Measuring planetary chemistry via observations of remnant planetary systems at white dwarfs

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Summary

Observations of remnant planetary systems at white dwarfs provide the only technique to measure the bulk chemical composition of rocky exoplanets. In this talk I will review the field, present notable results such as the detection of icy planetesimals, and discuss the implications of this research for planetary habitability.

Abstract

Observations of remnant planetary systems at white dwarfs provide important contributions to exoplanet science in general and habitability in particular. Foremost among these is the only method to directly measure the bulk chemical composition of solid extrasolar material. The high density of Earth radii, but ~ Solar mass white dwarfs implies that metals heavier than hydrogen or helium sink out of their atmospheres on short timescales. The metal absorption lines seen in ~30 percent of white dwarfs must all therefore have an external origin. Observations of transiting material and dusty debris discs from tidally disrupted planetesimals, scattered into the white dwarf by planets that survived the main sequence evolution, confirm this scenario. High resolution spectroscopy of an increasing number of white dwarfs has revealed a plethora of atomic species, allowing detailed conclusions about planetesimal compositions to be drawn. As the progenitor stars of white dwarfs are, on average, 2-3 Solar masses, these observations also explore a parameter space of host stars that is hard to be studied in systems with host stars still on the main sequence.

In this talk, I will first review the historical observations that have led to our current understanding of remnant planetary systems at white dwarfs, as well as the state of the field today. I will present Hubble Space Telescope and Very Large Telescope data of metal polluted white dwarfs where multiple metals have been detected, including objects with high levels of core (Fe, Ni) material that may have undergone mantle stripping during the post main sequence, as well as objects with carbon and oxygen measurements that can be used to place limits on the existence of the hypothetical carbon planets. Finally, I will describe how white dwarfs can be used to search for water in extrasolar systems via detection of excess oxygen and hydrogen.

Short Summary

Chemical composition of rocky exoplanets. In this talk I will review the field, present notable results such as the detection of icy planetesimals, and discuss the implications of this research for planetary habitability.