NUCLEOSYNTHETIC ACTIVITY OF WR STARS: IMPLICATIONS FOR ^{26}Al IN THE GALAXY AND ISOTOPIC ANOMALIES IN COSMIC RAYS AND THE EARLY SOLAR SYSTEM

N. PRANTZOS
Institut d' Astrophysique de Paris, 98bis, Bd. Arago, F-75014 Paris, France
Service d' Astrophysique, C.E.N. Saclay, F-91191 Gif sur Yvette, France

Abstract: The implications of the nucleosynthetic activity of WR stars are reassessed, in view of recent experimental and observational data. It is confirmed that WR stars may 1) contribute significantly (up to ~20%) to the ~3 $M_\odot$ of ^{26}Al detected in the galactic plane through its 1.8 MeV line, 2) be responsible for the isotopic anomalies of ^{22}Ne and ^{25,26}Mg, detected in galactic cosmic rays (GCR), and 3) be responsible for the inferred presence of ^{26}Al and ^{107}Pd in the early solar system (and, perhaps, some other nuclei as well).

In this work, we calculate nucleosynthesis during H burning (production site of ^{26}Al) and He burning (production site of ^{22}Ne, ^{25,26}Mg, and "light" s-elements, i.e. with mass number $60<A<90$) in WR stars with initial mass $50 < M/M_\odot < 100$. The injection of the corresponding products in the interstellar medium (ISM) through the WR winds (WN and WC phases) is properly taken into account. We improve upon our previous relative studies ([1],[2],[3]), by using an up-dated set of nuclear data, especially concerning the production and destruction of ^{26}Al (i.e. ^{25}Mg(p,γ)^{26}Al [4], ^{26}Al(p,γ) [5]), the neutron density during He burning (^{22}Ne(n,γ) [6], etc.). The main results are as follows:

1) ^{26}Al in the Galaxy: Due to the increase in its production rate [4], the ^{26}Al yield of WR stars is found to be enhanced w.r.t. our previous estimates [3] by ~10% for the 50 $M_\odot$ star, up to ~40% for the 100 $M_\odot$ star. Accordingly, the total quantity of ^{26}Al ejected by galactic WR stars in the ISM during the last million years is estimated to $M_{26} \sim$ 0.15-0.65 $M_\odot$, depending on the adopted WR distribution (see [3]); these quantities correspond to ~5-20% of the ~3 $M_\odot$ of ^{26}Al in the Galaxy, inferred from observations of its 1.8 MeV line. Thus, it seems that *WR stars may be significant, but not the main, contributors to the galactic content of ^{26}Al* (at least, with the current status of stellar and nuclear physics).

2) Isotopic anomalies in GCR: The result of the reduction in the ^{22}Ne(n,γ) cross-section [6] in nucleosynthesis during He-burning is twofold: a) ^{22}Ne is no more a "lethal" neutron poison and is destroyed less than before (in the WC wind and the stellar core), and b) some s-nuclei are produced in larger quantities than previously thought ([1]), due to the higher neutron densities. The conclusions for GCR isotopic anomalies ([1] and more recently [7]) are slightly affected by those new results, but *some new anomalies are predicted, concerning especiallly Se and Sr.*

3) Isotopic anomalies in meteorites: The recent changes in several key nuclear reaction rates affect the ^{26}Al/^{27}Al ratio in the Of-WN winds, which is reduced by a factor of ~2 w.r.t. [2] (the production of ^{27}Al is more enhanced than the one of ^{26}Al), but not significantly the ^{107}Pd/^{108}Pd ratio. The general conclusions as to the (presumed) role of WC stars ([2],[8]) remain valid. Contrary to [8], both in [2] and in our new calculations a substantial production of ^{205}Pb is obtained. A systematic analysis of those effects is in preparation [9].

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