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.