Contribution ID: **48** Type: **Poster**

Theoretical analysis of astrophysical S-factors of nuclear reactions 7Be(n,α)4He and 7Be(n,p)7Li

Tuesday, 22 September 2026 16:30 (5 minutes)

Theoretical analysis of astrophysical S-factors of nuclear reactions
^{7}Be(n,α)^{4}He and ^{7}Be(n,p)^{7}Li

V.I. Zhaba, V.S. Vasilevsky, Yu.A. Lashko

Bogolyubov Institute for Theoretical Physics, National Academy of Sciences of Ukraine

In this report, we study a range of reactions induced by the interactions ^{7}Li+p, ^{7}Be+n and ^{6}Li+d. Special attention is paid to the low-energy region in the input channels of reactions that take into account the dynamics of synthesis and decay of ^{6}Li, ^{7}Li and ^{7}Be nuclei. This study is performed within a microscopic three-cluster model, which allows us to involve all binary channels of the ^{8}Be decay. Besides, this model takes into account polarizability of interacting nuclei (clusters) [1, 2]. In Ref. [3], this model was successfully applied to study the structure of the ^{8}Be nucleus and the nature of high-energy resonance states of ^{8}Be.
Within the framework of our model, the astrophysical S-factors of the reactions ^{7}Be(n,α)^{4}He, ^{7}Be(n,p$_0$)^{7}Li and ^{7}Be(n,p$_1$)^{7}Li in the energy range E$_{cm}$=0-2 MeV were calculated. The dependence of the astrophysical S-factors on the form and intensity of the nucleon-nucleon interaction was investigated in detail. For the astrophysical S-factor of ^{7}Be(n,α)^{4}He reaction, the partial 2^{+} wave dominates over the entire energy range, and is then enhanced by the 0^{+} wave. The calculated S-factors for ^{7}Be(n,α)^{4}He reaction are further decomposed into contributions from reactions with ^{7}Be in its ground and first excited states. For ^{7}Be(3/2^{-})(n,α)^{4}He reaction, the 2^{+} wave has a maximum that is due to resonance. In our microscopic model, this 2^{+} resonance state appears at energy E≈1.27 MeV above ^{7}Be+n decay threshold, which is in good agreement with the experimental data obtained in [4].
For ^{7}Be(n,p$_0$)^{7}Li reaction, the 3^{+} partial wave dominates in the region of the maximum at Ecm=0.5 MeV, while the 2^{-} partial wave determines the behavior at low and high energies. For ^{7}Be(n,p$_1$)^{7}Li reaction, the 1^{-} partial wave dominates in the entire energy range and together with the $^{+}$, 2^{-}, 2^{+} states provide the main contribution to the astrophysical S-factor. It was demonstrated that the cluster polarization has a large impact on value and energy dependence of the S-factor for the ^{7}Be(n,p)^{7}Li reaction.
The calculated astrophysical S-factors for the reactions ^{7}Be(n,α)^{4}He and ^{7}Be(n,p)^{7}Li are in good agreement with experimental data from leading laboratories. Our partial astrophysical S-factors for the ^{7}Be+n reactions are compared with calculations in the R-matrix theory and with data in the ENDF database.

[1] Y.A. Lashko, G.F. Filippov, V.S. Vasilevsky. Nucl. Phys. A 958, 78 (2017).
[2] V.S. Vasilevsky, F. Arickx, J. Broeckhove, T.P. Kovalenko. Nucl. Phys. A 824, 37 (2009).
[3] V.I. Zhaba, Yu.A. Lashko, V.S. Vasilevsky. Phys. Rev. C 112 014328 (2025).
[4] D.R. Tilley, J.H. Kelley, J.L. Godwin et al. Nucl. Phys. A 745 155 (2004).

Primary authors: ZHABA, Victor (Інститут теоретичної фізики ім. М.М. Боголюбова НАН України); VASILEVSKY, Victor (Bogolyubov Institute for Theoretical Physics, National Academy of Sciences of Ukraine); LASHKO, Yuliia (Bogolyubov Institute for Theoretical Physics, National Academy of Sciences of Ukraine)

Presenter: ZHABA, Victor (Інститут теоретичної фізики ім. М.М. Боголюбова НАН України)

Session Classification: Poster Session

Track Classification: HIGH ENERGY PHYSICS AND NUCLEAR MATTER