Threshold states in ^{19}Ne and the CNO breakout reaction $^{15}O(\alpha,\gamma)^{19}Ne$

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The hot CNO cycles and the ensuing rp-process after the breakout play a principal role in energy production and nucleosynthesis of explosive hydrogen burning processes occurring in novae and accreting neutron stars[1]. Calculations have shown that the luminosity of X-ray bursters is dramatically increased by the breakout from the hot CNO cycles[2]. The route via $^{15}O(\alpha,\gamma)^{19}Ne$ is probably one of the most important breakout reactions[1]. However, the relevant states at excitation energies of 4-5 MeV have not been studied well. The lifetimes of these states have been experimentally constrained only with either upper or lower limits[3]. Particularly the 4.03 MeV state of ^{19}Ne which dominates the reaction rate for temperatures $T_9 < 0.5$ is largely uncertain on both gamma- and alpha- decay widths and its lifetime is set only with an upper limit set by the DSAM approach[4] and an lower limit by the coulomb excitation approach[5]. In this work, we employed an improved DSAM approach to obtain the definite lifetime values of these relevant states via $^{17}O(^3He,n-\gamma)^{19}Ne$. The experiment was conducted using the KN Van de Graaff accelerator at the University of Notre Dame. A beam of 3.0 MeV ^3He was produced with intensity of about 12 μA and impinged upon an ^{17}O target implanted on Ta backing. By detecting neutrons and gammas in coincidence clean Doppler shifted gamma spectra were obtained. Excitation energy values of these states were improved by averaging two symmetrically Doppler-shifted spectra. Their lifetimes were measured by the full line shape comparisons between the maximized Doppler-shifted experimental spectrum and the simulated spectrum with Geant4 taking into account the experimental setup. Experimental results and Geant4 analysis will be depicted in detail and astrophysical implications will also be discussed in the presentation. This work is supported by the Joint Institute for Nuclear Astrophysics.

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