Determination of the $^{18}F(p,\alpha)^{15}O$ Stellar Reaction Rate *

D. W. Bardayan[1,2] for the RIBENS Collaboration
[1] *Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA*
[2] *Dept. of Physics and Astronomy, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, USA*

In the standard model of a classical nova explosion, the energy source is explosive hydrogen burning in a degenerate layer on the surface of a white dwarf star. Proton-rich β-unstable nuclei are produced, and for those with longer lifetimes (greater than 100 s), convection can carry them to the top of the envelope before they decay. The γ-ray lines resulting from decays in the envelope are, in principle, observable and would provide a rather direct test of the model [1]. The most powerful emission in gamma rays from classical novae comes at energies of 511 keV and below, which originates from electron-positron annihilation. The main contributors to positrons in nova envelopes are ^{13}N and ^{18}F. When ^{13}N decays, the nova envelope is still too opaque for γ-ray transmission; therefore, the decay of ^{18}F is the most significant for observations. The amount of observable ^{18}F which survives the runaway and is transported into the envelope is severely constrained by its destruction rate [2]. This destruction occurs most rapidly by the $^{18}F(p,\alpha)^{15}O$ reaction which could be dominated by a resonance near 7.07 MeV in ^{19}Ne, depending on the resonance properties. Recent experimental results [3,4,5] have differed by as much as a factor of three in their adopted resonance strength and by as much as 21 keV in their excitation energy for this state. This results in up to a factor of three variation in the $^{18}F(p,\alpha)^{15}O$ rate at stellar temperatures. We have, therefore, measured the $^1H(^{18}F,p)^{18}F$ [6] and $^1H(^{18}F,\alpha)^{15}O$ [7] excitation functions with a thin (35-$\mu g/cm^2$) CH_2 target and a radioactive ^{18}F beam at the Holifield Radioactive Ion Beam Facility. Proton and alpha yields were measured in coincidence with the heavy recoil nuclei at 15 bombarding energies between 10 and 14 MeV. Resonance parameters for the astrophysically important 7.07-MeV state have been extracted and will be discussed. Future measurements to determine the properties of other important resonances in ^{19}Ne will also be discussed.

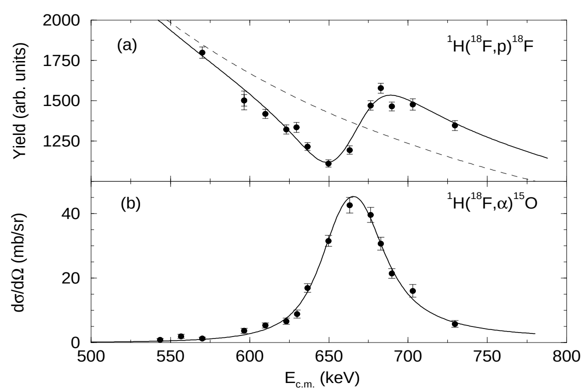

FIG. 1. A simultaneous fit of the $^1H(^{18}F,p)^{18}F$ and $^1H(^{18}F,\alpha)^{15}O$ excitation functions has been performed.

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