A 31: Fathoming Stellar Evolution with Laboratory Precision SYSE (with MS, Q, MO, EP)

Time: Wednesday 14:00–16:00 Location: Audimax

Invited Talk A 31.1 Wed 14:00 Audimax

Addressing open questions of stellar evolution with laboratory experiments — •Almudena Arcones — Technische Universität Darmstadt, Institut für Kernphysik, Germany — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Germany

After several hydrostatic burning stages, massive stars end their life as core-collapse supernova explosions. These high-energy events enrich the interstellar medium with elements formed during the stellar life, produce new heavy elements, and are the birthplace of neutron stars. An exciting stage in the life of neutron stars is the merger with another neutron star or a black hole. Both, core-collapse supernovae and neutron star mergers are sources of heavy elements in the universe. Elements from Sr to Ag can be synthesized in neutrino-driven winds after core-collapse supernovae via charged particle reactions through nuclei relatively close to stability. Heavier elements are produced in rare supernovae and neutron star mergers via the rapid neutron capture process (r-process). In this talk, the role of nuclear masses will be presented showing how further experimental information is highly necessary to constrain the nucleosynthesis and the still uncertain theoretical models. In addition, the r-process can be directly observed after a neutron star merger in the form of a light curve (kilonova) triggered by the radioactive decay of neutron-rich nuclei. In order to obtain the maximum information from such events more atomic data are required to calculate the opacities for r-process ejecta. Therefore, precision experiments are critical to understand supernova, neutron star mergers and their implication in the chemical history of the universe.

Invited Talk A 31.2 Wed 14:30 Audimax

Methods and problems of the modern theory of stellar evolution — •Achim Weiss — Max-Planck-Institut für Astrophysik, Garching

The theory of (hydrostatic) stellar evolution has developed into a mature field of astrophysics. We basically understand the structure and evolution of most stars. The most important input physics is accurate enough to model successfully the nuclear and photometric evolution of stars. I will, in the first part, review this canonical theory, and present a few highlights. A closer look on and into stars, that has become available due to observational progress in the fields of spectroscopy and asteroseismology, reveals, however, that fundamental physical effects, connected mostly with hydrodynamical processes and matter flows, are far from being understood. The second part of this overview will present some of the observational challenges and discuss attempts to improve our theoretical models. The importance of more accurate stellar models for other fields of astrophysics will also be discussed.

Invited Talk A 31.3 Wed 15:00 Audimax

Photoabsorption and opacity in the X-ray region: The role of highly charged ions — •José R. Crespo López-Urrutia — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Within the radiative zone of stars, the contribution to opacity by highly charged ions is the dominant one. In such a dense and hot environment, X-ray opacity determines radiation transport and radiation pressure. It strongly influences the hydrostatic equilibrium, and thus the structure and dynamic evolution, e. g., oscillations and collapse, of a star. Even minor amounts of iron present there play a key role: They are essential to explain the temperature profile of the Sun and main sequence stars. Highly charged iron ions make the star core almost completely opaque to X-rays, slowing down the energy flux. On the theoretical side, opacity calculations for astrophysics require the use of approximations, and until now very few accurate experimental benchmarks have been reported for them. Recently, with the use of electron beam ion traps at X-ray sources such as free-electron lasers and synchrotron facilities, new methods have been developed for detailed studies of such X-ray photoabsorption process. The results of these experiments test the values of cross sections and resonance energies for ions in charge states which had hitherto been beyond reach, and the experimental results achieve accuracies surpassing that of current theory.

Invited Talk A 31.4 Wed 15:30 Audimax

Neutron-rich matter: From cold atoms to neutron stars — •Achim Schwenk — Institut für Kernphysik - Theoriezentrum, TU Darmstadt — ExtreMe Matter Institute EMMI, GSI, Darmstadt

There are many synergies between neutron matter and ultracold Fermi gases with resonant interactions. This talk will discuss the physics of neutron-rich matter starting from universal properties at low densities to dense matter in neutron stars. We will focus on the similarities of these systems and on the current frontiers in describing neutron-rich systems in the laboratory and in stars.