HK 7: Invited Talks - II

Time: Tuesday 11:00–12:30 Location: H1

Invited Talk HK 7.1 Tue 11:00 H1

First observation of neutrinos from the CNO fusion cycle in the Sun — •Daniele Guffanti — Institute of Physics and Excellence Cluster PRISMA, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

The Sun, as all the other stars, is fuelled for most of its life by the fusion of hydrogen into helium taking place in its core. Neutrinos produced in such reactions are the only direct probe to the innermost part of our star and real time messengers of its engine. Decades of experimental and phenomenological efforts allowed us to study in detail the driving energy production mechanism in the Sun, the proton-proton chain, which is responsible for $\approx 99\%$ of the solar luminosity. The fusion processes accounting for the remaining 1% are believed to be catalysed by the presence of Carbon, Nitrogen and Oxygen (CNO-cycle) in the solar interior, but a direct evidence of the occurrence of such mechanism was still missing.

After years-long efforts, the Borexino experiment at the Gran Sasso National Laboratories has recently reported the first direct observation of solar neutrinos produced in the CNO-cycle. In this talk I will present the Borexino findings and I will discuss the importance of CNO neutrinos for astrophysics and for our understanding of the Sun.

Invited Talk HK 7.2 Tue 11:30 H1

The Compressed Baryonic Matter experiment at FAIR — •Alberica Toia for the CBM-Collaboration — Goethe University Frankfurt — GSI

The study of QCD matter at extreme temperature and density such as existing shortly after the Big Bang or in the core of neutron stars, can bring new insights into the innermost structure of matter and the fundamental forces between its building blocks.

While gravitational wave events reveal a glimpse of QCD matter at these extreme conditions, the future Facility for Antiproton and Ion Research (FAIR) will directly create and investigate its properties in the laboratory. For the very high net-baryon densities, produced by nucleus-nucleus collisions at SIS100 beam energies (3.5-12 AGeV), phenomena such as first order phase transition between hadronic and partonic matter which may terminate at a critical point or even more exotic phases may be expected.

The Compressed Baryonic Matter (CBM) experiment is a dedicated heavy-ion investigation designed to explicitly access rare observables sensitive to the detector media, employing fast and radiation hard detectors, self-triggered detector front-ends and a free-streaming readout architecture.

Several of the CBM detector systems, the data read-out chain and event reconstruction for several of the CBM detector subsystems are commissioned and already used in experiments for FAIR phase 0 and for a full-system setup at GSI SIS18. The physics program of CBM will be reviewed and the current status of the experiment will be reported.

Invited Talk HK 7.3 Tue 12:00 H1

Ab initio perspectives on strongly correlated nuclei — •Alexander Tichai — Institut für Kernphysik, Darmstadt, Germany

The description of nuclear many-body systems has witnessed tremendous progress in the last years due to the development of i) high-precision nuclear interaction models derived from chiral effective field theory and ii) the development of many-body expansion techniques building upon a suitably chosen A-body reference state [1]. The mild computational scaling of such expansion methods extends the reach of ab initio calculations that were previously limited by the capacity of large-scale diagonalization techniques. Nowadays, this allows for targeting up to one hundred interacting nucleons from first principles [2]. In this talk, I review the status of many-body expansion techniques applied to strongly correlated open-shell systems and discuss challenges that emerge for heavy nuclei well above the tin region.

For the description of open-shell nuclei symmetry-breaking techniques have been shown to provide a simple alternative to conceptually more involved multi-reference techniques [3]. Therefore, recent developments will be reviewed that build upon deformed mean-field states to capture the static correlations that emerge in nuclei away from shell closures. Finally, I provide an outlook on future perspectives for heavy nuclei that are out of reach of current ab initio technology [4].

[1] H. Hergert, Front. Phys. 8, 379 (2020) [2] T. Morris et al., Phys. Rev. Lett. 120, 152503 (2018) [3] A. Tichai et al., Phys. Lett. B, 786, 195 (2018) [4] A. Tichai et al., arXiv:2105.03935 (2021)