Joliot-Curie School 2016

Nuclear and astrophysics aspects of the heavy elements nucleosynthesis

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One of the major issues in modern astrophysics concerns the analysis and understanding of the present composition of the Universe and its various constituting objects. Nucleosynthesis models aim to explain the origin of the different nuclei observed in nature by identifying the possible processes able to synthesize them. 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 obscure 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 specific hydrostatic stellar burning phases, the rapid neutron-capture process (or r-process) believed to develop during the explosion of a star as a type II supernova or during the merging of two compact objects, and the photodisintegration process (or p-process) taking place in the high-temperature environment of type-Ia or type-II supernovae. The stellar production of heavy elements requires a detailed knowledge not only of the astrophysical sites and physical conditions in which the processes take place, but also the nuclear structure and interaction properties for all the nuclei involved.

These lectures describe our present understanding of these three nucleosynthesis processes as well as the may experimental and theoretical efforts devoted to determine the related nuclear physics inputs of relevance. They will also focus on the particular links developed between nuclear physics and astrophysics in order to understand the origin of the nuclides heavier than iron observed in the Universe.