Gravitation and Relativity Division with Astronomical Society Fachverband Gravitation und Relativitätstheorie (GR) gemeinsam mit der Astronomischen Gesellschaft e.V. (AG)

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This year's annual meeting of our division is marked by the centenary of General Relativity, a happy occasion that we intend to reflect in a somewhat special programme. We will have two plenary talks, one on the history of General Relativity and one on recent developments in cosmology. There will also be a joint symposium on geometric paradigms in modern physics (with divisions GP, MP, TT, and the working group AGPhil) and an unusual large number of invited talks by renowned researchers representing in some depth the impressive spectrum and fascination of ongoing research in observational and theoretical gravitation, including geodesy, astrometry, astrophysics of neutron stars and black holes, cosmology, and, last not least, the theory of General Relativity proper, its mathematical properties, its relation to other fundamental interactions, and its attempted integration into the realm of quantum(field)theories. As usual, there will be many short talks of mostly technical nature, which complete our programme in an essential way.

Overview of Invited Talks and Sessions

(Lecture rooms: H 2013 and H 2033)

Plenary Talks related to Gravitation and Relativity

PV VII	Mon	14:00–14:45	H 0105	**The Genesis and Renaissance of General Relativity** — •Jürgen Renn
PV XVIII	Wed	14:00–14:45	H 0105	**Cosmological Inflation - A Confrontation with Data** — •Dominik Schwarz

Invited Talks

GR 1.1	Mon	9:30–10:10	H 2013	**Was Einstein Right? A Centennial Assessment** — •Clifford Will
GR 1.2	Mon	10:10–10:50	H 2013	**Precision tests of General Relativity using cosmic clocks** — •Michael Kramer
GR 1.3	Mon	11:10–11:50	H 2013	**Results from the Wilkinson Microwave Anisotropy Probe** — •Eiichiro Komatsu
GR 1.4	Mon	11:50–12:30	H 2013	**General Relativity as everyday practical tool: time, navigation and geodesy** — •Claus Lämmerzahl
GR 4.1	Tue	9:30–10:10	H 2013	**Characteristic Cauchy problems in general relativity** — •Piotr Chrusciel
GR 4.2	Tue	10:10–10:50	H 2013	**Mass and center of mass of asymptotically flat spaces** — •Gerhard Huisken
GR 4.3	Tue	10:50–11:30	H 2013	**Loop quantum gravity – an unusual QFT** — •Hanno Sahlmann
GR 5.1	Tue	11:50–12:30	H 2013	**Quantum Gravity - General Introduction and Recent Developments** — •Claus Kiefer
GR 9.1	Wed	9:30–10:10	H 2013	**Gravitational radiation from compact binary systems** — •Luc Blanchet
GR 9.2	Wed	10:10–10:50	H 2013	**Black Holes and Neutron Stars in Numerical General Relativity** — •Bernd Bruegmann
GR 9.3	Wed	11:10–11:50	H 2013	**Supernova Cosmology** — •Bruno Leibundgut

GR 9.4	Wed	11:50–12:30	H 2013	**Large scale structures in the universe** — •Volker Mueller
GR 10.1	Wed	15:00–15:40	H 2013	**Neutron-star binaries: Einstein's richest laboratory** — •Luciano Rezzolla
GR 14.1	Thu	9:30–10:10	H 2013	**General Relativity and Astrometry** — •Sergei Klioner
GR 14.2	Thu	10:10–10:50	H 2013	**Where is the energy stored in the gravitational field?** — •Gerhard Schäfer
GR 17.1	Fri	9:30–10:10	H 2013	**The Galactic Center Massive Black Hole** — •Reinhard Genzel
GR 17.2	Fri	10:10–10:50	H 2013	**Gravitational lensing – a versatile tool for astrophysics** — •Peter Schneider

Invited talks of the joint symposium SYGP

See SYGP for the full program of the symposium.

SYGP 1.1	Thu	15:00–15:30	H 0105	**General relativity: a theory born in creative confusion** — •Harvey Brown
SYGP 1.2	Thu	15:30–16:00	H 0105	**Gravitating Non-Abelian Fields: Solitons and Black Holes** — •Jutta Kunz
SYGP 1.3	Thu	16:00–16:30	H 0105	**Geometric principles in the physics of topological matter** — •Alexander Altland
SYGP 1.4	Thu	16:30–17:00	H 0105	**General Covariance in Quantum Field Theory on Curved Spacetimes** — •Thomas-Paul Hack
SYGP 1.5	Thu	17:00–17:30	H 0105	**The (noncommutative) Geometry of the Standard Model of Particle Physics** — •Christoph Stephan

Sessions

GR 1.1–1.4	Mon	9:30–12:30	H 2013	**Invited Talks 1**
GR 2.1–2.2	Mon	15:00–15:40	H 2013	**Experimental Tests**
GR 3.1–3.4	Mon	15:40–17:30	H 2013	**Classical General Relativity**
GR 4.1–4.3	Tue	9:30–11:30	H 2013	**Invited Talks 2 (with MP)**
GR 5.1–5.1	Tue	11:50–12:30	H 2013	**Invited Talks 3**
GR 6.1–6.4	Tue	14:00–15:20	H 2013	**Quantum Gravity and Quantum Cosmology**
GR 7.1–7.2	Tue	15:20–16:00	H 2013	**Cosmology**
GR 8.1–8.9	Tue	14:00–16:00	H 2033	**Poster Session**
GR 9.1–9.4	Wed	9:30–12:30	H 2013	**Invited Talks 4**
GR 10.1–10.1	Wed	15:00–15:40	H 2013	**Invited Talks 5**
GR 11.1–11.3	Wed	15:40–17:10	H 2013	**Relativistic Astrophysics**
GR 12.1–12.3	Wed	17:10–18:10	H 2013	**Gravitational Waves**
GR 13.1–13.6	Wed	16:30–18:30	H 2033	**Alternative Aspects and Approaches**
GR 14.1–14.2	Thu	9:30–10:50	H 2013	**Invited Talks 6**
GR 15.1–15.5	Thu	11:10–12:50	H 2013	**Fundamental Problems and General Formalism**
GR 16.1–16.8	Thu	15:00–18:10	H 2013	**Numerical Relativity**
GR 17.1–17.2	Fri	9:30–10:50	H 2013	**Invited Talks 7**
GR 18.1–18.6	Fri	11:10–13:10	H 2013	**Black Holes**

Annual General Meeting of the Gravitation and Relativity Division

Thursday March 19th 18:30–19:30 H 2013

- opening and approval of the agenda
- approval of the minutes of our last annual general meeting
- report by the chairman
- past activities
- future activities
- dissertation prize
- book publications
- miscellaneous

GR 1: Invited Talks 1

Time: Monday 9:30–12:30 Location: H 2013

Invited Talk GR 1.1 Mon 9:30 H 2013
Was Einstein Right? A Centennial Assessment — •Clifford Will — University of Florida, Gainesville FL USA

A century after Einstein's formulation of general relativity, a remarkable diversity of precision experiments have established it as the "standard model" for gravitational physics. Yet it might not be the final word. We review the array of measurements that have verified general relativity in the laboratory, in the solar system and in binary pulsars. We then describe some of the opportunities and challenges involved in testing Einstein's great theory in strong-field, dynamical regimes and in cosmology.

Invited Talk GR 1.2 Mon 10:10 H 2013
Precision tests of General Relativity using cosmic clocks — •Michael Kramer — Max-Planck-Institut fuer Radioastronomie

The best tests of theories of gravity for strongly self-gravitating bodies are provided by radio pulsars. Observations of those allow for precision tests of general relativity, all of which have been passed by Einstein's theory with flying colours. In particular in recent years, the exploitation of new systems allowed to probe a wide range of effects, including gravitational wave emission, spin effects, and possible violations of the strong equivalence principle or gravitational Lorentz invariance. Experiments are also ongoing to directly detect low-frequency gravitational waves using regular observations of millisecond pulsars. This talk will review these recent results.

20 min. break

Invited Talk GR 1.3 Mon 11:10 H 2013
Results from the Wilkinson Microwave Anisotropy Probe — •Eiichiro Komatsu — Max-Planck-Institut für Astrophysik, Garching, Germany

The Wilkinson Microwave Anisotropy Probe (WMAP) mapped the distribution of temperature and polarization over the entire sky in five microwave frequency bands. These full-sky maps were used to obtain measurements of temperature and polarization anisotropy of the cosmic microwave background with the unprecedented accuracy and precision. The analysis of two-point correlation functions of temperature and polarization data gives determinations of the fundamental cosmological parameters such as the age and composition of the universe, as well as the key parameters describing the physics of inflation, which is further constrained by three-point correlation functions. WMAP observations alone reduced the flat Lambda cold dark matter cosmological model (six) parameter volume by a factor of >68,000 compared with pre-WMAP measurements. The WMAP observations (sometimes in combination with other astrophysical probes) convincingly show the existence of non-baryonic dark matter, the cosmic neutrino background, flatness of spatial geometry of the universe, a deviation from a scale-invariant spectrum of initial scalar fluctuations, and that the current universe is undergoing an accelerated expansion. The WMAP observations provide the strongest ever support for inflation; namely, the structures we see in the universe originate from quantum fluctuations generated during inflation.

Invited Talk GR 1.4 Mon 11:50 H 2013
General Relativity as everyday practical tool: time, navigation and geodesy — •Claus Lämmerzahl — ZARM, University of Bremen, Am Fallturm, 28359 Bremen, Germany

The effects of Special and General Relativity are very tiny. For standard everyday velocities the special relativistic Doppler effect is of the order 10^{-15} and also the gravitational redshift over ten meters height difference is of similar order. The reason for that is the comparatively large velocity of light. However, in the last years we experienced a boost of improvements of experimental accuracy and precision so that today these tiny effects can be measured with high precision. This opens up the possibility to determine precisely the gravitational potential with clocks, distances with laser interferometers and the gravitational field with gravi- and gradiometers based on freely falling masses like atoms. This can be done on ground or from space. In all these different measurement schemes relativity plays an essential part. This talk will highlight these recent and possible future developments and the huge impact they have on Earth sciences including the physics of the ocean, on navigation, positioning, leveling, and metrology.

GR 2: Experimental Tests

Time: Monday 15:00–15:40 Location: H 2013

GR 2.1 Mon 15:00 H 2013
Free fall mass determination — •Martin Thalhammer[1,2], Gunther Cronenberg[1], Hanno Filter[1], Peter Geltenbort[2], Jörg Herzinger[1], Tobias Jenke[1], Tobias Rechberger[1], and Hartmut Abele[1] — [1]Atominstitut, Technische Universität Wien, Stadionallee 2, 1020 Wien, Austria — [2]Institut Laue-Langevin, 71 avenue des Martyrs, 38000 Grenoble, France

With the qBounce Experiment we are able to derive both the inertial and the gravitational mass, from the free fall of single neutrons. The spatial modulation of the corresponding Schrödinger wave function scales with z_0, which is determined by the third root of the product of the two masses. The discrete energy spectrum of the gravitational bound states depends on the inertial as well as the gravitational mass with two different fractional powers. Knowing the local acceleration of the earth g and measuring two observables energy and spatial modulations, this information allows us for the first time to determine the inertial mass and the gravitational mass of a single particle, the neutron independently.

GR 2.2 Mon 15:20 H 2013
Measurement of the isotropy of the speed of light to 10^{-18} — •Moritz Nagel[1], Stephen R. Parker[2], Klaus Döringshoff[1], Sylvia Schikora[1], Paul L. Stanwix[1], John G. Hartnett[2,3], Eugene N. Ivanov[2], Evgeny V. Kovalchuk[1], Michael E. Tobar[2], and Achim Peters[1] — [1]Humboldt-Universität zu Berlin, Institut für Physik, AG Optische Metrologie, Newtonstr. 15, 12489 Berlin — [2]School of Physics, The University Of Western Australia, Crawley 6009, Western Australia, Australia — [3]Institut for Photonics and Advanced Sensing, The University of Adelaide, Adelaide, Australia

We present details on the data analysis of a Michelson-Morley-type experiment that utilizes two orthogonally aligned cryogenic sapphire microwave oscillators which have a fractional frequency stability in the 10^{-16} regime for integration times from 1 - 100 seconds. After more than one year of continuous rotation using a high-precision air-bearing turntable, we can set an upper limit for the isotropy of the speed of light of 10^{-18}, representing a ten-fold improvement over previous such experiments and also the first limit in the Planck suppressed electroweak unification energy regime set by a direct terrestrial measurement. We will also give detailed results on our bounds for the coefficients of the minimal Standard Model Extension.

GR 3: Classical General Relativity

Time: Monday 15:40–17:30 Location: H 2013

GR 3.1 Mon 15:40 H 2013

Progress in the evolution of collapsing gravitational waves — •DAVID HILDITCH — TPI Jena

I will present simulations of collapsing gravitational waves obtained using two methods. First, using the moving puncture gauge, I show that it is possible to evolve certain types of initial data through apparent horizon formation. Secondly I will present a new pseudo-spectral code which we are using to tackle the same initial data.

30 min. break

GR 3.2 Mon 16:30 H 2013

Plebański-Demiański solutions of General Relativity and their expressions quadratic and cubic in curvature: analogies to electromagnetism — •JENS BOOS — Institute for Theoretical Physics, University of Cologne, 50923 Köln, Germany

An electromagnetic field represented by the field strength 2-form F has two invariants: the scalar $\mathbf{B}^2 - \mathbf{E}^2$ and the pseudo-scalar $\mathbf{E}\cdot\mathbf{B}$. These relations taken from (linear) vacuum electrodynamics persist up to the full non-linear case of Einstein's General Relativity as applied to the exact seven parameter solution of Plebański and Demiański (PD).

The vacuum energy density $\mathbf{B}^2 + \mathbf{E}^2$ corresponding to an electromagnetic field can be deduced from the square of its symmetric energy momentum tensor. The square of the Bel-Robinson tensor gives the analogous expression in case of the PD solution.

We also determine the Kummer tensor, a tensor cubic in curvature, for the PD solution for the first time, and calculate the pieces of its irreducible decomposition.

The calculations are carried out in two coordinate systems: in the original polynomial PD coordinates, and in a modified Boyer-Lindquist-like version introduced by Griffiths and Podolský (GP) allowing for a more straightforward physical interpretation of the free parameters.

GR 3.3 Mon 16:50 H 2013

Visualization of finite-sized objects in General relativity — •THOMAS MÜLLER[1], SEBASTIAN BOBLEST[1], and DANIEL KRÜGER[2] — [1]Visualisierungsinstitut der Universität Stuttgart — [2]1. Institut für Theoretische Physik, Universität Stuttgart

In the visualization of general-relativistic scenarios one usually defines finite-sized test objects in a local tetrad and neglects the curvature of spacetime. As a first step towards a more detailed representation of extended objects, we define the surface of a sphere as the set of points resulting from the integration of space- and lightlike geodesics up to a certain value of the affine parameter. We analyze the effects of this definition on the visual impression of a sphere in several general-relativistic spacetimes, with special focus on the Reissner-Nordstrøm dihole metric.

GR 3.4 Mon 17:10 H 2013

General Relativity with a Variable Speed of Light — •ALEXANDER UNZICKER[1] and JAN PREUSS[2] — [1]Pestalozzi-Gymnasium München — [2]Technische Universität München

Einstein's first idea of how to describe curved paths of light, outlined in his 1911 paper on a variable speed of light, has a much closer similarity to general relativity than commonly perceived. The geodetic in a curved spacetime or the fastest path in a Euclidean space with variable c are actually two equivalent formulations of the same physics. Though this has been occasionally recognized in the literature, there seemed to be little need to change perspective. However, in 1957 Robert Dicke first pointed out that a variable speed formulation of general relativity could encompass Mach's principle, an idea with which Einstein had always been intrigued. Here, Dicke's idea is presented in a new form, using the Poisson equation. The relation to the usual Einstein equations is discussed.

GR 4: Invited Talks 2 (with MP)

Time: Tuesday 9:30–11:30 Location: H 2013

Invited Talk GR 4.1 Tue 9:30 H 2013

Characteristic Cauchy problems in general relativity — •PIOTR CHRUSCIEL — Gravitational Physics, University of Vienna

I will discuss various aspects of the general relativistic Cauchy problem on light-cones, including the case where the vertex of the light-cone is located at past timelike infinity.

Invited Talk GR 4.2 Tue 10:10 H 2013

Mass and center of mass of asymptotically flat spaces — •GERHARD HUISKEN — Fachbereich Mathematik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen

The lecture describes geometric constructions for the mass and the center of mass of isolated systems on asymptotically flat 3-manfifolds. In particular, recent existence and uniqueness results for radial foliations satisfying conditions on the mean curvature of their leaves are presented and discussed in relation to thier physical interpretation.

Invited Talk GR 4.3 Tue 10:50 H 2013

Loop quantum gravity – an unusual QFT — •HANNO SAHLMANN — Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)

I give a short introduction to loop quantum gravity, emphasizing the similarities and differences to other quantum field theories. Then I will highlight some recent developments regarding the dynamics of the theory and the description of black holes.

GR 5: Invited Talks 3

Time: Tuesday 11:50–12:30 Location: H 2013

Invited Talk GR 5.1 Tue 11:50 H 2013
Quantum Gravity - General Introduction and Recent Developments — •Claus Kiefer — Institute for Theoretical Physics, University of Cologne, Köln

One of the biggest open problems in physics is the consistent unification of quantum theory with general relativity. The resulting quantum theory of gravity would have an important bearing upon the physics of the early universe, the understanding of black holes, and the structure of spacetime. In my talk, I start by giving a general introduction to the motivation for and the problems of a theory of quantum gravity. I then briefly describe the main approaches - quantum general relativity (including loop quantum gravity) and string theory - and some of their applications. I conclude with presenting some recent results that deal with the possible observation of primordial gravitons, the microstructure of space, black-hole entropy, and quantum cosmology.

Ref.: C. Kiefer, Quantum Gravity (Oxford University Press, third ed. 2012).

GR 6: Quantum Gravity and Quantum Cosmology

Time: Tuesday 14:00–15:20 Location: H 2013

GR 6.1 Tue 14:00 H 2013
Probing the limits of classical gravity with trapped macroscopic quantum systems — •André Grossardt — Dipartimento di Fisica, Università degli Studi di Trieste, Italy

Whether gravity is quantised - and therefore correctly described by perturbative quantum gravity in the low-energy regime - is still subject to experimental tests. Here I discuss the most naive alternative, a theory in which the classical Einstein's equations are fundamental even at the microscopic level, and the gravitational field is sourced by the expectation value of energy-momentum - also known as "semi-classical gravity". In its non-relativistic limit, such a theory leads to the nonlinear Schrödinger-Newton equation, for which prospects for experimental tests will be discussed, particularly with trapped crystalline nanospheres.

GR 6.2 Tue 14:20 H 2013
Quantum-gravitational effects on scalar and tensor perturbations during inflation — David Brizuela[1,2], Claus Kiefer[2], and •Manuel Krämer[3,2] — [1]Fisika Teorikoa eta Zientziaren Historia Saila, UPV/EHU, 644 P.K., 48080 Bilbao, Spain — [2]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany — [3]Instytut Fizyki, Uniwersytet Szczeciński, ul. Wielkopolska 15, 70-451 Szczecin, Poland

We calculate corrections originating from canonical quantum gravity to the power spectra of gauge-invariant scalar and tensor perturbations during inflation. This is done by performing a semiclassical Born–Oppenheimer type of approximation to the Wheeler–DeWitt equation, from which we obtain a Schrödinger equation with a quantum-gravitational correction term. We perform our calculation both for a de Sitter universe as well as for a generic slow-roll model. The quantum-gravitational correction term leads to a modification of the power spectra on the largest scales, which is too small to be measurable, and we find a correction to the tensor-to-scalar ratio at the second order in the slow-roll parameters. We also compare these findings with results that were obtained in this context using just scalar-field perturbations in a non-gauge-invariant way.

GR 6.3 Tue 14:40 H 2013
Symmetry reductions in loop quantum gravity based on classical gauge fixings — •Norbert Bodendorfer, Jerzy Lewandowski, and Jedrzej Swiezewski — University of Warsaw, Poland

We discuss a new strategy to perform a symmetry reduction in loop quantum gravity based on classically gauge fixing the spatial diffeomorphism constraint. Symmetry reductions can then be performed by demanding the vanishing of certain classical phase space functions, which translates into implementing (some part of) spatial diffeomorphism invariance on the reduced phase space, thus solving the spatial diffeomorphism constraint "twice". We illustrate how this process works for reductions to spherical symmetry and Bianchi I cosmological models.

GR 6.4 Tue 15:00 H 2013
Quantum Geometrodynamics of Conformal Gravity — •Branislav Nikolic — Institute for Theoretical Physics, Cologne, Germany

In order to study the role of conformal symmetry (symmetry under local Weyl rescaling) at the level of quantum gravity, a toy model of conformally invariant gravitational action described with squared Weyl tensor (Weyl tensor action) is canonically quantized. An analog to the Wheeler-DeWitt equation has been proposed, leading to the formulation of quantum geometrodynamics of conformally invariant gravity. From this, the semiclassical expansion in terms of coupling constant is performed and it has been shown that in the highest order one obtains the Hamilton-Jacobi equation corresponding to the Weyl tensor action, while in the next order one obtains a functional Schroedinger equation, analogously to the case of quantum geometrodynamics of General Relativity. Furthermore, the conformal action is extended to the more physically justified action containing additional Einstein-Hilbert term, that breaks the conformal invariance. Upon performing the semiclassical expansion of the corresponding Wheeler-DeWitt equation with respect to the relative couplings of the two terms, it has been shown that the Einstein-Hamilton-Jacobi equation emerges as a classical limit of the theory. Moreover, the problem of time is discussed at the level of both actions. This opens the door to the formulation of quantum geometrodynamics of the higher derivative gravity theories.

GR 7: Cosmology

Time: Tuesday 15:20–16:00 Location: H 2013

GR 7.1 Tue 15:20 H 2013

The question of quantum equivalence between Jordan and Einstein frames in cosmology — •Christian F. Steinwachs[1] and Alexander Yu. Kamenshchik[2,3] — [1]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg, Germany — [2]Dipartimento di Fisica e Astronomia and INFN, Bologna, Italy — [3]L. D. Landau Institute for Theoretical Physics of the Russian Academy of Sciences, Moscow, Russia

We investigate the equivalence between two different parametrizations of fields in cosmology – the so-called Jordan frame and Einstein frame – in the framework of a general scalar-tensor theory. While it is clear that both parametrizations are mathematically equivalent at the level of the classical action, the question about their mathematical equivalence at the quantum level as well as their physical equivalence is still a matter of debate in cosmology. We analyze whether the mathematical equivalence still holds when the first quantum corrections are taken into account. We explicitly calculate the one-loop divergences in both parametrizations by using the generalized Schwinger-DeWitt algorithm and find that quantum corrections induce an off-shell dependence on the parametrization. An explanation of the origin and a possible resolution of this quantum ambiguity is suggested to be found within a geometric field theoretical approach. Finally, we discuss the physical implications of this analysis and its consequences for cosmology.

GR 7.2 Tue 15:40 H 2013

Coarse-grained cosmological perturbation theory: stirring up the dust model — •Cora Uhlemann[1,2] and Michael Kopp[1,2] — [1]Arnold Sommerfeld Center, LMU Munich — [2]Excellence Cluster Universe, Garching

Analytical methods for the theoretical description of large-scale structure formation are in general based on the dust model which describes cold dark matter as a pressureless fluid. We study the effect of coarse-graining the dynamics of such a pressureless selfgravitating fluid in the context of cosmological perturbation theory. The effect of the smoothing is illustrated by means of power and cross spectra for density and velocity that are computed up to 1-loop order. A prominent consequence of the coarse-graining is the generation of large-scale vorticity which is also observed in N-body simulations and has certain links to the effective field theory of large scale structure.

GR 8: Poster Session

Time: Tuesday 14:00–16:00 Location: H 2033

GR 8.1 Tue 14:00 H 2033

Realization of a Quantum Bouncing Ball Gravity Spectrometer — •Tobias Rechberger[1], Gunther Cronenberg[1], Hanno Filter[1], Peter Geltenbort[2], Jörg Herzinger[1], Andrej Ivanov[1], Tobias Jenke[1], Mario Pitschmann[1], Martin Thalhammer[1,2], and Hartmut Abele[1] — [1]Atominstitut, Technische Universität Wien, Stadionallee 2, 1020 Wien, Austria — [2]Institut Laue-Langevin, 71 avenue des Martyrs, 38000 Grenoble, France

In this poster we present the neutron as a measuring tool and as an object for gravity research. It provides access to all parameters: distance, mass, curvature, energy-momentum tensor and torsion. We show that Gravity-Resonance-Spectroscopy, a new method developed for that purpose, allows to test Newton's inverse square law and to search for dark matter and dark energy candidates. It is also possible to probe neutron's electric neutrality. We use a method based on spectroscopy, as frequency measurements have shown spectacular sensitivity in the past.

GR 8.2 Tue 14:00 H 2033

Quantum gravity improved black holes — Marco Knipfer[1,2], •Sven Köppel[1,2], and Piero Nicolini[1,2] — [1]Institut für theoretische Physik, Goethe-Universität Frankfurt am Main, Deutschland — [2]Frankfurt Institute for Advanced Sciences, Frankfurt am Main, Deutschland

We present recent developments in the field of short scale modified black holes (BHs). As a start we introduce a family of BH geometries due to the generalized uncertainty principle and the gravity self-complete paradigm. We show that the evaporation end-point of such black holes is a cold stable remanant. Secondly, we present the nature of black hole remnants at the light of recent developments on Plack scale deformations of quantum field theory. Comments about the extradimensional extension of the proposed models are offered at the end of the poster.

GR 8.3 Tue 14:00 H 2033

Sektormodell eines Wurmlochs — •Corvin Zahn und Ute Kraus — Universität Hildesheim

Wir stellen ein Anschauungsmodell des gekrümmten Raums eines Morris-Thorne-Wurmlochs vor. Es basiert auf der im Regge-Kalkül verwendeten koordinatenfreien, nur auf messbaren Abständen beruhenden Beschreibung der Raumzeit. Das Sektormodell verdeutlicht die dreidimensionale Raumkrümmung sowie die Topologie des Wurmlochs.

GR 8.4 Tue 14:00 H 2033

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

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

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

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

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

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

GR 8.5 Tue 14:00 H 2033

Special Relativity without time dilatation and length contraction. — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

Special Relativity derived by Einstein establishes a connection between two inertial frames based on the fact, that light that is emitted from one inertial frame with light speed has the same speed measured from a second inertial frame independent of the relative speed between the frames. The transformation between the inertial frames makes abstraction of the origin of that phenomenon. The authors "Emission & Regeneration" Field Theory shows that light that arrives with a speed different than the speed of light to measuring instruments like optical lenses or electric antennae, is absorbed and subsequently emitted with light speed, what explains why always light speed is measured in the frame of the instruments. Transformations between inertial frames which are derived taking into consideration the behaviour of the instruments don't require the assumptions of time dilatation and length contraction to arrive to the relevant Special Relativity equations. (www.odomann.com)

GR 8.6 Tue 14:00 H 2033

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

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

However, there are 2 very unspectacular explanations for the measurement.

Solution 1: The speed of light 'c' was higher in early times. This inserted into the Doppler equation for the determination of early speeds from red-shift yields higher speeds for early stars. So there is no acceleration.

Solution 2: From the present cosmological concept of inflation it follows that space was smaller in early times. This has caused (at constant 'c') higher frequencies for the eigenstates of the atoms, which in turn caused the frequency of spectral lines to be positioned towards 'blue' compared to now. So the resulting red-shift is higher than presently assumed and early stars have in fact been faster. No acceleration.

Further info: www.ag-physics.org/darkenergy

GR 8.7 Tue 14:00 H 2033

Überprüfungen der Weltpotentialtheorie — •Peter Wolff — Calfreisen, Schweiz

Die Weltpotentialtheorie (WPT) beschreibt die kosmische Gravitation der NKG (Neuklassische Gravitation) mit zugehörigem statischem Allmodell; die NKG wird in einem eigenen Vortrag vorgestellt. Ganz anders als auf lokalen Skalen unterscheidet sich die NKG auf kosmischen, homogen/isotropen Skalen wesentlich und grundsätzlich leicht überprüfbar von der ART.

Zur Überprüfung der WPT betrachten wir hauptsächlich die folgenden mehr oder weniger gut gesicherten Beobachtungen:

1. Die scheinbaren Supernova Ia-Helligkeiten als Funktion von z
2. Die scheinbaren Winkelgrössen von Galaxien als Funktion von z
3. Die Hintergrundstrahlung als Drei-Kelvin-Hohlkörperstrahlung
4. Die Temperatur der Hintergrundstrahlung als Funktion von z
5. Die Anisotropien der Hintergrundstrahlung auf Mikrokelvinskalen

Einen direkten Beleg der Existenz oder Nichtexistenz der Expansion des Alls der heutigen Schulkosmologie wird voraussichtlich erst das neue, europäische 39 m-Teleskop in Chile liefern können.

GR 8.8 Tue 14:00 H 2033

Die kosmischen Gleichungen und die Parameter des Universums. — •Norbert Sadler — Wasserburger Str. 25a; 85540 Haar

Das Universum kann als ein komplexes,thermodynamisches System verstanden werden und ist über die Algorithmen der ”Statistischen-Physik” und der ”Explorativen-Faktoren-analyse” physikalisch und mathematisch definiert. Die Fak-toren betreffen im Wesentlichen die Aufenthaltswahrschein-lichkeit von etwa (4/9) Protonen/1m, die Protonenenergie von (0.938GeV)sowie die Wechselwirkungs-Quanten.

Die kosmischen Gleichungen, definiert über die Entropie:

(i) (2xPi)x(alfa(QED))=(0.0458:bar.Mat.); die photonische, physikalische Wirklichkeit.

(ii) (0.0458)/((4.03/9)x log(3.97/9))=((0.288;gr.Mat)ist Entropie der Gravitation.

(iii) 2xlog(3.97/9)=-(0.71;dkl.E.)=alfa(QCD)/(0.288)ist die Entropie der QCD.

(iv) (3.97/9)x log(0.288;grav.Mat.)=-(0.2387;dkl.Mat.)ist die Entropie der primordialen Nukleosynthese.

Aus obigen Gleichungen folgert für die dkl. Materie von 23.87%, bei CP-Verletzung u. Beta-Zerfall, ein Bosonen-Energieäquivalent von (85.25GeV)x(CP-Verl.;0.0028)=(0.2387).

Die Parameter des Universums: H=(0.938)/(0.2387 x c=1)=70km/Mpcs; Die Reynolds-Zahl(Univ.)Re(Univ.)=(/H x H/)/alfa(Gravitation)=861.

Weitere Information: www.cosmology-harmonices-mundi.com

GR 8.9 Tue 14:00 H 2033

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

SRT and GRT are part of the foundations of physics. This will not be queried but is there more? The following argument demands it: There are two contradictory formulas about the total energy of a particle resting in the gravitational field [1]. From the formulas of radial free fall one gets: $E = mc^2\sqrt{(1-2GM/c^2)}$. This is at least qualitatively correct since removing the particle from the gravitational field needs energy. Doing this the total energy of the particle becomes $E = mc^2$ and therefore, within the gravitational field it has to be lower. On the other side, there is the equivalence principle. A particle resting in its local inertial system (i.e. the freely falling particle) has a total energy equal to its rest mass: $E = mc^2$. Both of the formula contradict each other. Certainly, they belong to different reference systems with one of them being accelerated, in fact. But: At time point $t = 0$ the free falling particle is also a resting one since its velocity $v = 0$. Only its acceleration $b \neq 0$. Special theory of relativity is applicable and therefore the freely falling particle at $t = 0$ as well as an always resting particle at the same position possess identical total energy $E = mc^2$.

Easy to solve? Look at [1], [2] and wonder at the reactions.

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

[2] Website http://www.grt-li.de

GR 9: Invited Talks 4

Time: Wednesday 9:30–12:30 Location: H 2013

Invited Talk GR 9.1 Wed 9:30 H 2013

Gravitational radiation from compact binary systems — •Luc Blanchet — Institut d'Astrophysique de Paris, France

To be observed and analyzed by the gravitational wave detectors LIGO/VIRGO on ground and LISA in space, inspiralling compact binaries (binary star systems composed of neutron stars and/or black holes) require high-accuracy predictions from general relativity. These very relativistic systems are accurately described by the post-Newtonian approximation, which is the flagship of approximation methods in general relativity. In this talk, after relevant motivating introduction, we shall review the current state of the art on post-Newtonian methods as applied to the motion and gravitational radiation of compact binaries. Then we shall make a comparison between the post-Newtonian results and numerical calculations of the gravitational self-force based on black-hole perturbation theory. Finally we shall present some recent work on the so-called ”first law of black hole binary dynamics”

Invited Talk GR 9.2 Wed 10:10 H 2013

Black Holes and Neutron Stars in Numerical General Relativity — •Bernd Bruegmann — University of Jena, Germany

Black holes and neutron stars are paradigms of extreme gravity described by Einstein's theory of general relativity. This talk reviews recent progress in numerical relativity that allows the simulation of the general relativistic two body problem for black holes and neutron stars. A key result is how such binaries generate gravitational waves that provide information about astrophysical phenomena like collisions and mergers at the endpoint of the gravitational inspiral. As a recent development we discuss simulations of binary neutron stars with realistic spin, which go beyond the conventional approximation of corotating or irrotational neutron stars.

20 min. break

Invited Talk GR 9.3 Wed 11:10 H 2013

Supernova Cosmology — •Bruno Leibundgut — European Southern Observatory, Garching, Germany

Mapping the universal expansion history has been a goal of cosmologists for decades. Thermonuclear supernovae have provided a tool to measure (relative) distances over more than half the age of the universe, were instrumental in the detection of accelerated expansion and the inference of Dark Energy. A constant equation of state parameter has been determined to better than 10 percent and is fully consistent with Einstein's cosmological constant.

During the decade after discovery the original result was confirmed and refined through larger samples and improved techniques. The existing data sets now have reached statistical levels, where the systematic uncertainties dominate the result. New ideas and techniques are required to measure a potential evolution of the equation of state parameter and rule out certain models of gravity or particle physics.

Upcoming surveys will assemble unprecedented supernova samples with thousands of objects. Provide the analysis procedures are developed sufficiently they may have the power to test for deviations from the cosmological constant.

Invited Talk GR 9.4 Wed 11:50 H 2013

Large scale structures in the universe — •Volker Mueller — Leibniz Institut fuer Astrophysik Potsdam, Deutschland

The galaxy distribution in the universe forms a hierarchical network of knots, filaments and walls around large void regions. New methods for quantifying these structures allow detailed investigations of their origin and our facility to explain them within the standard cosmological model. We present new results on the clustering of galaxies, on properties of groups and clusters of galaxies, and the supercluster-void distribution.

GR 10: Invited Talks 5

Time: Wednesday 15:00–15:40 Location: H 2013

Invited Talk GR 10.1 Wed 15:00 H 2013

Neutron-star binaries: Einstein's richest laboratory — •Luciano Rezzolla — Max-Von-Laue Str. 1, 60438 Frankfurt, Germany

If black holes represent one the most puzzling results of Einstein's theory of gravity, neutron stars in binary system are arguably its richest laboratory, where gravity blends with astrophysics and particle physics. I will overview the rapid recent progress made in modelling these systems and show how the dynamics of a binary of magnetized neutron stars leads to a rapidly-spinning black hole surrounded by a hot and highly-magnetized torus. I will also discuss how this process can be used to enhance the chances of gravitational-wave detection, infer the properties of the equation of state for matter at nuclear densities, and possibly model short gamma-ray bursts.

GR 11: Relativistic Astrophysics

Time: Wednesday 15:40–17:10 Location: H 2013

GR 11.1 Wed 15:40 H 2013

Relativistic Hydrodynamics in the Context of the Hadron-Quark Phase Transition in Compact Stars — •Matthias Hanauske — Johann Wolfgang Goethe-Universität, Institut für Theoretische Physik, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main

The properties of compact stars are mainly determined by two fundamental forces: Quantum chromodynamics (QCD) and general relativity. Relativistic hydrodynamical simulations of collapsing neutron stars and binary neutron star mergers depend strongly on the high density properties of the equation of state (EoS) of hadronic and quark matter. The appearance of the QCD - phase transition (the transition from confined hadronic to deconfined quark matter) will change the properties of neutron stars; eg. usually it is assumed that the loss of stability of a neutron star, exceeding its maximum mass, leads to the collapse into a black hole. However, realistic calculations within QCD-motivated models show that a neutron star collapse could be stopped before the black hole forms. Within such a collapse scenario the neutron star would be transformed into a hybrid star with a deconfined quark matter phase at its inner core. Several astrophysical observables of the Quark-Gluon-Plasma will be discussed during the talk. Whether these observables will be visible with telescopes and gravitational wave detectors depends strongly on the EoS and on the order and construction of the phase transition.

30 min. break

GR 11.2 Wed 16:30 H 2013

Constraining the Equation-of-State of Neutron Stars by Phase-Resolved X-ray Spectroscopy — •Ralph Neuhaeuser and Valeri Hambaryan — AIU, U Jena, Schillergäßchen 2, 07745 Jena, Germany

We use XMM X-ray observations of the isolated neutron stars RBS1213, RXJ1856, and RXJ0720 to measure their compactness by X-ray phase resolved spectroscopy. These objects are also called Magnificent Seven Neutron Stars. They are isolated in the sense that they neither have a supernova remnant nor any known companions. They are on the order of 1 Myr old, X-ray bright, optically faint, nearby (on the order of one to few 100 pc), and show fast proper motion. We use many XMM light curves for different energy bands and many spectra of different light curve phases. Our model assumes a thin highly magnetized atmosphere above a solid state surface with a warm surface for optical emission and two hot emitting areas near the magnetic poles for the X-ray emission. Among the free fit parameters of our model is the gravitational redshift, which is directly related to the compactness M/R (mass M and radius R). We have determined the compactness for all three objects and compare them with predictions from different equations-of-state. In addition, for at least one of the three objects RXJ1856, the distance and radius is known, so that compactness and radius can yield the true mass. This might be the first neutron star with known mass and radius. We will also discuss how to improve on the error budget.

GR 11.3 Wed 16:50 H 2013

Quadrupole Moments of Rapidly Rotating Compact Objects in Dilatonic Einstein-Gauss- Bonnet Theory — •Sindy Mojica, Burkard Kleihaus, and Jutta Kunz — University of Oldenburg

Rapidly rotating compact objects are considered laboratories to test general relativity and theories beyond. We determined observables such as the mass, the angular momentum, the moment of inertia, or the quadrupole moment for neutron stars and black holes in dilatonic Einstein-Gauss-Bonnet theory, a theory motivated by string theory. We used several equations of state (EOS) for the neutron matter and considered the dependence of the observables on the EOS and on the Gauss-Bonnet coupling constant. While there is a considerable EOS dependence for the observables themselves, the relation between the scaled moments of inertia and the scaled quadrupole moments is almost independent of the EOS, when the scaled angular momentum is held fixed.

GR 12: Gravitational Waves

Time: Wednesday 17:10–18:10 Location: H 2013

GR 12.1 Wed 17:10 H 2013

LISA Pathfinder — •Martin Hewitson — Max-Planck-Institut für Gravitationsphysik und Universitaet Hannover Callinstr. 38, 30167 Hannover, Germany

LISA Pathfinder (LPF) is a precursor and technology validation mission for LISA-like Gravitational Wave Observatories in space. Some of the key technology needed for these observatories, such as micro-Newton propulsion, space-based optical metrology, drag-free control, and inertial sensing, will be directly tested on LPF. With a scheduled launch date of July 2015, the mission is at an advanced stage of integration and testing, and the training and preparation for science operations is well underway. This talk will give an overview of the overall mission, giving the status of the various key components, a discussion on the key noise sources, and a brief introduction to the experiments and activities of the science operations phase.

GR 12.2 Wed 17:30 H 2013

Prospects for Joint Gravitational-Wave and Electromagnetic Observations of Neutron-Star/Black-Hole Coalescing Binaries — •Frank Ohme and Francesco Pannarale — Cardiff University, United Kingdom

Coalescing neutron star black hole (NS-BH) binaries are a promising source of gravitational-wave (GW) signals detectable with large-scale laser interferometers such as Advanced LIGO and Virgo. These systems are also one of the main progenitor candidates for short gamma-ray bursts (SGRBs). Detecting an NS-BH coalescence both in the GW and the electromagnetic (EM) spectrum offers a wealth of information about the source. How much can actually be inferred from a joint detection is unclear, however, as the accuracy of the GW measurement can be reduced by the presence of a mass/spin degeneracy. In order to shed light on this problem, we combine recent semi-analytical predictions for the post-merger remnant disc mass with estimates of the parameter-space portion that is selected by a GW detection. By varying the model for the currently unknown NS equation of state (EOS), we identify cases in which an SGRB ignition is assured, others in which it can be excluded, and finally others in which the outcome depends on the EOS. We pinpoint a range of systems that would allow us to place lower bounds on the EOS stiffness if both the GW and EM emission are observed. The methods we develop can broaden the scope of existing GW detection and parameter-estimation algorithms, and they extend our understanding of the potential of joint EM+GW observations.

GR 12.3 Wed 17:50 H 2013

Isofrequency Pairing of spinning particles in Schwarzschild-de-Sitter Spacetime — •Daniela Kunst[1], Volker Perlick[1], and Claus Lämmerzahl[1,2] — [1]ZARM, Universität Bremen, Bremen — [2]Universität Oldenburg, Oldenburg

Einstein's theory of general relativity leads to the prediction of gravitational waves, i.e. oscillations in the gravitational field propagating at the speed of light. One observable feature is the frequency of a gravitational wave. These frequencies can be related to the fundamental ones of the dynamical system representing the source. It was long thought that the frequencies describe the state of a conservative dynamical system uniquely and therefore offer clear information on the underlying source. However, it has been shown that the system of a testparticle moving around a Schwarzschild or Kerr black hole contains states with degenerate frequencies. Thus, having the frequencies is not sufficient to make a distinct deduction on the state of the dynamical system evoking obstacles for the scientists who are interpreting gravitational wave signals.

In order to make the system more astrophysically relevant we investigate the system of a spinning particle moving in a Schwarzschild geometry with a positive cosmological constant.

GR 13: Alternative Aspects and Approaches

Time: Wednesday 16:30–18:30 Location: H 2033

GR 13.1 Wed 16:30 H 2033

100 Jahre Einsteins ART - das letzte Wort? — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Einsteins ART gilt vielen als die erfolgreichste Theorie der Physik. Ein mathematisch komplettes Werk, dessen Vorhersagen sich stets präzise bestätigt haben. Lohnt also ein Hinterfragen? Antwort ist JA.

Einstein hat die relativistische Gravitation als Geometrie beschrieben, also mathematisch, nicht physikalisch. Logischer Ausgangspunkt ist das (starke) Äquivalenzprinzip. Es ist aus heutiger Sicht nicht gültig; also fehlt Einstein die logische Basis. Und der Formalismus fußt auf der riemannschen Geometrie eines gekrümmten, 4-dim. Raumes; für nur wenige Physiker handhabbar.

Es gibt als Alternative den Relativitäts-Ansatz nach Hendrik Lorentz. Dieser fußt nicht auf Prinzipien, sondern auf unabhängig bekannten physikalischen Vorgängen. Seine Vorhersagen sind mit gleicher Präzision korrekt wie die bei Einstein. Die Mathematik erfordert jedoch nur Schulniveau, und die Vorgänge sind der Vorstellung zugänglich. Darüber hinaus ist die Verträglichkeit mit der übrigen Physik vom Ansatz her gegeben, also auch kein Problem mit der Quantentheorie. Dunkle Energie, Dunkle Materie sind nicht notwendig.

Nach Hans Reichenbach ein Ansatz, der in Analogie dem Wechsel zum kopernikanischen Weltbild entspricht.

Für weitere Info: www.ag-physics.org

GR 13.2 Wed 16:50 H 2033

Cosmology and Lorentz-Interpretation (LI) of GRT — •Jürgen Brandes — Karlsbad, Germany

1.) GRT is standard physics and not in question. This talk rests on [1]. SM (Schwarzschild metic) of central symmetric stars, RWM (Robertson-Walker-metric) of exploding dust stars and RWM of expanding universe are closely connected. So it is no surprise that the proven contradiction of energy formulas of SM - formulas (2) and (3) of [1] - has a similiar consequence for RWM. In this case, the total energy of a sphere is predicted different from what would be measured. See formulas (1) and (3) of [2].

2.) The *physical reason* for this contradiction is similar to the one of SM [1]: The measurement of total energy in a free falling reference system (on a shell) does not realize the change of rest mass in a gravitational field. Considering the changing rest mass solves this contradiction. Above this, it allows some explanation of: (1) Why is there an inflationary phase at the beginning of big bang? (2) Where does the energy needed for today's acceleration phase of our universe could come from?

[1]*GRT - well proven and also incomplete?* http://www.grt-li.de/ [2]*Cosmology and Lorentz-Interpretation (LI) of GRT* http://www.grt-li.de/

GR 13.3 Wed 17:10 H 2033

A rotating gravitational ellipse — •Stefan Boersen — S.J.Boersen,The Hague, The Netherlands

A gravitational ellipse is the mathematical result of Newton's law of gravitation. The equation describing such an ellipse, is obtained by differentiating space-by-time twice. Le Verrier stated that rotating gravitational ellipses are observed in the solar system. One could be asked, to adjust the existing gravitational equation in such a way, that a rotating gravitational ellipse is obtained. The additional rotation is an extra variable, so the equation will be a three times space-by-time differentiated equation. To make this three times space-by-time differentiated equation we need to differentiate space-by-time for the third time. Differentiating space-by-time twice gives the following result:

$$(\ddot{X})^2 + (\ddot{Y})^2 = (\ddot{R} - R\dot{a}^2)^2 + (R\ddot{a} + 2\dot{R}\dot{a})^2 \tag{1}$$

A third time differentiation of space-by-time gives the result:

$$(\dddot{X})^2 + (\dddot{Y})^2 = (\dddot{R} - 3\dot{R}\dot{a}^2 - 3R\dot{a}\ddot{a})^2 + (R\dddot{a} + 3\dot{R}\ddot{a} + 3\ddot{R}\dot{a} - R\dot{a}^3)^2 \quad (2)$$

I assume that the reader accepts the mathematical differential equation, which defines a rotating gravitational motion as observed. But we now have two equations defining rotating gravitational ellipses as observed in nature. The EIH equations and the above equations, which obey the Euclidean space premises.

GR 13.4 Wed 17:30 H 2033

Die Gravitation, die Entropie der primordialen Nukleosynthese — •Norbert Sadler — Wasserburger Str. 25a; 85540 Haar

Wird das Universum als ein komplexes, kollektives, thermodynamisches System betrachtet kann die Gravitation als die Entropie der primordialen Nukleosynthese verstanden werden.

Die Gravitation wird über die Algorithmen der "Statistischen Physik" und der "Explorativen Faktorenanalyse" physikalisch und mathematisch definiert. Bei der Faktorenanalyse wird die Gravitation in nicht triviale Faktoren zerlegt, die zu den physikalischen Messwerten in eindeutigem Bezug stehen. Die Faktoren betreffen die Protonenenergie (0.938GeV), die Energiedichteverteilung, die Wechselwirkungs Quanten der Naturkräfte sowie die Aufenthaltswahrscheinlichkeit eines Protons von ((3.99/9)/1m))im Universum.

Die Gravitat.i.d.Faktorenanalyse:Newton(1kgxGx1kg)/(1m))**2 =((3.99/9)/1m))x(0.938)=(0.2387dkl.)/(4Pix0.0456bar.=83.3%/2

Die Gravitation ist die Entropie der 4.56% barion. Energie bei der Nukleosynth. und ist der 23.87% dkl.Mat. emergent. Die Gravitation ist somit eine abgeleitete und keine essentielle Naturkraft!

Beweis:alfa(Gravitation)=/Pl.-Länge/ x alfa(QEDxQCDxW-Boson) und alfa(Grav.)/(h quer)=(QED)**2/(0.938).

Weitere Information: www.cosmology-harmonices-mundi.com

GR 13.5 Wed 17:50 H 2033

Gravitation as the Result of the Reintegration of Migrated Electrons and Positrons to Their Atomic Nuclei. — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

The work is based on findings of the Emission & Regeneration Field Theory where particles are modelled as structured dynamic entities with the relativistic energy stored in Fundamental Particles distributed over the whole space; contrary to the model used in standard theory where particles are nearly point-like entities with the energy concentrated on one point in space. Fundamental concept of the mechanism of gravitation is the reintegration of migrated electrons and positrons to their nuclei. The gravitation force has two components, one component due to the reintegration in the direction of the two gravitating bodies (Induction law) and one component due to the reintegra- tion in the direction perpendicular to it (Ampere law). For sub-galactic distances the first component, which is inverse proportional to the square distance predominates, while for galactic distances the second component, which is inverse proportional to the distance is predominant. The second component explains the flattening of galaxies' rotation curves without the need of additional virtual matter (dark matter). The second component also explains the repulsive forces between galaxies without the need of additional virtual energies (dark energy). The two components of the gravitation force are quantized with the help of the elementary linear momentum deduced for the reintegration of migrated electrons and positrons to their nuclei. (www.odomann.com)

GR 13.6 Wed 18:10 H 2033

Neuklassische Gravitation — •Peter Wolff — Calfreisen, Schweiz

Die Neuklassische Gravitation (NKG) ist eine neue Gravitationstheorie auf klassischer Basis. Sie ist noch keine vollständige Theorie der Gravitation: Ihre zwei gut fundierten Standbeine sind die kosmische, allsymmetrische und die lokale, zentralsymmetrische Gravitation, während die Verbindung der beiden Teile, die sich an Faradays Feldlinienkonzept anlehnt, bisher noch nicht ohne Heuristik auskommt, weil sich Potentiale in der NKG nicht so einfach superponieren lassen wie bei Newton und ART, wo sich z.B. die Schwarzschildmetrik ganz einfach mit der de Sitter-Metrik zur Kottlermetrik von 1918 vereinen lässt.

Das lokale und kosmische NKG-Standbein entsprechen in metrischer ART-Gravitation der lokalen, zentralsymmetrischen Schwarzschildmetrik und der kosmischen, homogen/isotropen Friedmannmetrik. In die NKG-Schwarzschildmetrik gehen aber nur noch Potentialdifferenzen, aber nicht mehr die Potentiale selbst ein, und die konforme WPT-Metrik, die in der NKG die Friedmannmetrik ersetzt, ohne aber eine absolut definierte ART-Metrik zu sein, beschreibt – ganz anders als die Friedmannmetrik – ein stabil statisches All. Beide NKG-Metriken können allein aus einem etwas uminterpretierten SRT-Formalismus, der Urversion von Einsteins Äquivalenzprinzip von 1907 und dem lokalen, newtonschen Punktmassenpotential bzw. dem kosmischen Weltpotential hergeleitet werden, wobei das Weltpotential aber kein übliches, absolut definiertes Newtonpotential ist.

GR 14: Invited Talks 6

Time: Thursday 9:30–10:50 Location: H 2013

Invited Talk GR 14.1 Thu 9:30 H 2013

General Relativity and Astrometry — •Sergei Klioner — Lohrmann-Observatorium, TU Dresden

Unprecedented accuracy expected from space astrometry projects makes it indispensable to formulate the models of observational data in the framework of General Relativity. Without proper use of General Relativity it would impossible to extract any sensitive physical information from observational data. Moreover, a high level of consistency between various parts of data processing chain is required. In this way, General Relativity becomes an applied discipline with many standard applications at the engineering level. On the other hand, the effects entering the relativistic models can be used to test the theory of relativity. An example of the ESA space astrometry mission Gaia will be used to illustrate high-accuracy relativistic data modeling. A suite of relativistic tests with astrometric data will also be discussed.

Invited Talk GR 14.2 Thu 10:10 H 2013

Where is the energy stored in the gravitational field? — •Gerhard Schäfer — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Jena, Germany

We are used to describe and understand physical processes in terms of energy density and energy current density. But what about gravity? Applying a special setting, it will be shown that the Newtonian gravitational field does not allow the definition of physical energy density or energy current density. The special setting is a natural outcome of Einstein's general relativity theory where gravitational energy density and energy current density, i. g., are also notions without physical meaning. Only to gravitational waves, which are completely foreign to Newtonian gravity, energy density and energy current density can be attributed physical meaning, at least to some extent. The Einstein equivalence principle and tidal forces, which are the true gravitational forces, will make the non-localizability of the gravitational field energy evident. Energy in cosmology will also find a discussion.

GR 15: Fundamental Problems and General Formalism

Time: Thursday 11:10–12:50 Location: H 2013

GR 15.1 Thu 11:10 H 2013

On a unified framework for test body equations of motion in gravity — •Dirk Puetzfeld — ZARM, U Bremen, Germany

We present a unified covariant multipolar framework for the description of test bodies in gravity. The framework covers a very large class of gravitational theories, and one can use it as a theoretical basis for systematic tests of gravity by means of extended deformable test bodies. The classes of theories covered range from simple generalizations of General Relativity, e.g. encompassing additional scalar fields, to theories with additional geometrical structures, which are needed for the description of microstructured matter. Furthermore, we discuss the impact of nonstandard couplings between matter and gravity on the resulting test body equations of motion.

GR 15.2 Thu 11:30 H 2013

The Radar experiment in Finsler and Lorentzian spacetime geometry — •Christian Pfeifer — Institut für theoretische Physik, Leibniz Universität Hannover, Deutschland

The radar experiment intertwines an observers measurement of spatial lengths and distances and observers spatial equal time surfaces with the geometry of spacetime. Thus for any change of the geometry of spacetime, motivated for example from quantum gravity, explanations for dark matter and dark energy or an effective description of quantum field theory on curved spacetime, it has to be discussed how this change influences the observers measurement of spatial lengths. I will describe the radar experiment on a general Finsler spacetime geometry before I compare the experiment on two example geometries: a flat fourth order polynomial Finsler spacetime geometry and Minkowski spacetime geometry. The result for the forth order Finsler spacetime geometry will be the explicit spatial length measure of observers which deviates from the usual euclidean one and the change of the spatial equal time surfaces for observers moving relatively to each other. In a next step the radar experiment can be used to model observers on Finsler spacetime geometries such that the speed of light is a constant independent of the state of motion of the observer, as it is the case in Minkowski spacetime geometry.

GR 15.3 Thu 11:50 H 2013

Parametrized Non-Linear Electrodynamics — •Rico Berner, Horst-Heino von Borzeszkowski, and Thoralf Chrobok — Institute for Theoretical Physics, Technical University Berlin, Berlin

Based on the parametrization method introduced by Kuchař we derive the canonical Hamiltonian description out of the Lagrangian formulation for non-linear electrodynamics. We consider the Legendre transformation and the constraints that arise. In this framework, we introduce an extension of Dirac's approach and give an alternative view of the quantization procedure concerning the Born-Infeld electrodynamics. Further, we present the application of the extended approach to various theories of non-linear electrodynamics.

GR 15.4 Thu 12:10 H 2013

The Definition of Density in General Relativity — •Ernst Fischer — Stolberg, Germany

According to general relativity the geometry of space depends on the distribution of matter or energy fields. The relation between the local geometrical parameters and the volume enclosed in given limits varies with curvature and thus with the distribution of matter. As a consequence properties like mass or energy density, defined in Euclidean tangent space, cannot be integrated to give conserved integral data like total mass or energy. To obtain integral conservation, a correction term must be added to account for the curvature of space. This correction term is the equivalent of potential energy in Newtonian gravitation. With this correction the formation of singularities by gravitational collapse does no longer occur and the so called dark energy finds its natural explanation as potential energy of matter itself.

GR 15.5 Thu 12:30 H 2013

Fluid dynamics on Finsler spacetimes — •Manuel Hohmann — Institut für Physik, Universität Tartu, Estland

I discuss the description of fluid dynamics in the language of Finsler spacetime geometry. Such a description is an important ingredient for gravity theories based on Finsler geometry. The description I present here is based on the kinetic theory of fluids on the tangent bundle of spacetime. In my talk I introduce the basic geometric concepts and provide illustrative examples, in particular for fluids with cosmological symmetry.

GR 16: Numerical Relativity

Time: Thursday 15:00–18:10 Location: H 2013

GR 16.1 Thu 15:00 H 2013

Perturbing AdS space—turbulence and time-periodic solutions — •Maciej Maliborski — Albert-Einstein-Institut, Potsdam

In this talk I will present recent analytical and numerical analysis of asymptotically anti-de Sitter spacetimes in a spherical symmetry. I will review the turbulent phenomena in AdS gravity (discovered by Bizoń and Rostworowski) and present results supporting the existence of time-periodic solutions—non-generic, stable solutions with AdS asymptotics.

GR 16.2 Thu 15:20 H 2013

Critical behaviour in the Einstein-Yang-Mills system — •Oliver Rinne and Maciej Maliborski — Albert-Einstein-Institut, Potsdam

The Einstein-Yang-Mills system displays a variety of critical phenomena in gravitational collapse. Two new results are reported here. By tuning two parameters in the initial data, the magnetic Reissner-Nordström solution appears as an approximate intermediate attractor separating the critical line of coloured black hole solutions of opposite sign. The second result concerns the influence on critical collapse of a sphaleron contribution in the ansatz for the spherically symmetric Yang-Mills field.

GR 16.3 Thu 15:40 H 2013

Numerical evolution of the axisymmetric vacuum Einstein equations in spherical coordinates: the linear case — •Christian Schell and Oliver Rinne — Max Planck Institute for Gravitational Physics, Golm

We discuss a new approach to solving the axisymmetric vacuum Einstein equations numerically. Spherical polar coordinates are best suited for situations such as gravitational collapse. Also they allow for a spectral approach using spherical harmonics. In this talk we consider the linearization of the equations about flat spacetime. We show why the considered situation requires a new gauge condition and we derive an exact solution for our choice. After regularizing at the origin we present numerical evolutions and discuss their properties.

30 min. break

GR 16.4 Thu 16:30 H 2013

Discontinous Galerkin methods in general relativistic hydrodynamics — •Marcus Bugner[1], Tim Dietrich[1], Sebastiano Bernuzzi[2,3], and Bernd Brügmann[1] — [1]Theoretical Physics Institute, University of Jena, 07743 Jena, Germany — [2]TAPIR, California Institute of Technology, Pasadena, California, USA — [3]DiFeST, University of Parma, and INFN Parma, I-43124 Parma, Italy

We investigate the properties of a Discontinous Galerkin (DG) method applied to solve the equations of special and general relativistic hydrodynamics in 3+1 dimensions. In order to avoid artificial oscillations at discontinuities, this is combined with a weighted essentially non-oscillatory (WENO) limiting procedure. We test the stability, convergence and scaling of our algorithm and compare our results with finite differencing simulations.

GR 16.5 Thu 16:50 H 2013

Axisymmetric constant mean curvature slices in the Kerr space-time — •David Schinkel, Rodrigo Panosso Macedo, and Marcus Ansorg — Theoretisch-Physikalisches Institut, Jena, Germany

Recently, there have been efforts to solve Einstein's equation in the context of a conformal compactification of space-time. Of particular importance in this regard are the so called CMC-foliations, characterized by spatial hyperboloidal hypersurfaces with a constant extrinsic mean curvature K. However, although of interest for general space-times, CMC-slices are known explicitly only for the spherically symmetric Schwarzschild metric. This work is devoted to numerically determining axisymmetric CMC-slices within the Kerr solution. We construct such slices outside the black hole horizon through an appropriate coordinate transformation in which an unknown auxiliary function A is involved. The condition K=const throughout the slice leads to a nonlinear partial differential equation for the function A, which is solved with a pseudo-spectral method. The results exhibit exponential convergence, as is to be expected in a pseudo-spectral scheme for analytic solutions. As a by-product, we identify CMC-slices of the Schwarzschild solution which are not spherically symmetric.

GR 16.6 Thu 17:10 H 2013

Initial data for binary neutron stars with adjustable eccentricity — •Niclas Moldenhauer[1], Charalampos Markakis[2], Nathan Johnson-McDaniel[3], Wolfgang Tichy[4], and Bernd Brügmann[1] — [1]Theoretical Physics Institute, University of Jena — [2]Mathematical Sciences, University of Southampton — [3]ICTS of the Tata Institute of Fundamental Research — [4]Physics Department, Florida Atlantic University,

Binary neutron stars in circular orbits can be modeled as helically symmetric, i.e., stationary in a rotating frame. This symmetry gives rise to a first integral of the Euler equation. For eccentric orbits, however, the lack of helical symmetry has prevented the use of this method, and the numerical relativity community has often resorted to constructing initial data by superimposing boosted spherical stars, which leads to spuriously excited neutron star oscillations during the evolution. We consider eccentric confgurations at apoapsis that are instantaneously stationary in a rotating frame and extend the notion of helical symmetry to eccentric orbits. We use the obtained first integrals as the basis of a self-consistent iteration of the Einstein constraints to construct conformal thin-sandwich initial data for eccentric binaries. We discuss that effect of the improved data on the evolutions, e.g. by looking at the spurious stellar oscillations and the tidally induced oscillations.

GR 16.7 Thu 17:30 H 2013

Dynamical simulations of neutron star spacetimes with conservative mesh refinement — •Tim Dietrich[1], Sebastiano Bernuzzi[2,3], Maximiliano Ujevic[4], and Bernd Brügmann[1] — [1]Theoretical Physics Institute, University of Jena, 07743 Jena, Germany — [2]TAPIR, California Institute of Technology, 1200 E California Blvd,Pasadena, California 91125, USA — [3]DiFeST, University of Parma, and INFN Parma, I-43124 Parma, Italy — [4]Centro de Ciencias Naturais e Humanas, Universidade Federal do ABC, 09210-170, Santo Andre, Sao Paulo, Brazil

The most recent and improved general-relativistic grid-based simulations of neutron star systems produced with our code BAM are presented. We focus in particular on the adaptive mesh refinement (AMR) implementation. AMR is an important tool to reduce computational costs and still to resolve multiple scales: the stars interiors, the orbital strong field region, and the radiation zone. Here, the use of a conservative AMR enforcing mass conservation over refinement boundaries is investigated. We show the usage during (i) a variety of single neutron star test spacetimes, (ii) the gravitational collapse of rotating neutron stars to black holes, and (iii) the ejection of material in a binary neutron star system. According to our results accurate simulations beyond the merger should include a conservative mesh refinement.

GR 16.8 Thu 17:50 H 2013

A new gravitational wave generation algorithm for particle perturbations of the Kerr spacetime — •Enno Harms[1], Sebastiano Bernuzzi[2], Alessandro Nagar[3], and Anil Zenginoglu[4] — [1]TPI Uni Jena — [2]California Institute of Technology - USA — [3]IHES - Bures Sur Yvette - France — [4]IHES - Bures Sur Yvette - France

We present a new approach to solve the 2+1 Teukolsky equation for gravitational perturbations of a Kerr black hole. Our approach relies on a new horizon penetrating, hyperboloidal foliation of Kerr spacetime and spatial compactification. In particular, we present a framework for waveform generation from point-particle perturbations and its application to black-hole binary inspirals in the large-mass-ratio limit.

GR 17: Invited Talks 7

Time: Friday 9:30–10:50 Location: H 2013

Invited Talk GR 17.1 Fri 9:30 H 2013

The Galactic Center Massive Black Hole — •Reinhard Genzel — MPI für extraterrestrische Physik, Garching

Evidence has been accumulating for several decades that many galaxies harbor central mass concentrations that may be in the form of black holes with masses between a few million to a few billion time the mass of the Sun. I will discuss measurements over the last two decades, employing adaptive optics imaging and spectroscopy on large ground-based telescopes that prove the existence of such a massive black hole in the Center of our Milky Way, beyond any reasonable doubt. These data also provide key insights into its properties and environment. Most recently, a tidally disrupting cloud of gas has been discovered on an almost radial orbit that reached its peri-distance of ~2000 Schwarzschild radii in 2014, promising to be a valuable tool for exploring the innermost accretion zone. Future interferometric studies of the Galactic Center Black hole promise to be able to test gravity in its strong field limit.

Invited Talk GR 17.2 Fri 10:10 H 2013

Gravitational lensing – a versatile tool for astrophysics — •Peter Schneider — Argelander-Institut fuer Astronomie, Universitaet Bonn

Gravitational light deflection was a crucial early test of GR, and has since developed into a versatile tool for astrophysics and cosmology, with strong impact on topics like extra-solar planet detections, galaxies and clusters of galaxies, dark matter, the innermost structure of active galactic nuclei, dark matter, the evolution of the large-scale structure in the Universe and its expansion history. In this talk, several highlights of gravitational lensing research will be provided.

GR 18: Black Holes

Time: Friday 11:10–13:10 Location: H 2013

GR 18.1 Fri 11:10 H 2013

On wave propagation in Schwarzschild spacetime — •Dennis Philipp and Volker Perlick — ZARM, Universität Bremen, 28359 Bremen

The propagation of (massless) scalar, electromagnetic and gravitational waves on fixed Schwarzschild background spacetime is described by the general time-dependent Regge-Wheeler equation. We transform this wave equation to usual Schwarzschild, Eddington-Finkelstein and Painlevé-Gullstrand coordinates. After separating a harmonic time-dependence the resulting radial equations belong to the class of confluent Heun equations, i.e., we can identify two regular and one irregular singularities. Using the generalized Riemann-scheme we collect properties of all singular points and construct (local) solutions in terms of the standard confluent Heun function HeunC, Frobenius- and asymptotic Thomé series.

We study the Eddington-Finkelstein and Painlevé-Gullstrand cases in detail and obtain in each case a solution that is regular at the black hole horizon. This solution is connected to causal boundary conditions, i.e., purely ingoing radiation at $r = 2M$. To construct solutions on the entire open interval $r \in]0, \infty[$ we give an analytic continuation of local solutions around the horizon. Black hole scattering and quasi-normal modes are briefly considered as possible applications.

GR 18.2 Fri 11:30 H 2013

Shadows of Black Holes — •Arne Grenzebach, Volker Perlick, and Claus Lämmerzahl — ZARM, Universität Bremen, 28359 Bremen

In this talk I present how to calculate the shadow of a Kerr-Newman-NUT black hole with a cosmological constant analytically. For this, the existence of (unstable) spherical light rays in a region $\mathcal{K}$ is essential because these determine the boundary of the shadow. After transformation to celestial coordinates on the observer's sky, the shadow is viewed via stereographic projection as usual. The observer is located at arbitrary Boyer-Lindquist coordinates outside of the horizon.

GR 18.3 Fri 11:50 H 2013

Composite localized field solutions in the Einstein-Yang-Mills theory in AdS spacetime — •Olga Kichakova[1], Jutta Kunz[1], Eugen Radu[2], and Yasha Shnir[3] — [1]Oldenburg University — [2]Aveiro University — [3]JINR, Dubna

We construct new finite energy both regular and black hole solutions in Einstein-Yang-Mills-SU(2) theory. They are static, axially symmetric and approach at infinity the anti-de Sitter spacetime background. These configurations are characterized by a pair of integers (m,n), where m is related to the polar angle and n to the azimuthal angle, being related to the known flat space monopole-antimonopole chains and vortex rings. Generically, they describe composite configurations with several individual components, possesing a nonzero magnetic charge, even in the absence of a Higgs field. Such Yang-Mills configurations exist already in the probe limit, the AdS geometry supplying the attractive force needed to balance the repulsive force of Yang-Mills gauge interactions. The gravitating solutions are constructed by numerically solving the elliptic Einstein-DeTurck–Yang-Mills equations.

GR 18.4 Fri 12:10 H 2013

Rotating black holes in Einstein-Maxwell-Chern-Simons theory with negative cosmological constant — •Jose Luis Blazquez Salcedo — Oldenburg University, Oldenburg, Germany

We study 5-dimensional black holes in Einstein-Maxwell-Chern-Simons theory with negative cosmological constant, and free Chern-Simons coupling parameter. We consider topologically spherical black holes, with both angular momenta of equal magnitude. In particular, we study extremal black holes, which can be used to determine the boundary of the domain of existence. We compare the results of asymptotically flat solutions with the asymptotically Anti-de Sitter case. Several branches of black holes are found depending on the coupling parameters. The near horizon formalism is used to obtain some analytical results.

GR 18.5 Fri 12:30 H 2013

On gravity self-completeness in higher dimensions — •Sven Köppel[1,2], Euro Spallucci[3,4], Piero Nicolini[1,2] und Marcus Bleicher[1,2] — [1]Institut für theoretische Physik, Goethe-Universität Frankfurt am Main, Deutschland — [2]Frankfurt Institute for Advanced Sciences, Frankfurt am Main, Deutschland — [3]Dipartimento di Fisica, Sezione di Fisica Teorica, Università degli Studi di Trieste, Italy — [4]INFN, Sezione di Trieste, Strada Costiera 11, Trieste, Italy

There is a great expectation about the possibility for gravity of being self-complete, i.e., able to prevent the access to scales smaller of the Planck scale. According to such a paradigm, we propose black hole geometries with an improved short scale behavior. Specifically such models have a regular center and a stable cold evaporation end-point (remnant). We show that the proposed geometries can be derived by a non-local deformation of the Einstein-Hilbert action and are compatible with the large spatial extradimension scenario.

GR 18.6 Fri 12:50 H 2013

Generalized Uncertainty Principle and Black Holes — •Marco Knipfer[1,2], Sven Köppel[1,2], Maximiliano Isi[3], Jonas Mureika[4], Piero Nicolini[1,2], and Marcus Bleicher[1,2] — [1]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, Frankfurt am Main, Deutschland — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Deutschland — [3]Physics Department, California Institute of Technology, Pasadena, CA, United States — [4]Department of Physics, Loyola Marymount University, Los Angeles, CA, United States

Many of the current endeavors of finding a quantum theory of gravity introduce two basic adjustments: Additional space dimensions and the existence of a minimal length of about the *Planck length* $\ell_\mathrm{p} \approx 1.6 \times 10^{-36}$m. According to this line of reasoning we modify the *Heisenberg uncertainty relation* into the *generalized uncertainty principle* (GUP) $\Delta x \Delta p \geq \frac{\hbar}{2}\left[1 + \beta(\Delta p)^2\right]$. To evaluate the effects of the GUP in curved space, we consider a non-local gravity Lagrangian. The resulting field equations depend on a non-local operator not known *a priori*. We show that a particular profile of such an operator can reproduce GUP effects. Specifically we derive a GUP improved Schwarzschild metric. Even if the curvature singularity is just smoothened, the thermodynamics becomes regular, *i.e.*, the temperature no longer diverges in the final evaporation stage and a cold black hole remnant forms.