such as a contained cube, or by an irregular and non-smooth "LEGO^(TM) sphere" which may introduce numerical instabilities into the evolution.

In this poster I describe an alternate scheme, which uses multiple $\{r \times (\text{angular coordinates})\}$ grid patches, each patch using a different

(nonsingular) choice of angular coordinates. This allows excision on a smooth $r = \text{constant}$ 2-sphere.

In this poster I discuss some of the key design choices in such a multiple-patch scheme, and present sample results from a prototype implementation for the full nonlinear 3 + 1 BSSN (Einstein) equations. Finally, I outline current efforts to integrate such a multiple-patch scheme into the Cactus numerical relativity toolkit.

GR 18.8 Fr 14:00 Poster TU BH

Curvature and quantum physics — ●JAKOB LAMEY — University of Regensburg

In the context of general relativity fairly simple curvature calculations can express orders of magnitudes, which are usually estimated to lie entirely in the quantum physical realm.

GR 18.9 Fr 14:00 Poster TU BH

Stereoskopische Visualisierung in der speziellen Relativitätstheorie — ●THOMAS MÜLLER und MARC BORCHERS — Institut für Astronomie und Astrophysik, Abt. Theoretische Astrophysik, Auf der Morgenstelle 10, 72076 Tübingen

Stereoskopische Beobachtung erlaubt die Bestimmung der Form und Entfernung von Körpern im Raum. Durch die relativistischen Effekte wird die stereoskopische Entfernungsbestimmung verfälscht. Die dabei auftretenden Effekte werden zunächst theoretisch erklärt und anschließend interaktiv dem Publikum vorgeführt.

GR 18.10 Fr 14:00 Poster TU BH

Zur Krönung des klassischen, Maxwell'schen Äthers — ●KARL MOCNIK — Institut für Weltraumforschung der Österr. Akademie der Wissenschaften, Schmiedlstrasse 6, 8042 Graz

Der Nulleffekt im Michelson-Morley-Experiment (MME) von 1887 bestätigte unwiderleglich die Existenz des Ruhesystems Äther. Die persistente Minorisierung dieses Faktums nährt sich aus einer ambigüösen Interpretation des MME durch Suspendierung des Huygensschen Prinzips sowie zentraler Theoreme der Euklidischen Geometrie. Licht ist uniaxial, nicht dualistisch / Die stellare Aberration schließt Photonen aus: Keine Längenkontraktion, keine relativistische Zeitdilatation, keine Lorentz-Transformation / Es gibt a) die isotrope Echo-Lichtgeschw. und b) die anisotrope Einweg-Lichtgeschw., welche im rasch rotierenden Mach-Zehnder Interferometer den Erd-Apex anzeigt. (Mocnik 1982) / Die Zuflucht zur Hubble-Hypothese der kosmologischen Deutung der spektralen Rotverschiebung, als eine Inflation des Universums, ist versperrt / Schrödinger favorisierte die Deutung des Photoeffekts mittels Wellen. / Karl Mocnik: The Unnoticed Discovery. How Michelson was Misled by the Aether, Graz, 2002, ISBN 3-901805-99-0 und Coronation of Maxwells Aether in: Proc. of the Internat. Conf. Problems of Geocosmos, Sankt Petersburg 2002, p. 246-251, ISBN 5-7997-0463-0.

GR 18.11 Fr 14:00 Poster TU BH

Slowly rotating relativistic star perturbations — ●ISABEL RICA MÉNDEZ — Institut für Astronomie und Astrophysik Universität Tübingen, D-72076 Tübingen, Germany

Compact stellar objects like neutron stars are promising candidates for gravitational wave sources. For measuring purpose it is important to determine first theoretically the frequencies of the axial and polar oscillation modes. In particular we focus on slowly rotating neutron stars. For that case we show results of the numerically calculated time-evolution of the fluid- and the metric-perturbations of the linearized Einstein field equation, thus without the frequently used Cowling approximation. The set of coupled wave equations, a first-order hyperbolic evolution system, is derived in the frame of the ADM formalism in the BCL gauge. By including also the metric-perturbations we are able to determine the error of the Cowling approximation and increase the accuracy of the resulting frequencies.

GR 18.12 Fr 14:00 Poster TU BH

Gleichgewichtszustände in der relativistischen Thermodynamik — ●HORST-HEINO V. BORZESZKOWSKI und THORALF CHROBOK — Institut für Theoretische Physik PN7-1, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In der Theorie der irreversiblen thermodynamischen Prozesse nahe dem Gleichgewicht wird eine Reihe von Voraussetzungen gemacht, die unter anderem zum Ergebnis haben, daß im vollständigen thermodynamischen Gleichgewicht der (inverse) Temperaturvektor ein Killing-Vektor ist. Es wird gezeigt, daß im Unterschied zu den bekannten Darstellungen

im Gleichgewicht (1) der Temperaturvektor auch ein konformer Killing-Vektor sein kann, (2) die Killing-Eigenschaft des Temperaturvektors die meisten der üblicherweise gemachten Voraussetzungen zur Folge hat, ohne die Materie auf ein ideales Fluid zu reduzieren, (3) der Wärmestrom bei nicht verschwindender Rotation des Fluids nicht gleich Null ist und (4) sich Relationen ergeben, die von der Struktur des Cattaneo-Ansatzes sind, was auf eine kausale Ausbreitung der Temperatur hinweist.

GR 18.13 Fr 14:00 Poster TU BH

Broadening of neutron states quantized in gravitational field —
•BORIS P. TOPERVERG — Department of Experimental and Solid State Physics, Ruhr-University Bochum, 44780 Bochum

Various sources of the line width of resonance levels formed in gravitational potential and horizontal reflecting surface are theoretically discussed in view of possible experimental applications. One of them is just absorption inside the reflecting potential on a depth comparable with the extinction length. Two others, e.g. inelastic scattering by thermal fluctuations and off-specular scattering from surface roughness, partially destroy interference between waves impinging onto and reflected from the surface. Both mechanisms are considered within the framework of the Distorted Wave Born Approximation (DWBA). It is shown that they can be rather efficient if the lateral scale of fluctuations is smaller than the lateral projection of the neutron coherence length.