RADIOACTIVE ISOTOPE ^{26}Al IN THE INTERSTELLAR MATTER
(resulting from a mass loss by AGB stars)

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ABSTRACT. Several calculations of the Asymptotic Giant Branch star evolution have been performed with the aim of explaining the synthesis of interstellar ^{26}Al in these stars. The agreement of theoretically calculated mass of interstellar ^{26}Al and observations is rather satisfactory, the best for the abrupt tenfold jump in the mass-loss rate for the stars reaching the luminosity $\log(L/L_\odot) \simeq 4.0$.

Although possible sources of the measured interstellar ^{26}Al (about $3M_\odot$ [1-2]) have been investigated, they appear inadequate to account for the observed ^{26}Al gamma-ray flux [3]. The origin of the ^{26}Al in the interstellar medium has remained a mystery. It has been suggested that ^{26}Al, synthesized in the AGB stars, are carried to the surface by a process of convective dredging and that, in the result of rapid mass loss from the surface, this isotope could contribute to the enrichment of the interstellar medium. Several different cases have been considered for the value of the mass-loss law. The main processing in the He shell follows the sequence:

$$^{14}\mathrm{N}(\alpha,\gamma)^{18}\mathrm{F}(\beta^+)^{18}\mathrm{O}(\alpha,\gamma)^{22}\mathrm{Ne}(\alpha,n)^{25}\mathrm{Mg}.$$

The ^{25}Mg brought into the envelope could be efficiently transformed into the unstable isotope ^{26}Al: $^{25}\mathrm{Mg}(p,\gamma)^{26}\mathrm{Al}$. The star is presumed to shed mass by stellar wind; the loss rate will then be expressed by Reimer's low: $\dot{M}=-4\times10^{-13}\alpha L/gR$, were $\dot{M}$ is in units of $M_\odot\,\mathrm{yr}^{-1}$, L, g, R denote the star's luminosity, surface gravity, and radius in solar units. The coefficient α is undetermined but is usually taken to be of order unity. Many observations, however, suggest that apart from the conventional stellar wind and planetary nebulae ejection, some other mechanism also ought to operate during the AGB phase, substantially raising the mass-loss rate [4-5]. The results of our calculations are presented in Table 1.

P. D. Singh (ed.), Astrochemistry of Cosmic Phenomena, 411–412.

Table 1. The mass of ^{26}Al in the interstellar medium in the Galaxy (for different α)

Nr	α	$M_{^{26}Al}(M_\odot)$
1	1.0	39.4
2	3.0	19.2
3	α=1 if log($L/L_\odot$)<4.1 α=10 if log ($L/L_\odot$)>4.1	6.4
4	α=1 if log($L/L_\odot$)<4.0 α=10 if log($L/L_\odot$)>4.0	5.0

The contribution of different initial mass stars on the amount of ^{26}Al in the interstellar medium is illustrated in Table 2. Successive columns contain the range of masses M, the number of stars in this range N (the assumed total number of stars between 1 and 100 $M_\odot$ is 10^9), and the contribution of ^{26}Al in the interstellar medium of stars in successive mass ranges (for cases 2 and 4 of mass loss laws, see Table 1).

Table 2. The contribution of different mass stars on the interstellar ^{26}Al

ΔM, $M_\odot$	N	$\Delta M_{^{26}Al}/M_{^{26}Al}$, %	
		Nr 1	Nr 2
1 - 2	646	0.4	9
2 - 3	162	4	10
3 - 4	67	7	7
4 - 5	36	12	9
5 - 6	21	13	16
6 - 7	14	27	20
7 - 8	10	38	30

References

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