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Type: **Invited Talk**

The Universe in the Laboratory

Friday, 1 December 2023 14:25 (25 minutes)

“Astrophysics is applied nuclear physics”. This statement of Willy Fowler, the father of nuclear astrophysics, summarizes that nuclear processes are at the origin of the synthesis of the elements in the Universe and also the engine of the astrophysical objects which produce them. This includes the synthesis of the lightest elements during the Big Bang, but also the evolution of stars during their long lifetimes spent in hydrostatical equilibrium. Driven by novel astronomical observational tools, much focus has been recently put on extreme astrophysical objects like supernovae, neutron stars and their mergers. These events involve conditions of temperature, density and also neutron excess which present a challenge to study the related nuclear physics in the laboratory. However, modern facilities, operational and planned, promise decisive breakthroughs in the near future. It will be possible at FAIR to create matter by ultrarelativistic heavy-ion collisions which correspond to the density/temperature regime reached in neutron star mergers or core-collapse supernovae. At radioactive ion-beam facilities, like RIKEN, FRIB und later FAIR, it is possible to produce and study many of the short-lived neutron-rich nuclei which determine the dynamics of r-process nucleosynthesis. Due to the milestone event GW170817 neutron star mergers have been established as one astrophysical site of the r-process.

Simulations of such events are formidable challenges due to the strong interplay of nuclear, neutrino and atomic physics.

The talk will introduce the astrophysical events and discuss the nuclear challenges and future perspectives.

Attendance Type

In-person

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