Predicting Surface Variability of White Dwarfs Accreting Planetary Debris

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White dwarfs with metal-polluted atmospheres have been studied widely in the context of the accretion of rocky debris from evolved planetary systems. One open question is the geometry of accretion and how material arrives and mixes in the white dwarf surface layers. Using the 3D radiation-hydrodynamics code CO5BOLD, we have recently derived transport coefficients which describe the advection-diffusion of a passive scalar across the surface-plane for the vast majority of convective white dwarfs. Coupled with previously published vertical diffusion coefficients, I will discuss new theoretical constraints on surface spreading of metals in white dwarfs. Our results suggest that convection in warm hydrogen-rich atmospheres (DA; $\gtrsim$ 13,000 K) and helium-rich atmospheres (DB, DBA; $\gtrsim$ 30,000 K) is unable to efficiently spread the accreted metals across their surface, regardless of the time dependence of accretion. This result may be at odds with the current non-detection of surface abundance variations at white dwarfs with debris discs. For cooler hydrogen- and helium-rich atmospheres, we predict a largely homogeneous distribution of metals across the surface within a vertical diffusion timescale.