Stellar nucleosynthesis: experimental yields of the $^{112}Sn(\gamma,n)^{111}Sn$ and $^{112}Sn(\gamma,p)^{111m,g}In$ reactions for p-nuclei production simulation

A.V. Chekhovska[a], I.L. Semisalov[b], V.I. Kasilov[b], Ye.O. Skakun[b]

[a] *V. N. Karazin Kharkiv National University, 61022 Kharkiv, Ukraine*
[b] *National Science Center "Kharkiv Institute of Physics and Technology", 61108 Kharkiv, Ukraine*

The nuclei of the overwhelming majority of the occurring in nature stable isotopes of medium and heavy chemical elements were synthesized in hot stars during the scenarios of rapid (*r*) and slow (*s*) neutron capture, that is (n,γ)-reactions, and following β^--decays. However, in the formation of a so-called *p-nuclei* group including the ^{112}Sn nuclide, simple photonuclear reactions of the (γ,n), (γ,p), and (γ,α) type play a key role, and that is why this scenario was named the γ-*process*. There is a need to know the rates of a large array of low energy nuclear reactions to simulate the current natural abundances of the p-nuclei.

In the present work using the thin tantalum converter bremsstrahlung of the NSC KIPT (Kharkiv) electron linac for the target irradiations and high energy resolution gamma spectrometry for the induced radioactivity measurements we determined the integral yields of the $^{112}Sn(\gamma,p)^{111m,g}In(T_{1/2}^m = 7.7$ m$, J_m^\pi = 1/2^-, T_{1/2}^g = 2.8$ d$, J_g^\pi = 9/2^+)$ and $^{112}Sn(\gamma,n)^{111}Sn(T_{1/2} = 35.3$ m$)$ reactions in the relevant to astrophysical interest energy range between the threshold and 15 MeV. The results of the measurements are compared with the available data obtained by counting the neutrons and protons to be emitted, and with the calculations of the statistical theory of nuclear reactions implemented by the widely used for astrophysical calculations NON-SMOKER [1] and TALYS [2] computer codes with different models of nuclear level density and radiation strength function.

As an additional result, the branching coefficients of the strongest γ-transitions between the ^{111}In excited states populated at the ^{111}Sn nucleus decay have been determined. They differ from the currently accepted values [3].

References

[1] T. Rauscher, F.-K. Thielmann, ADNDT 80, 1 (2004).

[2] A.J. Koning, S. Hilaire and M.C. Duijvestijn, TALYS-1.0, Proceedings of the International Conference on Nuclear Data for Science and Technology, April 22-27, 2007, Nice, France, editors O.Bersillon, F.Gunsing, E.Bauge, R.Jacqmin, and S.Leray, EDP Sciences, 2008, p. 211-214.

[3] http://www.nndc.bnl.gov/nudat2/.