One-micron spectroscopic studies of accretion and outflow in T Tauri stars

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Abstract

High-resolution spectroscopy of classical T Tauri stars (CTTS) at one micron yields new insight into the interaction of accretion disks, outflowing gas, and the central stars. Eighty-one 0.95–1.12 μm spectra of 38 CTTS were obtained with NIRSPEC on Keck II (R = 25, 000) between 2001 and 2007. They were reduced with a modified version of Redspec that features an improved interface developed by the author to remove intrinsic spectral features from atmospheric calibrator stars. Profiles of the one-micron neutral helium line (λ10830) are powerful probes of the kinematics and geometry of infalling and outflowing gas within the innermost ~ 10 R_* of the accreting systems. Subcontinuum blueshifted absorption components, tracing outflow, are found in about 75% of the CTTS and indicate a dual origin for the winds that power outflows observed farther from the star. Modeling of blue absorption and emission indicates that heavily accreting sources, with one-micron veilings $r_Y > 0.5$, are dominated by stellar winds, while lightly accreting sources with lower r_Y show evidence for a mixture of stellar winds and disk winds. Subcontinuum redshifted absorption components, tracing infall, are found in about 50% of the CTTS, almost never when $r_Y > 0.5$, and indicate accretion along magnetic field lines that connect the star to the disk. Modeling of red absorption indicates that in about half of the objects with such features, the absorption morphology is consistent with previously modeled flows, but in the remaining half, consisting of stars with $r_Y \leq 0.1$, wider and more dilute flows are required than have previously been proposed. Over the entire sample, Paγ morphologies are roughly consistent with their expected formation in a funnel flow, but trends with veiling suggest that accretion shocks and winds can also contribute to the profiles. Finally, ratios of r_Y to optical veilings are on average higher than the expectations of existing models, indicating the possibility of additional sources of excess emission at 1 μm.

The evidence for two types of inner wind and an accretion flow geometry that depends on accretion rate suggests that the means of mass and angular momentum transport in CTTS systems are more diverse than previously realized.^

Subject Area

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