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A new underground measurement of the ^{14}N(p,γ)^{15}O reaction at Bellotti Ion Beam Facility

Content

The ^{14}N(p,γ)^{15}O is the slowest reaction of the CNO cycle and serves as its bottleneck, directly impacting the production of solar CNO neutrinos and the estimation of stellar lifetimes. Despite significant experimental efforts, including several underground measurements, uncertainties in its cross section continue to affect our understanding of solar composition and Standard Solar Models.

In the framework of the LUNA (Laboratory for Underground Nuclear Astrophysics), directly following on the initial commissioning phase of the LNGS Bellotti Ion Beam Facility, a new measurement of the ^{14}N(p,γ)^{15}O cross section has been performed deep-underground at its 3.5 MV accelerator. In this talk I will present new experimental results from the measurement of this key reaction, including high-quality datasets in the proton energy range 0.25-1.2 MeV for the primary transitions to the 6.79 MeV and ground states of ^{15}O, as well as the contributions from the capture to the states at 6.17, 5.24, and 5.18 MeV, which had not been measured at these energies since the work of Schroder et al. (1987). Additionally, the angular distributions for the dominant transitions were measured down to a center-of-mass energy of 380 keV, in an energy range previously unexplored.

The experimental setup featured solid nitrogen targets produced via reactive sputtering and implantation, ensuring optimal stability and minimal contamination under high beam currents. The results provide significant new insights to constrain the extrapolation of the total S-factor of ^{14}N(p,γ)^{15}O obtained with a multi-channel R-matrix of the available literature data and can contribute in resolving uncertainties in solar models. Combined with solar neutrino flux measurements from Borexino experiment, these findings may help refine our understanding of the solar abundance problem.

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