Astrophysical production of ^{146}Sm in nuclear p-processes

Cristiana Oprea,[1] Alexandru Mihul,[2] Alexandru Ioan Oprea,[1] Sorin Zgura,[3] Mihai Potlog,[3] and Alina Neagu[3]

[1] *Joint Institute for Nuclear Researches (JINR)*

Frank Laboratory of Neutron Physics (FLNP)

141980 Dubna Moscow Region Russian Federation

[2] *European Organization for Nuclear Research (CERN), CMS*

CH-1211 Genve 23, Switzerland

[3] *Institute for Space Sciences (ISS)*

RO-077125 Bucharest Magurele, Romania

The large time of life of ^{146}Sm suggests the possibility to use this p-nuclide as astrophysical chronometer to study the geochemical galactic evolution. Due to the high temperature and large densities of gamma quanta, neutrons and protons in stellar environment ^{146}Sm nucleus can be obtained in (γ,n), (n,2n), (p,2n) processes on ^{147}Sm. The knowledge of corresponding cross sections of gamma rays, neutrons and protons induced processes is of a great importance for the explanation of (^{146}Sm/^{144}Sm) ratio uncertainties observed on the Earth, meteorites, Moon and other celestial bodies.

Cross sections of (γ,n), (n,2n), (p,2n) processes induced by fast gamma rays, neutrons and protons on ^{147}Sm from threshold up to 25 MeV were evaluated and predicted in the frame of Hauser-Feshbach statistical model by using Talys software and own computer programs. For each nuclear reaction contribution of direct, compound and pre-equilibrium mechanisms were determined. For (γ,xn) reaction, transition multiplicity function is used in the analysis of theory and measurements results. Theoretical evaluations are compared with existing experimental data for other nuclear processes as well. Parameters of optical potential in the incident and emergent channels and of nuclear densities were extracted. Calculated cross sections together with corresponding nuclear data were used in the evaluation of astrophysical rates and of elemental abundances from nuclear networks.

[1] E. M. Burbidge, G. R. Burbidge, W. A. Fowler, Rev. Mod. Phys **29, 4**, 547-654 (1957).

[2] M. Lugaro, M. Pignatary, Ulrich Ott, Kai Zuber, C. Travaglio, G. Gyurky, Zs. Fulop, Proceedings of National Academy of Sciences of USA **113, 4**, 907-912 (2016).

[3] N. Kinoshita, M. Paul, Y. Kashiv, P. Collon, C. M. Deibel, B. DiGiovine, J. P. Greene, D. J. Henderson, C. L. Jiang, S. T. Marley, T. Nakanishi, R. C. Pardo, K. E. Rehm, D. Robertson, R. Scott, C. Schmitt, X. D. Tang, R. Vondrasek, A. Yokoyama, Science **35, 6076**, 1614-1617 (2012).

[4] V. V. Varlamov, B. S. Ishkhanov, V. N. Orlin, K. A. Stopani, Eur. Phys. J. A **50**, 114 (2014).