Experimental Study of the $E_{cm}\simeq$183 keV Resonances in ^{17}O(p,α)^{14}N and ^{17}O(p,γ)^{18}F for Classical Nova Nucleosynthesis

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Classical nova explosions are thought to be a major source of the oxygen rarest isotope, ^{17}O and to synthesize the radioisotope ^{18}F ($T_{1/2}$=110 min), whose β^+-decay produces a γ-ray emission that could be detected with the INTEGRAL observatory or with future γ-ray satellites. However, both the ^{17}O and ^{18}F productions strongly depend on the ^{17}O(p,α)^{14}N and ^{17}O(p,γ)^{18}F thermonuclear reaction rates, whose precise knowledge is thus required in the range of temperatures attained during nova outbursts ((1–4)$\times 10^8$ K).

The ^{17}O+p reaction rates are dominated in this temperature range by a narrow resonance at $E_{cm}\simeq$183 keV. We first performed a new experimental study of the corresponding state in the ^{18}F compound nucleus via the ^{14}N(α,γ)^{18}F reaction. We used the Doppler-shift attenuation method to specify both its excitation energy (E_x=5789.8$\pm$0.3 keV) and width ($\Gamma>$250 meV). We then measured in a second experiment the strengths of the resonances at $E_{cm}\simeq$183 keV in both the ^{17}O(p,γ)^{18}F and ^{17}O(p,α)^{14}N reactions. For the latter reaction, the resonance ($\omega\gamma_{p\alpha}$=1.6$\pm$0.2 meV) was never observed before our measurements. The branching ratio was determined to be $\Gamma_\alpha/\Gamma_\gamma$=470$\pm$50, from measurements by an activation method of the ^{18}F total production in irradiated ^{17}O targets. These new resonance properties have important consequences for ^{17}O nucleosynthesis and γ-ray astronomy of classical novae.