GR 2: Gravitationswellen I

Zeit: Montag 16:30–19:00 Raum: HS 6

GR 2.1 Mo 16:30 HS 6

Resolving multiple supermassive black hole binaries with pulsar timing arrays. — •Stanislav Babak — Albert Einstein Institut, Am Muehlenberg 1, D-14476 Golm

Pulsar timing arrays might detect gravitational waves from massive black hole binaries within this decade. The signal is expected to be an incoherent superposition of several nearly-monochromatic waves of different strength. The brightest sources might be individually resolved, and the overall deconvolved, at least partially, in its individual components. We study resolvability of individual sources and estimation of their location on the sky.

GR 2.2 Mo 16:45 HS 6

Equation-of-state dependence of gravitational waves, nucleosynthesis and optical transients from neutron-star mergers — •Andreas Bauswein and Hans-Thomas Janka — Max-Planck-Institut fuer Astrophysik, Garching, Germany

Based on a representative set of relativistic hydrodynamical simulations we discuss the influence of the high-density equation of state on observable features of neutron-star mergers. The dependence of the gravitational-wave emission on the equation of state of neutron-star matter is addressed. On the basis of our survey we point out a novel possibility to determine neutron-star radii from gravitational-wave detections from the postmerger phase of a neutron-star coalescence. The likelihood of an corresponding gravitational-wave observation is estimated. Moreover, nucleosynthesis calculations are presented revealing a robust rapid neutron-capture process in the ejecta of neutron-star collisions. The properties of optical transients which are powered by the radioactive decay of the freshly synthesized elements, are discussed as well.

GR 2.3 Mo 17:00 HS 6

Gravitational-wave measurements from binary black holes and their dependency on waveform models — •Frank Ohme — Cardiff University, Cardiff, United Kingdom — Max-Planck-Institut für Gravitationsphysik, Potsdam/Hannover, Germany

Successfully detecting and interpreting gravitational waves from coalescing black-hole binaries requires a detailed model of the signals to be expected. With a combination of analytical approximations and full-relativistic numerical simulations it only recently became possible to predict the entire signal emitted by an inspiraling and merging binary, even in the complicated case of precessing black hole spins. However, these models are not free of errors, and I will summarize in this talk how to construct state-of-the-art waveform models, how to assess their errors and estimate the impact those may have on actual gravitational-wave measurements.

GR 2.4 Mo 17:15 HS 6

Measuring the spin of compact objects with advanced ground-based gravitational wave detectors — •Alex Nielsen — Max Planck Institut, Hannover

Inspirals of neutron stars and stellar sized black holes are a promising source of gravitational waves for ground-based laser interferometer detectors. The intrinsic spin of these objects is an important astrophysical observable and affects the gravitational wave signal due to general relativity. We discuss some of the issues involved in measuring these spins using the gravitational wave signal and the data analysis techniques that are needed to determine them.

GR 2.5 Mo 17:30 HS 6

GEO600: Gequetschter Gravitationswellendetektor lauscht der Milchstrasse — •Hartmut Grote — MPI für Gravitationsphysik und Leibniz Universität Hannover

Der Deutsch-Britische Gravitationswellendetektor GEO600 ist derzeit das einzige Laser-Interferometer weltweit, welches regelmässig Daten zur Suche nach Gravitationswellen nimmt. Wir geben einen kurzen Überblick über die Szene der erdgebundenen Gravitationswellendetektoren und berichten über die aktuellen Fortschritte bei GEO600. Unter anderem wird bei GEO600 kontinuierlich gequetschtes Licht (bzw. gequetschtes Vakuum) zur Erhöhung der Empfindlichkeit eingesetzt. Also dann: Auf dass Beteigeuze explodieren möge!

GR 2.6 Mo 17:45 HS 6

Einstein@Home all-sky search for periodic gravitational waves in LIGO S5 data — •Paola Leaci — Max Planck Institut fuer Gravitationsphysik

We present results of an all-sky search for periodic gravitational waves in the frequency range [50, 1 190] Hz and with frequency derivative range of $\sim [-20, 1.1] \times 10^{-10}$ Hz s^{-1} for the fifth LIGO science run (S5). The search uses a non-coherent *Hough-transform* method to combine the information from coherent searches on timescales of about one day. Because these searches are very computationally intensive, they have been carried out with the Einstein@Home volunteer distributed computing project. Post-processing identifies eight candidate signals; deeper follow-up studies rule them out. Hence, since no gravitational wave signals have been found, we report upper limits on the intrinsic gravitational wave strain amplitude h_0. For example, in the 0.5 Hz-wide band at 152.5 Hz, we can exclude the presence of signals with h_0 greater than 7.6×10^{-25} at a 90% confidence level. This search is about a factor 3 more sensitive than the previous Einstein@Home search of early S5 LIGO data.

GR 2.7 Mo 18:00 HS 6

Space Interferometry Simulation for LISA — •Andreas Schreiber, Markus Otto, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik, Callinstraße 38, 30167 Hannover

The "Laser Interferometer Space Antenna" (LISA) is a space-borne gravitational wave detector planned for the next decade. LISA aims at the detection of gravitational waves (GW) in the band of 0.1 mHz to 1 Hz. Sources within this band are, e.g., white dwarf and SMBH binaries. However, the detection of GW is disturbed by various noise sources. In particular, these are laser frequency noise, clock noise and displacement noise due to the motion of the satellites.

In our talk, we will present a numerical "Space Interferometry Simulation" (SIS). The simulation consists of models for GW, satellites and their orbits. Moreover, we implemented "Time-Delay Interferometry" (TDI) algorithms to remove the dominant noises listed above. The goal of the simulation is the verification of noise reduction by TDI within a realistic detector model. This talk will give an overview of the simulation and the gravitational wave detection in space, including first results.

GR 2.8 Mo 18:15 HS 6

Time-Delay Interferometry for a flexing LISA constellation — •Markus Otto, Andreas Schreiber, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik, Callinstraße 38, 30167 Hannover

Laser phase noise is the dominant noise source in the on-board measurements of the space-based gravitational wave detector LISA. A well-known data analysis technique, so-called "Time-Delay Interferometry" (TDI), provides synthesized data streams free of laser phase noise. At the same time TDI also removes the next largest noise source: phase fluctuations of the on-board clocks which distort the sampling process. Therefore TDI needs precise information about the spacecraft separations, sampling times and differential clock noises between the three spacecrafts. These are measured using auxiliary modulations on the laser light. Hence, there is a need for algorithms that account for clock noise removal schemes combined with TDI while preserving the gravitational wave signal.

In this talk, we will present the mathematical formulation of the LISA-like data streams and discuss a compliant TDI-algorithm that corrects for both clock and laser noise in the case of a rotating and flexing LISA constellation.

GR 2.9 Mo 18:30 HS 6

Squeezed light for gravitational wave astronomy — •Alexander Khalaidovski, Henning Vahlbruch, Moritz Mehmet, Karsten Danzmann, Hartmut Grote, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany

The measurement sensitivity of the first generation of interferometric gravitational wave (GW) detectors is limited by quantum shot noise at Fourier frequencies above a few hundred Hertz. Future generations of GW observatories will even be limited by quantum noise almost over their entire detection band. A non-classical approach to further improve the signal-to-quantum-noise ratio is based on the injection of squeezed states of light. Such a light field has a characteristic non-classical noise distribution in the field quadratures. Injected from the signal port, the squeezed states replace the vacuum states, thereby reducing the interferometer's quantum noise.

This contribution presents an overview over the field of squeezed-light generation for GW astronomy. The squeezed-light laser that is now operated in GEO 600 is discussed in detail. Prospects for the use of squeezed light in the 2nd and 3rd observatory generations are presented.

GR 2.10 Mo 18:45 HS 6

Two-mode squeezed light for gravitational wave detectors — •Sebastian Steinlechner, Jöran Bauchrowitz, Melanie Meinders, Helge Müller-Ebhardt, Karsten Danzmann, and Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany

The high-frequency sensitivity of interferometric gravitational-wave detectors is limited by the light's quantum noise, i.e. shot-noise arising from zero-point fluctuations at the detection dark-port. Non-classical, squeezed-light readout can reduce this noise and has been successfully implemented in GEO600 and was recently also tested in LIGO. In the mid-frequency region, the quantum noise is obscured by both thermal noise and parasitic interferences due to scattered light. Here we present a novel quantum-dense interferometer readout scheme, which we implemented in a table-top experiment. This scheme is able to identify and possibly remove parasitic signals, thus increasing the detection sensitivity in frequency bands that were previously not quantum-noise limited.