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Populating α-unbound states in 16O via 19F(p,α)16O

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Several reactions of light nuclei require a better understanding in Nuclear Astrophysics. The most relevant one is 12C(α,γ)16O. The reason for this is both, the unmitigated importance of the reaction, and the complexity of its cross section at the relevant energies of static helium burning (300 keV) which uncertainty is still undesirably large. As there is no state of natural parity to serve as a resonance for radiative capture in the energy region of interest, the total cross section originates from a sum of resonance tails and direct captures, both, to the ground and excited states of 16O. Among the resonance tails contributing are two bound subthreshold states, i.e., the 1- state at -45 keV and the 2+ state at -200 keV below the α+12C threshold [1]. One of the methods to estimate these contributions consists in determining all the important reduced α-widths of the subthreshold states by indirect measurements, that are more sensitive to the α-width than the direct radiative capture measurement.

With this aim, a study of the 19F(p,α)16O reaction is being performed at CMAM facility (Madrid, Spain), using a proton beam with energies between 1.3 and 2.9 MeV to populate α-unbound states in 16O [2]. The experimental setup consists in 14 pixelated silicon detectors forming a quarter sphere configuration that cover forward angles from 27° to 87° [3] with an angular resolution of 9°. In the backward direction, three multi-segmented silicon detectors that cover from 82° to 171° backwards with an angular resolution of 3°, and an array of four scintillator units of 4 cm LaBr3(Ce) coupled with 6 cm LaCl3(Ce).

In this work we will present branching ratios to the population of the different 16O levels at different energies, measured, for the first time, through the study of the α-particles and γ-rays emitted in the reaction simultaneously in this energy range. We will conclude discussing the relative cross section obtained for those subthreshold levels that were highly populated at these energies.

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[3] L.M. Fraile, J. Äystö. Nuclear Instruments and Methods in Physics Research A 513 (2003) 287-290.

Author: GARCIA TAVORA, Vicente (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

Co-authors: TENGBLAD, Olof (Consejo Superior de Investigaciones Cientificas (CSIC) (ES)); GARCIA BORGE, Maria Jose (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

Presenter: GARCIA TAVORA, Vicente (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

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