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Nuclear physics and stellar MHD coupled together solve the puzzle of oxide grain composition

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Summary

Oxide grains, enclosed in meteorites, give us very precise information about the stars in which they formed. Grains that belong to group 1 and 2 are characterized by values of 17O/16O and 18O/16O, inconsistent with explosive nucleosynthesis scenarios, and are then believed to form in red giant stars [1]. The measurements of the 14N(p,⊠)15O and the 16O(p,⊠)17F cross sections remarked that these grains condensate in the envelope of stars less massive than 2M⊠⊠⊠⊠⊠⊠⊠. Nevertheless, the high 18O dilution and the large 26Al abundance found in several grains remained unexplained, unless in precence of very deep mixing mechanisms coupled with nuclear burning [4,5]. The fine tuning of extra-mixing parameters and a new measurement of the 17O+p reaction rates significantly improved the agreement between the grain oxygen isotopic mix and the model predictions. AGB stars with M<1.5M⊠⊠were proved ⊠⊠⊠⊠⊠⊠progenitors of group 2 grains [6,7]. However, two challenges remained to be addressed: the physical origin of the extra-mixing mechanisms and high amount of 26Al found in some grains (26Al/27Al»0.02).
Recently, [8] have shown that the MHD equations allow for exact analytical solutions in the relevant layers of AGB stars. Applying this model of mixing driven by the buoyancy of magnetized materials, we find that the 17O/16O, 18O/16O and 26Al/27Al ratios shown by group 1 and 2 grains are perfectly reproduced by a 1.2M⊠ AGB stars, without encountering any relevant energy feedback.

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Primary author: PALMERINI, Sara (PG)

Co-authors: LA COGNATA, MARCO SALVATORE (LNS); BUSSO, Maurizio (PG); TRIPPELLA, Oscar (PG)

Presenter: PALMERINI, Sara (PG)

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