Heavy Elements Nucleosynthesis On Accreting White Dwarfs surface: seeding the the p-process

U. Battino[a], C. Travaglio[b], M. Pignatari[c d e] and C. Lederer-Woods[a]

[a]School of Physics and Astronomy, University of Edinburgh, EH9 3FD, UK, [b]INFN - Istituto Nazionale Fisica Nucleare, Turin, Italy, [c] E.A. Milne Centre for Astrophysics, University of Hull, HU6 7RX, UK, [d] Joint Institute for Nuclear Astrophysics, Center for the Evolution of the Elements, Michigan State University, East Lansing, MI 48824, USA, [e] Konkoly Observatory, H-1121, Budapest, Hungary

The production of the proton-rich isotopes beyond iron that we observe today in the solar system is still uncertain ([1]). Thermonuclear supernovae (SNe Ia) exploding within the single-degenerate scenario have been proposed to be a potential source for these isotopes ([2]). Recent works studying the p-process production in SNe Ia ([3] and [4]) assume s-process rich pre-explosive seeds, built by neutron captures in the external layers of the progenitor, during the accretion phase. Presently there are no complete stellar models calculating these abudances, covering the WD mass range up to the Chandrasekhar mass (see [5]). We calculate accretion models for five white dwarfs (WDs) with different initial masses (0.85, 1, 1.26, 1.32, 1.38 solar masses) using the stellar code MESA. We then focus on the nucleosynthesis of the 1, 1.26, 1.32 and 1.38 solar masses models, calculating the full abundance distribution. In our models the dominant neutron source are the ^{22}Ne$(\alpha,$n$)^{25}$Mg, which is activated at the bottom of the convective thermal pulse driven by the He flashes along the accretion phase, for WD masses lower than 1.26 solar masses, and the ^{13}C$(\alpha,$n$)^{16}$O for WD masses equal or higher than 1.26 solar masses. We found neutron densities up to few 10^{15} cm^{-3} in the most massive WDs. In particular, the neutron density and the total production of neutrons increase with increasing mass of the accreting WD. The abundance distribution peaks between Fe and Zr for the models at M = 0.85 and 1 solar masses, while for larger WDs much higher production efficiency is obtained beyond iron, with a strong production up to the Pb region. Using these results, we compute the nucleosynthesis of proton rich heavy isotopes using a multi-D SNe Ia model, and discuss the uncertainties affecting our results. Finally, the frequency of the single-degenerate scenario channel to produce SNIa is controversial ([5]). The impact on the p-process production in this scenario is also discussed.

References

[1] T. Rauscher *et al.*, Rep. Prog. Phys. **76**(2013) 066201.

[2] W.M. Howard *et al.*, The Astrophysical Journal **373:L5-L8**(1991).

[3] M. Kusakabe *et al.*, The Astrophysical Journal, **766:25**(2011).

[4] C. Travaglio *et al.*, The Astrophysical Journal **739:93**(2011).

[5] P.A. Denissenkov *et al.*, The Astrophysical Journal Letters **834:L10**(2017).