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Rapport sur les résumés

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Understanding 22Na cosmic abundance: femtosecond lifetime measurements in 23Mg

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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 gamma-ray line at 1.275 MeV has not been observed yet by the gamma-ray space observatories. This radioisotope should bring constraints on nova models. It may also help to explain abnormal 22Ne abundance observed in presolar grains and in cosmic rays. Hence accurate yields of 22Na are required. At peak nova temperatures, the main destruction reaction 22Na(p,γ)23Mg has been found dominated by a resonance at Er=0.204 MeV corresponding to the Ex=7.785 MeV excited state in 23Mg. However, the different measurements of the strength of this resonance disagree by more than a factor 3, see Ref. [1, 2].

An experiment was performed at GANIL facility to measure both the lifetime and the proton branching ratio of the key state at Ex=7.785 MeV. The principle of the experiment is based on the one used in Ref. [3]. With a beam energy of 4.6 MeV/u, the reaction 3He(24Mg,α)23Mg* populated the state of interest. This reaction was measured with particle detectors (magnetic spectrometer VAMOS++, silicon detector SPIDER) and gamma tracking spectrometer AGATA. The expected time resolution with AGATA high space and energy resolutions is 1 fs. Several Doppler based methods were used to analyse the lineshape of γ-ray peaks with a new simulation code EVASIONS.

Our new results will be presented. Doppler shifted γ-ray spectra from 23Mg states were improved by imposing coincidences with the excitation energies reconstructed with VAMOS. This ensured to suppress the feeding from higher states. Lifetimes in 23Mg were measured with a new approach. Proton emitted from unbound states in 23Mg were also identified. With an higher precision on the measured lifetime and proton branching ratio of the key state, a new value of the resonance strength ωγ was obtained, it is below the sensitivity limit of the direct measurement experiments. The 22Na(p,γ)23Mg thermonuclear rate has been so reevaluated with the statistical Monte Carlo approach. The amount of 22Na ejected during novae will be discussed as a tool for better understanding the underlying novae properties. The detectability limit of 22Na from novae and the observation frequency of such events will also be discussed with respect to the next generation of gamma-ray space telescopes.

References

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