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Accretion in Very Low Mass Young Objects

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Abstract. We have investigated evidence for active accretion in a sample of ~ 30 young, very low mass objects, including at least 10 brown dwarfs. About 30% of the sample exhibits broad, asymmetric Hα emission line profiles, indicative of gas accretion via magnetospheric infall. There is a distinct lack of associated optical continuum veiling in these accretors, suggesting very low mass accretion rates. Our models yield an upper limit to the accretion rates that is several orders of magnitude smaller than typical of higher-mass T Tauri stars, suggesting a dependence of accretion rates with stellar mass.

1. Introduction

The origin and early evolution of brown dwarfs are still a matter of some debate. Strong evidence for circumstellar disks around very low mass objects has begun to emerge, as apparent infrared excesses are now being observed (e.g., Liu, this volume). However, detailed comparisons of disk properties with the higher-mass T Tauri stars (TTSs) have yet to be done. We have chosen to look for evidence of disk-fed gas accretion onto very low mass young objects, and, where appropriate, to compare mass accretion rates to those of the well-studied TTSs. To this end, we have obtained high-resolution optical spectra of a sample of 31 objects with $M \sim 0.05 - 0.2\ M_{\odot}$ in several star forming regions. The spectra, obtained with the Keck HIRES and ESI spectrographs, provide several diagnostics typically associated with accretion, including Hα emission and optical continuum veiling.

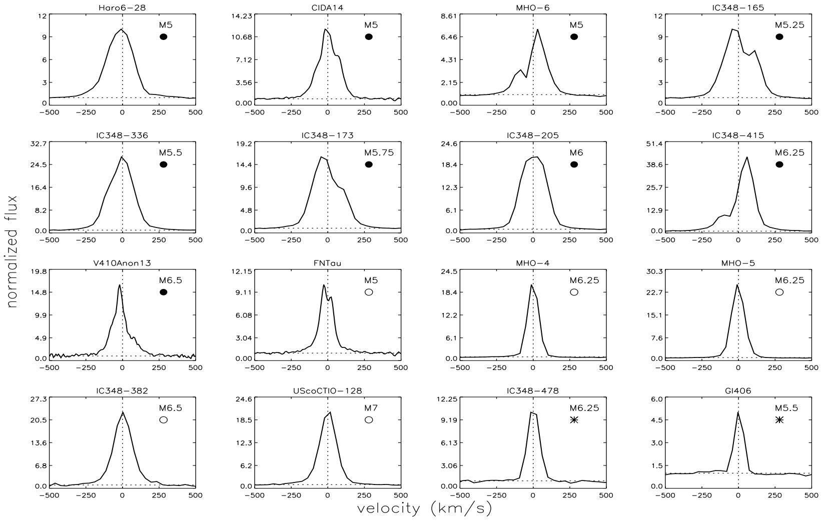

Figure 1. Hα profiles for all definitive (filled circles) and possible (open circles) accretors in the sample. A non-accreting young object and a field dwarf are also plotted (asterisks), showing emission typical of chromospheric activity.

2. Results

We identify 9/31 objects, including at least 3 likely brown dwarfs, as active accretors based on their Hα profiles (see Fig. 1). These all show linewidths much larger than typical for chromospheric activity alone, and most show blue asymmetries consistent with magnetospheric accretion models (e.g., Muzerolle et al. 2001). Several of the likely accretors also show blueshifted absorption, tracing accretion-powered mass loss. An additional 5 objects show more ambiguous evidence for accretion at Hα, but also exhibit other emission lines typically associated with accretion, such as He I, Ca II, and [OI].

We further find that no objects in our sample show signficant veiling, expected to be produced by the hot accretion shock at accretion rates typical of TTSs. Only 2 objects show marginal veiling ($r = 0.1 - 0.3$) at 6000-7000 Å, while the rest show no measurable veiling at all ($r \lesssim 0.1$). This puts critical constraints on the mass accretion rates; our models of accretion shock emission show that $\dot{M}$ cannot be larger than $\sim 10^{-10}$ $M_\odot\, yr^{-1}$ (consistent with the range of values from preliminary Hα models; e.g., Muzerolle et al. 2000). This upper limit is roughly equivalent to the lower envelope of values for 1 Myr-old TTSs, and about two orders of magnitude lower than the average values for TTSs. This suggests a mass dependence for accretion rates in objects with $M \lesssim 2$ $M_\odot$.

References

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