

WHITE DWARFS AS A TOOL TO TRACE THE COMPOSITION AND
GEOLOGY OF EXOPLANETS

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Absorption features in the spectra of some white dwarfs tell us about the presence of metals in their atmospheres. Such metals must have accreted recently; most likely from an outer planetary system that orbits the white dwarf. Key elements such as Ca, Fe, Mg, Si tell us the bulk composition of the planetary material, whilst volatiles such as C, O, Na, Mn tell us about the processes that determine the volatile abundances of exoplanets, crucial, for example, to the origin of life. I will present a Bayesian framework that aims to find the most likely explanation for the observed abundances. The framework highlights evidence for the geological process of core formation, as well as the loss of volatiles, taking into account relative sinking of different elements (Harrison et al, 2018, 2021a). The loss of volatiles is a key process in the formation of a potentially habitable rocky planet and planetary material in the atmospheres of white dwarfs provides a unique window regarding how and when exoplanetary bodies lost volatiles. Using Mn and Na as key tracers, I will present evidence that some white dwarfs accreted material that lost volatiles during the formation of the planetary building blocks embedded in the nebula gas, whilst some white dwarfs have accreted planetary bodies that lost volatiles after the nebula gas dissipated, for example due to heating in impacts (Harrison et al, 2021b). The final composition of planets depends crucially on the initial material available in a particular planetary system. White dwarfs

in wide binary systems have a unique potential to trace how planetary bodies derive their composition. Wide binary pairs are chemically homogeneous, thus, the abundances of a main-sequence companion can represent the initial abundances in the white dwarf planetary system. In Bonsor et al, 2020, we show how comparison between pollution in the atmosphere of white dwarfs and wide binary companions to the white dwarfs has the unique ability to inform our understanding of how planet formation alters the composition of planetary bodies. To summarise, white dwarfs that have accreted planetary material provide a unique means to trace the volatile content and geology of exoplanets.