A possible measurement of the ^{25}Mg(p,g)^{26g}Al reaction at DRAGON

- 89 resonances in the NACRE compilation ranging from 37.5 to 1920.5 keV
- direct measurements down to 189 keV
- below 189 keV resoncance strength were calculated from proton partial width derived from ^{25}Mg(^{3}He,d)^{26}Al
- a resent measurements with AMS [A.Arazi et al., PRC 74 (2006) 025802] showed good agreement with resonances at 305, 374 and 418 keV, but a factor ~5 lower resonance strength at 189 keV !

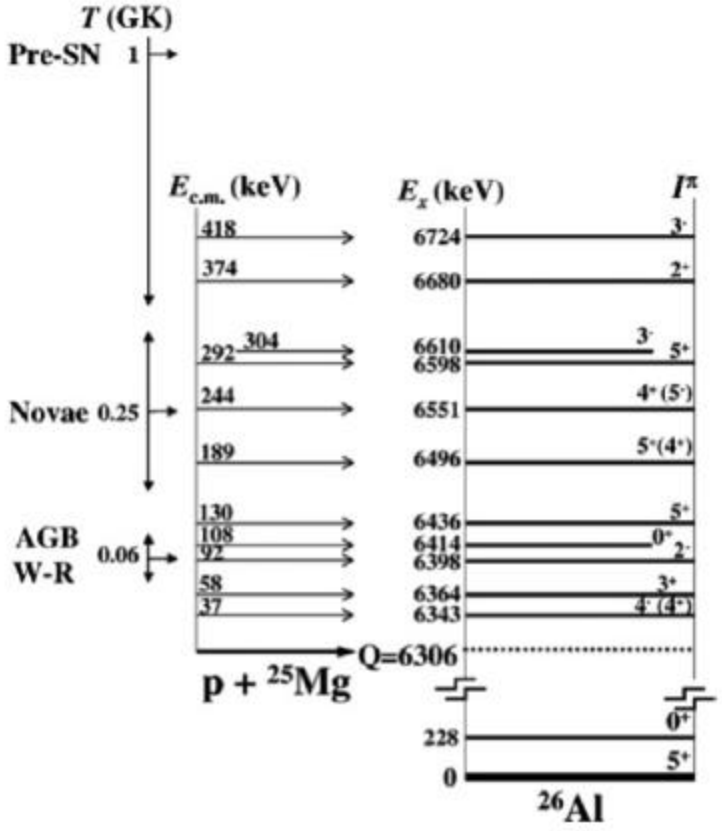

FIG. 1. Level scheme of ^{26}Al. Plotted are the ground state ($t_{1/2}$ = 0.716 Myr), the isomeric state at 228 keV ($t_{1/2}$ = 6.3 s) and excited levels (E_x) above the ^{25}Mg + p threshold (Q = 6306 keV) with the corresponding center-of-mass resonance energies ($E_{c.m.}$). Typical temperatures and the corresponding Gamow peaks for different astrophysical scenarios are also shown. For a given temperature, the Gamow peak indicates *a priori* which resonances might have the larger contribution to the reaction rate.

TABLE II. Resonance strengths of the ^{25}Mg(p, γ) reaction for the formation of ^{26}Al in its ground state, $\omega\gamma^g = \omega\gamma f_0$. Listed values for Refs. [21–23] are calculated from published resonance strengths $\omega\gamma$, and branching ratios to the ground state f_0 taken from Ref. [12] (see also Refs. [7,8]). Errors indicate a 68% (1 s.d.) confidence level.

$E_{c.m.}$ (keV)	f_0	$\omega\gamma^g$ (eV)		
		Present work	NACRE [21,22]	Powell *et al.* [23]
92.2	(85 ± 1)%	$<2 \times 10^{-8}$	$(1^{+0.1}_{-0.3}) \times 10^{-10}$	
189.5	(74 ± 1)%	$(1.1 \pm 0.2) \times 10^{-7}$	$(5.3 \pm 0.7) \times 10^{-7}$	
304.0	(87 ± 1)%	$(2.1 \pm 0.2) \times 10^{-2}$	$(2.7 \pm 0.2) \times 10^{-2}$	
374.0	(67 ± 1)%	$(4.0 \pm 0.4) \times 10^{-2}$	$(4.2 \pm 0.3) \times 10^{-2}$	
417.8	(96 ± 1)%	$(7.1 \pm 0.2) \times 10^{-2}$	$(11.1 \pm 0.6) \times 10^{-2}$	$(9.0 \pm 0.6) \times 10^{-2}$

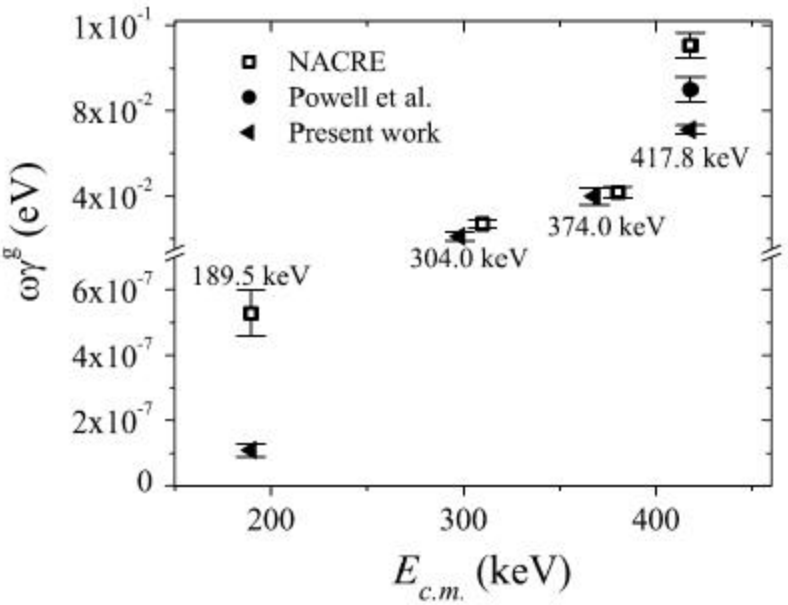

FIG. 2. Strengths of resonances at $E_{\text{c.m.}} = 189$, 304, 374, and 418 keV of the ^{25}Mg(p, γ) reaction for the formation of ^{26}Al in its ground state. Measured values of this work are compared to those recommended by NACRE [21,22] and to a value measured by Powell *et al.* [23].

TABLE I. Relevant experimental parameters for the determination of the resonance strengths. The $^{26}Al/^{27}Al$ ratio of samples irradiated at resonance energies of $E_{c.m.} = 304.0$, 374.0 and 417.8 keV were measured at both AMS facilities, in Munich (M) and at the VERA laboratory in Vienna (V). For those cases the weighted mean value (mean) is also indicated. For the resonance at $E_{c.m.} = 189.5$ keV four different targets were independently irradiated (samples *a* to *d*). Those samples and the one irradiated at $E_{c.m.} = 92.2$ keV were measured at VERA only. Quoted $^{26}Al/^{27}Al$ ratios are corrected for background.

Resonance energy $E_{c.m.}$ (keV)	Proton dose N_p ($\times 10^{18}$)	Al-carrier C_{Al} (μg)	^{26}Al events N_{26}^{das}	Background events	$^{26}Al/^{27}Al$ ratio r ($\times 10^{-15}$)	
92.2	390	100	0	0.1 ± 0.05	<5	(V)
189.5	(a) 230	500	2	0.6 ± 0.2	2.1 ± 1.5	(V)
	(b) 337	250	4	0.4 ± 0.1	12 ± 6	(V)
	(c) 223	400	9	1.4 ± 0.3	3.0 ± 1.1	(V)
	(d) 352	400	9	1.5 ± 0.3	2.8 ± 1.1	(V)
304.0	5.4	500	109	0.8 ± 0.4	844 ± 120	(M)
			110	0.1 ± 0.02	591 ± 58	(V)
				mean:	640 ± 65	
374.0	1.0	300	53	2.5 ± 1	364 ± 64	(M)
			50	0.1 ± 0.01	314 ± 45	(V)
				mean:	333 ± 37	
417.8	4.5	500	120	0.4 ± 0.2	1527 ± 207	(M)
			1075	0.4 ± 0.06	1510 ± 55	(V)
				mean:	1511 ± 53	

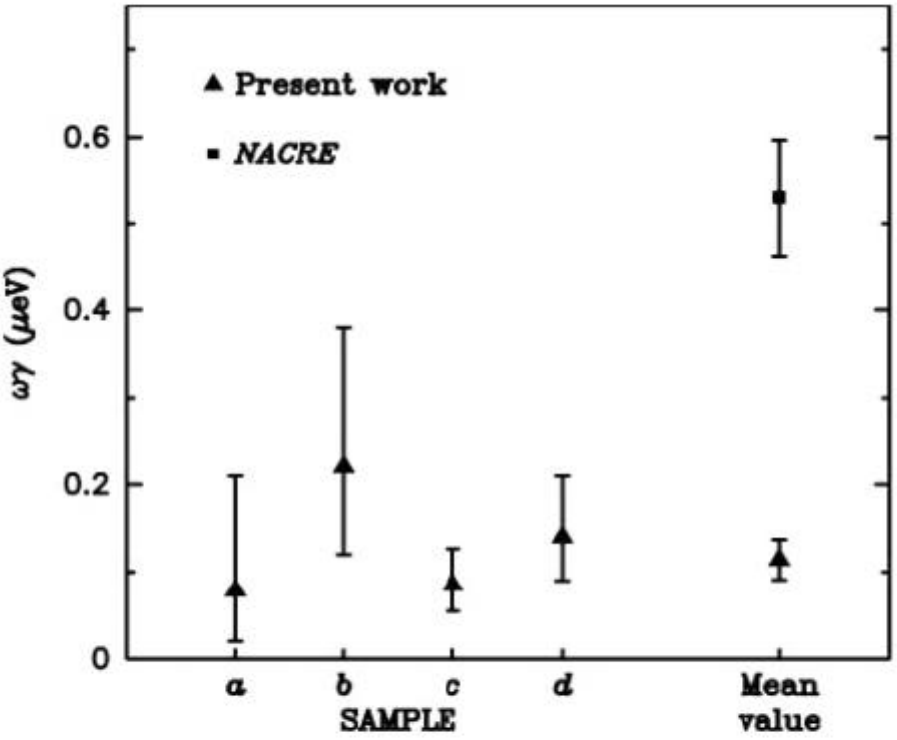

FIG. 3. Results of the four independent resonance-strength measurements (*a*, *b*, *c*, and *d*) at $E_{c.m.} = 189$ keV performed in the present work and their mean value, compared to the recommendation of NACRE [21,22].

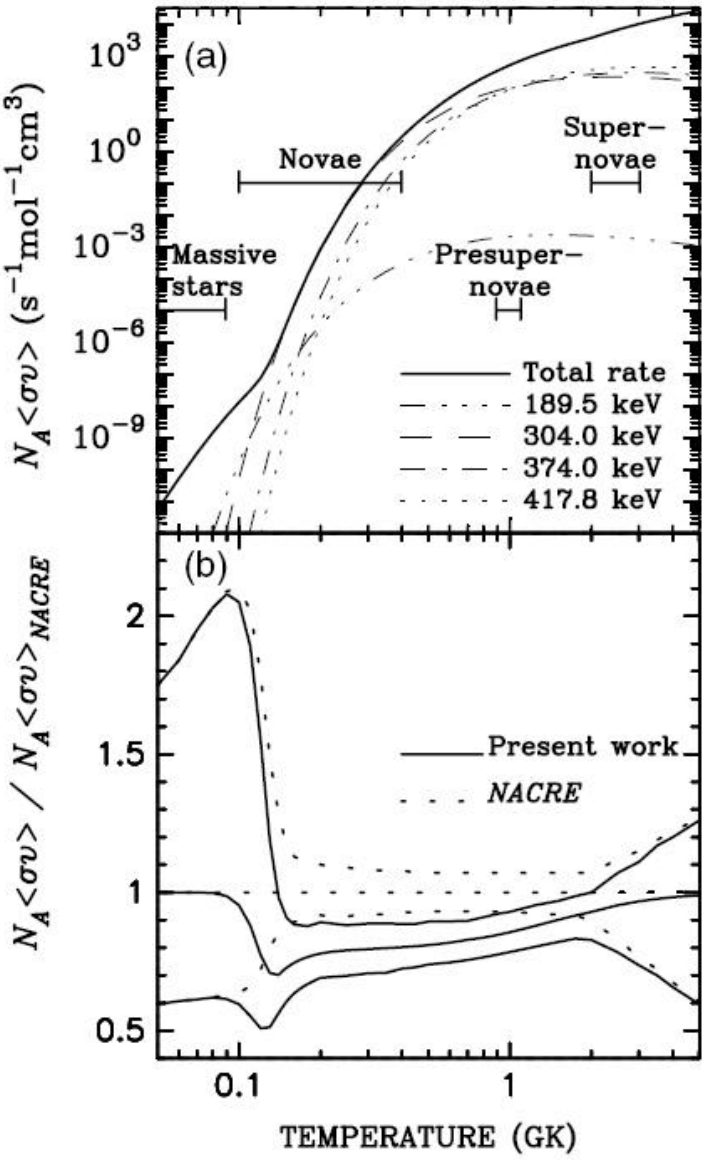

FIG. 4. Dependence of the ^{25}Mg$(p,\gamma)^{26}$Al^g reaction rate with the stellar temperature. (a) Individual contributions of the resonances at $E_{\text{c.m.}} = 189$, 304, 374, and 418 keV to the reaction rate, calculated from the values obtained in this work, and total reaction rate (full line) using values recommended by NACRE [21,22] for other 85 resonances between $E_{\text{c.m.}} = 37.5$ and 1920.5 keV. These calculations were performed with the program RATEERRORS [26]. The characteristic temperature ranges in which ^{26}Al is produced in the various astrophysical scenarios are also shown. (b) Ratio of the total reaction rate obtained in the present work to that recommended by NACRE, with their corresponding 68% lower and upper confidence limits (solid lines). NACRE confidence limits are also plotted (dashed lines).

- 189 keV at 0.1 – 0.5 μeV would be the lowest resonance strength measured at DRAGON (previous record was 35 μeV – ^{26g}Al(p,γ)^{27}Si)

- other proposed experiments request measurements in the same yield range (e.g. E813, ^{15}O(α,γ)^{19}Ne, Y(4.033 MeV) ~ 10^{-15})

- high demand on beam suppression in spectrometer

- additional suppression at the end detector might be necessary
    - local TOF – 2nd MCP detector
    - ion chamber with thin SiN entrance windows
    - …

- high beam intensities required: > 100 pnA on target

- scientific motivation to push OLIS ECR ion source (ion source it in house and only a few parts are necessary for installation; however, it has (very) low priority right now)