Contribution ID: **49** Type: **Invited Presentation**

Progress in the development of nuclear models for astrophysical applications

Wednesday 24 September 2025 09:30 (30 minutes)

Though the origin of most of the nuclides lighter than iron is now quite well understood, the synthesis of the heavy elements (i.e. heavier than iron) remains puzzling in many respects. The major mechanisms called for to explain the production of the heavy nuclei are the slow neutron-capture process (or s-process), occurring during the hydrostatic stellar burning phases, the rapid neutron-capture process (or r-process) believed to develop during the explosion of a star as a supernova or the coalescence of two binary neutron stars. In addition, the origin of the neutron-deficient nuclides observed in the solar system is attributed to the so-called p-process taking place in supernovae. Recently, the intermediate neutron-capture process (or i-process) has been called for to explain the surface enrichment of specific metal-poor stars.

All these nuclear processes are due to nuclear reactions taking place in conditions of locally established thermodynamic equilibrium. Composition changes in the cosmos can also be the result of nuclear transformations in too dilute and/or too cold media to establish thermodynamic equilibrium between the reaction partners. This is the case for stellar/solar energetic particles interacting with circumstellar media and for Galactic cosmic rays bombarding the interstellar medium. This is referred to as "non-thermal nucleosynthesis". While almost all the existing nucleosynthesis models are based on thermal processes, non-thermal processes have been called for to explain specific species or chemically peculiar stars.

Both thermal and non-thermal nucleosynthesis require a detailed knowledge not only of the astrophysical sites and physical conditions in which the processes take place, but also of accurate and reliable nuclear data. The present talk will critically review the different astrophysical models as well as the enormous theoretical challenges in nuclear physics. These include the reaction model needed to describe the captures by exotic nuclei, as well as the nuclear ingredients needed to estimate the corresponding reaction rates, namely nuclear structure properties, level densities, photon strength functions, as well as fission properties. New progress based on mean-field and beyond-mean-field models will be described and their impact on nucleosynthesis processes illustrated.

Author: GORIELY, Stephane (Université Libre de Bruxelles)

Presenter: GORIELY, Stephane (Université Libre de Bruxelles)

Session Classification: Plenary Session

Track Classification: Nuclear Astrophysics