What Debris Disks Can Tell Us about the Masses, Orbits, and Compositions of Planets

Timothy Rodigas*[1], Alycia Weinberger , Chris Stark , John Debes , Renu Malhotra , and Phil Hinz

[1]Carnegie Institution of Washington – United States

Abstract

Our solar system contains four gas giant planets that have interacted and shaped the Kuiper Belt since their formation. They have affected its structure and shape and in the process have flung comets and small rocky bodies towards the inner terrestrial planets. Many of these bodies contain organic materials and water ice, the main ingredients required for Earth-like life. Therefore the Kuiper Belt holds clues to the properties of the solar system's planets. In the same way, it is thought that extrasolar debris disks, analogous to the solar system's Kuiper Belt, contain information on nearby planets. In this talk, I will discuss several recent results that relate the properties of debris disks to masses, orbits, and compositions of as-yet undetected planets. First, I will present 3.8 micron LBTI high-contrast adaptive optics (AO) imaging on the bright, edge-on debris disk around HD 32297 (Rodigas et al. 2014b). Combing our high signal-to-noise (S/N) detection with archival images at 1-2 microns, we constrain the composition of the dust grains in the disk. In particular, we test a recently proposed cometary grains model. We find that pure water ice is a better overall fit, suggesting at least one of the key ingredients for life may be present in this system. Second, I will present Magellan AO (MagAO) imaging results on the debris ring around HR 4796A at seven wavelengths from 0.7-4 microns (Rodigas et al. 2014c, in prep.). With such complete wavelength coverage and high S/N detections, we are able to obtain accurate photometry and constrain the composition of the dust—in particular with regard to organic materials. Finally, I will present a new tool designed specifically for observers and planet hunters. Using a simple equation that depends solely on the width of a debris disk in scattered light, observers can estimate the maximum mass of an interior planet shepherding the disk (Rodigas et al. 2014a). This provides an independent, dynamical check on an imaged planet's mass, which can be very uncertain. The planet's minimum semimajor axis and eccentricity can also be calculated. In general, more massive planets create broader debris rings, meaning observers should target wider debris disks while searching for planets.

*Speaker