EMMI workshop: Neutron Matter in Astrophysics: From Neutron Stars to the r-Process

Thursday 15 July 2010 - Sunday 18 July 2010

GSI

Scientific Programme

On the one hand, the workshop will cover research on neutron-rich exotic nuclei, their properties and reactions (strong and weak), i.e. issues central to existing GSI and future FAIR activities as well as the rapid neutron capture process, which is responsible for the production of the heaviest elements found in nature. On the other hand, all astrophysical scenarios for the site of the r-process involve old or newly born neutron stars, which is related to another central activity, (asymmetric) compressed baryonic matter. These scenarios include neutrino winds from hot proto-neutron stars after their formation in core collapse supernova, possible polar jet ejection in rotating neutron stars, and matter ejection in neutron star mergers. In order to have an independent witness of the source of r-process elements in galactic evolution, abundance observations of old stars as a function of their metallicity can serve as an indicator.

While there has been progress in the understanding of exotic nuclei, open questions include shell closures and related nuclear masses, neutron skins, fission barriers, direct capture at low resonance densities in the compound nucleus, the energy distribution of the strength of collective electromagnetic resonances like the E1 giant dipole resonance at low energies (pygmy resonances and their physical understanding) and decay half-lives as well as the interaction with neutrinos. The nuclear (and supra-nuclear) equation of state still harbors essential uncertainties. Recent applications of a simple EoS, based on an MIT bag model for the quark-hadron phase transition, have led to an interesting outcome for supernova explosions and the related neutrino wind. However, there is clearly a need for further improvements, not only at high densities but also at and below the nuclear densities, where so called pasta phases and nuclear clusters can play a decisive role.

Summary of workshop topics:

- r-process scenarios

- exotic nuclei: their properties and reactions

- neutron stars: formation, equation of state, evolution

- neutron star mergers

- observations of r-abundances in low metallicity stars.