GR 12: Gravitational Waves

Zeit: Donnerstag 14:00–16:30 Raum: HS 4

Hauptvortrag GR 12.1 Do 14:00 HS 4

Gravitational-Wave Astronomy in Action — •Frank Ohme — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Hannover, Germany — Leibniz Universität Hannover, Germany

The Advanced LIGO gravitational-wave detectors and Virgo have concluded their first two observing runs and are about to start the longest observing run yet, O3. In total, the gravitational-wave signals of ten black-hole binary mergers and one binary neutron-star system have been observed and released in the first Gravitational-Wave Transient Catalog (GWTC-1). In my talk, I will summarize these observations, the methods that were used to identify them, and I will give a glimpse of what we can expect to come in the near future.

GR 12.2 Do 14:45 HS 4

Gravitational-wave luminosity of binary neutron stars mergers — •Francesco Zappa and Sebastiano Bernuzzi — Friedrich-Schiller-Universität Jena Theoretisch-Physikalisches Institut, Fröbelstieg 1, D-07743 Jena

We give Numerical Relativity estimate of the luminosity peak of Gravitational Waves emitted during the coalescence of Binary Neutron Stars. Our model is constructed from the CoRe-collaboration database and depends only on the main binary's parameters, allowing to make predictions of the luminosity of such events. Highest luminosity peaks are produced when the merger ends in a Black Hole that promptly forms after the collision of the two stars, while the largest amount of GW energy is emitted when a massive, rapidly rotating neutron star forms. This allows to make estimates on the outcome of BNS mergers based on the fundamental parameters of the binary of the binary system only. In addition we provide the upper limit for the maximum GW energy emitted in the process as predicted by NR and eventually we discuss a simple empirical relation between the total GW energy and the angular momentum of the remnant, with its implications.

GR 12.3 Do 15:00 HS 4

Deep learning in gravitational wave data analysis — •Marlin Schäfer — Albert Einstein Institut, Hannover, Deutschland

We discuss the application of machine learning through deep convolution neural networks to the search for gravitational waves from compact binary mergers. We further consider the usefulness of such techniques in low and high latency searches, and discuss the prospects for the future.

GR 12.4 Do 15:15 HS 4

Laser Amplification and Coherent Beam Combination for Gravitational Wave Detectors — •Nina Bode[1,2] and Benno Willke[1,2] — [1]Max-Planck-Institut für Gravitationsphysik, Hannover, Deutschland — [2]Albert-Einstein Institut der Leibniz Universität Hannover, Deutschland

The sensitivity of gravitational wave detectors scales with the laser power. To reduce shot noise it is nescessary to have a high power, scalable and stable laser system.

Here we present two options for such systems. Both are based on solid state high power amplifiers seeded with NPRO lasers at a wavelength of 1064nm.

In the first system the laser power from two separetly seeded amplifiers is coherently combined on a variable beam splitter. The second one comprises two amplifiers in sequence. Compared to actual laser systems these techniques achieve a better noise behaviour and a higher reliability with similar output power.

We show the promising results of the characterization of both systems.

GR 12.5 Do 15:30 HS 4

IMR consistency tests with higher modes on gravitational signals from the second observing run of LIGO and Virgo — •Matteo Breschi — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Jena, Germany

Current tests of General Relativity are performed using approximations which neglet a key feature of complete solution: higher-order modes. Our analysis will reasses these tests including the higher modes effects. We have chosen to perform inspiral-merger-ringdown consistency tests on the gravitational transients detected by LIGO and Virgo during the observing run O2. We use an approximant which include all higher modes with $\ell \leq 4$, labelled NRSur7dq2. For the most interesting cases, we repeat the tests involving fits on Numerical Relativity simulations from the RIT catalog. We do not find any inconsistency of the data with the predictions of General Relativity.

GR 12.6 Do 15:45 HS 4

Binary Hybrid Star Mergers and the Phase Diagram of Quantum Chromodynamics — •Matthias Hanauske[1,2], Luciano Rezzolla[1,2], and Horst Stöcker[1,2,3] — [1]Institute for Theoretical Physics, Goethe University Frankfurt, Germany — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The astrophysical consequences of a hadron-quark phase transition (HQPT) in the interior of a neutron star merger product will be focused within this presentation. The results of numerical simulations of binary neutron star mergers will be presented, where a strong HQPT has been implemented in the equation of state of the underlying elementary matter of the compact star binary. The evolution of the density and temperature distributions inside the produced hypermassive hybrid star will be analysed and visualised in a QCD phase diagram manner. The results show that the appearance of the HQPT in the interior region of the produced hypermassive hybrid star will change the spectral properties of the emitted gravitational wave, if the phase transition is strong enough.

GR 12.7 Do 16:00 HS 4

Gravitational waves and neutrino signals from magneto-rotational stellar core collapse — •Martin Obergaulinger[1,2], Miguel Ángel Aloy[2], Pablo Cerdá-Durán[2], José Antonio Font[2], and Alejandro Torres-Forné[2,3] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Departament d'Astronomía i Astrofisica, Universitat de València, Spain — [3]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Potsdam, Germany

The collapse of the cores of massive stars to a proto-neutron star (PNS) can power supernova explosions or long gamma-ray bursts and leaves behind either a neutron star or a black hole. The evolution is shaped by the interplay of many complex processes such as relativistic gravity,(magneto-)hydrodynamics, nuclear physics, and neutrino radiation and depends strongly on the pre-collapse state of the core. Direct observational evidence of the inner engine, otherwise obscured by the outer layers of the star, could be provided by gravitational waves (GWs) and neutrinos. Present instruments would be detect signals of galactic events. Their interpretation relies on numerical models. We analysed detailed simulations to connect the GW signal to oscillation modes of the core. Our rapidly rotation stars produce strong, highly variable GW amplitudes. To facilitate the analysis, we performed a detailed analysis of the eigenmodes of the PNS that could be used to extract properties of the PNS from the signal. Furthermore, the models are the sources of intense neutrino emission, which is characterised by a strong asymmetry between emission along the rotational axis and in the equatorial plane.

GR 12.8 Do 16:15 HS 4

Reanalysis of Gravitational Wave Data with Mathematica — •Alexander Unzicker[1] and Jan Preuss[2] — [1]Pestalozzi-Gymnasium München — [2]Universität Lübeck

Thanks to the open data policy of LIGO/VIRGO, gravitational waves events are independently analyzed with the Mathematica software. We follow the template-free statistical method proposed by Liu et.al. (arXiv:1802.00340, CJAP) which is based on cross-correlations. Results show the peculiar properties of GW150914.