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Search for 22Na in novae supported by a novel method for measuring femtosecond nuclear lifetimes.

Simulations of explosive nucleosynthesis in novae predict the production of the radioisotope 22Na. Its half-life of 2.6 yr makes it a very interesting astronomical observable by allowing space and time correlations with the astrophysical object. Its -ray line at 1.275 MeV has not been observed yet by -ray space observatories. This radioisotope should bring constraints on nova models and help to explain abnormal 22Ne abundance observed in presolar grains. At peak nova temperatures, the main destruction reaction 22Na(p,)23Mg is dominated by a resonance at 0.204 MeV associated to the Ex=7.785 MeV excited state in 23Mg. However, the different determinations of the resonance strength disagree, resulting in uncertainties of one order of magnitude for the expected mass of 22Na ejected in novae.
An experiment was performed at GANIL facility to measure both the lifetime and the proton branching ratio of the Ex=7.785 MeV state. The reaction 3He(24Mg,)23Mg* was measured with particle detectors, magnetic spectrometer VAMOS++ and silicon detector SPIDER, and -ray tracking spectrometer AGATA. Lifetimes in 23Mg, down to the femtosecond, were measured with a new approach and protons emitted from unbound states were identified. With a reevaluated thermonuclear rate of 22Na(p,)23Mg, stellar modelling was performed. Robust estimates of the detectability limit of 22Na in novae were found promising for the detection the 1.275 MeV -ray line over the coming decades.

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