GR 2: Relastro I

Time: Tuesday 13:30–15:35 Location: ZHG008

Invited Talk GR 2.1 Tue 13:30 ZHG008

Beyond the thick accretion disk model: external influences and their observational consequences — •Audrey Trova[1], Eva Hackmann[1], Vladimir Karas[2], and Jiří Kovář[3] — [1]University of Bremen, Center of Applied Space Technology and Microgravity (ZARM), 28359 Bremen, Germany — [2]Astronomical Institute, Czech Academy of Sciences, Boční II 1401, Prague, 141 00, Czech Republic — [3]Research Centre for Theoretical Physics and Astrophysics, Institute of Physics, Silesian University in Opava, Bezručovo nám. 13, 746 01, Opava, Czech Republic

The strong gravity regime near black holes and neutron stars provides an exceptional laboratory for testing General Relativity. Accretion disks extend deep into this regime, reaching down to the horizon scale. Various accretion disk models have been developed to better understand the complex phenomena at play. Among them, the thick accretion disk, the simplest analytical model, that considers only gravity and a perfect fluid, captures key features of these objects.

In this talk, we will explore different variants of the thick accretion disk model, incorporating additional effects such as an external magnetic field influencing the charge of the fluid, the deformation of the central object, and the presence of an external mass distribution that can mimic the self-gravity of the disk itself. We will discuss the implications of these factors on the disk's geometry, density, and pressure distribution. Furthermore, we will analyze their impact on observational signatures of black hole accretion disks, particularly in the context of high-frequency quasi-periodic oscillations (HFQPOs).

GR 2.2 Tue 14:15 ZHG008

Magnetic field dynamics in isolated neutron stars: insights from GRMHD simulations — •Aurora Capobianco — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, 07743, Jena, Germany

The internal magnetic field topology and equilibrium configurations of neutron stars are thought to play a fundamental role in determining the nature and strength of astrophysical phenomena. We model the development of the super strong magnetic fields in neutron stars using the General Relativistic MagnetoHydroDynamic (GRMHD) code AthenaK. In this talk, I will present the long-term evolutions of isolated neutron stars with an outer dipole-like field and various initial internal magnetic-field configurations, exploring the growth times of the various instability-driven oscillation modes and turbulence. I will highlight how resolution impacts the magnetic field evolution due to instabilities that arise from small-scale effects and discuss future developments.

GR 2.3 Tue 14:35 ZHG008

Realistic models of general-relativistic differentially rotating stars — •Marie Cassing[1] and Luciano Rezzolla[1,2,3] — [1]Institute for Theoretical Physics, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [3]School of Mathematics, Trinity College, Dublin, Ireland

General-relativistic equilibria of differentially rotating stars are expected in a number of astrophysical scenarios, from core-collapse supernovae to the remnant of binary neutron-star mergers. The latter, in particular, have been the subject of extensive studies where they were modelled with a variety of laws of differential rotation. Starting from accurate and fully general-relativistic simulations of binary neutron-star mergers with various equations of state, we establish the time when the merger remnant has reached a quasi-stationary equilibrium and extract in this way realistic profiles of differential rotation. This allows us to explore how well traditional laws reproduce such differential-rotation properties and to derive new laws of differential rotation that better match the numerical data. In this way, we have obtained a novel and somewhat surprising result: the stability line computed from the turning-point criterion can have a slope that is not necessarily negative with respect to the central rest-mass density, as previously found with traditional differential-rotation laws. For stellar models reproducing well the properties of the merger remnants, the slope is actually positive, thus reflecting remnants with angular momentum at large distances from the rotation axis, and hence with cores having higher central rest-mass densities and slower rotation rates.

GR 2.4 Tue 14:55 ZHG008

Can a collapsing White Dwarf power a long GRB with kilonova? — •Luis Felipe Longo Micchi — Friedrich-Schiller Universität, Jena, Deutschland

In this talk, I will present the results of axisymmetric simulations of accretion-induced collapse (AIC) of rapidly rotating, magnetized white dwarfs. Using general relativistic neutrino magnetohydrodynamics, we explore how strong magnetic fields and rotation during collapse drive the formation of relativistic jets and neutron-rich outflows. These findings offer a compelling explanation for the observed properties of long gamma-ray bursts (LGRBs) like GRB 211211A and GRB 230307A, including their associated kilonovae. I will discuss how our models reproduce the energy and duration of these LGRBs and their accompanying kilonovae without fine-tuning, highlighting AIC as a significant astrophysical site for heavy r-process element production.

GR 2.5 Tue 15:15 ZHG008

Listening to the long ringdown: a novel way to pinpoint the equation of state in neutron star cores — •Christian Ecker — Goethe University Frankfurt

Multimessenger signals from binary neutron star (BNS) mergers are promising tools to infer the largely unknown properties of nuclear matter at densities that are presently inaccessible to laboratory experiments. The gravitational waves (GWs) emitted by BNS merger remnants, in particular, have the potential of setting tight constraints on the neutron-star equation of state (EOS). In this talk I will present a novel and tight correlation between the ratio of the energy and angular momentum losses in the late-time portion of the post-merger signal, i.e., the *long ringdown*, and the properties of the EOS at the highest pressures and densities in neutron-star cores. By applying this correlation to post-merger GW signals, I will show a significant reduction of the EOS uncertainty at densities several times the nuclear saturation density, where no direct constraints are currently available.