Fachverband Gravitation und Relativitätstheorie (GR)

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This year's focus-topic of our division is the still insufficiently understood relation between Quantum Theory and General Relativity. Together with the divisions *Particle Physics, Theoretical and Mathematical Physics*, and the working group *Philosophy of Physics* we will have a symposium on this topic with four talks by renowned experts in their respective fields. The focus-topic is also reflected by the global structure of the whole programme, which allows a little more than average space to the discussion of related issues. In addition, we will have a joint session with the division *Theoretical and Mathematical Physics* on aspects of classical and quantum gravity.

Übersicht der Hauptvorträge und Fachsitzungen

(Hörsäle VMP6 HS A und VMP6 HS C; Poster VMP6 Foyer)

Hauptvorträge

GR 1.1	Mo	9:00– 9:45	VMP6 HS A	**Time Dilation in Quantum Systems and Decoherence** — •Caslav Brukner
GR 1.2	Mo	9:45–10:30	VMP6 HS A	**Semiclassical Einstein equation** — •Rainer Verch
GR 2.1	Mo	11:00–11:40	VMP6 HS A	**Dynamics of Loop Quantum Gravity** — •Kristina Giesel
GR 5.1	Di	13:45–14:25	VMP6 HS A	**Static vacuum photon spheres have no hair** — •Carla Cederbaum
GR 6.1	Di	16:45–17:25	VMP6 HS A	**A No-Hair Theorem for Astrophysically Relevant Black Holes** — •Norman Gürlebeck
GR 7.1	Mi	16:45–17:25	VMP6 HS A	**Back in the saddle: Large-deviation statistics of the cosmic log-density field** — •Cora Uhlemann
GR 11.1	Do	13:45–14:25	VMP6 HS A	**Fresnel-Kummer wave surfaces in transparent (meta)materials, the Kummer tensor in general relativity, and beyond** — Alberto Favaro, •Friedrich W. Hehl
GR 11.2	Do	14:25–15:05	VMP6 HS A	**Influence of a plasma on gravitational lensing by compact objects** — •Volker Perlick

Hauptvorträge des fachübergreifenden Symposiums SYQG

Das vollständige Programm dieses Symposiums ist unter SYQG aufgeführt.

SYQG 1.1	Mi	13:30–14:10	VMP4 Audimax 1	**Quantum Tests of Gravity** — •Markus Aspelmeyer
SYQG 1.2	Mi	14:10–14:50	VMP4 Audimax 1	**A Practitioner's View on Quantum Gravity** — •Renate Loll
SYQG 1.3	Mi	14:50–15:30	VMP4 Audimax 1	**Standard Model Fermions and N=8 Supergravity** — •Hermann Nicolai
SYQG 1.4	Mi	15:30–16:10	VMP4 Audimax 1	**Quantum and gravity: blend or mélange?** — •Christian Wüthrich

Fachsitzungen

GR 1.1–1.2	Mo	9:00–10:30	VMP6 HS A	**Quantum (Field) Theory and Gravity**
GR 2.1–2.3	Mo	11:00–12:20	VMP6 HS A	**Quantum Gravity I**
GR 3.1–3.7	Mo	16:45–19:05	VMP6 HS A	**Quantum Gravity II**
GR 4.1–4.4	Di	8:30–10:30	VMP6 HS A	**Mathematical Aspects of Classical and Quantum Gravity (with MP)**
GR 5.1–5.7	Di	13:45–15:55	VMP6 HS A	**Classical General Relativity I**
GR 6.1–6.6	Di	16:45–19:05	VMP6 HS A	**Black Holes and other Black Objects**
GR 7.1–7.6	Mi	16:45–19:05	VMP6 HS A	**Cosmology**
GR 8.1–8.13	Mi	17:30–19:00	VMP6 Foyer	**Poster**
GR 9.1–9.4	Do	8:30– 9:50	VMP6 HS A	**Quantum Cosmology**
GR 10.1–10.5	Do	11:00–12:40	VMP6 HS A	**Relativistic Astrophysics**
GR 11.1–11.6	Do	13:45–16:05	VMP6 HS A	**Classical General Relativity II**
GR 12.1–12.5	Do	13:45–15:25	VMP6 HS C	**Alternative Theories**
GR 13.1–13.7	Do	16:45–19:05	VMP6 HS A	**Quantum Gravity III**
GR 14.1–14.3	Do	16:45–17:45	VMP6 HS C	**Experimental Tests**
GR 15.1–15.4	Do	17:45–19:05	VMP6 HS C	**Numerical Relativity**
GR 16.1–16.6	Fr	8:45–10:45	VMP6 HS A	**Gravitational Waves**
GR 17.1–17.5	Fr	11:15–12:55	VMP6 HS A	**Quantum Gravity IV**

Postersitzung

Die Poster können ab Dienstag an den Posterwänden im VMP 6 Foyer angebracht werden. Während der für die Poster angebenen Sitzung sollten die Poster von den Autoren für Diskussionen betreut werden.

Mitgliederversammlung Fachverband Gravitation und Relativitätstheorie

Donnerstag 19:30–20:30 VMP6 HS A

- Tagesordnung
- Protokoll des letzten Jahres
- Bericht des Vorsitzenden
- Vergangene und zukünftige Aktivitäten
- Wahl der Leiterin / des Leiters und des Beirats
- Büchertisch
- Verschiedenes

GR 1: Quantum (Field) Theory and Gravity

Zeit: Montag 9:00–10:30 Raum: VMP6 HS A

Hauptvortrag GR 1.1 Mo 9:00 VMP6 HS A

Time Dilation in Quantum Systems and Decoherence — •Caslav Brukner — Fakultät für Physik, Universität Wien, Austria — Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Austria

Phenomena where both quantum theory and general relativity become relevant are typically assumed to be present at extreme physical conditions: at high energies and in strong gravitational fields. In this talk I will consider low-energy quantum mechanics in the presence of weak gravitational time dilation and show that the latter leads to novel phenomena that could be accessible in quantum optical experiments. I will present a quantum version of the "twin paradox" in which a quantum system is brought in superposition of being at two different gravitational potentials, and show that time dilation induces entanglement between internal degrees of freedom and the center-of-mass of a composite particle. In particular, I will derive that time dilation can cause decoherence of composite quantum systems and thus contribute to the transition to classicality. Finally, using relational point of view, I will analyze what these results could imply for the situations where the quantum system is localized but the (space-time) background is in a quantum superposition.

Hauptvortrag GR 1.2 Mo 9:45 VMP6 HS A

Semiclassical Einstein equation — •Rainer Verch — Institut für Theoretische Physik, Universität Leipzig

The semiclassical Einstein equation is formulated in the setting of quantum field theory in curved spacetimes, and features the Einstein tensor of a classical spacetime geometry on the left hand side, and the expectation value of the stress-energy tensor of a quantum field on that classical spacetime geometry, in a suitable state, on the right hand side. In the talk, several results pertaining to this equation, which have emerged over the past several years, will be reviewed. This includes, in particular, ruling out certain "designer spacetime" scenarios, solutions and stability for cosmological spacetimes, the possibility or not of having Chaplygin-gas type solutions, quantization of fluctuations in cosmology, and the non-relativistic limit.

GR 2: Quantum Gravity I

Zeit: Montag 11:00–12:20 Raum: VMP6 HS A

Hauptvortrag GR 2.1 Mo 11:00 VMP6 HS A

Dynamics of Loop Quantum Gravity — •Kristina Giesel — Institute for Quantum Gravity, FAU Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen

Loop quantum gravity is a candidate for a theory of quantum gravity, which takes general relativity as its classical starting point. The quantum theory is obtained by applying canonical quantization to general relativity. For this purpose, the techniques known from quantum field theory need to be generalized. As a consequence, loop quantum gravity is based on a quantum field theory, which is in many aspects different from the quantum field theory, that is used to formulate the Standard Model of particle physics. The dynamics of the quantum theory is described by the so called quantum Einstein equations, the quantum analog of Einstein's equations. After a brief introduction to the ideas and concepts of loop quantum gravity, we will discuss the current status of the dynamics, particularly the role of gauge invariance in this context and also present further research directions currently addressed in loop quantum gravity.

GR 2.2 Mo 11:40 VMP6 HS A

Semiclassical perturbation theory in Loop Quantum Gravity — •David Winnekens and Kristina Giesel — University of Erlangen-Nürnberg, Institute for Quantum Gravity, Theoretical Physics III, Staudtstr. 7, 91058 Erlangen

The volume operator plays a pivotal role in the quantum dynamics of Loop Quantum Gravity, yet its full spectrum is unknown. This also affects a semiclassical analysis of the theory since that requires computing semiclassical expectation values of dynamical operators, which themselves involve the volume operator. Within the context of Algebraic Quantum Gravity [1] – a model formulated in the framework of Loop Quantum Gravity –, a formalism called semiclassical perturbation theory was developed, which allows calculating these semiclassical expectation values perturbatively as a power series in $\hbar$.

This talk presents an application of this formalism to the operator of the inverse scale factor, which is an important ingredient for the dynamics of quantum cosmological models. In [2], a semiclassical analysis of this operator has been performed via substituting SU(2) by $U(1)^3$. In this case, the volume operator simplifies drastically. With the work presented in this talk, the analysis of [2] can be generalized to the full SU(2)-case.

[1] Algebraic Quantum Gravity (AQG) III. Semiclassical Perturbation Theory, K. Giesel, T. Thiemann, Class.Quant.Grav.24:2565-2588, 2007 [2] On (Cosmological) Singularity Avoidance in Loop Quantum Gravity, J. Brunnemann, T. Thiemann, Class.Quant.Grav.23:1395-1428, 2006

GR 2.3 Mo 12:00 VMP6 HS A

A physical Hamiltonian obtained from four Klein-Gordon Fields — Kristina Giesel and •Almut Oelmann — Institute for Quantum Gravity, FAU Erlangen-Nürnberg

In Loop Quantum Gravity (LQG) we do not have a true Hamiltonian which describes the dynamics of General Relativity. Instead one obtains from the Einstein-Hilbert action a sum of constraints, called the Diffeomorphism and the Hamiltonian constraint. They represent spatial and temporal diffeomorphisms which are the gauge transformations of General Relativity. In order to obtain Dirac observables which are real physical (gauge invariant) quantities one introduces additional matter fields as reference fields. A special Dirac observable is the physical Hamiltonian. It describes the physical evolution (dynamics) of the considered system. A well known approach to obtain Dirac observables that are invariant under spatial and temporal diffeomorphisms is the so called relational formalism combined with the so called Brown-Kuchar mechanism, where four dust fields are used as reference fields. Here we consider the model of the gravitational field coupled to four Klein-Gordon reference fields and derive the physical Hamiltonian of this model. We compare this model to the Brown-Kuchar dust model and discuss the differences and similarities of the two models with a particular focus on the reduced phase space quantization of this model in the context of Loop Quantum Gravity.

GR 3: Quantum Gravity II

Zeit: Montag 16:45–19:05 Raum: VMP6 HS A

GR 3.1 Mo 16:45 VMP6 HS A

The group field theory formalism for quantum gravity: progress and prospects — •Daniele Oriti — Max Planck Institute for Gravitational Physics (Albert Einstein Institute)

I review the basic aspects of the group field theory formalism for quantum gravity, and its relation with the loop quantum gravity approach, and with discrete quantum gravity. I highlight recent results and forthcoming challenges for what concerns group field theory renormalisation, both perturbative and non-perturbative, and the extraction of effective continuum physics, in particular cosmological dynamics.

GR 3.2 Mo 17:05 VMP6 HS A

Effective Spacetimes from Quantum Cosmology — •Andrea Dapor — Institute for Quantum Gravity, University of Erlangen-Nürnberg

I will describe a general mechanism for the emergence of a classical spacetime from an underlying theory of quantum cosmology coupled to matter. This idea is based on QFT on quantum spacetime, and the emergent classical metric is not just the naïve expectation value of a “metric operator” on the quantum state of geometry. In fact, if the matter sector consists of as simple a species as a massive real scalar field, then the emergent classical metric depends explicitly on the momentum of the particle used to probe it. This is therefore an explicit realization of the concept known in the literature as “rainbow metric” (the name comes from the analogy with propagation of light in cristals, where photons of different colors move along different pahts). Application of this method to homogeneous isotropic Loop Quantum Cosmology will be presented, and the intensity of local Lorentz-violation will be estimated. Time permitting, I will also sketch some preliminary results in the context of anisotropic cosmologies.

GR 3.3 Mo 17:25 VMP6 HS A

Boundary conditions, black holes and the Duflo map in LQG — •Thomas Zilker and Hanno Sahlmann — FAU Erlangen-Nürnberg

This talk will focus on the boundary condition satisfied by spherically symmetric isolated horizons in their SU(2)-invariant formulation. After briefly discussing its geometric interpretation, I will then present an approach to quantize this boundary condition in the framework of loop quantum gravity. The Duflo map provides a possible solution to the ordering ambiguities occurring in this approach.

GR 3.4 Mo 17:45 VMP6 HS A

Chaos, Dirac observerbles and constraint quantization — •Philipp Höhn[1], Bianca Dittrich[2], Tim Koslowski[3], and Mike Nelson[4] — [1]Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Vienna, Austria — [2]Perimeter Institute for Theoretical Physics, Waterloo, Canada — [3]Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico, Mexico — [4]African Institute for Mathematical Sciences, Legon, Accra, Ghana

There is strong evidence that a generic general relativistic spacetime features chaotic dynamics. This has severe (and often ignored) repercussions for the quantization and interpretation of the dynamics as a chaotic (Hamiltonian) constrained system generally does not give rise to a Poisson algebra of Dirac observables. Nevertheless, in certain cases one can explicitly quantize such systems. By means of toy models, I will discuss general challenges and some surprising consequences for the quantum theory of chaotic constrained systems which presumably will also appear in canonical quantum gravity.

GR 3.5 Mo 18:05 VMP6 HS A

The algebra of observables in Gaussian normal (space)time coordinates — •Norbert Bodendorfer[1], Pawel Duch[2], Jerzy Lewandowski[1], and Jedrzej Swiezewski[1] — [1]Faculty of Physics, University of Warsaw, Pasteura 5, 02-093, Warsaw, Poland — [2]Institute of Physics, Jagiellonian University, Lojasiewicza 11, 30-348 Krakow, Poland

We discuss the locality properties of general relativistic observable algebras based on Gaussian normal space and spacetime coordinates. While a suitable local algebra can be constructed in the spatial case, this fails in the spacetime case. The relevance of these results for quantum gravity and the AdS/CFT correspondence are discussed.

GR 3.6 Mo 18:25 VMP6 HS A

Quantum Gravity a la Aharonov-Bohm — •Marcin Kisielowski — University of Erlangen-Nürnberg, Erlangen, Germany

In the Regge approximation to General Relativity a space-time is a simplicial complex equipped with a metric structure determined by the edge lengths. For each such Regge space-time we construct a smooth manifold equipped with flat connection and a compatible tetrad. The resulting manifold is not simply connected – we will say that it is a manifold with defects. Although the connection is flat a parallel transport around a closed loop can be non-trivial. This is a mathematical basis of the Aharonov-Bohm effect: the magnetic field is zero outside thin and long solenoid but the holonomy around a loop encircling the solenoid is non-trivial. Using this analogy we introduce a (distributional) curvature on the simplicial complex. This allows us to define the Eintein-Hilbert-Palatini action as a measure, which coincides with the Regge action. We apply this alternative formulation of Regge calculus to construct a path-integral measure on histories of the gravitational field and arrive at a spin-foam model of Quantum Gravity. In my talk I will focus on 3D Euclidean gravity.

GR 3.7 Mo 18:45 VMP6 HS A

Towards the Quantum-Yang-Mills Spectrum — •Klaus Liegener — Friedrich-Alexander-Universität, Erlangen, Deutschland

A fundamental quantum theory of all interactions must include the gravitational quantum field. Thus, a quantum gravity theory is needed. With this goal in mind to describe the standard model coupled to gravity, we focus in this work on the quantum Einstein-Yang-Mills sector quantised by the methods of Loop Quantum Gravity (LQG). We point out the improved UV behaviour of the coupled system compared to pure quantum Yang-Mills theory on a fixed classical background spacetime, as was considered in a seminal work by Kogut and Susskind. Furthermore, we develop a calculational scheme by which the fundamental spectrum of the quantum Yang-Mills Hamiltonian can be computed in principle and by which one can make contact to the Wilsonian renormalisation group, possibly purely within the Hamiltonian framework. We extend already established calculations for the SU(2) gauge group to SU(3), meaning that the full standard model can now be tackled with our formalism.

GR 4: Mathematical Aspects of Classical and Quantum Gravity (with MP)

Zeit: Dienstag 8:30–10:30 Raum: VMP6 HS A

Hauptvortrag GR 4.1 Di 8:30 VMP6 HS A

The Black Hole Stability Problem — •Gustav Holzegel — Imperial College, London

A fundamental open problem in general relativity is to establish the non-linear stability of the Kerr-family of black holes. I will review recent progress in this field including a discussion of a proof of the linear stability of the Schwarzschild solution under gravitational perturbations, which I obtained in collaboration with Dafermos and Rodnianski.

Hauptvortrag GR 4.2 Di 9:00 VMP6 HS A

Towards Quantum Gravity via Quantum Field Theory: Problems and perspectives — •Klaus Fredenhagen — II. Institut fuer Theoretische Physik, Universität Hamburg

General Relativity is a classical field theory; the standard methods for constructing a corresponding quantum field theory, however, meet severe difficulties, in particular perturbative non-renormalizability and the problem of background independence.

Nevertheless, modern approaches to quantum field theory have significantly lowered these obstacles. On the side of non-renormalizability, this is the concept of effective theories, together with indications for better non-perturbative features of the renormalization group flow. On the side of background independence the main progress comes from an improved understanding of quantum field theories on generic curved spacetimes. Combining these informations, a promising approach to quantum gravity is an expansion around a classical solution which then is a quantum field theory on a given background, augmented by an identity which expresses independence against infinitesimal shifts of the background.

The arising theory is expected to describe small corrections to classical general relativity. Inflationary cosmology is expected to arise as a lowest order approximation.

Hauptvortrag GR 4.3 Di 9:30 VMP6 HS A

Asymptotically Safe Quantum Gravity — •Frank Saueressig — Radboud University, Nijmegen, The Netherlands

Weinberg's Asymptotic Safety scenario, building on a non-trivial fixed point of the gravitational renormalization group flow, provides an elegant mechanism to construct a quantum theory of gravity within the framework of quantum field theory. The most important tools for investigating this scenario are functional methods which allow constructing renormalization group flows of a theory without resorting to the expansion in a small parameter or specifying the fundamental action a priori. This talk will give a concise introduction to the gravitational Asymptotic Safety program before reviewing its current status and future perspectives.

Hauptvortrag GR 4.4 Di 10:00 VMP6 HS A

Loop quantum gravity: a canonical review — •Christian Fleischhack — Institut für Mathematik, Universität Paderborn, 33095 Paderborn

Over the past 25 years, loop quantum gravity has become a relevant attempt to explain the mystery of quantum gravity. However, despite several remarkable achievements, not all the initial dreams have turned into reality; e.g., the dynamics of the theory has remained a rather open territory.

In our review on the current status of loop quantum gravity, we will focus on its canonical part. After presenting the well-understood kinematical basis, we will address dynamical issues as well as an implementation of symmetries that allows to partially relate loop quantum gravity to loop quantum cosmology.

GR 5: Classical General Relativity I

Zeit: Dienstag 13:45–15:55 Raum: VMP6 HS A

Hauptvortrag GR 5.1 Di 13:45 VMP6 HS A

Static vacuum photon spheres have no hair — •Carla Cederbaum — University of Tübingen, Germany

We will present two different mathematical proofs showing that the Schwarzschild spacetime is the only static vacuum asymptotically flat general relativistic spacetime that possesses a suitably geometrically defined photon sphere. In other words, we will show that static (vacuum) photon spheres have no hair. We will also discuss generalizations to the electrovacuum case as well as to higher spacetime dimensions.

The proofs extend classical static black hole uniqueness results. Part of this work is joint with Gregory Galloway.

GR 5.2 Di 14:25 VMP6 HS A

Deviation equations and measurement of the gravitational field in General Relativity — •Dirk Puetzfeld — ZARM, U Bremen

In General Relativity, the comparison of test bodies moving along adjacent world lines is of direct operational significance. The observation of a suitably prepared set of test bodies allows for the determination of the components of the curvature. We present some recent results on generalized deviation equations for test bodies and the measurement of the gravitational field by means of these equations.

GR 5.3 Di 14:40 VMP6 HS A

Null geodesics in accelerating black hole spacetimes — •Eva Hackmann — ZARM, Universität Bremen

The accelerating black hole spacetime, also known as C-metric, is a two parameter solution of the vacuum field equations with conical singularities on the z-axes. We discuss null geodesics in the C-metric using spherical-type coordinates as introduced by Griffith and Podolsky (Class. Quantum Grav. 23:6745, 2006), which reduce to the familiar form of the Schwarzschild metric in Boyer-Lindquist coordinates for vanishing acceleration. The characteristic features of null geodesics in this spacetime are studied and an analytical solution of the equation of motion will be presented. We also discuss possible locations of timelike stable circular orbits and the observation of light emitted from there.

GR 5.4 Di 14:55 VMP6 HS A

Circular motion in NUT spacetime — •Pavel Jefremov and Volker Perlick — ZARM, Bremen, Deutschland

For the geodesic motion we find the surface where circular motion takes place as well as characteristic radii of the spacetime (last stable and marginally bound orbits). For the fluid motion we investigate the model of geometrically thick tori ("Polish Doughnuts") and discuss how their structure is influenced by the parameters of the metric. For ultrarelativistic motion in a general anxially symmetric spacetime we derive formula for the potential lines of centrifugal and Coriolis forces and discuss the results in the NUT spacetime.

GR 5.5 Di 15:10 VMP6 HS A

On relativistic geodesy and orbit deviations — •Dennis Philipp[1], Claus Laemmerzahl[1,2], Volker Perlick[1], and Dirk Puetzfeld[1] — [1]ZARM, University of Bremen, Bremen, Germany — [2]University of Oldenburg, Oldenburg, Germany

For metrology, geodesy and gravimetry in space, satellite based instruments and measurement techniques are used and the orbits of the satellites as well as possible deviations between nearby ones are of central interest. The measurement of this deviation itself gives insight into the underlying structure of the spacetime geometry, which is curved and therefore described by the theory of general relativity. We investigate the deviation of nearby orbits that can be modeled using the relativistic deviation equation (Jacobi equation for first order deviations) and we comment on the applicability and physical effects that can be described within this framework.

GR 5.6 Di 15:25 VMP6 HS A

A general pseudo-Newtonian limit of geodesic motion — •Vojtech Witzany — ZARM, Universität Bremen, Am Fallturm, 28359 Bremen, Germany

Almost from the very first investigations into the nature of black-hole accretion, astrophysicists have used "pseudo-Newtonian" potentials to describe the dynamics of accretion discs. These potentials seamlessly reduce to the Newtonian gravitational potential in the far-field limit, but posses simple modifications in the close field to mimic some of the key features of particle motion near a black hole.

Recently, a new class of elegantly derived and accurate velocity-dependent potentials emerged in the literature raising the question whether there is a general pseudo-Newtonian description for any spacetime. In this talk, I will show that there is such a description both for massive and massless particle motion, and that this description can give exact coordinate-time-parametrized null geodesics in stationary space-times. Futhermore, I will demonstrate the effectivity of this description in the Kerr space-time.

GR 5.7 Di 15:40 VMP6 HS A

Parameterized post-Newtonian limit of Horndeski's gravity theory — •Manuel Hohmann — Physikalisches Institut, Universität Tartu, Estland

We discuss the parameterized post-Newtonian (PPN) limit of Horndeski's theory of gravity, also known under the name generalized G-inflation or G^2-inflation, which is the most general scalar-tensor theory of gravity with at most second order field equations in four dimensions. We derive conditions on the action for the validity of the post-Newtonian limit. For the most general class of theories consistent with these conditions we calculate the PPN parameters $\gamma(r)$ and $\beta(r)$, which in general depend on the interaction distance r between the gravitating mass and the test mass. For a more restricted class of theories, in which the scalar field is massless, we calculate the full set of PPN parameters. It turns out that in this restricted case all parameters are constants and that the only parameters potentially deviating from observations are γ and β. We finally apply our results to a number of example theories, including galileons and different models of Higgs inflation.

GR 6: Black Holes and other Black Objects

Zeit: Dienstag 16:45–19:05 Raum: VMP6 HS A

Hauptvortrag GR 6.1 Di 16:45 VMP6 HS A
A No-Hair Theorem for Astrophysically Relevant Black Holes — •Norman Gürlebeck — ZARM, University of Bremen, Germany

With the upcoming capabilities to observe black holes, it will be feasible to measure their properties with unprecedented detail. In particular, it will become possible to carry out so-called tests of the no-hair theorem. The no-hair theorem states that black holes are entirely characterized by their mass, angular momentum and charge alone. For this result to hold, the black hole must be isolated, i.e., there should be no additional sources of the gravitational field in their neighborhood like accretion disks. However, measurements of the angular momentum of the black hole rely heavily on the existence of such an accretion disk. Naturally, the question arises if the additional matter, say, an accretion disk impedes the suggested tests of the no-hair theorem. I will give a possible formulation of the no-hair theorem for such astrophysical black holes surrounded by matter alongside with a proof for static black holes. The proof employs the source integral formalism, which I review shortly. Perturbative approaches showed that deformations of black holes, which are immersed in an external gravitational field, measured by the second Love numbers vanish. But there was no consensus whether this result is still valid in case higher orders of the perturbation schemes are considered. The here presented no-hair theorem also implies that the second Love numbers of black holes vanish in full general relativity settling this debate also for the strong field regime. In the end of my talk, I will apply the developed formalism to existence and uniqueness questions in mathematical relativity.

GR 6.2 Di 17:25 VMP6 HS A
Lower-Dimensional Black Hole Chemistry — •antonia frassino[1,2], robert mann[2,3], and jonas mureika[4] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Perimeter Institute, Waterloo, Ontario, Canada — [3]Department of Physics and Astronomy, University of Waterloo, Waterloo, Ontario, Canada — [4]Department of Physics, Loyola Marymount University, Los Angeles, California USA

We will address the issue of the phase structure for black holes in Anti-deSitter space, by treating the cosmological constant as a thermodynamic pressure within the black hole chemistry paradigm.

In particular, we will focus on the connection between black hole thermodynamics and chemistry in the lower-dimensional gravity regime by analysing rotating and charged BTZ metrics in the (2+1)-D and (1+1)-D limits of Einstein gravity.

GR 6.3 Di 17:45 VMP6 HS A
Constructing highly deformed non-uniform black string solutions — •Michael Kalisch and Marcus Ansorg — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Germany

We construct numerically static non-uniform black string solutions in five and six dimensions by using pseudo-spectral methods. An appropriately designed adaptation of the methods in regard of the specific behaviour of the field quantities in the vicinity of our numerical boundaries provides us with extremely accurate results, that allows us to get solutions with an unprecedented deformation of the black string horizon. Consequently, we are able to investigate in detail a critical regime within a suitable parameter diagram. In particular, we observe three clearly pronounced turning points in the curves of thermodynamic quantities, resulting in a spiral curve in the black string's phase diagram.

GR 6.4 Di 18:05 VMP6 HS A
Thermodynamics of a rotating black hole in minimal five-dimensional gauged supergravity — •Saskia Grunau and Hendrik Neumann — Carl von Ossietzky Universität Oldenburg

We study the thermodynamics of a general non-extremal rotating black hole in minimal five-dimensional gauged supergravity. Therefore we analyse the entropy-temperature diagram and the free energy. Additionally the thermodynamic stability is considered by calculating the specific heat, the isothermal moment of inertia tensor and the adiabatic compressibility.

GR 6.5 Di 18:25 VMP6 HS A
Analytic solutions of the geodesic equation for Einstein-Maxwell-dilaton-axion black holes — •Kai Flathmann and Saskia Grunau — Institut für Physik, Universität Oldenburg, D-26111 Oldenburg, Germany

In this talk we present the geodesic motion of test particles and light in the Einstein-Maxwell-dilaton-axion spacetime. This family of black hole solutions is characterized by 4 constants: mass, angular momentum, dilaton and axion charge. We only consider black holes with vanishing axion charge. The equations of motion are of elliptic type and their solutions are given in terms of the Weierstraß $\wp$, σ and ζ functions. With the help of parametric diagrams and effective potentials we analyze the geodesic motion and give a list of all possible orbit types.

GR 6.6 Di 18:45 VMP6 HS A
On gravity self-completeness on Anti-de Sitter background — •Sven Köppel[1,2], Antonioa Frassino[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

Recently Dvali proposed a new interpretation of the concept of a black hole, that turns out to be a condensate of gravitons. We present in this talk a metric model able to capture the properties of the graviton condensate beyond the semiclassical limit. We present also the effects of extra-dimension on the geometry and thermodynamics of such a new metric, as well as, the inclusion of an Anti-de Sitter cosmological term.

GR 7: Cosmology

Zeit: Mittwoch 16:45–19:05 Raum: VMP6 HS A

Hauptvortrag GR 7.1 Mi 16:45 VMP6 HS A
Back in the saddle: Large-deviation statistics of the cosmic log-density field — •Cora Uhlemann — 1 Institute for Theoretical Physics & Center for Extreme Matter and Emergent Phenomena, Utrecht University, Leuvenlaan 4, 3584 CE Utrecht, The Netherlands

We present a first principle approach to obtain analytical predictions for spherically-averaged cosmic densities in the mildly non-linear regime that go well beyond what is usually achieved by standard perturbation theory. A large deviation principle allows us to compute the leading-order cumulants of average densities in concentric cells. In this symmetry, the spherical collapse model leads to cumulant generating functions that are robust for finite variances and free of critical points when logarithmic density transformations are implemented. Hence, they yield accurate density probability distribution functions (PDFs) from a straightforward saddle-point approximation valid for all density values. Based on this easy-to-implement modification, explicit analytic formulas for the evaluation of the one- and two-cell PDF are provided. The theoretical predictions obtained for the PDFs are accurate to a few percent compared to the numerical integration, regardless of the density under consideration and in excellent agreement with N-body simulations for a wide range of densities. This formalism should prove valuable for accurately probing the quasi-linear scales of low redshift surveys for arbitrary primordial power spectra. The large deviation principle exemplified here extends far beyond this concrete application and can be invoked for any cosmological quantities taken in concentric cells.

GR 7.2 Mi 17:25 VMP6 HS A
Cosmology with the Square Kilometre Array and its Pathfinders — •Dominik Schwarz — Universität Bielefeld

Observations at radio frequencies played a crutial role in establishing the isotropy and vast size of the Universe in the early days of our modern cosmological model. With the discovery of the cosmic microwave background, radio observations had to step back. With the development of a new generation of radio facilities like LOFAR and the SKA, which allow for all-sky, sensitive and fast surveys, there are now new windows of opportunity for game changing cosmologial observations in radio, especially via HI observations. I'll focus in my talk on how those observations will be unique cosmological probes.

GR 7.3 Mi 17:45 VMP6 HS A

Models of reionization and dark matter decay — •Isabel Oldengott, Daniel Boriero, and Dominik Schwarz — Universität Bielefeld

We investigate two different parametrizations of cosmic reionization and their impact on the CMB anisotropy spectrum. We furthermore include an additional source of reionization which we assume to be the decay of a dark matter species and which can in principle modify the ionization history of the universe already at relatively high redshifts. Given the uncertainties of cosmic reionization we want to understand how reliably we can constrain dark matter quantities like the decay rate.

GR 7.4 Mi 18:05 VMP6 HS A

Galactic center analysis with Fermi LAT Pass 8 data and limits on dark matter annihilation — •Dmitry Malyshev for the Fermi LAT-Collaboration — ECAP, Erwin-Rommel str. 1, Erlangen, Germany

We study the excess emission around a few GeV towards the Galactic center (GC) with Pass 8 Fermi-LAT data and estimate the uncertainty of its spectrum due to diffuse emission modelling. In particular, we test several GALPROP models of Galactic diffuse emission, develop an alternative distribution of gas along the line of sight based on starlight extinction data, model the Fermi bubbles at low latitudes, and test additional sources of cosmic ray electrons near the GC. We find that in all models that we have tested the excess emission persists. As an alternative approach to estimate the uncertainty due to diffuse emission modelling we perform a scan of a cusp template along the Galactic plane. We find that the excess emission as a fraction of the background is comparable to the uncertainties found elsewhere in the Galactic plane. We put limits on DM annihilation assuming that DM particles cannot produce a signal that exceeds the uncertainties due to diffuse emission modelling.

GR 7.5 Mi 18:25 VMP6 HS A

Dark Energy Is Obsolete in Einstein-Dicke Cosmology — •Alexander Unzicker — Pestalozzi-Gymnasium München

Einstein's very first idea when dealing with general relativity was considering a variable speed of light in 1911. As it is little known, Robert Dicke in 1957 constructed an almost equivalent theory of gravity that is in agreement with all classical tests. However, Dicke's model leads to a different cosmology in which the redshift of distant galaxies is caused by a decrease of the speed of light.

Since there is no expansion of matter, just the spreading of light, no slowdown of the expansion due to gravity is expected. This absence of deceleration is precisely the anomaly (sometimes called 'empty universe' model of supernova data) that is usually interpreted as accelerated expansion, caused by a hypothetical substance called dark energy. In Dicke's model, there is no need for dark energy, because the expansion of the universe itself is an illusion, originating from a decrease of the speed of light over cosmological times.

GR 7.6 Mi 18:45 VMP6 HS A

Weltpotentialtheorie (WPT) mit stabil statischer Kosmologie — •Peter Wolff — Calfreisen

Zur WPT gibt es im Netz eine Leseempfehlung: www.wolff.ch/astro/WPT-Lesetipp.pdf

Bei genügendem Interesse werde ich die Kernpunkte der WPT in einem Kurzvortrag vorstellen.

GR 8: Poster

Zeit: Mittwoch 17:30–19:00 Raum: VMP6 Foyer

GR 8.1 Mi 17:30 VMP6 Foyer

Visualizing Kerr Spacetime — •Thomas Reiber — Universität Hildesheim

Ray Tracing methods are used to calculate images of a background scenery as seen by an observer in Kerr spacetime. Contrary to most simulations I use the maximal analytic extension of Kerr spacetime as described by Boyer and Lindquist in 1967. The program is to be developed towards an interactive flight simulator.

GR 8.2 Mi 17:30 VMP6 Foyer

Exploring the Event Horizon of a Black Hole — •Ute Kraus and Corvin Zahn — Universität Hildesheim

We present a sector model of a Schwarzschild black hole describing the spacetime both outside and inside the event horizon. The model illustrates the event horizon, the singularity and the causal structure of the black hole spacetime.

Sector models describe spacetimes as in the Regge calculus by subdivision into blocks with Minkowski geometry. The description is based on measurable lengths and so is coordinate-free.

GR 8.3 Mi 17:30 VMP6 Foyer

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 8.4 Mi 17:30 VMP6 Foyer

Gravitationswellen binärer Systeme in expandierendem Universum — •Marco Orts[1,2] und Nikodem Szpak[2] — [1]Fakultät für Physik, Ludwigs-Maximilians-Universität München — [2]Fakultät für Physik, Universität Duisburg-Essen

Wir haben Gravitationswellen im expandierenden Universum untersucht, ein Thema das mit fortschreitender Detektorsensitivität weiter an Bedeutung gewinnen wird. Die Suche nach Gravitationswellen benötigt die erwartbaren Signalformen als Filter, um im stochastischen Hintergrund die Signale der Quellen detektieren zu können. Hierbei ist ein Einfluss der Expansion des Universums insbesondere bei fernen Objekten mit starker Rotverschiebung zu erwarten. Wir berechnen für binäre Systeme die theoretisch beobachtbaren Signale mit Hilfe der Greenfunktion der Gravitationswellen auf expandierendem Hintergrund. Besondere Aufmerksamkeit gilt dabei den Effekten der Propagation, die aus der Dynamik der Hintergrundmetrik resultieren. Die Größenordnung und die Signalform dieser Effekte wird berechnet und mit der Signalstärke der anderen Anteile verglichen. Hierbei ergibt sich, dass die Echoeffekte für eine Detektion in naher Zukunft nur eine untergeordnete Rolle spielen. Sie können bei bestimmten Quellenparameter aber die dominante Korrektur darstellen.

GR 8.5 Mi 17:30 VMP6 Foyer

General Relativistic Corrections for Free Falling Bose-Einstein Condensates in Fermi Coordinates — •Oliver Gabel and Reinhold Walser — Institut für Angewandte Physik, Technische Universität Darmstadt, Hochschulstr. 4a, 64289 Darmstadt

Measuring general relativistic effects in the gravitational field of the Earth is a main goal of current research in atom interferometry. In this context, the QUANTUS collaboration is aiming at a test of the Einstein equivalence principle for quantum matter, having demonstrated Bose-Einstein condensates (BECs) and interferometry in free fall [1,2].

In this contribution, we show how free falling BECs can be described at the mean-field level in terms of the non-linear Klein-Gordon equation and Fermi normal coordinates. We study the arising frame-dependent corrections to Newtonian physics in Schwarzschild spacetime as well as in a parametrised post-Newtonian setting for different centre-of-mass world lines.

[1] T. van Zoest et. al., *Bose-Einstein Condensation in Microgravity*, Science, **328**, 1540 (2010).
[2] H. Müntinga et. al., *Interferometry with Bose-Einstein Condensates in Microgravity*, Phys. Rev. Lett. **110**, 093602 (2013).

GR 8.6 Mi 17:30 VMP6 Foyer

TARGET: an integrated readout electronics for Cherenkov Telescopes — •Adrian Zink, Stefan Funk, and Manuel Kraus — ECAP, Erlangen, Deutschland

TARGET is an Application Specific Integrated Circuit (ASIC) designed for the readout of different photosensors in various types of experiments. The ASIC is capable of sampling at high rates (typically 1 GSamples/s), digitizing with 12-bit precision and to supply trigger information.

The small package size, high integration (16 channels/ASIC), deep buffer for trigger latency (16μs at 1 GS/s) and low cost per channel make TARGET an excellent candidate for systems with large number of telescopes equipped with a compact silicon and multi-anode photomultipliers, like the Cherenkov Telescope Array (CTA).

The TARGET concept, performance studies and the integration in a prototype camera will be presented.

GR 8.7 Mi 17:30 VMP6 Foyer

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

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

However, there is an unspectacular explanation for this observation.

We can assume that the speed of light 'c' was higher in earlier times. Inserting this into the Doppler equation for determining early speeds using red shifts yields higher speeds for early stars. So there is no acceleration.

Mainstream physics objects to this, however, arguing that according to Einstein c has always been constant. This was not clearly stated by Einstein, however, and is anyway in conflict with the assumed cosmological inflation:

Cosmological inflation was introduced to explain the horizon problem, i.e. the apparent logical connection of parts of the universe far apart from each other. It assumes that after the big bang 'space' was extremely small. It then expanded, first rapidly then slowly, up to the present day. But to what is c related? To the actual size of space or to an assumed non-changing background? The first assumption would not be a solution for the horizon problem; the second means that, in relation to actual space c has to decrease with time; which refutes dark energy.

GR 8.8 Mi 17:30 VMP6 Foyer

Das universelle Potential und die Gravitation: dunkle Massen und Energie — •Arnold Stangl[1] und Rolf Stangl[2] — [1]BRD, 85579 Neubiberg, Albrecht-Dürer-Str. 9A — [2]Singapur, nus.edu.sg

Bekannte gravitative Phänomene werden über ein universelles Bezugspotential (Energiedichte zu Massendichte) energetisch gedeutet.

Das konstante universelle Potential erfüllt den Raum und behindert nicht die Bewegung von Himmelskörpern. Die Einlagerung einer kompakten Masse erzeugt einen Potentialgradienten ("Massen krümmen den Raum"). Dieser verleiht einem Probekörper Schwere ("Der gekrümmte Raum schreibt den Massen ihre Bewegung vor"). Die eingelagerte Masse ruht im Gradientenfeld des universellen Potentials (Schwerefeld). Um sie zu verschieben bedarf es einer Kraft, der Trägheitskraft (Gleichheit von Trägheit und Schwere).

Die Materie im Kosmos setzt sich zusammen aus bekannter, gravitativ wirksamer stofflicher Materie (~3%), aus unbekannter, gravitativ wirksamer, kompakter, dunkler Materie (~24%), und unbekannter, dunkler Energie (~73%), eine Konsequenz der OMEGA-Gleichung.

Die neue Deutung lautet: Es gibt keine kompakten , dunklen Massen. Sie werden ersetzt durch gravitativ wirkende, nicht an stoffliche Materie gebundene Massenäquivalente. Diese entstehen durch Einlagerung kompakter Massen in das universelle Potential.

Viele gravitativen Phänomenen sind so erklärbar:: konstante Umlaufgeschwindigkeit von Sternen am Galaxienrand; Zusammenhalt ganzer Galaxien/Galaxienverbände und der die Galaxien umgebende HALO.

GR 8.9 Mi 17:30 VMP6 Foyer

Die Entropie des Universums: S(Univ.)=-(5/6) x log(5/6) — •Norbert Sadler — Wasserburger Str. 25a ; 85540 Haar

Wird das Universum als ein komplexes, thermodynamisches System verstanden, kann die Entropie bzw. die Enthalpie des Universums bestimmt werden.

Die Entropie des Universums ist ein Maß für die Größe der Energieentwertung bei den spontanen Mikro-Systemübergängen der primordinalen Nukleosynthese des Protonenäquivalentes von (0.9384 GeV), der Wechselwirkungsquanten der 3 Naturkräfte, der Energiedichteverteilung im Universum sowie der adiabatisch extrahierten Gravitation.

Durch Anwendung der Explorativen-Faktorenanalyse konnte die Komplexität des Makrosystems (Phasenraum) auf die Anzahl von (5/6) Mikrosysteme verringert und in Form eines universellen Gesetzes, der Entropie des Universums, verstanden und bestimmt werden.

Die Entropie des Universums: S(Univ.)=-(5/6) x log(5/6)=0.0659.

Weitere Darstellungen: S(Univ.)=(1-(0.9384))/(0.9384).

S(Univ.)=(23.8%Mat.)x(70%dkl.E.)/(2.5GeV Prot.Confinement).

S(Univ.)=(5/6)/(4Pi)=(1/6)-(1/10) der Primfaktor des Univ.

Die Entropie S(Univ.) ist der universelle Primfaktor und eine Grundform der "Theorie von Allem".

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

GR 8.10 Mi 17:30 VMP6 Foyer

Überprüfungen der Weltpotentialtheorie — •Peter Wolff — Calfreisen

Die Weltpotentialtheorie (WPT) basiert auf einer neuen kosmischen Gravitation mit stabil statischer Kosmologie.

Die wichtigsten kosmischen Beobachtungen werden plakativ den theoretischen WPT- und ΛCDM-Erwartungen gegenübergestellt: www.wolff.ch/astro/WPT-Plakat_2.pdf

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

GR 8.11 Mi 17:30 VMP6 Foyer

Lorentz interpretation of GRT – the book and its review — •Jürgen Brandes — Karlsruhe, Germany

Dr. habil. Ludwig Neidhart reviewed the book [1] concerning Lorentz interpretation of SRT and GRT written by J. Brandes and J. Czerniawski. He recommends book [1] even to those who are critical against Lorentz interpretation of GRT (LI of GRT) and especially to those who don't know it at all: "Auch wer dem Standpunkt der Autoren kritisch gegenübersteht, wird es mit Gewinn lesen können, weil . . . [2]". Also, the well-known gravitational physicist Kip S. Thorne accepts both standpoints as correct, the curved spacetime paradigm or classical GRT and the flat spacetime paradigm or LI of GRT. He asks: "Is spacetime really curved? Isn't it conceivable that spacetime is actually flat, but the clocks and rulers with which we measure it . . . are actually rubbery?" and his answer is: "Yes." [2]. The poster presents these ideas and the total review of L. Neidhart.

[1] J. Brandes, J. Czerniawski: *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen - Einstein- und Lorentz-Interpretation, Paradoxien, Raum und Zeit, Experimente*, 4. Aufl., VRI 2010, [2] Website www.grt-li.de

GR 8.12 Mi 17:30 VMP6 Foyer

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

SR as derived by Einstein is the product of an approach of 1905 when the quantized nature of matter was still not accepted by everybody (God doesn*t throw dice). It is a rough undifferentiating approach which omits the origin of the constancy of light speed in inertial frames, arriving to wondrous results about time and space. With the findings made during the last 100 years by experimentalists, an update of Einstein*s theoretical approach is more than overdue. Based on these findings, a theoretical approach is presented taking into consideration that the constancy of light speed in inertial frames is due to the emission of light with light speed *c* relative to its source, which includes also refracted and reflected light in a medium with index n=1. The results are transformation rules without time and space distortions and a consistent theory without paradoxes. More at www.odomann.com

GR 8.13 Mi 17:30 VMP6 Foyer

Demonstration of a Logical Conflict in Special Relativity —

•Albrecht Giese — Taxusweg 15, 22605 Hamburg

Einstein's Special Relativity comprises changes (i.e. the contraction) of space in motion. After a Lorentz transformation into another inertial system - performed according to the rules given by Einstein - distances are altered.

We will present a mechanical experiment containing two connected motions, which violate Einstein's concept. We will show that two objects which are in immediate contact (mechanically connected) in one inertial system will appear separated once they are relativistically transformed into another inertial system. This is ontologically incorrect.

To stimulate a discussion, we are offering a reward of € 100 to the first three persons who can show that this mechanical process is not in conflict with Einstein's concept of relativity.

We will further show that this logical conflict does not occur when the Lorentzian view of relativity is applied.

GR 9: Quantum Cosmology

Zeit: Donnerstag 8:30–9:50 Raum: VMP6 HS A

GR 9.1 Do 8:30 VMP6 HS A

Comparison of a quantum cosmology scenario with observations — •Susanne Schander[1,2], Aurélien Barrau[2], Boris Bolliet[2], Julien Grain[3], Linda Linsefors[2], and Jakub Mielczarek[2] — [1]TU Kaiserslautern, Germany — [2]LPSC Grenoble, France — [3]CNRS, Orsay, France

In the cosmological context, it is often argued that all physical events that happened before inflation are washed out by the latter, such that a priori quantum cosmology models are not testable. In this talk, based on arXiv:1508.06786 and arXiv:1510.08766, I am going to present cosmological results obtained by investigation of a quantum cosmology scenario within the loop approach that can be compared to observations, and refute in this way the above assertion. In particular, I will present the primordial power spectrum of scalar perturbations in loop quantum cosmology within the deformed algebra approach, and with a massive scalar field as the matter content of the Universe, which allows us to generate the angular power spectrum as it was measured very recently by cosmologists (PLANCK Collaboration 2015). The results will be compared to these observations, showing an incompatibility with the latter. This refutes the initial hypothesis that, in general, quantum cosmology models cannot be falsified.

GR 9.2 Do 8:50 VMP6 HS A

How does canonical quantum gravity affect inflationary perturbations? — David Brizuela[1], Claus Kiefer[2], and •Manuel Krämer[3] — [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 present detailed calculations for quantum-gravitational corrections to the power spectra of gauge-invariant scalar and tensor perturbations during inflation. We use canonical quantum gravity with the Wheeler–DeWitt equation as our formalism and perform a semiclassical Born–Oppenheimer type of approximation to obtain a Schrödinger equation with quantum-gravitational correction terms. As a first step, we carry out our calculation for a pure de Sitter universe and find that the correction terms lead to an enhancement of power on the largest scales. Furthermore, we present numerical methods to give an estimate for the modification of the corrections in the case of slow-roll inflation.

GR 9.3 Do 9:10 VMP6 HS A

A perfect bounce in quantum cosmology — •Steffen Gielen[1] and Neil Turok[2] — [1]Theoretical Physics, Blackett Laboratory, Imperial College London, London SW7 2AZ, United Kingdom — [2]Perimeter Institute for Theoretical Physics, Waterloo ON N2L 2Y5, Canada

We study the quantum cosmology of a universe with conformal matter comprising a perfect radiation fluid and a number of conformally coupled scalar fields. For FRW backgrounds, we are able to perform the path integral exactly; the evolution describes a "perfect bounce," in which the universe passes smoothly through the singularity. The Feynman path integral amplitude is precisely that of a relativistic oscillator, for which the scale factor of the universe is the time and the scalar fields are the spatial coordinates. We also study the quantum evolution of anisotropies (for a Bianchi I model) and of inhomogeneous perturbations, at linear and nonlinear order, viewed as a "scattering process" between incoming and outgoing asymptotic modes. We provide evidence for a semiclassical description in which all fields pass around the cosmological singularity along regular, complex classical paths.

GR 9.4 Do 9:30 VMP6 HS A

Cosmology of Born-Infeld type models — Alexander Kamenshchik[1,2], Claus Kiefer[3], and •Nick Kwidzinski[3] — [1]Dipartimento di Fisica e Astronomia, Università di Bologna and INFN, Bologna, Italy — [2]L.D. Landau Institute for Theoretical Physics of the Russian Academy of Sciences, Moscow, Russia — [3]Institut für Theoretische Physik, Universität zu Köln, Köln, Germany

We discuss the classical and quantum cosmology of a universe filled with a tachyon condensate and other Born-Infeld type fields. We analyse, in particular, the cases with a constant potential and with an inverse square potential. We apply the Wheeler-DeWitt equation of canonical quantum gravity to these models and show how it can be appropriately reformulated as a difference equation.

GR 10: Relativistic Astrophysics

Zeit: Donnerstag 11:00–12:40 Raum: VMP6 HS A

GR 10.1 Do 11:00 VMP6 HS A

About the internal structure of neutron star merger products — •Matthias Hanauske[1,2], Kentaro Takami[2], Luciano Rezzolla[1,2], and Horst Stöcker[1,2] — [1]Institut für Theoretische Physik, Max-von-Laue-Straße 1, 60438 Frankfurt, Germany — [2]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Straße 1, 60438 Frankfurt, Germany

Gravitational waves emitted from merging neutron star binaries are on the verge of their first detection with advanced gravitational-wave interferometers. Depending on the initial masses of the system, the binary merger product could generate a hypermassive neutron star (HMNS) or promptly form a black hole surrounded by a hot and dense torus. Fully general relativistic numerical simulations of merging neutron star binaries are able to describe the overall evolution ranging from the inspiral and merger phase up to the post merger, collapse and ringdown phase. The emitted gravitational-wave signal from the produced HMNS is composed of specific characteristics of the equation of state of matter which can be analysed from its spectral features. This talk will focus on the internal HMNS properties (e.g. differential rotation profiles, structure of the space-time metric, particle composition and hadron-quark phase transition) and their connection with the emitted gravitational-wave signal.

GR 10.2 Do 11:20 VMP6 HS A

A large-scale dynamo and magnetoturbulence in rapidly rotating core-collapse supernovae — Philipp Mösta[1,2], Christian Ott[2], David Radice[2], Luke Roberts[2], Erik Schnetter[3,4,5], and •Roland Haas[6] — [1]Department of Astronomy, 501 Campbell Hall #3411, University of California at Berkeley, Berkeley, California 94720, USA — [2]TAPIR, Walter Burke Institute for Theoretical Physics, Mailcode 350-17, California Institute of Technology, Pasadena, California 91125, USA — [3]Perimeter Institute for Theoretical Physics, Waterloo, Ontario N2L 2Y5, Canada — [4]Department of Physics, University of Guelph, Guelph, Ontario N1G 2W1, Canada — [5]Center for

Computation & Technology, Louisiana State University, Baton Rouge, Louisiana, 70803, USA — [6]Max Planck Institute for Gravitational Physics, Am Mühlenberg 1, 14476 Potsdam-Golm, Germany

We report on a recent simulation of magnetohydrodynamics turbulence resolving the MRI in a global, three-dimensional core collapse supernova simulation.

MRI and the dynamo mechanism are expected to be the engine to supply energy to hypernovae, yielding the most energetic explosions observed in the Universe. Using very high resolution simulations we observe the development of a large-scale toroidal magnetic field generated through MRI and dynamo action. We observe an inverse cascade of energy to larger scales suitable to drive outflows along the axis of rotation.

GR 10.3 Do 11:40 VMP6 HS A

Rapidly rotating neutron stars in Einstein-Gauss-Bonnet dilaton theory — •Sindy Mojica[1], Burkhard Kleihaus[1], Jutta Kunz[1], and Marco Zagermann[2] — [1]University of Oldenburg — [2]University of Hannover

Motivated by string theory, we studied neutron stars in Einstein Gauss Bonnet dilaton theory (EGBD). Neutron stars are considered as laboratories to test general relativity and theories beyond. We calculated observables such that: mass, angular momentum, moment of inertia and quadrupole moment for rapidly rotating neutron stars in EGBD gravity.

In order to determine the dependence on neutron stars matter constituents and the coupling parameter from the EGBD approximation, we have proven that universal relations for neutron stars may exist in EGBD theory, when the angular momentum is fixed and the moment of inertia and quadrupole moment are scaled.

GR 10.4 Do 12:00 VMP6 HS A

Quantifying the Kelvin-Helmholtz instability in interstellar jets with radiation observable on Earth — •Richard Pausch[1,2], Alexander Debus[1], Axel Huebl[1,2], Klaus Steiniger[1,2], René Widera[1], and Michael Bussmann[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf — [2]Technische Universität Dresden

We present a new diagnostic method to both identify the presence of the Kelvin-Helmholtz instability (KHI) in interstellar plasma jets and determine its growth rate by measuring the emitted radiation.

Based on the electron dynamics inside the KHI vortices, we derive the emitted radiation power and polarization and show their correlation to the magnetic field evolution, driving the instability. These correlations are verified against simulations of the relativistic KHI using the 3D3V particle-in-cell code PIConGPU. It determines the angularly resolved radiation spectra for billions of electrons using generally valid Liénard-Wiechert potentials. The simulation shows that the growth rate correlation between radiation power and magnetic field agrees over orders of magnitude for the entire linear phase of the KHI while the polarization signature allows a clear identification of this phase.

The method presented can resolve the question whether the KHI occurs in astro-physical particle jets and furthermore provides quantitative insides to the jet dynamics by analyzing the radiation observable on Earth.

GR 10.5 Do 12:20 VMP6 HS A

Quasi-normal modes of realistic neutron stars in Einstein-Gauss-Bonnet-dilaton theory — •Jose Luis Blazquez Salcedo — Oldenburg University ,Oldenburg, Germany

In this talk we present our results on quasi-normal modes (QNM) of realistic neutron stars in Einstein-Gauss-Bonnet-dilaton (EGBd) gravity. We consider 8 realistic equations of state for nuclear, hyperonic, and hybrid matter. We focus on the fundamental curvature mode of the axial component, and compare the results with those of pure Einstein theory. Our results show that the QNM of neutron stars in EGBd theory present higher frequencies than the QNM of stars in Einstein theory. On the other hand, the impact on the damping time of the Gauss-Bonnet-dilaton term is typically smaller. We study universal relations for the QNM spectrum of these configurations, and obtain that relations valid in pure Einstein theory are also valid in EGBd gravity. We will explain how these results could be used to constraint the EGBd parameters using gravitational wave detections.

GR 11: Classical General Relativity II

Zeit: Donnerstag 13:45–16:05 Raum: VMP6 HS A

Hauptvortrag GR 11.1 Do 13:45 VMP6 HS A

Fresnel-Kummer wave surfaces in transparent (meta)materials, the Kummer tensor in general relativity, and beyond — Alberto Favaro[1] and •Friedrich W. Hehl[2] — [1]Imperial College London — [2]Univ. of Cologne and Univ. of Missouri, Columbia

The premetric Maxwell equations are expressed in terms of the excitations (D, H) and field strengths (E, B). A material with local and linear constitutive law carries, besides permittivities and permeabilities, magnetoelectric terms. In a spacetime description, this yields a 4th rank constitutive tensor χ with $36 = 20{+}15{+}1$ independent components. We restrict ourselves to the reversible case with 21 components. The light propagation in such a material is described by quartic Fresnel surfaces, which are determined by a 4th rank tensor $\mathcal{G}$ cubic in χ, that is, $\mathcal{G} \sim \chi^3$. We show that these Fresnel surfaces are Kummer surfaces (from algebraic geometry) and study some of their singularities. — In general relativity, we can define analogously a 4th rank Kummer tensor $\mathcal{K}$ that is cubic in the 20 compoment Riemann tensor R, that is, $\mathcal{K} \sim R^3$. The Kummer tensor is related to the Petrov classification of the gravitational field. We generalize these results to the Poincaré gauge theory of gravity with a 36 components curvature tensor.

See Baekler, Favaro, Itin, fwh, Ann. Phys. (NY) 349, 297 (2014); Favaro, fwh, arXiv:1510.05566v1

Hauptvortrag GR 11.2 Do 14:25 VMP6 HS A

Influence of a plasma on gravitational lensing by compact objects — •Volker Perlick — ZARM, University of Bremen, Germany

I discuss light bending by compact objects (black holes, wormholes, ultracompact stars, etc.) that are surrounded by a plasma. The plasma is assumed to be pressureless (“cold”), non-magnetised and optically thin. After deriving the general formula for the bending angle in a plasma under the assumption of spherical symmetry and staticity, I discuss in some detail the angular diameter of the shadow of a compact object in a plasma, again under the same symmetry assumptions. The Schwarzschild spacetime and the Ellis wormhole are treated as particular examples. In the last part, I consider a plasma on the Kerr spacetime. The perspectives of actually observing the discussed effects with supermassive black holes will be addressed as well. - The talk is largely based on joint work with Oleg Tsupko and Gennady Bisnovatyi-Kogan (Space Research Institute, Russian Academy of Science, Moscow).

GR 11.3 Do 15:05 VMP6 HS A

Spielzeugmodel eines relativistischen Akkretionsflusses in Kerr-Newman Raum-Zeit — •Kris Schroven, Eva Hackmann und Claus Lämmerzahl — ZARM, University of Bremen, Am Fallturm, 28359 Bremen, Germany

Wir stellen ein relativistisches Spielzeugmodel vor, welches den stationären Akkretionsfluss einer rotierenden Wolke aus nicht wechselwirkenden Teilchen beschreibt, die auf ein Kerr-Newman Schwarzes Loch fallen. Zur Beschreibung der Stromlinien verwenden wir zeitartige Geodäten, die durch Jacobi-elliptische Integrale ausgrdrückt werden können. Des weiteren wird das zugehörige lokale Geschwindigkeitsfeld bestimmt. Es kann ein analytischer Ausdruck für die äußere Kante der Akkretionscheibe gefunden werden, die sich während des Prozesses der Akkretion bildet. Dieses Spielzeugmodell bietet eine gute Mölichkeit, die Auswirkungen des spezifischen Drehimpulses und die Ladung des schwarzen Loches auf den Verlauf des Akkretionsflusses und die äußere Kante der Akkretionsscheibe in starken Gravitationsfeldern darzustellen.

GR 11.4 Do 15:20 VMP6 HS A

Initial data for an black hole universe — •Michael Fennen[1] and Domenico Giulini[1,2] — [1]ZARM, Universität Bremen — [2]ITP, Universität Hannover

The standard model of cosmology describes the universe as a homogeneous and isotropic fluid on the largest scales very well. But if we consider smaller scales, the matter is actually concentrated in small regions within an almost empty universe. Therefore we construct vacuum intitial data for an inhomogeneous spherical universe where the matter is modelled by black holes. We want to investigate if and how these models resemble a Friedmann universe at the moment of maximal expansion to get a better understanding of the averaging and backreaction problem.

GR 11.5 Do 15:35 VMP6 HS A

General-relativistic ray optics in a nonmagnetized, pressureless two-fluid plasma — •Karen Schulze-Koops[1], Volker Perlick[2], and Dominik Schwarz[3] — [1]Uni Bielefeld/ ZARM — [2]Uni Bremen/ ZARM — [3]Uni Bielefeld

We investigate the influence of a plasma on the propagation of light in a general-relativistic spacetime. We restrict to the simple plasma model of a nonmagnetized, pressureless two-fluid plasma. Applying the Hamilton formalism to light rays we describe how Sachs equations, reciprocity theorem, and distance measures have to be modified when the influence of the plasma is considered. We briefly discuss applications to Robertson-Walker universes.

GR 11.6 Do 15:50 VMP6 HS A

Conformal (Weyl) Gravity — •Patric Hölscher — Bielefeld University, Bielefeld, Germany

Conformal (Weyl) Gravity is a theory which is an alternative to the standard theory of gravity by Albert Einstein. Opposed to the standard theory, which has to impose dark matter and dark energy to agree with the observational data, Conformal Gravity is based on an invariance principle, which leads to a unique action for gravity. By exploiting this invariance principle one is able to tackle astrophysical and cosmological problems like the flattening of rotation curves of galaxies or the cosmological constant problem. Furthermore, this theory provides an approach for a unification of gravity and quantum mechanics. Unfortunately, this theory contains some unsolved problems like the gravitational wave solutions, which could lead to energy conservation being violated.

GR 12: Alternative Theories

Zeit: Donnerstag 13:45–15:25 Raum: VMP6 HS C

GR 12.1 Do 13:45 VMP6 HS C

Special Relativity without paradoxes. — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

SR as derived by Einstein is the product of an approach of 1905 when the quantized nature of matter was still not accepted by everybody (God doesn*t throw dice). It is a rough undifferentiating heuristic approach which omits the origin of the constancy of light speed in inertial frames, arriving to wondrous results about time and space. With the findings made during the last 100 years by experimentalists, an update of Einstein*s theoretical approach is more than overdue. Based on these findings, a theoretical approach is presented taking into consideration that the constancy of light speed in inertial frames is due to the emission of light with light speed *c* relative to its source, which includes also refracted and reflected light in a medium with index n=1. The results are transformation rules without time and space distortions and a consistent theory without paradoxes. GR is the theory of gravitation of the SM and is based on time and space distortions, consequently a revision is also needed. The paper presents an alternative theory for gravitation without paradoxes based on the reintegration of migrated electrons and protons to their nuclei. More at www.odomann.com

GR 12.2 Do 14:05 VMP6 HS C

Relativity: The unneeded phenomenon of space-time — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Our understanding of the theory of relativity is closely tied to the view that Einstein had to change our understanding of space and time. In textbooks we learn that this altered understanding is an inevitable condition for handling relativistic phenomena.

It is essential to understand that Einstein's assumption of space-time is a consequence of his intention to develop SR without assuming a fixed frame of reference (ether). However, Hendrik Lorentz showed early on that the Michelson Morley experiment is not in conflict with the presence of an ether. This was also accepted by Einstein, however it was not in agreement with Einstein's own intuitions.

Regarding GR, Einstein's assumption of a curved 4-dimensional space-time resulted from his strict aim to avoid a fixed frame of reference with respect to acceleration.

However, if we follow the original way in which Lorentz related relativistic phenomena to known physical processes, then the acceptance of a fixed frame of reference with respect to linear motion and also to accelerated motion leads to an interpretation of relativity that is free of paradoxes and much easier to operate. It leaves space and time unaltered and gives additional insights into other physical phenomena.

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

GR 12.3 Do 14:25 VMP6 HS C

Ein universelles Potential als Ursache für das Quadrat von Signalausbreitungsgeschwindigkeiten — •Arnold Stangl[1] und Rolf Stangl[2] — [1]BRD, 85579 Neubiberg, Albrecht-Dürer-Str. 9A — [2]Singapur, nus.edu.sg

Die konstante Lichtgeschwindigkeit und der Gamma-Faktor der speziellen Relativitätstheorie werden üblicherweise kinematisch definiert. Hier erfolgt eine energetische Interpretation als Verhältnis von Energiedichte zu Massendichte. Der Gamma-Faktor ist der Transformationsfaktor zweier Bezugssysteme mit unterschiedlichem Energieniveau. Die Zeitdilatation wird über den Zuwachs an Potential energetisch gedeutet.

Bezugssysteme sind gleichwertig für eine forminvariante Schreibweise der Naturgesetze. Sie können aufgrund eines verschiedenen Potential-Bezugsniveaus unterschieden werden. Der Zuwach am Bezugspotential bewirkt die auftretende Zeitdilatation. Das nicht frei wählbare Potential-Bezugsniveau der speziellen Relativitätstheorie, legt als minimales Bezugspotential des Kosmos, unseren Zeitstandard fest.

Der Quotient von Energiedichte zu Massendichte bestimmt stets das Quadrat von Signalausbreitungsgeschwindigkeiten, auch für niedrigere Geschwindigkeiten. Dies lässt sich allgemein ableiten und über Beispiele belegen

Ergebnis: Nicht die Lichtgeschwindigkeit ist eine Naturkonstante, sondern das minimale Bezugspotential unseres Kosmos. Dieses bestimmt das Quadrat der maximalen Signalausbreitungsgeschwindigkeit.

GR 12.4 Do 14:45 VMP6 HS C

Classical GRT and its Lorentz Interpretation — •Jürgen Brandes — Karlsruhe, Germany

Classical GRT and Lorentz Interpretation of GRT are very similar in their experimental predictions so up to now one cannot decide experimentally between them. But there are other differences. GRT has two formulas concerning the energy of particles in the gravitational field which contradict each other. These are $E = mc^2\sqrt{(1-2GM/rc^2)}$ and $E = mc^2$ both describing the total energy of a particle at rest in the gravitational field. Above this, the second one contradicts the Newtonian limiting case and therefore classical GRT becomes incomplete, too. Within Lorentz Interpretation of GRT these conflicts are solved. Details:

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

[2] Website www.grt-li.de

GR 12.5 Do 15:05 VMP6 HS C

Gravitation, die Krümmung der Entropie des Universums. — •Norbert Sadler — Wasserburger Str. 25a 85540 Haar

Wird das Universum als ein geschlossenes, thermodynamisches Makrosystem angesehen, kann die Gravitation als die Krümmung bzw. Filterung der Entropie des Universums verstanden werden. Durch Anwendung der Explorativen-Faktorenanalyse kann die Komplexität des Phasenraumes verringert und die Entropie des Universums S(Univ.) und die Entropie der mittleren, linearen Energiedichte S((3.96/9) Protonen/1m) bestimmt werden.

S(Univ.)=-(5/6)xlog(5/6); S(lin.E.)=-(3.96)/9)xlog(3.96/9).

Die Faktoren der Analyse betreffen die Energiedichte des Protonengases (Faktor 0.9384**3) und die lineare Energiedichte von ((3.96/9)Prot/1m)x(0.9384)=Faktor 0.413, der Faktor der Gravitation bzw. der Feldstärke des Universums.

Die Faktorenanalyse:
(0.9384)**3=2x((3.96/9)Pr./1m)x(0.9384))=2x(Faktor 0.413).

Thermodynamische Deutung der Gravitation:
(Gravitat.Faktor 0.413)=(2Pi)x S(Univ.)=S(Univ.)/S(lin.E.).

Die Gravitation bzw. Feldstärke resultiert aus der Krümmung bzw. Filterung der S(Univ.) bei der primordinalen Nukleosynthese. Die Gravitation kann somit aus dem universellen Gesetz der Energieerhaltung verstanden werden.

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

GR 13: Quantum Gravity III

Zeit: Donnerstag 16:45–19:05 Raum: VMP6 HS A

GR 13.1 Do 16:45 VMP6 HS A

Background-independent renormalization in spin foam quantum gravity — •Benjamin Bahr — Universität Hamburg

What has become known as "spin foam approach" realises the path integral for quantum gravity as a state sum model. This serves as a computational tool for the physical inner product of loop quantum gravity.

Despite many successes of this formulation in the task for constructing a background-independent theory for quantum gravity, many of its aspects remain unsolved. In particular the renormalization (i.e.: scale-dependent running of coupling constants) of these models is not yet well understood.

In this talk, I will report on the recent advances in defining a background-independent formulation of the Wilsonian RG flow equations. Furthermore, I will demonstrate how asymptotic and RG methods allow for making physical statements about the overall path integral. As an example, we show how the existence of a Minkowski-like vacuum depends on the value of coupling parameters in the state sum.

GR 13.2 Do 17:05 VMP6 HS A

Coupled intertwiner dynamics: a toy model for matter on spin foams — •Sebastian Steinhaus — University of Hamburg, II. Institute f. Theoretical Physics, Germany

The universal coupling of matter and gravity is one of the most important features of general relativity. In spin foam models, a path integral approach related to loop quantum gravity, matter couplings have been defined in the past, but little is known about the mutual dynamics. This is tightly related to the fact that the spin foams are defined on a lattice (more precisely a 2-complex), which generically results in several ambiguities. Furthermore, the geometry "seen" by matter is encoded in the spin foam itself and thus dynamical. One approach to investigate the continuum limit of such systems is via renormalizing (e.g. coarse graining) the theory.

In this talk I will present and discuss the before mentioned issues for a simpler 2D toy model, namely an Ising model coupled to a dynamical background. The distance / coupling between Ising spins will be given by the labels of this background. I investigate the phases of this model by a numerical algorithm (tensor network renormalization) and identify regions (in parameter space) in which the two systems are weakly coupled and regions in which they are strongly coupled.

Based on: Phys.Rev. D92 (2015) 064007 / arXiv:1506.04749 [gr-qc]

GR 13.3 Do 17:25 VMP6 HS A

Towards higher dimensional quantum geometries — •Johannes Thürigen — Albert-Einstein-Institut Potsdam

One way to a quantum description of spacetime geometry is random geometries as generated by matrix and tensor models. Since tensors of rank D come naturally with an interpretation as D-dimensional spacetime manifolds they are a in fact a proposal for D=4 dimensional quantum gravity. Nevertheless, despite huge progress in the understanding of tensor models in recent years, only tree-like and planar regimes have been identified in their 1/N expansion until now. In this contribution we will present a particular tensor model which raises the hope that it will become possible to control also regimes of effective higher dimensionality.

GR 13.4 Do 17:45 VMP6 HS A

Hamilton geometry - Dispersion relations and the geometry of spacetime — •Christian Pfeifer — ITP Uni Hannover, Hannover, Deutschland

One feature how a fundamental theory of quantum gravity is expected to manifest itself in observations is an effective modification of the standard dispersion relation of fundamental point particles in metric spacetime geometry. Since the point particle dispersion relation and the geometry of spacetime are closely intertwined any modification of the dispersion relation leads to a, possibly energy and momentum dependent, modification of the geometry of spacetime. In this talk I will interpret the dispersion relation as Hamilton function on the phase space of test particles on spacetime and show how one can derive the geometry of phase space from the Hamiltonian, similarly as one derives the geometry of spacetime from a metric. Since phase space is composed out of spacetime (configuration space) and momentum space the result for a general Hamiltonian is that not only the spacetime is curved but also the momentum space. Moreover, both, the curvature of spacetime and that of momentum space, depend in general on positions and momenta. I will demonstrate this framework on the example of a perturbation of the metric Hamiltonian $H = g^{-1}(p,p) + \ell h(p,p,p)$ which contains as special cases famous models used in quantum gravity phenomenology.

GR 13.5 Do 18:05 VMP6 HS A

Deformed kinematics and Planck scale modifications of Special Relativity — •Lukas Brunkhorst — ZARM, Universität Bremen

In the absence of gravitational fields, Special Relativity provides a well-tested framework for the description of classical point particle motion. And in fact, as will be shown, algebraic analysis reveals as well that there are not many plausible ways to depart from the Poincaré Lie group of spacetime automorphisms. Entering the category of Hopf algebra, the Kappa-Poincaré algebra then forms the attempt to include quantum gravitational effects. I will present its geometrical nature and discuss the derived notion of spacetime, as well as address the occurence of non-quadratic mass shell conditions.

GR 13.6 Do 18:25 VMP6 HS A

Generalized geometry and non-symmetric gravity — Branislav Jurco[1], •Fech Scen Khoo[2], Peter Schupp[3], and Jan Vysoky[4] — [1]Mathematical Institute, Faculty of Mathematics and Physics, Charles University, Prague, 186 75, Czech Republic. — [2]Department of Physics and Earth Sciences, Jacobs University, Bremen, 28759, Germany. — [3]Department of Physics and Earth Sciences, Jacobs University, Bremen, 28759, Germany. — [4]Mathematical Sciences Institute, Australian National University, Canberra, ACT, Australia.

Generalized geometry provides the framework for a systematic approach to non-symmetric metric gravity theory and naturally leads to an Einstein-Kalb-Ramond gravity theory with totally anti-symmetric contortion. The approach is related to the study of the effective closed string gravity actions.

GR 13.7 Do 18:45 VMP6 HS A

Geometrical structure of electrodynamics in 5D spacetimes as a candidate for quantum gravity — •Wolf-Dieter R. Stein — Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

Considering the Gauss-Bonnet-Chern-Theorem (GBC) for two and four dimensional space-like submanifolds of a five-dimensional spacetime a geometrically given structure of classical electrodynamics different from that discussed by Kaluza and Klein is investigated. Magnetic flux and charge quantization as a result of topology are discussed with regard to the recent finding of quantized orbital magnetic flux in atoms to be fundamental for the quantization of electrodynamics. The dynamics of the system will be discussed within canonical formalism and shows similarities to the time evolution of a quantum mechanical system. The model will be analysed in terms of being a candidate for a quantum theory of gravitation.

GR 14: Experimental Tests

Zeit: Donnerstag 16:45–17:45 Raum: VMP6 HS C

GR 14.1 Do 16:45 VMP6 HS C

Precision test of General Relativity with Galileo navigation satellites — •Daniela Kunst, Sven Herrmann, Felix Finke, Meike List, Benny Rievers, and Dirk Pützfeld — Center of Applied Space Technology and Microgravity (ZARM), University Bremen, Bremen, Germany

Einstein's theory of general relativity leads to various predictions that have already been verified by experiments, such as the perihelion shift of Mercury or the gravitational redshift. The best measurement of the gravitational redshift up to today has been achieved with the Gravity Probe A experiment in 1976 with an uncertainty of $1.4 \cdot 10^{-4}$. Today, two of the Galileo navigation satellites provide us with an excellent opportunity to improve this uncertainty. GSAT0201 and GSAT0202 have accidentally been injected onto an eccentric orbit, so that the onboard accurate, stable atomic clocks experience a daily modulation of the gravitational potential resulting in a measurable dilation of time. Using the data obtained by the satellites and a sophisticated model for the influence of solar radiation pressure on the satellites we aim to analyse the data and determine this time dilation to high accuracy and therewith improve previous results.

This project is supported by the German Space Agency DLR with funds provided by the Federal Ministry of Economics and Technology (BMWi) under grant number DLR 50 WM 1548.

GR 14.2 Do 17:05 VMP6 HS C

First test of the Weak Equivalence Principle in space: Preparation of the data analysis for Microscope — •Stefanie Bremer, Meike List, Benny Rievers, and Hanns Selig — ZARM, Universität Bremen

With the launch of the French satellite Microscope in April 2016, the first space-based experiment to test the Weak Equivalence Principle (WEP) will start. The mission aims at improving the accuracy of the Eötvös parameter η by three orders of magnitude compared to present tests. The experiment is carried out with two capacitive differential accelerometers each equipped with two cylindrical test masses. The satellite will be operated in drag free mode which means that all disturbances are reduced to a minimum by the attitude control system in order to achieve high-precision differential acceleration measurements. Nevertheless residuals will remain due to various sources. In preparation of the data analysis, the Microscope team at ZARM performs simulations in order to characterise the environmental conditions Microscope will be exposed to on its orbit. The simulation results serve as input to the data reduction procedures that are established at ZARM. The project status and the intended data analysis scheme will be presented.

GR 14.3 Do 17:25 VMP6 HS C

Characterization of the TARGET Readout Electronics — •Manuel Kraus, Stefan Funk, and Adrian Zink — ECAP, Erlangen, Deutschland

The future ground-based gamma-ray experiment Cherenkov Telescope Array (CTA) will feature multiple types of imaging atmospheric Cherenkov telescopes, each with thousands of pixels. To be affordable, camera concepts for these telescopes have to feature low cost per channel, on the other hand the requirements given by the CTA consortium have to be met in order to reach the scientific goals.

We present the Compact High Energy Camera (CHEC) concept for CTA and introduce the Application-Specific Integrated Circuit TARGET (TeV Array Readout Electronics with GSa/s sampling and Event Trigger). One of these chips provides 16 parallel input channels, a 16k sample buffer for each channel, full waveform information in a tight readout window and adjustable sampling rate. We show preliminary results of the characterization and testing of this readout electronics performed at the Centre for Astroparticle Physics in Erlangen.

GR 15: Numerical Relativity

Zeit: Donnerstag 17:45–19:05 Raum: VMP6 HS C

GR 15.1 Do 17:45 VMP6 HS C

Binary Neutron Stars with Generic Spin and Mass ratio — •Tim Dietrich[1,2], Niclas Moldenhauer[2], Nathan Johnson-McDaniel[3], Sebastiano Bernuzzi[4,5], Charalampos Markakis[6], Bernd Brügmann[2], and Wolfgang Tichy[7] — [1]Max-Planck-Institut for Gravitational Physics, Albert-Einstein-Institut, D-14476 Golm, Germany — [2]Theoretical Physics Institute, University of Jena, 07743 Jena, Germany — [3]International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, Bengaluru 560012, India — [4]DiFeST, University of Parma, and INFN Parma, I-43124 Parma, Italy — [5]Theoretical Astrophysics, California Institute of Technology, 1200 E California Blvd, Pasadena, California 91125, USA — [6]Mathematical Sciences, University of Southampton, Southampton SO17 1BJ, United Kingdom — [7]Department of Physics, Florida Atlantic University, Boca Raton, FL 33431 USA

Binary neutron star mergers are associated with a variety of observable phenomena in the gravitational and electromagnetic spectra. We investigate such systems in the last milliseconds before and after their merger with full 3D numerical simulations. We focus on previously inaccessible regions of the binary neutron star parameter space and discuss as exemplary cases results for the highest mass ratio simulation in full general relativity and the first precessing binary neutron star merger. We find that both setups show interesting new physics, e.g, mass transfer during the inspiral or precession induced oscillations in subdominant modes of the gravitational wave signal.

GR 15.2 Do 18:05 VMP6 HS C

Discontinous Galerkin methods in dynamical neutron star simulations — •Marcus Bugner, David Hilditch, Hannes Rüter, and Bernd Brügmann — Theoretical Physics Institute, University of Jena, 07743 Jena, Germany

After the successful application of Discontinous Galerkin (DG) methods to a single isolated 3D neutron star in the Cowling approximation, we present further extensions of the method. In order to exploit more general physical setups, we added the full support of DG on 3D curvilinear grids, as well as the inclusion of system symmetries. Having this hybrid pseudo-spectral + DG tool at hand, we target the fully relativistic simulation of more complex neutron star systems.

GR 15.3 Do 18:25 VMP6 HS C

Novel Efficient ADER-DG Scheme for General Relativistic Hydrodynamics — •Matthias Pilz[1], Marcus Bugner[1], Tim Dietrich[1,2], and Bernd Brügmann[1] — [1]Theoretisch-Physikalisches Institut, Jena — [2]Albert-Einstein-Institut, Potsdam-Golm

We study a discontinuous Galerkin (DG) finite element method applying an a posteriori finite volume subcell limiter technique for solving the equations of general relativistic hydrodynamics. A key part of the algorithm is the calculation of a space-time predictor solution, which enables us to obtain a high order approximation of the numerical fluxes in the one-step DG scheme. A novel alternative to the existing iterative procedure using an element-local continuous extension of Runge-Kutta methods is proposed. We aim at simulating the TOV star to show convergence and efficiency of our implementation.

GR 15.4 Do 18:45 VMP6 HS C

Simulations for the critical collapse of the scalar field — •Hannes Rüter and Bernd Brügmann — Theoretical Physics Institute, University of Jena, 07743 Jena, Germany

We present simulations of a massless salar field obtained from our pseudo-spectral evolution code, BAMPS. In particular we are looking for critical phenomena of the scalar fields gravitational collapse. To study the features in non-spherically symmetric collapses, we look into evolutions of perturbations of spherically symmetric initial data.

GR 16: Gravitational Waves

Zeit: Freitag 8:45–10:45 Raum: VMP6 HS A

GR 16.1 Fr 8:45 VMP6 HS A

Black-hole Physics with Advanced Gravitational-Wave detectors — •Frank Ohme — School of Physics and Astronomy, Cardiff University, United Kingdowm

September 2015 marked the birth of a new era of gravitational-wave astronomy as the Advanced LIGO interferometers started their operation after a major upgrade. One of the most promising sources of the detector network is the coalescence of black-hole binaries. In this talk, I will highlight some of the prospects and limitations in measuring the parameters of such systems with gravitational-wave observations, and I will show how limited information extracted from few (or even no) detections can place interesting bounds on binary formation predictions made by state-of-the-art population synthesis models.

GR 16.2 Fr 9:05 VMP6 HS A

Analytic models for compact binaries — •Jan Steinhoff — Max Planck Institute for Gravitational Physics (Albert Einstein Institute)

Compact binaries are the most promising source for the advanced gravitational wave detectors, which started operation recently. The influence of finite-size effects (e.g., spin or tidal deformation) on the binary evolution is can be large. This talk gives an overview of recent progress in the analytic description of finte-size effects through an action principle for spinning point-particles. These spinning point-particles serve as an analytic model for extended bodies. The internal structure can be modelled by augmenting the point-particle with higher-order multipole moments. The dynamics of these multipoles can be modelled as a function of the spin and external tidal field, which completes the analytic description of the binary.

GR 16.3 Fr 9:25 VMP6 HS A

Next generation nonclassical light sources for gravitational-wave detectors — •Stefan Ast[1,2], Christoph Baune[1,2], Jan Gniesmer[1,2], Alexander Khalaidovski[2], Lisa Kleybolte[1,2], Moritz Mehmet[2], Axel Schönbeck[1,2], Fabian Thies[1,2], Henning Vahlbruch[2], Christina Vollmer[2], and Roman Schnabel[1,2] — [1]Institut für Laserphysik und Zentrum für Optische Quantentechnologien, Universität Hamburg, 22761 Hamburg, Deutschland — [2]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) und Leibniz Universität Hannover, 30167 Hannover, Deutschland

A key technology in future gravitational-wave detectors will be the use of squeezed states of light to further enhance the sensitivity of these devices. The British-German gravitational-wave detector GEO 600 is the first of its kind to employ a squeezed light source in regular science mode. Its successful implementation marks a starting point for the further development of nonclassical light sources in GW detectors. I will review the newest developments in nonclassical and nonlinear light sources from the nonlinear quantum optics group. Thus, I will discuss high-efficiency second harmonic generation, doubly resonant squeezed light sources, the frequency up-conversion of squeezed light as well as the use of entangled light in gravitational-wave detection.

GR 16.4 Fr 9:45 VMP6 HS A

Enhancing future gravitational wave detectors with two-mode-squeezed light — •Melanie Ast[1,2], Sebastian Steinlechner[2,3], and Roman Schnabel[1,2] — [1]Institut für Laserphysik und Zentrum für Optische Quantentechnologien der Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg, Germany — [2]Institut für Gravitationsphysik der Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstraße 38, D-30167 Hannover, Germany — [3]School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, United Kingdom

Advanced gravitational-wave (GW) detectors employ kilometer scale Michelson-type interferometers to measure differential arm length changes in the order of $10^{-23}/\sqrt{\text{Hz}}$. The detectors are limited by quantum shot noise over a wide frequency range and squeezed light will most likely be used to push their sensitivity even further. The "classical" approach for lowering the quantum shot noise is to increase the circulating light power, which is accompanied by increased stray light. Inelastic back-scattering of stray light into the interferometer is a known problem and a potential limitation for the sensitivity of GW-detectors. In a table-top experiment we demonstrate the improvement of a scattered-light limited measurement below the quantum shot noise by employing two-mode-squeezed dual readout of an interferometer's phase and amplitude quadrature.

GR 16.5 Fr 10:05 VMP6 HS A

Tailoring the quantum noise of gravitational-wave detectors — •Mikhail Korobko[1,2], Nikita Voronchev[3], Haixing Miao[4], and Farid Khalili[3] — [1]Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany — [3]Faculty of Physics, Moscow State University, Moscow 119991, Russia — [4]3School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT, United Kingdom

We explore new regimes of laser interferometric gravitational-wave detectors with multiple optical carriers which allow us to tailor the quantum noise of these detectors. In particular, we show that using two carriers with the opposite detunings, homodyne angles, and squeezing angles, but identical other parameters (the antisymmetric carriers), one can suppress the quantum noise in such a way that its spectrum follows the Standard Quantum Limit (SQL) at low frequencies. Combining several such pairs in the xylophone configuration, it is possible to shape the quantum noise spectrum flexibly. We show that it is possible to significantly increase the narrowband sensitivity at frequencies of interest (where the known sources of GW are located), without affecting the broadband behaviour.

GR 16.6 Fr 10:25 VMP6 HS A

Optical absorption in substrate-transferred crystalline coatings at 1064 nm and 1550 nm for gravitational wave detectors — •Amrit Pal Singh[1,2], Garrett Cole[3], and Roman Schnabel[1] — [1]Institut für Laserphysik und Zentrum für Optische Quantentechnologien, Universität Hamburg, Germany — [2]Institut für Gravitationsphysik, Leibniz Universität, Hannover, Germany — [3]Crystalline Mirror Solutions GmbH, Vienna, Austria

A limiting noise source of gravitational-wave detectors like Advanced LIGO in the frequency range between 10-100 Hz is thermal noise of the dielectric multilayer coatings made of silica and tantala. By decreasing the mechanical loss of the coating material, monocrystalline AlGaAs coatings have lead to a tenfold reduction of thermal noise. In order to improve their measurement sensitivity, gravitational wave detectors use high circulating laser powers. Due to absorption of laser power in the coatings, thermal lensing and thermal expansion can decrease the interferometer's stability. We used the photothermal self-phase-modulation technique, a cavity based measurement method, to obtain the absorption of AlGaAs coatings. We measured absorption in the range of parts per million.

GR 17: Quantum Gravity IV

Zeit: Freitag 11:15–12:55 Raum: VMP6 HS A

GR 17.1 Fr 11:15 VMP6 HS A

Testing the necessity of quantum gravity — •André Grossardt — Department of Physics, University of Trieste, Italy

What evidence do we have that the gravitational field must be quantised? I briefly review some of the most common arguments for quantum gravity and discuss an experimental proposal that could shed some light on this matter.

The experiment – a detailed analysis of the spectrum of a macroscopic oscillator – is feasible with existing technology, and is supposed to test the Schrödinger-Newton equation, a nonlinear, self-gravitating modification of quantum mechanics. This equation can be derived from the hypothesis that space-time is fundamentally classical and its curvature is sourced by the expectation values of quantum fields, which appears to be one of the most natural alternatives to a quantisation of the gravitational field.

GR 17.2 Fr 11:35 VMP6 HS A

Structural Features of the Weyl-Wheeler-DeWitt Equation — Claus Kiefer and •Branislav Nikolic — Institute for Theoretical Physics, University of Cologne, Germany

We discuss the canonical quantization of the action consisting of Einstein-Hilbert term plus Weyl-tensor squared term. The latter has the property of being invariant under local Weyl rescalings of the metric tensor (conformal transformations). We first discuss some classical aspects within the context of Hamiltonian formulation, constraints, and symmetries. We then perform the canonical quantization and discuss various properties of the arising new "Weyl-Wheeler-DeWitt" equation.

GR 17.3 Fr 11:55 VMP6 HS A

Asymptotic safety of gravity-matter systems — Jan Meibohm, Jan M. Pawlowski, and •Manuel Reichert — Institut für theoretische Physik, Universität Heidelberg

We study the ultraviolet stability of gravity-matter systems for general numbers of minimally coupled scalars and fermions. This is done within a functional renormalisation group setup. It includes full dynamical propagators and a genuine dynamical Newton's coupling, which is extracted from the graviton three-point function.

We find ultraviolet stability of general gravity-fermion systems. Gravity-scalar systems are also found to be ultraviolet stable within validity bounds for the chosen generic class of regulators, based on the size of the anomalous dimension. Remarkably, the ultraviolet fixed points for the dynamical couplings are found to be significantly different from those of their associated background counterparts, once matter fields are included. In summary, the asymptotic safety scenario does not put constraints on the matter content of the theory within the validity bounds for the chosen generic class of regulators.

GR 17.4 Fr 12:15 VMP6 HS A

Renormalization of Hořava Gravity — •Christian F. Steinwachs[1], Andrei O. Barvinsky[2,3], Diego Blas[4], Mario Herrero-Valea[5], and Sergey M. Sibiryakov[4,6,7] — [1]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg — [2]Theory Department, Lebedev Physics Institute, Moscow — [3]Pacific Institue for Theoretical Physics, Department of Physics and Astronomy UBC, Vancouver — [4]CERN, Theory Division, Geneva — [5]Instituto de Física Teórica UAM/CSIC, Madrid — [6]Institut de Théorie des Phénomènes Physiques, Lausanne — [7]Institute for Nuclear Research of the Russian Academy of Sciences, Moscow

We prove perturbative renormalizability of *projectable* Hořava gravity. The key element of the argument is the choice of a gauge which ensures the correct anisotropic scaling of the propagators and their uniform falloff at large frequencies and momenta. This guarantees that the counterterms required to absorb the loop divergences are local and marginal or relevant with respect to the anisotropic scaling. Gauge invariance of the counterterms is achieved by making use of the background-covariant formalism. We also comment on the difficulties of this approach when addressing the renormalizability of the *non-projectable* model.

GR 17.5 Fr 12:35 VMP6 HS A

Heat kernel coherent states for $SU(3)$ gauge theories in the loop quantum gravity framework — •Thorsten Lang — Friedrich-Alexander Universität Erlangen-Nürnberg

At the heart of loop quantum gravity lies a framework for the diffeomorphism invariant quantization of gauge theories. The Hilbert spaces consist of states that carry representations of the corresponding gauge groups on their edges. In order to probe the semiclassical properties of a quantum gauge theory in this framework, a method for the construction of coherent states, based on an earlier construction by Hall that makes use of the heat kernel on compact connected semisimple Lie groups, was proposed by Thiemann. These states are expected to satisfy many desirable semiclassical properties, some of which need to be studied on a case by case basis. While the construction was carried out and the semiclassical properties were studied in the case of $U(1)$ for the electromagnetic sector and $SU(2)$, which is relevant for the gravitational and electroweak sectors, the remaining group of immediate physical interest is $SU(3)$, which is the gauge group of quantum chromodynamics. We present our construction of the states for this group and discuss our progress on establishing their peakedness properties.