ASTROPHYSICAL S-FACTOR AND REACTION RATE FOR ^{11}B(p,γ)^{12}C REACTION

S.V. Artemov[1,2], N. Burtebayev[1,3], S.B. Sakuta[1,4], **S.B. Igamov[2]**, Maulen Nassurlla[1,3], Marzhan Nassurlla[1],K. Rusek[5], F.Kh. Ergashev[2], O.R.Tojiboev[2], I.Ya. Son[2], D.A. Issayev[1,3]

1 Institute of Nuclear Physics, 050032 Almaty, Kazakhstan
2 Institute of Nuclear Physics, 100214 Tashkent, Uzbekistan
3 Al-Farabi Kazakh National University, 050040 Almaty, Kazakhstan
4 National Research Center "Kurchatov Institute", 123182 Moscow, Russia
5 Heavy Ion Laboratory University of Warsaw, PL-20-093 Warsaw, Poland
E-mail: igamov@inp.uz

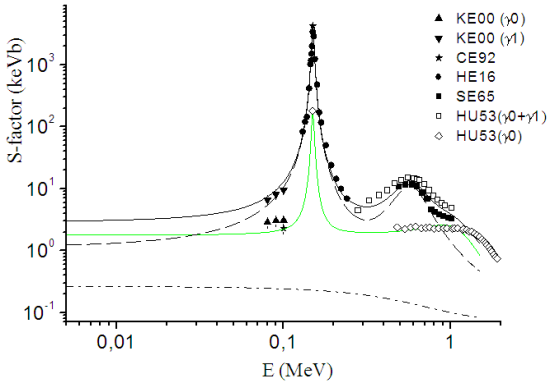
It is generally accepted that the ^{12}C nucleus is formed mainly by fusion of three α particles, $3\alpha \rightarrow {}^{12}C^*$ through the Hoyle state (0^+) with an excitation energy of 7.65 MeV, as the proton capture by the ^{11}B nucleus at E_p < 100 keV has a small cross section for ^{12}C formation in primary nucleosynthesis. However, the alternative pathways of its formation considered, for example, in the inhomogeneous Big Bang model [1] leading to radiative capture of a proton by the ^{11}B nucleus, cannot be ignored. As noted in [1,2], in the processes of nucleosynthesis in proton-rich environment, the following chains of nuclear reactions may also be important:

…^{7}Be(p,γ)^{8}B(α ,p)^{11}C(e+ν)^{11}B(p,γ)^{12}C…

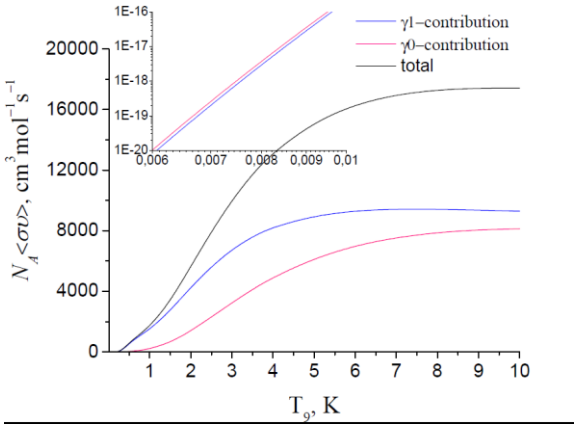
The direct measurements of the total *S*-factors of radiative capture on ^{12}C, even at not too low energies, is a non-trivial experimental task, since it is necessary to measure the γ spectra of low-intensity high-energy γ-quanta ($E\gamma$>10 MeV) and also high-energy cascade quanta [1]. Note that in the astrophysically significant energy region below 100 keV in the ^{11}B+p system there are no resonances, and therefore, for extrapolating calculations of the total S-factors and reaction rates, it becomes very important to know the ANCs for bound states of the proton in the ^{12}C nucleus, which can make a significant contribution to the total direct proton capture cross section.

The aim of this work is to calculate the astrophysical S-factor and the reaction rate ^{11}B(p,γ)^{12}C using the ANC square values for the ground (0^+) and excited (2^+) states of the ^{12}C nucleus (where the experimental data are available), obtained from the analysis of the peripheral ^{11}B(^{10}B,^{9}Be)^{12}C proton transfer reaction.

The calculation of the astrophysical *S* factor of the ^{11}B(p,γ)^{12}C radiative capture reaction was carried out within the framework of the modified *R*-matrix method for transitions to the ground (0^+) and 1-st exited ($E^* = 4.44$ MeV, 2^+) states of the ^{12}C nucleus. This work also presents the results of the calculation of the reaction rate ^{11}B(p,γ)^{12}C based on the energy dependence of the S-factor at the astrophysical relevant temperatures.



Astrophysical S −factors of γ_0 −, γ_1 – transitions and total ($\gamma_0 + \gamma_1$) astrophysical S −factor in the ^{11}B(p,γ)^{12}C reaction.



^{11}B(p,γ)^{12}C reaction rate.

References

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2. V. Guimaraes and C. A. Bertulani AIP Conf. Proc. 1245, 30 (2010)