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THE ASTROPHYSICAL INTERPRETATION OF ISOTOPE ANOMALIES IN GRAPHITE AND SiC GRAINS OF CHONDRITES.

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The C, N, Mg isotopic compositions in graphite and SiC grains of carbonaceous chondrites can be explained by nuclear processes in massive O,B stars of second generation passed a stage of WR star with intensive stellar wind, where grain condensation had taken place.

The interstellar graphite and SiC grains with anomalous isotopic compositions of C, N, Ne, Si and other elements of nucleosyntetic origin, found in non-equilibraited chondrites, are most suitable for determination of astrophysical objects, where nucleosynthesis had taken place. We were examined two objects: 1-massive O,B stars of second generation passed a stage of WR star with intensive stellar wind (O,B-WR model) (1) and 2- low-mass stars ($1 \leq M/M_{\odot} \leq 3$) during thermally pulsing asymptotic giant branch phase (TP-AGB model)(2). The calculations by means of these models were used for explanation of Ne and Mg isotopic anomalies in graphite and SiC grains of the Murchison CM carbonaceous chondrite (3-6). Graphite grains are carriers of pure Ne-E(L), SiC grains are carriers of Ne-E(H) and ^{4}He. They have various isotopic compositions of C and N (5,7). The most of SiC grains have $^{12}C/^{13}C$=40-90, but many grains have $^{12}C/^{13}C$=4-40. The unusual grains X have $^{12}C/^{13}C$=200--2500 and grains Y ~ 200. For most of SiC grains and Y grains $^{14}N/^{15}N$=275-5000 and X grains $^{14}N/^{15}N$=15-200. The graphite grains have $^{12}C/^{13}C$=4-5000 and $^{14}N/^{15}N$=170-300. Only four grains have anomalous N($^{14}N/^{15}N$=100-700). According to (1) such isotopic compositions of C and N can be explained by mixing of the products of following nuclear reactions: 1) quasi-equilibrium CNO cycle at H burning stage, explaining high enrichments of graphite and SiC grains in ^{13}C and SiC grains in ^{14}N, 2) reactions on He burning stage: $3\,^4He \rightarrow {}^{12}C$, $^{12}C(\alpha,\gamma)^{16}O$ and $^{14}N(n,p)^{14}C$. Former leads to high $^{12}C/^{13}C$ rations (up to 5000), the latter leads to moderate impoverishments in ^{12}C and third leads to very high enrichments of SiC X grains in ^{15}N. According to (8) in massive stars CNO cycle happens at O,B star and WN stages, and He burning happens in star core at WR star stage (8,9) with intensive wind, carring out nuclear reaction products into circumstellar envelope.

By laser gas extraction technique high contents of Ne-E(H) in SiC grains (up to 2.74 10^{-3}cc g^{-1}) and Ne-E(L) in graphite grains (up to 16.89 10^{-3}cc g^{-1}) were discovered (6). Only a small fraction (~4%) of SiC grains accounts for ~90% of Ne-E(H) and ^{4}He, but ~30% of graphite grains appear to carry Ne-E(L). The implantation is incorporation mechanism for Ne-E(H) and ^{4}He, thus there is no need to invoke in situ decay of ^{22}Na as the source for Ne-E(H) (3). During He burning ^{14}N is transformated into ^{22}Ne through

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the chain: $^{14}N(\alpha,\gamma)^{18}F(\beta^+\nu)^{18}O(\alpha,\gamma)^{22}Ne$. This process has taken place in He shell of carbon stars of population I for TP-AGB model and in He core of WR stars for O,B-WR model. ^{22}Na is not formed in He burning.

However ^{22}Na may be a source of pure ^{22}Ne-E(L) in graphite grains (6). ^{22}Na forms in massive stars during Ne-Na cycle of H burning at $T=5\times10^7$K. The calculations (8) for stellar wind of WR stars M=80 M⊙ at this stage give very low value for ^{22}Ne($^{22}Na/^{20}Na=7\times10^{-4}$). Besides in these conditions $C/O<1$, and graphite and SiC grains would not condense. ^{22}Na as sourse of pure ^{22}Ne can be only formed in explosion H burning. But this process should not be lead to explanation of the observed anomalies in isotopic composition of Mg at the expence of decay of ^{26}Al, which in Mg - A cycle of H burning has formed. So at supernova explosion $(^{26}Al/^{27}Al)_0=0.006$ (10), which is lower than maximum values of this ratio for graphite and SiC grains (5,7). Hence ^{22}Na is not source of pure ^{22}Ne-E(L).

The calculations (2) for TP-AGB model give $^{20}Ne/^{22}Ne$= =0.07-0.085, which are near to minimum value of this ratio for SiC grains of KJH fraction (0.0973) (3). And they are essentially higher than most of values for graphite (0.015- -0.7) (11). According to O,B-WR model this value is equal to 0.0083 (8). It can correspond to end member of mixing line both for Ne-E(H) and for Ne-E(L).

In stellar wind of WN stars ratios of $(^{26}Al/^{27}Al)_0$ are 0.006-0.5 (8). These limits correspond to corresponding values for SiC grains (4.10^{-5}-0.61) (7) and for graphite grains (0.005-0.086) (5).

We propose the following scenario (12). In stellar wind of O,B(WN) star in CNO cycle end has taken place condensation of ultra small grains of Al(^{26}Al)N. According to (13) it happens over wide limits of C/O ratious (lg C/O from -6 to +7). In stellar wind of WR(WC) star at He burning stage, where $C/O>1$ (8), AlN grains are condensation embryos of graphite and SiC grains. Graphite grains condense at $T\geq1700$ K and SiC grains at T=1300 K (13). This difference of condensation temperatures has lead to various degree of noble gas retention of graphite and SiC grains. Graphite grains lose implanted ^{4}He and small fraction of SiC grains should trappe its.

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