

In-beam capture reaction cross-section measurements relevant to p -process nucleosynthesis

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The origin in the cosmos of the so-called p nuclei is one of the most puzzling problems yet to be solved by any model of heavy-element nucleosynthesis. The class of p nuclei consists of 35 proton-rich stable nuclei that are heavier than iron and cannot be synthesized by the two neutron-capture processes referred to as s and r process. To date, these nuclei have been observed only in the solar system. The reproduction of p -nuclei abundances on the basis of astrophysical processes occurring outside the solar system, such as exploding supernovae (SNII) or He-accreting white dwarves with sub-Chandrasekhar mass, will enable us not only to understand the nuclidic composition of the solar system but also to further elucidate our fundamental picture of its creation.

So far, all the models of p -process nucleosynthesis are able to reproduce most of the p -nuclei abundances within a factor of 3, but they fail completely in the case of the light p nuclei. Due to the huge number of reactions involved in abundance calculations, the latter have to rely almost completely on the reaction cross-section predictions of the Hauser-Feshbach (HF) theory. It is therefore of key importance, on top of any astrophysical model improvements, to investigate the uncertainties in the nuclear data, and in particular in the nuclear level densities (NLD), nucleon-nucleus optical model potentials (OMP), and γ -ray strength functions entering the HF calculations.

In view of these problems, we have performed several in-beam cross sections measurements of proton- as well as α -capture reactions in the Ni-Te region at energies well below the Coulomb barrier. Our aim is to contribute to a cross-section database relevant to the modelling of the p process and to obtain global models of input parameters (OMP, NLD) for HF calculations. This contribution reports on recent results of our systematic investigations comprising more than 30 capture reactions. Our results, as well as all other existing data, are compared with HF calculations using various microscopic and phenomenological models of the nuclear input (NLD, OMP). Several aspects of all the experiments performed so far, as well as plans for additional measurements, are presented.