The Gas Component of the KH 15D Transition Disk

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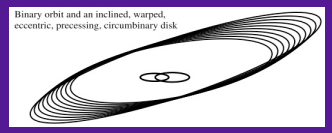
The KH 15D System

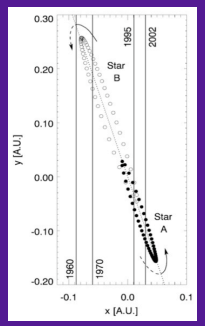


Winn et al. 2006

KH 15D is a 3 Myr-old K7 WTTS located in NGC 2264, 760 pc away (Herbst et al. 2008). The star was first identified as unusual because of its deep (3 mag in I), flat-bottomed eclipses with long (~48 day) periods and a significant fraction of the lightcurve (~1/3) in the dimmer state (Kearns & Herbst 1998). Extensive photometric observations (Hamilton et al. 2005) combined with data from plate archives (Johnson et al. 2005) and radial velocity measurements (Johnson et al. 2004) led to the current theory: KH 15D is an eccentric binary star system gradually being occulted by a warped, precessing circumbinary disk (Chiang & Murray-Clay 2004, Winn et al. 2004, Winn et al. 2006).

What makes this particular disk so interesting beyond the fortuitous alignment is that there is no reddening as Star A is eclipsed, as would be expected for a disk composed of small grains. Herbst et al. 2008 calculate that the grains in this disk must be at least 1 mm in size.

The solids have apparently condensed into chondrule-sized grains. What about the gas?



Winn et al. 2004

Abstract

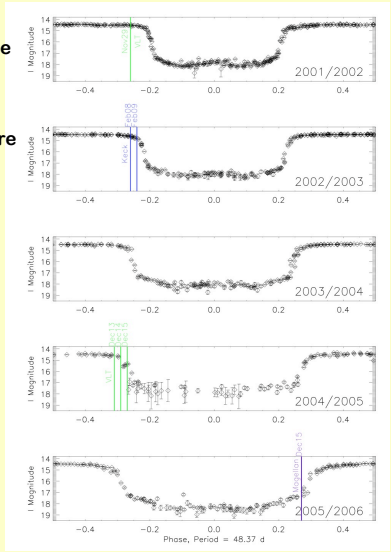
High resolution spectra of KH 15D have been obtained at a variety of elevations of Star A with respect to the occulting edge of its circumbinary disk. The optical light variations provide information on the opacity distribution, which comes from the solid component. Here we inspect the NaI D lines to measure the vertical distribution of the gas density. Comparing the gas and dust distributions will allow us to model the degree of settling of the dust in this transition disk.

Data

Spectral data are from Keck/HIRES, VLT/UVES, and Magellan/MIKE. Data were reduced with standard IRAF/IDL procedures.

In the plots to the far right, the spectrum of KH 15D (solid red line) is compared to a K7 standard star (dotted red line). Also shown are the resulting differences (solid orange line) and ratios (solid purple line) between KH 15D and the standard star. The NaI D lines of the standard star are centered on the predicted RV of Star A (dashed yellow line). In the difference and ratio spectra, an absorption feature is visible at the systemic velocity of KH 15D, which is exactly where we would expect to see absorption by gas in the disk.

Observations and KH 15D Lightcurve



Conclusion and Future Work

The gas in the disk is observed at the predicted systemic velocity

Next: add more data (HET and Keck) and measure Na column densities at different values of Δ

Improvements to current measurements:

- Use models and/or K7 WTTS spectra for the photosphere
- Measure ISM absorption toward KH 15D

References:

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Johnson, J. A., et al. 2004, AJ, 128, 1265
Johnson, J. A., et al. 2005, AJ, 129, 1978
Kearns, K., & Herbst, W. 1998, AJ, 116, 261
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Spectra

Δ is the elevation of Star A above the disk, in R_A (1.3 $R_\odot$)