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

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It is generally accepted that the ¹²C nucleus is formed mainly by fusion of three α particles, 3α→¹²Cthrough the Hoyle state (0⁺) with an excitation energy of 7.65 MeV, as the proton capture by the ¹¹B nucleus at E_p < 100 keV has a small cross section for ¹²C 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 ¹¹B 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:
⋯⁷Be(p,γ)⁸B(α,p)¹¹C(e+ν)¹¹B(p,γ)¹²C⋯
The direct measurements of the total S-factors of radiative capture on ¹²C, 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<sub>γ</sub»10 MeV) and also high-energy cascade quanta [1]. Note that in the astrophysically significant energy region below 100 keV in the ¹¹B+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 ¹²C 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 ¹¹B(p,γ)¹²C using the ANC square values for the ground (0⁺) and excited (2⁺) states of the ¹²C nucleus (where the experimental data are available), obtained from the analysis of the peripheral ¹¹B(¹⁰B,<sup>9</su
proton transfer reaction.
The calculation of the astrophysical S factor of the ¹¹B(p,γ)¹²C 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 ¹²C nucleus. This work also presents the results of the calculation of the reaction rate ¹¹B(p,γ)¹²C based on the energy dependence of the S-factor at the astrophysical relevant temperatures.

References
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Section

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