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β-delayed γ decay of ^{20}Mg and the ^{19}Ne(p,γ)^{20}Na breakout reaction in Type I X-ray bursts

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Certain astrophysical environments such as thermonuclear outbursts on accreting neutron stars (Type-I X-ray bursts) are hot enough to allow for breakout from the Hot CNO hydrogen burning cycles to the rapid proton capture (rp) process. An important breakout reaction sequence is 15O(α,γ)19Ne(p,γ)20Na and the 19Ne(p,γ)20Na reaction rate is expected to be dominated by a single resonance at 457 keV above the proton threshold in 20Na. The reaction rate depends strongly on whether this 20Na state at excitation energy 2647 keV has spin and parity of 1+ or 3+. Previous 20Mg (Jπ=0+) β+ decay experiments have relied almost entirely on searches for β-delayed proton emission from this resonance in 20Na to limit the log ft value. However there is a non-negligible γ-ray branch expected that must also be limited experimentally to determine the log ft value and constrain Jπ. We have measured the β-delayed γ decay of 20Mg to complement previous β-delayed proton decay work and provide the first complete limit based on all energetically allowed decay channels through the 2647 keV state. Our limit confirms a 1+ assignment for this state is highly unlikely.

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