Offline Measurement of the ^{25}Mg(p,γ)^{26}Al Resonance Strengths via AMS

A. Arazi [a], W. Bürger [b], T. Faestermann, J. Fernandez-Niello [a], K. Knie, G. Korschinek, E. Richter [b], G. Rugel [c], and A. Wallner [c]

[a] Laboratorio TANDAR, CNEA, Argentina [b] Forschungszentrum Rossendorf, Dresden
[c] Strahlenbiologisches Institut, Ludwig-Maximilians Universität München

In the last 20 years the long-lived radionuclide ^{26}Al ($T_{1/2}$=0.716 Myr) became the key isotope to test stellar nucleosynthesis models. At first this nuclide was recognized as the heat source responsible for asteroids melting, which allowed to predict an isotopic excess of ^{26}Mg (the β-decay product of ^{26}Al) in those bodies. Indeed such an excess was found in the Allende meteorite and it was interpreted as freshly produced ^{26}Al material by a near-by supernova that has been introduced to the early solar system [1]. Since then, the gamma fingerprint of interstellar ^{26}Al, the 1.809 MeV line, represents the main target for γ-ray telescopes. In 1982 a 1.809 MeV flux well above all expectations was observed [2] drawing tremendeous interest for determining the sources of this stellar ^{26}Al. Lately, 1.809 MeV–maps of our Galaxy have been traced by γ-ray telescopes and its bright regions have been identified [3].

Stellar ^{26}Al is mainly produced through the ^{25}Mg(p,γ) reaction via two possible scenarios: 1) hydrostatic H–burning at proton energies between 100 and 200 keV in massive stars, or 2) explosive H–burning at 300 – 400 keV in novae and supernovae. To discriminate between both possibilities requires a better knowledge of the ^{25}Mg(p,γ) reaction rate. This rate relies on very weak resonances which in turn makes measurements of this reaction a very difficult task. Experiments have been performed so far applying the usual promt γ-ray on-line detection method [5,6].

We developed, instead, an off-line method in order to achieve new experimental data of the strengths of resonances, $\omega\gamma$, which dominate the ^{25}Mg(p,γ)^{26}Al reaction under explosive conditions. To this end, thick ^{25}MgO targets (50 μg/cm^2) were bombarded with $\sim 10^{18}$ protons in an implanter at the Forschungszentrum Rossendorf, setting the beam energy in such a way that a single resonance energy within each target was meet. Subsequently, these targets, containing about 10^7 ^{26}Al nuclei, were chemically treated by adding a 300 – 500 μg ^{27}Al carrier material and by reducing the amount of Mg in that samples down to levels of about 5 ppm. Then, the ^{26}Al/^{27}Al ratio of the samples (around 10^{-12}) was measured at the Munich tandem accelerator applying the AMS technique. In order to optimize the overall efficiency in the AMS measurements, we extracted molecular AlO$^-$ (instead of Al$^-$, commonly used in AMS) from the ion source. However, injecting AlO$^-$ requires a careful chemical procedure [7] and the use of the Gas Filled Magnet detection system (GAMS [8]) in order to suppress the interfering isobar ^{26}Mg.

Up to now, encouraging results were obtained (see table 1). Ongoing measurements will determine, in addition, the strengths of resonances at E_p^{lab} = 96 keV and 197 keV which dominate the ^{26}Al production in massive stars.

E_p^{lab} (keV)	$\omega\gamma$ (meV)		
	[9]	[10]	Present work
316.1	27 ± 2		30 ± 3
389.0	42 ± 3		51 ± 8
434.5	111 ± 6	90 ± 6	85 ± 9

Table 1: Results for the resonance strengths of the ^{25}Mg(p,γ)^{26}Al reaction obtained via the AMS technique and compared with reported values.

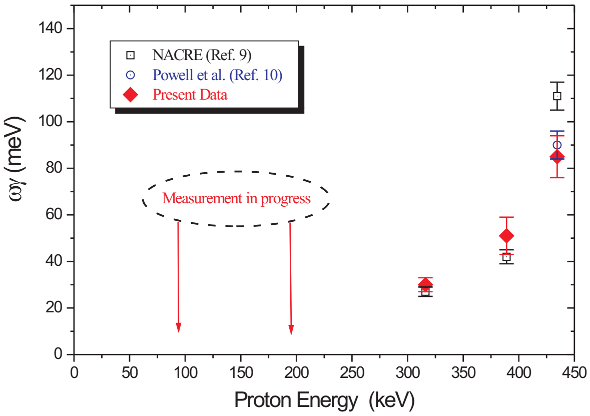

Fig. 1: Resonance strengths of the ^{25}Mg(p,γ)^{26}Al reaction obtained in this work and compared to previous data. In addition, ongoing measurements are indicated by arrows.

References

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