Iron and helium emission lines in classical T Tauri stars

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Abstract

Results are presented for the He emission in 31 CTTS from the Taurus-Auriga molecular cloud spanning two orders of magnitude in the mass accretion rate, and for the Fe emission in DR Tau, based on a series of high resolution echelle spectra. ^ The He lines admit a description in terms of a narrow component (*NC*) and a broad component (*BC*). The *NC* has FWHM between 32–55 km/s and centroid velocities near zero km/s or moderately redshifted, consistent with an origin in the postshock region of the magnetospheric accretion model. The *BC*, with FWHM between 128 and 287 km/s and centroid velocities between –93 and +35 km/s, includes a wind and an accretion component; we argue the *BC* is predominantly formed in the wind. Estimates of the wind and accretion component equivalent widths are oppositely related to the *NC*, so the *NC* equivalent width increases with the accretion component but decreases as the wind component increases. The *NC* is undetectable where profiles appear dominated by the wind, requiring a source of veiling other than the accretion shock to account for the observed continuum excess. Intensity ratios indicate that physical conditions are nearly uniform in the *NC* but span a range in the *BC*. ^ For DR Tau, the range of morphologies in 62 unblended Fe I and Fe II lines can be resolved in terms of a narrow component (*NC*) that dominates the weakest lines, and a broad component (*BC*) that dominates the strongest lines. The (*NC*) has FWHM ∼20 km/s and centroid velocity near zero km/s. The (*BC*) has FWHM ∼100 km/s, and a tendency to be blueshifted by ≤10 km/s. Estimates of iron line opacities τ and column densities *N* yield $\tau_{NC} \sim 3 \times \tau_{BC}$, N_{FeI} ≳ $10^{17} – 10^{18}$ cm^{-2}, and N_{FeII} ≳ $10^{18} – 10^{19}$ cm^{-2} for the *BC*. Estimates of kinetic temperature for iron suggest that the *NC* gas is hotter than the *BC* by several thousand degrees. For iron, the *NC* is consistent with an origin in the postshock gas while the *BC* may originate in the inner accretion disk close to the corotation radius. ^

Subject Area

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