GR 14: Poster Session (posters are permanently on display)

Zeit: Donnerstag 16:30–18:30 Raum: HS 6

GR 14.1 Do 16:30 HS 6

Relativistic Interactive Flight Simulation — •Stephan Preiss — Universität Hildesheim, Hildesheim, Germany

First-person visualizations can be used as virtual laboratories where relativistic scenes are explored and relativistic phenomena like length contraction, time dilation and aberration of light are directly observable. We developed an interactive relativistic flight simulation with a drastically reduced speed of light to show these effects. The images are calculated using ray tracing methods. The observer can move through scenes that consist of static and relativistically moving objects. With this tool, we are able to address common difficulties in the understanding of the special theory of relativity that arise in the treatment of e.g. the twin and ladder paradoxa.

GR 14.2 Do 16:30 HS 6

Flying around and through a rotating black hole – Visualizations — •Thomas Reiber — Universität Hildesheim, Universitätsplatz 1, 31141 Hildeheim

Kerr spacetime describes the axisymmetric gravitational field of a rotating black hole. The maximal analytic extension of slow Kerr spacetime contains an infinity of asymptotically flat "exterior" regions connected by a strongly curved region. An observer may stay in one of the exterior regions or – crossing event horizons – pass through the strongly curved region to reach one of the other asymptotically flat regions. What would one observe on such a journey? Tracing the light rays back to a background scene in the exterior part, we calculate videos of the observers view.

GR 14.3 Do 16:30 HS 6

Simulation of the general-relativistic light deflection with a plastic lens — •Volker Perlick and Claus Lämmerzahl — ZARM, University of Bremen, Germany

One of the most important predictions of the general theory of relativity is the light deflection by gravitating masses. This effect was verified for the first time in 1919 with light rays passing close by our Sun. It is now one of the most important tools for discovering dark matter. Here we explain how the general-relativistic light deflection can be simulated with an appropriately shaped plastic lens and we demonstrate this with a lens made from plexiglass. In this way an important aspect of general relativity can be visualised in a way that makes it accessible to high school students.

GR 14.4 Do 16:30 HS 6

Geodesic equations for the Reissner-Nordström (anti-)de Sitter black hole surrounded by different kinds of regular and exotic matter fields — Anik Rudra[1], •Kai Flathmann[2], Arindam Chatterjee[3], and Hemwati Nandan[4] — [1]H. N. B. Garhwal University, Uttarakhand-249199, India — [2]University of Oldenburg, D-26111 Oldenburg, Germany — [3]West Bengal State University, Barasat, Kolkata-700126, India — [4]Gurukul Kangri Vishwavidyalaya, Haridwar 249407, India

We study the geodesic motion of test particles and light for the Reissner-Nordström (anti-)de Sitter black hole surrounded by different kinds of regular and exotic matter fields. We use effective potentials and parametric diagrams to analyze the possible orbit types for each matter field separately. The solution of the geodesic equations can be formulated in terms of hyperelleptic functions. Furthermore we present a list of all possible orbit types.

GR 14.5 Do 16:30 HS 6

Quantum mechanics in non-inertial frames — •André Grossardt — Queen's University Belfast, United Kingdom — Friedrich-Schiller-Universität Jena

Separability of the centre of mass and internal motion serves as a helpful tool when studying the dynamics of non-relativistic complex quantum systems. When special or general relativistic corrections to the dynamics are taken into account, separability is lost and the very definition of a centre of mass becomes ambiguous. We present a framework in which relativistic corrections can be treated in a well-defined and systematic way. Consequences with regard to different effects, decoherence effects in particular, are discussed, as well as open problems.

GR 14.6 Do 16:30 HS 6

Quantum electrodynamics with area-metric deviations from a metric — •Roberto Tanzi — University of Bremen, Center of Applied Space Technology and Microgravity (ZARM), 28359 Bremen

The most general theory of electrodynamics with linear field equations introduces a new geometry, the area metric, that regulates the propagation of light rays and massive particles instead of the usual Lorentzian metric. In the majority of the experimental situations, the area metric is expected to be a small perturbation around a metric background. In this perturbative case, two interesting results can be achieved. First, the dynamics of the area metric can be found explicitly. Second, the relative quantum theory of electrodynamics can be shown to be renormalisable at every loop order in a gauge-invariant way and can be used to compute various fundamental processes.

I will show that, when one combines the results of quantum electrodynamics with the dynamics of an area-metric perturbation, the anomalous magnetic moment of the electron, the cross sections of Bhabha scattering, and the hyperfine splitting of the hydrogen pick up a dependence on the position. This way, measurements of the position dependence of these quantities provide a new channel to investigate area-metric deviations from a metric spacetime.

GR 14.7 Do 16:30 HS 6

Quantum-improved Schwarzschild-(A)dS and Kerr-(A)dS Spacetimes — •Dennis Stock[1,2] and Jan M. Pawlowski[2] — [1]University of Bremen, Center of Applied Space Technology and Microgravity (ZARM), 28359 Bremen, Germany — [2]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Germany

We study the effects of quantum gravity on black hole geometries within the set-up of asymptotically safe quantum gravity. Under the assumption that leading order quantum effects are taken into account by promoting Newton's and the cosmological constant to scale-dependent functions, we arrive at a quantum-improved metric for Schwarzschild-(A)dS and Kerr-(A)dS. Because scale identifications based on a radial path or the eigentime of an infalling observer in the quantum improved geometry lead to problems, we base our scale identification on the upgraded classical Kretschmann scalar. The arising spacetimes are discussed by studying the Penrose diagrams, the motion of test particles, the effect on the central curvature singularity and the implication for the endpoint of the black hole evaporation process.

GR 14.8 Do 16:30 HS 6

Off-equatorial orbits as a violation of No-hair theorem — •Leonardo A. Pachon, Andres F. Gutierrez, and Juan L. Restrepo — Universidad de Antioquia, Medellin, Colombia

The problem of describing the motion of a highly-diluted electrically-charged medium when both gravitational and electromagnetic fields are present is widely studied and is of great interest for describing magnetospheres, accretion disks and when investigating chaos in general relativity. Nevertheless, this problem is commonly addressed treating the electromagnetic filed as a perturbation instead of solving the exact Einstein-Maxwell field equations. In this paper, it is considered the coupling between both fields and used a closed solution of the Einstein-Maxwell field equations for a neutron star in order to obtain the dynamics of charged particles orbiting it. This exact description is particularly important in the vicinity of the star where both fields are both strong and alter the geometry of the space time. It is shown here that even for a qualitative description this closed solution has to be used because its closest approximation gives regular dynamics where there is actually a chaotic one. Off-equatorial lobes are found and cases when they are separated, mixed and when they begin to mix are studied. Chaos is found when separated and when mixed in contrast whit the closest approximate solution that only shows chaos when they are mixed. For studying chaos 3-D Poincare surfaces are plotted, in contrast with the 2-D common ones, for a conceptual advantage: in the 3-D surfaces the chaotic an regular regions do not cross each other.

GR 14.9 Do 16:30 HS 6

Frame Dragging Suppresses Astrophysical Chaos around Compact Objects — •Leonardo A. Pachon and Andres F. Gutierrez — Universidad de ANtioquia, Medellin, Colombia

Dragging of inertial frames is one of the most surprising and quintessential effects of General Relativity. In its simplest version, a particle which is directed radially towards a rotating source acquires non-radial components of motion as it falls freely in the gravitational field. Here, by considering analytical exact solutions to the Einstein-Maxwell field equation, it is shown that this purely general relativistic effect is capable of reconstructing KAM tori from initial highly chaotic configurations around static gravitational sources. Since signatures of chaotic dynamics in gravitational waves have been suggested to test the validity of General Relativity in the strong field regime, chaos suppression by inertial frame dragging may undermine present proposals to verifying the no-hair theorem and validity of General Relativity.

GR 14.10 Do 16:30 HS 6

The AEI 10 m prototype interferometer — •Philip Koch — Albert Einstein Institut Hannover, Deutschland

Precision interferometry is the leading method for extremely accurate measurements in gravitational wave astronomy. The current generation of gravitational wave detectors is designed to be limited by quantum processes, whereas future gravitational wave detectors will use techniques to surpass the quantum noise. The AEI 10 m prototype interferometer will be a test bed for these techniques. It will be limited by quantum radiation pressure noise at frequencies between 20 and 200 Hz and by shot noise above 200 Hz. To reach these fundamental noise sources, all classical noise sources such as seismic, thermal and technical noise have to be suppressed. We present techniques of active and passive seismic isolation, frequency stabilization of our laser to a suspended reference cavity and an overview of the AEI 10 m prototype interferometer.

GR 14.11 Do 16:30 HS 6

Investigation towards fibre-based squeezed light injection into gravitational wave detectors — •Joscha Heinze — Max-Planck-Institute for Gravitational Physics, Hanover, Germany

It has been investigated whether a commercially available optical fibre can transport (squeezed) light at an efficiency which is sufficient for gravitational wave detectors. An incoupling efficiency of up to 99.1%, a power transmission of up to 97.9% and a visibility between two fibre output beams of 99.0% has been achieved. This corresponds to a maximum loss in the squeezing level of 4dB for initial 15dB.

The incoupling stage was found to be highly stable and the usage of non-angled fibre end faces as well as relatively large residual Fresnel reflections limited the results. This is, however, easy to improve on.

The performance may also be improved by using fibres with a larger core and lens-shaped end caps directly attached to the fibre end faces. Such a monolithic connection provides an even higher mechanical stability. Possible effects of the attachment procedure on the fibre output have been examined by comparing an untreated fibre to one that had a substrate (two plane faces) attached. The substrate-fibre showed a power transmission which was remarkably higher by 0.7% without any deterioration in the beam profile or polarisation extinction ratio.

GR 14.12 Do 16:30 HS 6

Coating Thermal Noise Interferometer for the AEI 10m Prototype — •Janis Wöhler — MPI für Gravitationsphysik Hannover, Deutschland

Thermal noise in the coatings of highly reflective mirrors is becoming a limiting noise source in interferometers used for the detection of gravitational waves. It is caused by mechanical losses of the thin films used in the coatings. A way to reduce the noise is to use crystalline coatings due to their inherently lower mechanical losses. Crystalline AlGaAs-coatings are a promising candidate and their noise properties will be measured before using them in a quantum limited Michelson interferometer. For the measurement, all other noise sources, especially seismic noise and acoustic disturbances, have to be reduced below the thermal noise level. The AEI 10 m Prototype facility is probably the best suited environment for this kind of experiment.

On this poster the setup of the Thermal Noise Interferometer will be presented, which will be able to measure thermal noise in a frequency band from 10Hz to 50kHz, limited from below by seismic noise and from above by photon shot noise. Current progress in commissioning and aquiring lock in a test environment is shown. Furthermore prospects of using crystalline coatings in large scale gravitational wave detectors will be discussed.

GR 14.13 Do 16:30 HS 6

Active seismic isolation for the AEI 10 m prototype interferometer — •Robin Kirchhoff — Albert-Einstein-Institute for gravitational physics Hannover, Germany

High precision measurements in various scientific fields suffer from seismic motion. Active seismic isolation is used to decouple the experiments from this disturbance. It is based on feedback control loops. The motion is measured by sensors and sent to actuators applying a counter force to reduce the motion. The poster explains the active seismic isolation of the AEI 10 m prototype interferometer. This is a testbed for large scale gravitational wave detectors. Different techniques to improve the isolation are introduced and the overall isolation performance is depicted.

GR 14.14 Do 16:30 HS 6

Mirror suspensions to reduce seismic noise of the AEI 10m prototype interferometer — •Johannes Lehmann — Albert Einstein Institute for Gravitational Physics, Hannover

The coupling of unwanted ground motion to interferometer test masses is reduced by suspending them. In order to control the suspended mirrors without feeding back ground motion in the process, special actuators are needed.

A new design for an electrostatic drive has been tested on the triple cascaded-pendulum suspensions used as part of the AEI 10m prototype interferometer. This interferometer is planned to reach and surpass the standard quantum limit, which limits the sensitivity of gravitational wave interferometers employing classical laser light.

This poster will present a preliminary experiment where one interferometer arm was set up to act as a testbed for suspensions, control schemes and actuators, and to measure the performance of the pre-isolation system and laser stabilisation.

GR 14.15 Do 16:30 HS 6

Interferometer to measure temperature-dependent angular tilts and mode matching of fiber couplers — •Juliane von Wrangel — Max-Planck-Institut für Gravitationsphysik Hannover (Albert-Einstein-Institut)

Space-based laser interferometers as the Laser Interferometer Space Antenna (LISA) bear the challenge of developing qualified optical components that have to meet several requirements. One of the most important aspects to be considered is thermal stability: Thermally induced tilts of the components can easily couple to changes in the optical pathlength.

This poster explains an interferometer that was constructed to measure temperature-dependent angular tilts and mode matching of fiber couplers. Differential Wavefront Sensing as well as Differential Power Sensing will be used to investigate the thermal stability of commercial fiber couplers.

GR 14.16 Do 16:30 HS 6

Pre-Stabilized Laser System for Ground Based Gravitational Wave Detectors — •Fabian Thies and Benno Willke — Max Planck Institute for Gravitational Physics, Hannover, Germany

Current gravitational wave detectors (GWDs) are Fabry-Pérot dual-recycling laser interferometers, which sense space-time strain caused by gravitational waves. Besides many other subsystems, they require a low noise, high power pre-stabilized laser system to reach their design sensitivity. In such a laser system power stability and frequency stability is achieved by feedback control, so that noise does not couple significantly to the readout of the interferometer.

Here we present improvements of the solid state laser systems at 1064nm wavelength for current GWDs (aLIGO [1], Virgo[2]). These laser systems show a reduced noise and operate at 100W of laser power.

In addition we started to setup a pre-stabilized laser system at 1550nm wavelength for future GWDs (ET[3]). This laser system operates at a wavelength usable with cryogenically cooled silicon test masses. We characterized the free running noise of the laser and started to implement active stabilizations.

[1] J. Aasi et al. (LIGO Scientific Collaboration), Class. Quantum Gravity 32, 074001 (2015).

[2] F. Acernese et al. (Virgo Collaboration), Class. Quantum Gravity 32, 024001 (2014).

[3]ET Science Team, ET conceptual design document ET-0106C-10, http://www.et-gw.eu/index.php/etdsdocument

GR 14.17 Do 16:30 HS 6

Relevance of tidal effects and post-merger dynamics for binary neutron star parameter estimation — •reetika dudi[1],

FRANCESCO PANNARALE[2], TIM DIETRICH[3], MARK HANNAM[2], SEBASTIANO BERNUZZI[1], FRANK OHME[4], and BERND BRUEGMANN[1] — [1]Theoretical Physics Institute, University of Jena, Jena, Germany — [2]School of Physics and Astronomy, Cardiff University, Cardiff — [3]Nikhef, Amsterdam, The Netherlands — [4]Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Hannover, Germany

Measurements of the properties of binary neutron star systems from gravitational-wave observations require accurate theoretical models for such signals. However, current models are incomplete, as they do not take into account all of the physics of these systems. In this work, we have explored the importance of two physical ingredients: tidal interactions during the inspiral and the imprint of the post-merger stage. We use complete inspiral–merger–post-merger waveforms constructed from a tidal effective-one-body approach and numerical-relativity simulations as signals against which we performe parameter estimates with waveform models of standard LIGO-Virgo analyses. We show that neglecting tidal effects does not lead to appreciable measurement biases in masses and spin for typical observations (small tidal deformability and signal-to-noise ratio approx. 25). However, with increasing signal-to-noise ratio or tidal deformability there are biases in the estimates of the binary parameters. The post-merger regime, instead, has no impact on gravitational-wave measurements with current detectors for the signal-to-noise ratios we consider.

GR 14.18 Do 16:30 HS 6

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

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

However, if we follow Hubble’s view of the universe, then there is a very unspectacular explanation for the measurement. There are indications that the speed of light ’c’ was higher at early times. This inserted into the Doppler equation to determine the star’s speed from red-shifts yields higher speeds for early stars. So there is no acceleration.

This is, however, objected by main stream physics by the argument that according to Einstein’s relativity ’c’ was always constant. But this was not clearly stated by Einstein. And there is anyway the non-understood problem of cosmologic inflation.

To explain the horizon problem, i.e. the apparent logical connection of parts of the universe far apart from each other, the cosmological inflation was introduced. It is the assumption that after the big bang ’space’ was extremely small compared to now. Then it expanded first rapidly, these days still slowly. - But there is no understanding why this expansion should have happened. The assumption of a higher ’c’ at earlier times can be backed by a comparatively simple model.

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

GR 14.19 Do 16:30 HS 6

What is Dark Matter? — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Dark matter is one of the great mysteries in today’s physics.

There are fundamentally two solutions possible: (1) there may exist a type of presently undetected particles which provides the missing contribution to the gravitational field; (2) the theory of gravity of Newton and of Einstein which related gravitation to mass and energy may be erroneous.

For the second alternative there is a working ansatz. If one extends the Lorentzian interpretation of relativity to the area of general relativity, so to gravitation, there follows a different causality for gravity. Gravity is no longer caused by mass or energy but it is a side effect of other forces. So every elementary particle contributes to the field independently of its mass. And in this case photons and neutrinos are playing a particular role.

If the thoroughly investigated rotating galaxy NGC 3198 is taken as an example for this approach, it can be shown that the result for the amount of the field as well as its spatial distribution fits quite precisely to the measurement. And the recently detected galaxy NGC 1052-DF2, which emits dim light and has only a small amount of Dark Matter, is a good confirmation of this view.

On the other hand, the search for specific particles as an explanation of this phenomenon has up to now not yielded any hints for their existence.

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

GR 14.20 Do 16:30 HS 6

Time dilation and length contraction — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

SR as derived by Einstein is the product of an approach of 1905 when the interactions between light and the measuring instruments were still not well understood. SR is a rough undifferentiating heuristic mathematical approach which ignores the reason 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, a critical revision of Einstein’s theoretical approach is more than overdue. Based on these findings, a theoretical approach is presented which takes into consideration the interactions between light and optical lenses and electric antennas of the measuring instruments, explaining why always ’c’ is measured in the frame of the instruments. The approach treats relativity as a speed problem with absolute time and space variables, resulting equations of Galilean relativity multiplied with the gamma factor. More at www.odomann.com

GR 14.21 Do 16:30 HS 6

Possible experimental proof of Lorentz interpretation (LI) of GRT - further arguments — •Jürgen Brandes — Karlsruhe, Germany

LI of GRT [1] is a rational variation of classical GRT. Nobel Prize winner Kip S. Thorne calls it ” the flat spacetime paradigm ” of GRT [2]. There is no difference in the predictions of relativistic experiments of both interpretations except, within LI of GRT black holes have no event horizon. It contradicts: ” A black hole is a region of spacetime exhibiting such strong gravitational effects that nothing - not even particles and electromagnetic radiation such as light - can escape from inside it. ” *But claiming the same for gravitational waves LI of GRT is proven:* In the case of GW170608 the total mass of the binary system was 19 M_{sun} with components of 12 and 7 M_{sun}. The final black hole mass was 18 M_{sun}. This means a loss of mass as large as 1 M_{sun} and contradicts the features of a black hole. At least it is an argument for even better measurements of the GW spectra and looking for an effect happened to GW170817 where a black hole became a neutron star of 2.75 M_{sun}. Further proof: Using the Tolman Oppenheimer Volkoff (TOV) equation [2] LI of GRT gets supermassive objects larger than its Schwarzschild radius - possibly realized in the galactic centers. The poster discusses newest results of LIGO, GRAVITY and EHT.

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

GR 14.22 Do 16:30 HS 6

Quantum gravity without additional theory - Compatibility of Schwarzschild metric and quantum mechanics — •René Friedrich — Strasbourg

The apparent incompatibility of the current spacetime concept with quantum mechanics seems to be the main obstacle of quantum gravity. But as it will be shown here, our spacetime concept is based on assumptions which are not only contradicting quantum mechanics, but also the two postulates of special relativity and the Schwarzschild metric.

The following three corrections of the current spacetime concept are necessary to avoid these contradictions:

1. Spacetime is not continuous, in particular not in spacelike direction, and thus it cannot be quantized.

2. For the solution of fundamental problems of physics about time, we must consider the notion of proper time instead of the coordinate time of spacetime.

3. Gravitation may be represented by Schwarzschild metric not only as the curved spacetime, but alternatively also as gravitational time dilation in absolute, uncurved space.

From these three insights are following the characteristics of quantum gravity. The result: Gravity appears within quantum mechanics in the form of gravitational time dilation.