Using Gravity Darkening on Variable Stars to Constrain Planetary Formation Theories
Samuel A. Myers, Jason W. Barnes, John P. Ahlers
University of Idaho – Department of Physics

Introduction

• Observations of exoplanets have revealed many systems to be misaligned (Figure 1)
  • This poses problems for our understanding of planetary formation theory.
  • We set out to measure the spin-orbit misalignment of systems with orbit periods between 30 and 100 days.
  • These systems have alignments that are likely preserved from initial formation.
  • This will provide a wealth of statistical data with which to constrain new theories of planet formation.

Methods

• We measure spin-orbit misalignment using data from the Kepler Space Telescope.
• We study early-type, fast-rotating stars that display gravity darkening.
  • This produces asymmetric lightcurves (Figure 3) which can be fit with a y
    minimization technique to measure spin-orbit misalignment.
• Gravity darkened stars are often variable stars.
  • We can independently use oscillations to measure spin-orbit misalignment.
  • Oscillations can obscure the transit.
  • We employ a specialized technique to remove and analyze the variability.
  • We remove each oscillation individually in frequency space using a least squares fitting algorithm.

Expected Results

Our combined stellar oscillation-gravity darkening technique allows for the characterization of planets orbiting most high-mass, fast-rotating stars. In the future we expect to further constrain parameters for KOI-972 and measure the spin-orbit misalignment of systems KOI-972 and KOI-972. Preliminary fits and stellar oscillation removal has already been performed on these systems. Additionally, we expect to be able to apply our technique to dozens of other high-mass, fast-rotating KOIs. Compiling a list of spin-orbit misalignments for these systems will then allow us to use the data to put constraints on theories of planetary formation and evolution.

References