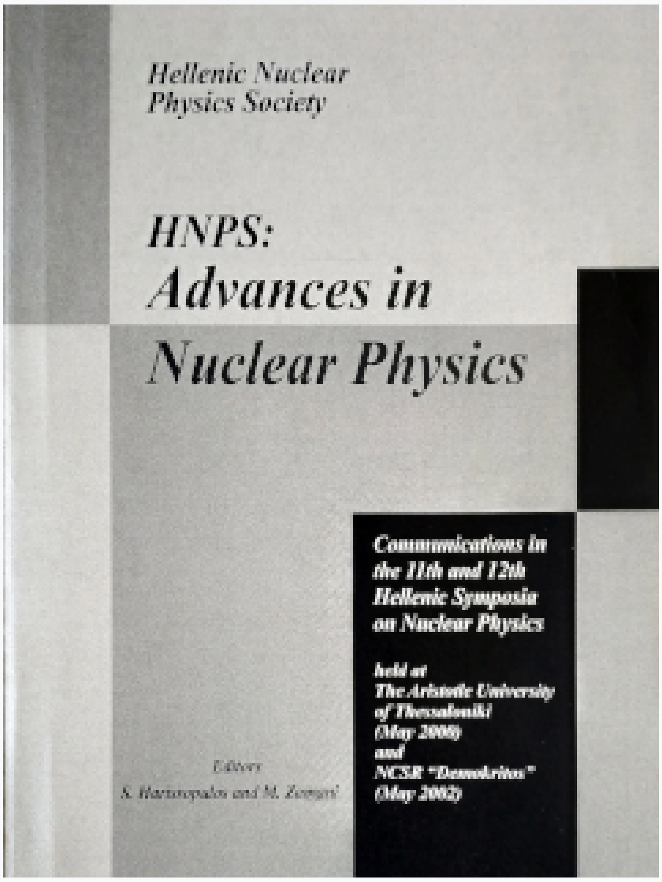
HNPS Advances in Nuclear Physics

Vol 11 (2002)

HNPS2000 and HNPS2002



A systematic study of proton capture reactions in the Se-Sn region relevant to p-process nucleosynthesis

S. Harissopulos, P. Demetriou, S. Galanopoulos, G. Kriembardis, M. Kokkoris, P. Tsagari, E. Skreti, Ch. Zarkadas, A. G. Karydas, J. W. Hammer, R. Kunz, M. Fey, A. Dewald, K. O. Zel, P. von Brentano, R. Julin, S. Goriely

doi: [10.12681/hnps.2210](https://doi.org/10.12681/hnps.2210)

A systematic study of proton capture reactions in the Se-Sn region relevant to p-process nucleosynthesis

S. Harissopulos, P. Demetriou, S. Galanopoulos, G. Kriembardis, M. Kokkoris, P. Tsagari, E. Skreti, Ch. Zarkadas, and A. G. Karydas
Institute of Nuclear Physics, NCSR "Demokritos", 15310 Aghia Paraskevi, Athens, Greece.
J.W. Hammer, R. Kunz, and M. Fey
Institut für Strahlenphysik, Universität Stuttgart, Allmandring 3, 70550 Stuttgart, Germany
A. Dewald, K.O. Zell, and P. von Brentano
Institut für Kernphysik, Universität zu Köln, Zülpicherstr. 77, 50937 Cologne, Germany
R. Julin
Department of Physics, University of Jyväskylä, POB 35, 40351 Jyväskylä, Finland
S. Goriely
Institut d' Astrophysique, CP226, Universitè Libre de Bruxelles, 1050 Brussels, Belgium

Abstract

The synthesis of the so-called *p nuclei*, i.e. a certain class of proton rich nuclei that are heavier than iron, requires a special mechanism known as *p process*. This process consists of various nucleosynthetic scenaria. In some of them proton and alpha-capture reactions are strongly involved. p-process nucleosynthesis is assumed to occur in the Oxygen/Neon rich layers of type II supernovae during their explosion. p nuclei are typically 10-100 times less abundant than the corresponding more neutron-rich isotopes. The prediction of their abundances is one of the major puzzles of all models of p-process nucleosynthesis. Until now all these models are capable of reproducing these abundances within a factor of 3. However, they all fail in the case of the light p nuclei with A≤100. The observed discrepancies could be attributed to uncertainties in the pure "astrophysical" part of the p-process modelling. However, they could also be the result of uncertainties in the nuclear physics data entering the corresponding abundance calculations. In order to perform these calculations the cross sections of typically 10000 nuclear reactions of an extended reaction network involving almost 1000 nuclei from A=12 to 210 are used as input data. Such a huge amount of experimental cross section data are not available. Hence, all extended network calculations rely almost completely on cross sections predicted by the Hauser-Feshbach (HF) theory. It is therefore of paramount importance, on top of any astrophysical model improvements, to test also the reliability of the HF calculations, i.e. to investigate the uncertainties associated with the evaluation of the nuclear properties, like nuclear level densities and nucleon-nucleus potentials, entering the calculations. Until now, this check has been hindered significantly by the fact that in the Se-Sn region there has been scarce experimental information on cross sections at astrophysically relevant energies.

In the present work, a systematic investigation of (p,γ) cross sections of nuclei from Se to Sb is presented for the first time. The in-beam cross section measurements reported were carried out at energies relevant to p-process nucleosynthesis, i.e. from 1.4 to 5 MeV. The experiments were performed by using either an array of 4 HPGe detectors of 100% relative efficiency shielded with BGO crustals for Compton suppression, or a 4π NaI summing detector. The resulting cross sections, astrophysical S-factors and reaction rates of more than 10 nuclear reactions are compared with the predictions of various statistical model calculations.

Contribution to:
12TH SYMPOSIUM OF THE HELLENIC NUCLEAR PHYSICS SOCIETY
NCSR "DEMOKRITOS", ATHENS, MAY 10-11, 2002