Cross section measurements of alpha-capture reactions relevant to p-process nucleosynthesis

A. Lagoyannis, T. Konstantinopoulos, P. Demetriou, S. Harissopulos

Institute of Nuclear Physics, National Centre for Scientific Research "Demokritos", POB 60228, 153.10 Aghia Paraskevi, Athens, Greece.

H. W. Becker

DTL, Institut für Experimentalphysik III, Ruhr-Universität Bochum, Germany

The origin in the cosmos of the so-called *p* nuclei is one of the most puzzling problems 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 occuring 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 Se-Sb 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 input parameters for HF calculations. This contribution reports on the $^{94}Mo(\alpha,\gamma)^{98}Ru$ and $^{65}Cu(\alpha,\gamma)^{69}Ga$ 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. Finally, the question of whether there is sufficient experimental information to put constraints on the theory and draw final conclusions is discussed.