HK 51: Nuclear Astrophysics IV

Zeit: Donnerstag 14:00–15:15 Raum: HS 18

Gruppenbericht HK 51.1 Do 14:00 HS 18

Nuclear Pasta Matter in the Intermediate Density Regime — •Bastian Schuetrumpf and Gabriel Martínez-Pinedo — GSI Helmholzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

Nuclear matter as present on earth in the center of atoms is almost isotropic with a central density of the nuclear saturation density. This changes drastically in astrophysical environments such as neutron stars or core-collapse supernova. In particular, in the inner crust of neutron stars at sub-saturation densities (10% - 80% of saturation density), nucleonic matter is expected to form complex structures commonly referred to as "pasta" phases. Because of high densities at macroscopic dimensions, pasta phases represent a unique environment, which is not present on earth and cannot be recreated in the laboratory.

In my talk I will focus on density functional theory calculations of different topologies of nuclear pasta matter and its properties, such as the static structure factor which quantifies the influence e.g. on neutrino opacity. In detail I will present the slab configuration as well a several minimal surface configuration. It turns out that the binding energy per nucleon is very similar for all configurations. In contrast, the properties of the different configurations are very divers.

HK 51.2 Do 14:30 HS 18

Signals in the tidal deformability for phase transitions in compact stars with constraints from GW170817 — •Jan-Erik Christian, Andreas Zacchi, and Jürgen Schaffner-Bielich — Institut für Theoretische Physik, Goethe-Universität Frankfurt

Since the measurement of the merger event GW170817 tidal deformabilies are pivotal in constraining the equation of state for compact stars. We compute the tidal deformabilities for equations of state with a strong first order phase transition producing a new separate branch in the mass-radius diagram. A case is found where all three possible pairs of combinations between these two neutron star branches are present for the total mass of $M = 2.7_{\odot}$ of the observed merger event GW170817. It is demonstrated that the plot of the two tidal deformabilities Λ_1 and Λ_2 of the binary neutron star can show up to three separate branches. We propose that the future detections of neutron star merger events with the same value for Λ_1 but different values of Λ_2 serve as a signal for the existence of a strong first order phase transition in neutron star matter.

HK 51.3 Do 14:45 HS 18

Neutron star merger accretion discs — •Christian Schwebler[1,2], Kevin Ebinger[1,2], and Gabriel Martínez Pinedo[1,2] — [1]Institut für Kernphysik (Theoriezentrum), Technische Universität Darmstadt, Schlossgartenstraße 2, 64289 Darmstadt, Germany — [2]Gesellschaft für Schwerionenforschung Darmstadt, Planckstr. 1, D-64259 Darmstadt, Germany

The merger of binary neutron stars results in the formation of a hyper massive neutron star or a black hole and an accretion disk. During the merger a part of the material outflows as dynamical ejecta and from the disc secular ejecta gets expelled which is an important source of rapid neutron capture (r-process) nucleosynthesis which produces heavy elements like gold. To understand how and what amounts of heavy elements are created in this scenarios we investigate the conditions in these accretion disks and the outflowing material with general-relativistic hydrodynamic simulations using the Einstein Toolkit.

HK 51.4 Do 15:00 HS 18

Exploring the astrophysical conditions for the creation of the first r-process peak — •Stylianos Nikas[1,2], Andre Sieverding[1,2], Gabriel Martinez - Pinedo[1,2], and Meng Ru Wu[3] — [1]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [3]Institute of Astronomy and Astrophysics, Academia Sinica, Taipei, Taiwan

The r-process is responsible for the production of about half of the heavy elements observed in the solar abundances. The site of the r-process was unknown until recent observations. The gravitational wave event GW170817, which was identified as a binary Neutron Star Merger (NSM), was followed by the detection of fast fading optical counterpart consistent with the predictions for a kilonova, associated with r-process nucleosynthesis. The observation of bright, fast fading UV component, established the production of heavy element in the aftermath of NSM.

The complicated atomic structure of lanthanides implies high opacity ejecta which would shift the wavelength of the observed light to the red, the blue color of the ejecta indicates relatively high Y_e and consequently low lanthanide production. We present a study of nucleosynthesis for conditions of high Y_e outflows from NSMs and investigate the effect of various nuclear properties and the astrophysical conditions under which this could be the site for the production of the elements of the r-process abundance pattern for $A < 100$.

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