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Mg isotope yields from three-dimensional core-collapse supernova models

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Stellar explosions enrich interstellar space with stardust and have provided the raw materials for our solar system planets. Stardust can be used to place better constraints on the nucleosynthesis occurring in explosions as well as provide vital clues about n-rich isotopes observed in planetary materials. Silicate and oxide stardust grains found in meteorites that exhibit ^{17}O-rich compositions with solar to depleted ^{18}O/^{16}O ratios (categorized as group 1 and 2) have been argued to be exclusively formed within low-mass stars of close-to-solar metallicity. However, recent Mg isotopic studies of group 1 and 2 grains identified ^{25}Mg-rich grains [1-2], which cannot be reconciled with AGB nucleosynthesis. We use the isotopic yields from realistic three-dimensional (3D) symmetric and asymmetric core-collapse supernova (CCSN) models [3] to probe the origins of ^{25}Mg-rich stardust. The CCSN models include $15M_{\odot}$ progenitor stars subjected to a spherically symmetrical explosion (named 15S), while the asymmetric model has a 2:1 velocity asymmetry between the poles and the equator (named 15A) during explosion. The Mg isotopic yield in 15S and 15A revealed two key distributions: (a) Clumps on a plot of δ^{25}Mg vs δ^{26}Mg fall along a line with slopes >1 called ‘branch’. (b) Clumps that show ^{25}Mg excesses of up to 1000 ‰ and slopes that are ~3 called the ‘loop’. The loop in the 15A simulations is a better fit to the stardust grain data than 15S. Next, we investigated the physical characteristics of the explosion. There is no discernible difference between the densities, temperature or pressure of the loop and the branch in either model. However, temperatures remained above 1×10^9 K prior to the shockwave and thus, the conditions are conducive to rapid proton capture. The elemental and isotopic yields of the loop and branch, specifically focusing on Cr, Ti and Ca will be presented at the meeting.

[1] Hoppe, P., Leitner, J., Kodolányi, J., & Vollmer, C. (2021). *The Astrophysical Journal*, *913*, 10.

[2] Leitner, J., Hoppe, P. (2019) *Nature Astronomy,* 3, 725.

[3] Schulte, J., Bose, M., Young, P. A., & Vance, G. S. (2021). *The Astrophysical Journal*, *908*,