GR 4: GW I

Time: Tuesday 16:15–17:55 Location: ZHG008

GR 4.1 Tue 16:15 ZHG008

Predicting black-hole spins from hierarchical mergers of binary black holes — •Angela Borchers[1,2], Claire Ye[3], and Maya Fishbach[3] — [1]Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Callinstraße 38, 30167 Hannover, Germany — [2]Leibniz Universität Hannover, Callinstraße 38, 30167 Hannover, Germany — [3]Canadian Institute for Theoretical Astrophysics, 60 St George St, University of Toronto, Toronto, ON M5S 3H8, Canada

Stellar black holes often form binaries in dense stellar clusters. When these binaries merge, they produce remnant black holes, which, after some time, might find a black hole companion and merge again. We call these hierarchical mergers. Previous studies have shown that the spin distribution of black holes in hierarchical mergers peaks at 0.69, independent of the initial black hole spins and the merger generation. However, these mergers can produce recoil kick velocities large enough for remnants to be ejected from their clusters, which means they will not contribute to the black-hole spin distribution in the cluster. We have investigated what are the spins of black holes from hierarchical mergers when recoil kicks are considered. In this talk, I will show that the distribution of retained black holes is not identical to the distribution of all black holes. Besides, I will discuss how the distribution depends on the black-hole birth spins and the merger generation. Our results complement earlier studies in understanding the characteristics of black holes formed in hierarchical mergers, which is essential when identifying the formation origin of black holes from gravitational-wave observations.

GR 4.2 Tue 16:35 ZHG008

Fixing the dynamical evolution of self-interacting vector fields — •Marcelo Rubio — GSSI - L'Aquila, Italy

I will discuss the Cauchy problem of self-interacting massive vector fields, and explain why they often face instabilities and apparent pathologies. After showing that these issues are due to the breakdown of the well-posedness of the corresponding initial-value problem, I will characterize the well-posedness breakdowns and explicity show that they can be avoided by fixing the equations in a suitable way. As an application, I will numerically show that no Tricomi-type breakdown takes place in the quadratic case, and investigate initial configurations which lead to gravitational collapse and the formation of black holes.

GR 4.3 Tue 16:55 ZHG008

Full-spectrum analysis of gravitational waves from binary neutron star mergers — •Giulia Huez — Friedrich-Schiller-University of Jena, Jena, Germany

The gravitational-wave (GW) observation of the full-spectrum (inspiral-merger-postmerger) of a binary neutron star (BNS) merger can convey unique information on the nuclear matter that constitutes these compact objects. BNS are optimal targets for next-generation ground-based GW detectors, which would give the possibility to measure the astrophysical parameters with a higher precision with respect to current detectors. Thus, the development of waveform models for the full GW spectrum of BNS mergers is fundamental in order to minimize biases in the parameter estimation processes.

In this talk, a full Bayesian analysis of GWs from inspiral to postmerger is presented. I will review the waveform template used, based on effective-one-body model and numerical relativity simulations, and show preliminary results on neutron star matter properties.

GR 4.4 Tue 17:15 ZHG008

Probing gravity using black hole ringdown — •Pratik Wagle[1], Dongjun Li[2], Yanbei Chen[3], and Nicolas Yunes[2] — [1]Max Planck Institute for Gravitational Physics, Potsdam, Germany — [2]University of Illinois at Urbana Champaign, Urbana, IL, USA — [3]California Institute of technology, Pasadena CA, USA

The detection of gravitational waves from compact binary mergers by the LIGO/Virgo collaboration has opened new avenues for testing relativistic gravity. With future ground- and space-based gravitational wave detectors, we are poised to extract further insights into astrophysical events and investigate the implications for Einstein's theory of relativity in contexts where gravitational fields are both strong and dynamical. In this presentation, I will discuss recent advancements in the study of gravitational perturbations related to gravitational wave ringdown. I will highlight the necessity for these investigations and outline prospective research directions. Central to my discussion will be a novel approach that enables us to derive a "modified Teukolsky equation", a set of linear, decoupled differential equations that characterize the dynamical perturbations of non-Kerr black holes through the radiative Newman-Penrose scalars Ψ_0 and Ψ_4. This foundational work facilitates the examination of gravitational waves emitted during the ringdown phase of black hole coalescence within beyond GR frameworks applicable to black holes of any spin. Additionally, I will discuss the application of this approach in the context of a quadratic theory of gravity, where the metric and scalar fields exhibit non-minimal coupling, and calculate the QNM frequencies.

GR 4.5 Tue 17:35 ZHG008

Neural Network Assisted Reduced Order Modeling of Black Hole Mergers — •Julian Luca Berg[2], Frank Ohme[1], and Thomas Wick[2] — [1]Max Planck Institute for Gravitational Physics, Hannover, Germany — [2]Leibniz University Hannover, Germany

Since 2015, the detection of gravitational waves gives us the possibility to study objects in the universe such as black holes and neutron stars. By parameter estimation, we can approximate properties of these objects. This includes the masses, spins, and distances. To perform reliable parameter estimation, it is important to have precise and fast models for the corresponding gravitational waves. One approach to speed up numerical computations is reduced order modeling. In this presentation, an approach by J.S. Hesthaven and S. Ubbiali is applied to gravitational wave models that performs reduced order modeling with neural networks. Therein, a neural network is built that can quickly compute a reduced order model for a given set of parameters such that the solution is still a reliable approximation. Our approach is substantiated with some numerical simulations.