HK 31: Nuclear Astrophysics II

Time: Tuesday 17:30–19:00 Location: HBR 19: C 103

Group Report HK 31.1 Tue 17:30 HBR 19: C 103

Quark-hadron phase transition in neutron star cooling — •Melissa Mendes[1,2], Jan-Erik Christian[3], Farrukh Fattoyev[4], Andrew Cumming[5], Jürgen Schaffner-Bielich[6], and Charles Gale[5] — [1]Technische Universität Darmstadt, Germany — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum fu*r Schwerionenforschung GmbH, Germany — [3]Universität Hamburg, Germany — [4]Manhattan College, United States — [5]McGill University, Canada — [6]Goethe-Universität, Frankfurt, Germany

The study of neutron stars has proved complex, both from a theoretical point of view as well as from an observational one. Nonetheless, major advances have been achieved lately with research initiatives, such as NICER and LIGO, which provided relevant constraints to the nuclear equation of state (EOS) with astronomical observations. We give a brief overview of the state-of-the-art data constraints to the neutron star EOS and introduce the possibility of constraining these EOS even further with neutron star temperature measurements. We claim that investigating the cooling of already cold neutron stars is crucial for a better understanding of the nuclear EOS, in particular regarding the existence of a possible quark-hadron phase transition. In this talk, we describe the cooling signature of a quark phase in neutron star temperature evolution considering quark-hadron hybrid equations of state with a first-order phase transition. We compare our calculations with current neutron star luminosity data and obtain estimates for phase transition density. MM funded by the ERC Grant Agreement No. 101020842.

HK 31.2 Tue 18:00 HBR 19: C 103

Generating ultra compact boson stars with modified scalar potentials — •Sarah Louisa Pitz and Jürgen Schaffner-Bielich — Goethe Universität, Frankfurt am Main, Deutschland

The properties of self-interacting boson stars with different scalar potentials going beyond the commonly used ϕ^4 ansatz are studied. The scalar potential is extended to different values of the exponent n of the form $V \propto \phi^n$. Two stability mechanism for boson stars are introduced, the first being a mass term and the second one a vacuum term. In this talk analytic scale-invariant expressions for these two classes of equations of state are presented. The resulting properties of the boson star configurations differ considerably from previous calculations. The maximal compactness can reach extremely high values going to the limit of causality $C_{\max} = 0.354$ asymptotically for $n \to \infty$. The maximal compactnesses exceed previously calculated values of $C_{\max} = 0.16$ for the standard ϕ^4-theory and $C_{\max} = 0.21$ for vector-like interactions and is in line with previous results for solitonic boson stars. Hence, boson stars even described by a simple modified scalar potential in the form of $V \propto \phi^n$ can be ultra compact black hole mimickers where the photon ring is located outside the radius of the star.

HK 31.3 Tue 18:15 HBR 19: C 103

Hyperons in binary neutron star mergers — •Hristijan Kochankovski[3], Sebastian Blacker[1,2], Andreas Bauswein[2,4], Angels Ramos[3], and Laura Tolos[5] — [1]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany — [3]epartament de Fisica Quàntica i Astrofisica and Institut de Ciències del Cosmos, Universitat de Barcelona, Mart** i Franquès 1, 08028, Barcelona, Spain — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Darmstadt, 64291 Darmstadt, Germany — [5]Institute of Space Sciences (ICE, CSIC), Campus UAB, Carrer de Can Magrans, 08193 Barcelona, Spain

The coalescence of a neutron star binary system is an ideal situation for studying extremely dense and hot matter. It is possible that exotic species like hyperons exist in these extreme conditions. In this talk, I will discuss how the appearance of hyperons affects the equation of state and, in turn, what kind of signatures they can leave in the observables that are measured from astrophysical phenomena. I will pay close attention to the signatures originating from the thermal behavior of hyperons in matter. The thermal pressure significantly decreases when hyperons are present. As a result, in comparison to purely nucleonic EoS models, this effect causes a characteristic increase of the dominant postmerger gravitational-wave frequency by as much as 150 Hz.

HK 31.4 Tue 18:30 HBR 19: C 103

Nuclear Matter Equation of State from Delta-full Chiral Interactions — •Yannick Dietz[1,2], Jonas Keller[1,2], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

We report results for infinite homogeneous nuclear matter calculations for the energy per particle and pressure at zero and finite temperature using Delta-full interactions based on chiral effective field theory. Our computations are carried out in many-body perturbation theory, where we include nucleon-nucleon and three-nucleon forces up to third order. Our results at zero temperature are consistent with previous studies of the equation of state based on Delta-less chiral potentials and lead to an improved convergence of uncertainty of the energy per particle.

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HK 31.5 Tue 18:45 HBR 19: C 103

γ-ray angular distribution of the ^{2}H$(p,\gamma)^3$He reaction studied at Felsenkeller lab — •Till Lossin[1,2], Daniel Bemmerer[1], Axel Boeltzig[1], Antonio Caciolli[3,4], Eliana Masha[1], Konrad Schmidt[1], Steffen Turkat[2], Anup Yadav[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]TU Dresden — [3]INFN Sezione di Padova, Italy — [4]Università degli Studi di Padova, Italy

The ^{2}H$(p,\gamma)^3$He reaction is one of the main destruction channels of deuterium (^{2}H) during Big Bang Nucleosynthesis (BBN) and sensitively affects the primordial ^{2}H abundance found at the end of BBN. Its cross section has recently been measured precisely at LUNA, using a large detector at 90° angle. Here, we report on preliminary data from a measurement of the γ-ray angular distribution of this reaction in the proton beam energy range 300-1200 keV. The experiment has been carried out at the Felsenkeller 5 MV shallow-underground accelerator lab in Dresden. The preliminary data are compared with *ab initio* calculated angular distributions.