# AMS Measurements of the $^{25}$Mg(p,$\gamma$)$^{26}$Al$^g$ Resonance Strengths

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The experimental determination of the stellar production rate of the $^{26}$Al became a very challenging task for nuclear physics. The interest on this radioisotope began in 1977 with the discovery of an isotopic excess of $^{26}$Mg in the Allende meteorite [1]. This excess could be explained as the $\beta$-decay product of $^{26}$Al, which was added to the protosolar nebula. It has been also suggested that the source of this $^{26}$Al, e.g. a nearby supernova, could even have triggered the formation of the solar system [2]. This created a great expectation on detecting live $^{26}$Al in the interstellar medium. In 1982 its characteristic $\gamma$-ray of 1.809 MeV was detected by $\gamma$-ray telescopes on satellites [3], identifying the bright regions of our Galaxy and imposing constrains on nucleosynthesis models [4].

The 1.809 MeV line is produced by the deexcitation of the first excited state of $^{26}$Mg, which is fed by the $\beta^+$ (15 % E.C.) decay of the ground state of $^{26}$Al ($T_{1/2}$=0.716 Myr). There is also a metastable state of $^{26}$Al at 228 keV ($T_{1/2}$=6.3 s), but this is of no observational interest since it decays directly to the $^{26}$Mg ground state without producing any $\gamma$-ray.

Stellar $^{26}$Al is mainly formed through the $^{25}$Mg(p,$\gamma$) reaction in two posible scenarios:

i) hydrostatic H-burning at proton energies between 100 and 200 keV in massive stars, or

ii) explosive H–burning at 300–400 keV in novae and supernovae.

In order to distinguish between both possibilities a better knowledge of the $^{25}$Mg(p,$\gamma$) reaction rate is required. At these very low energies the reaction rate relies on very weak resonances whose measurement pose a very difficult task to the usual promt $\gamma$-ray on-line detection [6,7].

We applied, instead, an off-line method to achieve new measurements of the strengths $\omega\gamma$ for the resonances which dominate the $^{25}$Mg(p,$\gamma$)$^{26}$Al reaction. In our case, $^{25}$MgO targets were bombarded with $10^{18} - 10^{21}$ protons at each resonance energy with an implanter at the Forschungszentrum Rossendorf. Subsequently, these targets, cointaining about $10^6$ $^{26}$Al nuclei, were chemically treated by adding a few hundreds micrograms of $^{27}$Al carrier material and eliminating the Mg down to ppm levels. Then, the $^{26}$Al/$^{27}$Al ratio of the samples (ranging from $10^{-12}$ to $10^{-15}$) was measured by means of the AMS technique at the Munich tandem accelerator [8] and at the Vienna Environmental Research Accelerator (VERA). Since measurements are off-line, nuclei in the metastable state decay before the measurement and only the production of the astrophysically relevant ground state of $^{26}$Al is measured.

Results obtained for the 316, 389 and 435 keV resonances generally agree with presently accepted values (see fig. 1 and table 1). Ongoing measurements aim to reduce the statistical uncertainty for the preliminary result for the resonance at $E_p^{lab}$ = 197 keV which dominate the $^{26}$Al production in massive stars.

| $E_p^{lab}$ (keV) | $\omega\gamma$(meV) | |
|---|---|---|
| | Ref. [9] | Present work |
| 95.8 | $(1^{+0.1}_{-0.3}) \times 10^{-10}$ † | $< 1.1 \times 10^{-8}$ |
| 197.0 | $(5.0 \pm 0.6) \times 10^{-7}$ | $(1.1 \pm 0.8) \times 10^{-7}$ |
| 316.1 | $27 \pm 2$ | $31 \pm 3$ |
| 389.0 | $42 \pm 3$ | $49 \pm 8$ |
| 434.5 | $111 \pm 6$ | $83 \pm 9$ |
| | $90 \pm 6$ [10] | |

Table 1: Calculated (†) and measured values for the resonance strength of the $^{25}$Mg(p,$\gamma$)$^{26}$Al reaction

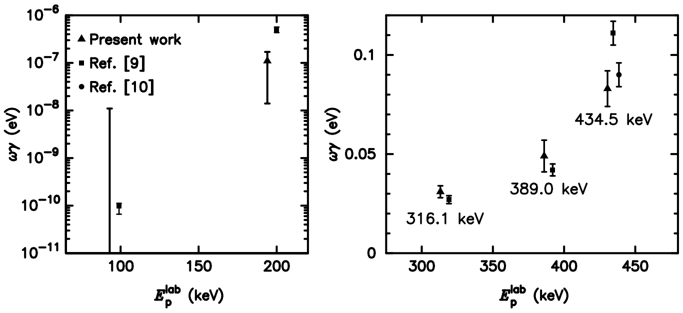


Fig. 1: Results for the resonance strengths of the $^{25}$Mg(p,$\gamma$)$^{26}$Al reaction obtained via the AMS technique compared with values reported elsewhere.

## References

[1] T. Lee, D.A. Papanastassiou and G.J. Wasserburg, Astrophys.J.Lett **211** (1977) L107
[2] D.D. Clayton and M.D. Leising, Phys.Rep. **144** (1987) 233
[3] W. Mahoney *et al.*, Ap.J. **262** (1982) 742.
[4] N. Prantzos and R. Diehl,Phys.Rep. **267** (1996) 1
[5] C. Iliadis *et al.*,Phys.Rev. **C53** (1996) 475
[6] K. Elix *et al.*,Z.Phys. **A293** (1979) 261
[7] C. Iliadis *et al.*,Nucl.Phys. **A512** (1990) 509
[8] A. Arazi *et al.*,New Astronomy Rev. **46** (2002) 525
[9] European Compilation of Reaction Rates for Astrophysics, http://pntpm.ulb.ac.be/nacre.htm.
[10] D.C. Powell *et al.*,Nucl.Phys. **A644** (1998) 263