Dusty White Dwarfs and the Late Stages of Planetary Systems

Justin Ely
AST630 University of Maryland College Park, MD
13 October, 2014

Abstract

Exoplanet discovery has exploded in recent decades. After detections of hundreds of extrasolar planets around many different types of stars and stellar remnants, we can conclude that planetary systems exist in abundance in the galaxy in various states of evolution. Arguments for the existense of planetary systems surviving main sequence evolution and existing around white dwarfs (WD) have been supported by observations of WD stars with heavy metal enrichment and infra-red excess indicative of dust. Further studies of the chemical abundances and dynamics of these enrichments concluded that the material is reminiscent of terrestrial planets which had been tidally disrupted.

The recent study by Debes et al. 2012 used numerical N-body simulations to demonstrate that the dusty disk around white dwarfs can be produced by interior mean motion resonances (IMMRs) between surviving planetesimals and a giant planet. The IMMR perturbs the planitesimals from the asteroid belt into highly eccentric orbits that eventually cross close enough to the central star to be tidally disrupted. This method appears to be most efficient at the 2:1 resonance, and can be shown to provide material to the disk over timescales comparable to what is needed to fit observations.

This study is important because it can help to tie down the eventual fate of solar systems similar to our own, as well as supplying information about the type of planetary systems that existed during the main sequence evolution of observed WDs. In particular, this method can be used to estimate the frequency and mass of asteroid belts as well as the characteristics of large surviving planets in WD systems.

The question of whether or not the disruption of the planitesimal eventually forms a disk that matches the observed properties of dusty white dwarfs was left out of this study as too computationally intensive. I will expand on this work to simulate the end evolution of the dusty disk.