SHINING THROUGH THE FOG

Polarization and the Origin of the Mid-Eclipse Light in KH15D

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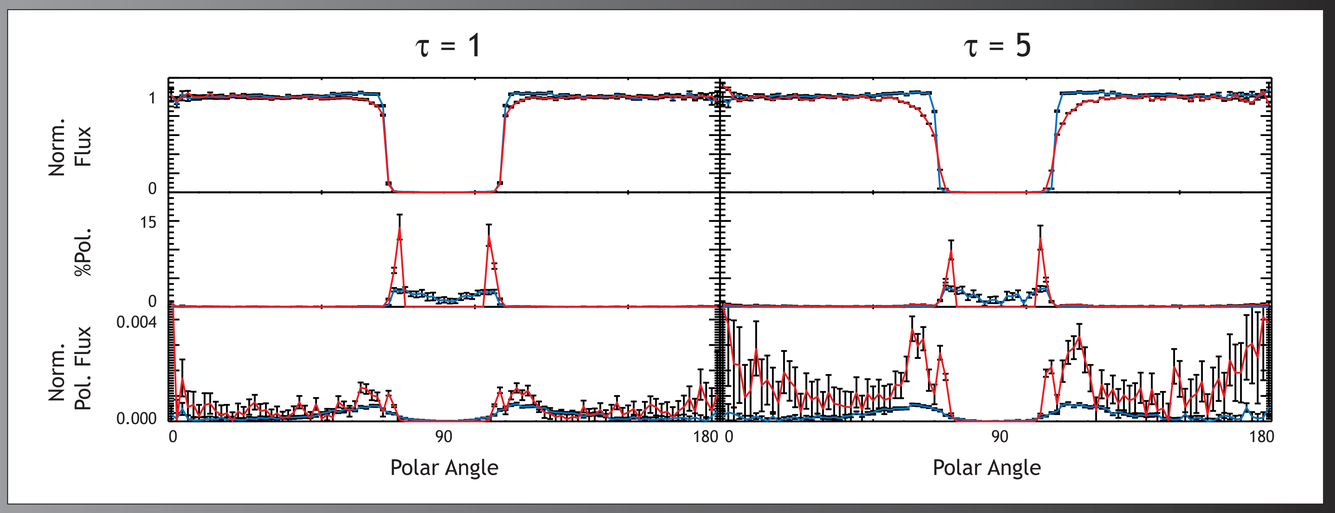
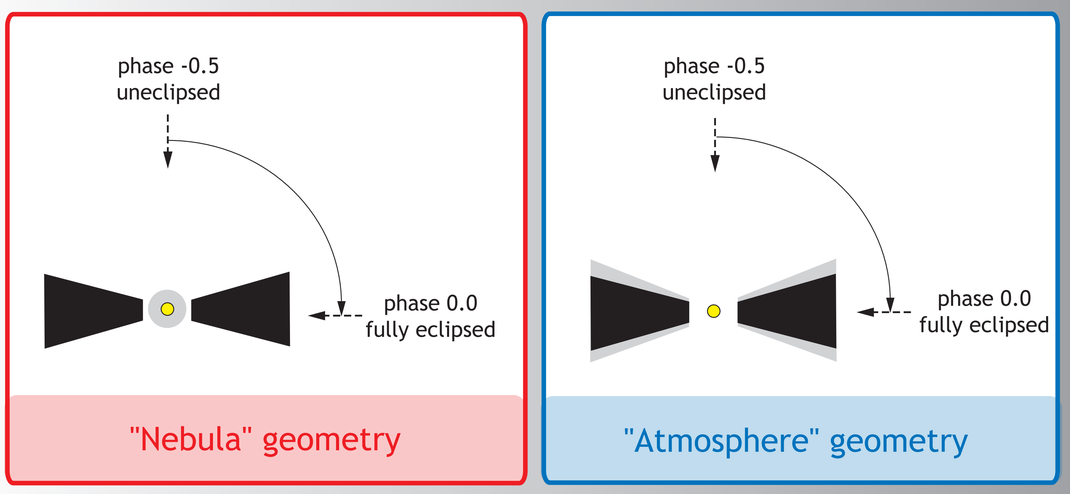
KH 15D is an unusual binary star whose eclipses change in duration and shape over time as the stars are gradually occulted by a precessing circumbinary disk. Currently, 5% of the total flux remains at mid-eclipse; this light is polarized at P ~ 2% (Agol et al. 2004). Determining from where this polarization arises can help us understand the nature of the system. Winn et al. (in prep.) suggest the light scatters either in circumstellar "nebulae" or in a disk "atmosphere." I have created simple Monte Carlo radiative transfer models to distinguish between the polarization signals produced by Mie scattering in these scenarios. Each model has a central source of light and simulates eclipses via changes in viewing angle with respect to an opaque disk.

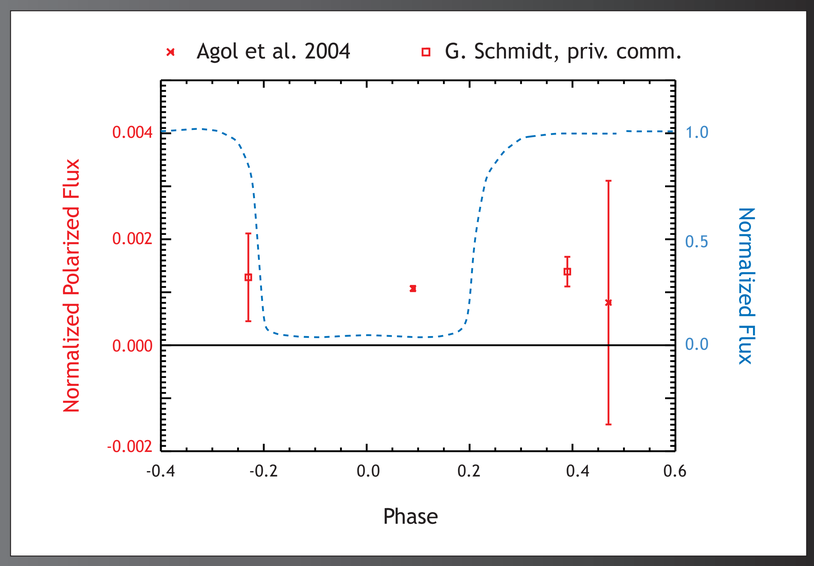




For various optical depths, I created "nebula" and "atmosphere" models that agreed closely in the shape of flux ingress. Above, I compare the resulting polarization and polarized flux variations of the two geometries. The main differences occur within the eclipse: the nebula models show zero polarization in eclipse because the nebula is then fully occulted by the disk. In contrast, the disk atmosphere can be illuminated by the star and produce polarization even at mid-eclipse. However, the difference between the two models could be decreased if another star with a circumstellar scattering region contributed to the polarization in the "nebula" case, as suggested by Winn et al. Note that when the shape of flux ingress agrees between the two models, so does the shape of the polarization variation at ingress. Neither model shows any polarized flux at mid-eclipse.

Agol et al. (2004) presented polarimetric observations of KH 15D at eclipsed and non-eclipsed phases. Here, I show these data points and present polarization data for two more phases in the KH 15D light curve, taken by G. Schmidt at U. Arizona in November and December 2002 with a 2.3 m telescope. All observations have been phased with the most recent ephemeris quoted in Johnson & Winn (2004). Schmidt also measured the interstellar polarization by observing 4 nearby stars; the resulting small interstellar contribution has been removed from these data.

By multiplying fractional polarization in the 7000-8000Å band by normalized I-band flux, I created a light curve of the scattered light in the KH 15D system. The error bars are large, but these data hint that the polarized light in the system may remain nearly constant with phase. If borne out by future observations, this finding would invalidate both scenarios for the shape of the scattering region presented above (compare polarized flux curves). Instead, it would imply that the scattering region must remain visible and constantly illuminated throughout the binary cycle. I plan further models to investigate this scattering scenario and urge spectropolarimetric observers to focus on the polarimetric behavior of KH 15D throughout its eclipse.



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Two models for the source of polarization in KH 15D differ mainly within the eclipse. But new observations suggest that neither one may be correct. Further polarimetric observations should focus on covering the eclipse as completely as possible.