HK 34: Invited Talks IV

Time: Wednesday 11:00–12:30 Location: HK-H1

Invited Talk HK 34.1 Wed 11:00 HK-H1

Nuclear equation of state constrained by nuclear physics, microscopic and macroscopic collisions — •Sabrina Huth — Institut für Kernphysik, TU Darmstadt — EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

Interpreting high-energy, astrophysical phenomena, such as supernova explosions or neutron-star collisions, requires a robust understanding of matter at supranuclear densities. We present new equations of state where the parameter range of the energy-density functional underlying the equation of state is constrained by chiral effective field theory as well as by functional renormalization group computations based on QCD. We implement observational constraints from measurements of heavy neutron stars, the gravitational wave signal of GW170817, and NICER results. Thermal effects are captured by a novel effective mass parametrization. This has been shown to determine the proto-neutron star contraction in supernova simulations.

Additionally, we use Bayesian inference to combine data from astrophysical multi-messenger observations of neutron stars and from heavy-ion collisions with microscopic nuclear theory calculations to improve our understanding of dense matter. Our findings show that constraints from heavy-ion collision experiments show a remarkable consistency with multi-messenger observations and provide complementary information on nuclear matter at intermediate densities.

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Invited Talk HK 34.2 Wed 11:30 HK-H1

Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis — •Andreas Flörs[1], Luke Shingles[1], and Gabriel Martínez-Pinedo[1,2] — [1]GSI, Darmstadt, Germany — [2]TU Darmstadt, Darmstadt, Germany

It has long since been established that observable actinides in the universe originate from the r-process. In 2017, the electromagnetic counterpart to the gravitational wave detection of two merging neutron stars was observed. From the light curve alone it was possible to characterize two ejecta components: one that contains low-Y_e material such as lanthanides and possibly actinides, and a high-Y_e component with low lanthanide abundances. The dividing characteristic between the two components is the opacity of the material: lanthanides have a ∼100 times higher opacity than iron-group material. The opacity of actinides is expected to be on a similar level as that of the lanthanides, or, possibly, even higher.

To identify specific elements, spectroscopic information is required. However, so far no clear detection of individual lanthanides or actinides has been made in the only observed neutron star merger. A great challenge for spectroscopic modeling of kilonovae using radiative transfer codes is the almost non-existent atomic data currently available for lanthanides and actinides. I will present converged and, where possible, calibrated atomic structure calculations from Zr to U. I will then use this collection of atomic data to show how we can use radiative transfer simulations to identify signatures or place constraints on the amount of heavy r-process material synthesized in kilonovae.

Invited Talk HK 34.3 Wed 12:00 HK-H1

Towards a next-generation LHC heavy-ion Experiment with ALICE — •Raphaelle Bailhache for the ALICE-Collaboration — Goether-universität Frankfurt am Main, Germany

Ultrarelativistic heavy-ion collisions are used to study the physics of strongly interacting matter under extreme conditions, i.e. high temperature and density, similar to those of the early universe. In such collisions a deconfined state of quarks and gluons, the Quark-Gluon Plasma (QGP), is formed. Nuclear collisions at the LHC provide access to the highest-temperature, longest-lived experimentally accessible QGP. After three years of Long Shutdown and intensive installation of detector and accelerator upgrades, ALICE is about to take data at a peak Pb–Pb collision rate of 50 kHz to further characterize the properties of this unique state of matter. In spite of the ambitious scientific programme for the upcoming Runs 3 and 4, crucial questions will still remain unanswered with the present detector concepts. Therefore, a next-generation LHC heavy-ion experiment ALICE 3 is proposed for the 2030s. Among others, this should give access to next-level measurements of electromagnetic probes down to unprecedented very low momenta and a clean reconstruction of heavy-flavour hadrons including multi charm states and exotic objects inaccessible in LHC Run 3 and 4. Such measurements call for a substantial increase in luminosity in combination with unprecedented detector performance.

In this talk, we will present the physics programme of ALICE and the resulting detector requirements. We will then discuss a detector concept suitable to meet these requirements.