Stellar Rotation
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Rotation of M and L Dwarfs from High Resolution Infrared Spectra

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Abstract. v sin i has been measured from high-resolution ($\lambda/\Delta\lambda$~50000) infrared spectra of ~30 M and L dwarfs. The spectral region observed covers approximately 0.01 μm centered at 2.312 μm in the CO 2-0 band. v sin i, measured from the CO lines, increases dramatically from the M to L dwarfs. In extreme cases the rotational periods are a few hours.

1. Introduction

M 9 to L 8 dwarfs were observed using the Phoenix infrared spectrograph (Hinkle et al. 2000) on the 8 m Gemini South telescope. Observations of earlier M dwarfs were obtained with Phoenix on Kitt Peak. While many M dwarfs can be observed with Phoenix on Gemini, observing more than a few L dwarfs remains challenging. The L dwarfs in this program have K magnitudes ranging from 11.3 to 12.9 requiring exposure times of about one hour per object. Projected rotational velocities (v sin i) were measured by comparing the observations with models and with dwarfs of known v sin i. Most of the M dwarfs have fairly narrow lines but the CO line widths increase notably in the L dwarfs.

2. CO v sin i

Figure 1 shows our v sin i measurements of CO lines as a function of spectral type. The trend of v sin i to increase with later spectral types has been reported for the M dwarfs by Reid et al. (2002) and for the L dwarfs by Basri et al. (2000). Figure 1 shows no effect as the mass drops below that required for hydrogen burning in the coolest M dwarfs or deuterium burning in the L dwarfs. Given the relatively small sample it is impossible to say if the trend in Figure 1 is the result of sampling, however, the absence of apparent slow rotators in spite of the sin i term is remarkable.

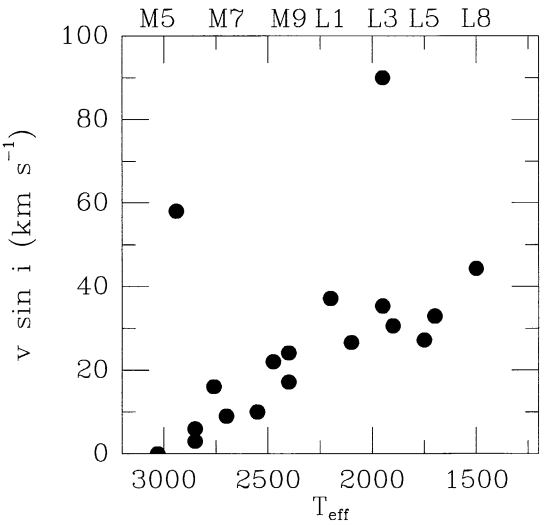

Figure 1. v sin i, determined from the 2.3 μm CO lines, as a function of spectral type for M and L dwarfs. The two dwarfs with large v sin i are GJ 65A and Kelu-1. GJ 65A=BL Cet is a companion to the flare star UV Cet.

3. Kelu-1

Kelu-1, one of the brightest of the L dwarfs in the near IR (K=11.8), has remarkably broad CO lines, with v sin i =90±10 km s^{-1}. Basri et al. (2000) found v sin i for Kelu-1 to be in the range 60 to 90 km s^{-1} and suggested that Kelu-1 was a binary. Clarke et al. (2002) found a 1.8 hour periodicity in the I band light of Kelu-1. This could be ellipsoidal variability, the signature of an orbiting companion, or the rotational modulation of the light by surface features. Assuming the 1.8 hour period is the stellar rotation period and taking a stellar radius of 0.1 R$_\odot$ (Chabrier et al. 2000), the rotational velocity at the equator is 67 km s^{-1}. This would imply that the spectral lines are broadened not entirely by rotation but by line blending with a second dwarf of similar spectral type. If this is the case the width of the lines should be modulated over the 1.8 hour period. Our data consists of four half-hour exposures and does not appear to show modulation. However, the shallow broad lines are very difficult to evaluate.

References

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