Contribution ID: **109** Type: **not specified**

ASYMPTOTIC NORMALIZATION COEFFICIENTS FROM THE $^{14}\mathrm{C}(^{3}\mathrm{He},d)^{15}\mathrm{N}$ REACTION ANALYZIS

The work is devoted to determining the values of the Asymptotic Normalization Coefficients (ANCs) of bound proton states in the $^{15}\mathrm{N}$ nucleus from the experimental data on the reaction $^{14}\mathrm{C}(^{3}\mathrm{He},d)^{15}\mathrm{N}$ [1]. In addition to new data on the structure of the $^{15}\mathrm{N}$ nucleus, knowledge of the squares of ANC is necessary for calculating the astrophysical S factors and reaction rates for the radiative proton capture $^{14}\mathrm{C}(p,\gamma)^{15}\mathrm{N}$ reaction. The study of radiative proton capture reactions occurring in the processes of primordial and stellar nucleosynthesis is an important part of nuclear astrophysics. In particular, the above reaction can play an important role in inhomogeneous Big Bang models, being a participant in the chain of processes [2,3]
We have analyzed the differential cross sections (DCS) of the $^{14}\mathrm{C}(^{3}\mathrm{He},d)^{15}\mathrm{N}$ reaction from [1] (at a beam energy of 25.4 MeV,) within the Modified DWBA (MDWBA) [4] framework, which can be applied in the case of a one-stage process of peripheral proton transfer.The verification of the peripherality of a proton transfer in the region of the forward angles of deuteron emission was carried out using MDWBA tools. It showed that the transfers of a proton to the ground state as well as to 5.27 MeV $5/2^{+}$, 5.30 MeV $1/2^{+}$, 6.32 MeV $3/2^{-}$, 7.16 MeV $5/2^{+}$ and 7.30 MeV $3/2^{+}$ states of the $^{15}\mathrm{N}$ nucleus are practically peripheral, since the spread of the test function ρ(b) values does not exceed the experimental DCS errors. At that, the single-particle ANC b changed when the geometric parameters of Woods-Saxon potential of the proton bound states varied in the range 1.10 < r < 1.40 fm and 0.5 < a < 0.8 fm. When calculating the MDWBA DCSs, we employed both optical potential (OP) parameters found by the authors of [1] and modern widely-used global OPs in the entrance and exit channels of the reaction [5,6].
It was found that the calculations describe the experimental DCSs well in the forward hemisphere of the deuteron escape, including the main diffraction maximum of the angular distributionsfor all considered cases. This suggests that the dominant mechanism of the reaction is a one-step proton transfer. Under this assumption, for these states of the $^{15}\mathrm{N}$ nucleus, the values of the squared ANCs of proton bindingwere estimated by normalizing the calculated DCSs to the experimental ones for angles in the region of the main maximum of the angular distributions. For $^{3}\mathrm{He} \longrightarrow$ d+p binding, the value of the squared ANC was used equal to 4.28±0.50 fm^{-1} [7]. The values of the ANC squares were found to be 0.49±0.08 fm^{-1}, 0.033±0.006 fm^{-1} and 0.0063±0.0011 fm^{-1} for the states 6.32 MeV, 7.16 MeV and 7.30 MeV, respectively. Data for the final states of 5.27 and 5.30 MeV, which were not resolved in the experiment (see [1]), are currently being analyzed by us. We also note that the ANC for the ground state of the $^{15}\mathrm{N}$ nucleus was found by us in work [8]
The found ANC values are planned to be used in calculating the astrophysical S-factors and the rates of radiative proton capture by the $^{14}\mathrm{C}$ nucleus at stellar temperatures.

References:

1. R.R. Sercely et al., Nucl. Phys. A 324, 53 (1979)
2. J. Applegat et al., Astrophys. J. 329, 527 (1988).
3. R. Malaney and W. Fowler, Ap. J. 333, 14 (1988).
4. O.R. Tojiboev et al., Phys. Rev. C 94, 054616 (2016).
5. An Haixia and CaiChonghai.,Phys. Rev. C 73, 054605 (2006).
6. Y. Zhang, D.Y. Pang,J.L. Lou.,Phys. Rev. C 94, 014619 (2016).
7. S.V. Artemov., Bull. Russ. Acad. Sci.: Phys. 73, 165 (2009).
8. E.T. Ruziev et al., Int.Jour.Mod.Phys. E 33, 2450024 (2024).

Section

Nuclear physics (Section 1)

Primary author: RUZIEV, E.T. (Institute of Nuclear Physics, 100214 Tashkent, Uzbekistan)

Co-author: ARTEMOV, S.V. (Institute of Nuclear Physics, 100214 Tashkent, Uzbekistan)

Presenter: RUZIEV, E.T. (Institute of Nuclear Physics, 100214 Tashkent, Uzbekistan)

Track Classification: The V International Scientific Forum "Nuclear Science and Technologies": Nuclear physics (Section 1)