THE RW AUR MICROJET: TESTING MHD DISK WIND MODELS *

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Abstract. We conduct a detailed comparison between the kinematics, morpology and excitation conditions of the RW Aur microjet on scales < 200 AU with predictions from stationary, self-similar, *cold* disk wind solutions. Implications for launching and ionization mechanisms of jets in young stars are discussed.

Keywords: Star formation, Mass-loss, RW Aur

1. Introduction

We present results from an on-going observational study aimed at constraining the launching and ionization mechanisms of jets from young stars. We focus here on spectro-imaging observations of the RW Aur microjet obtained with the adaptive optics bonnette PUE'O and OASIS spectroimager at the CFHT with spatial sampling of 0.11 and 0.16$''$ and spectral sampling of 45 km s^{-1}. Properties of the DG Tau and CW Tau microjets are discussed in Lavalley et al. (1997), Dougados et al. (2000), Lavalley-Fouquet et al. (2000).

We compare these observations with detailed predictions from the class of stationary, self-similar, *cold* disk wind solutions developped by Ferreira (1997). These solutions extend radially in the disk out to 1 AU and two dominant heating mechanisms are considered: ambipolar diffusion (Garcia et al., 2001) and mechanical heating ($\alpha\ \rho V^3/R$, O'Brien et al., 2002). More details on the disk wind solutions and their thermal structure can be found in the contributions of J. Ferreira and P. Garcia (these proceedings).

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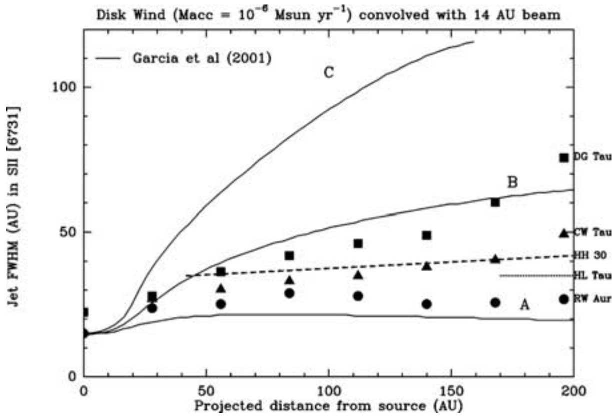

Figure 1. Observed jet FWHM (black symbols, dashed and dotted lines) are compared with predictions from *cold* disk wind models (blue solid lines) convolved with 14 AU beam.

2. Collimation

We show in Figure 1 derived jet FWHM for the 5 microjets for which we currently have constraints on spatial scales $\leq$ 200 AU (HL Tau, HH 30: Ray et al., 1996; DG Tau, CW Tau, RW Aur: Dougados et al., 2000; Bacciotti et al., 2002). We also show in this figure predicted jet widths from 3 cold disk wind solutions with different ejection efficiencies, convolved with the appropriate beam size (14 AU=0.1$''$). Both apparent collimation scales and jet widths are compatible with predictions for moderate to high ejection efficiency solutions (A and B). The inclusion of mechanical heating does not affect these conclusions.

3. Heating Mechanism

We compare in Figure 2 the evolution of observed line ratios along the RW Aur microjet in 3 velocity intervals with 1) predictions from planar J-type shocks (Hartigan, Morse and Raymond, 1994), and 2) ambipolar diffusion and mechanical heating in cold MHD disk winds (Garcia et al., 2001; O'Brien et al., 2002). Line ratios in the redshifted part of the flow, at all but the highest velocities, appear best explained by J-type shocks, as in the case of DG Tau (Lavalley-Fouquet et al., 2000), with shock speeds $\simeq$ 40 km s^{-1} and preshock densities decreasing away from the star. In contrast, line ratios in the blueshifted jet appear in close agreement with predictions from cold disk winds with mechanical heating (α = 0.003), except for the [SII]6716/[S II]6731 ratio, clearly overestimated in the model (i.e. *ne* underestimated). Indeed total jet densities, derived using the inversion method proposed by Bacciotti and Eisloffel (1999), exceed model predictions by a factor $\simeq$ 10.

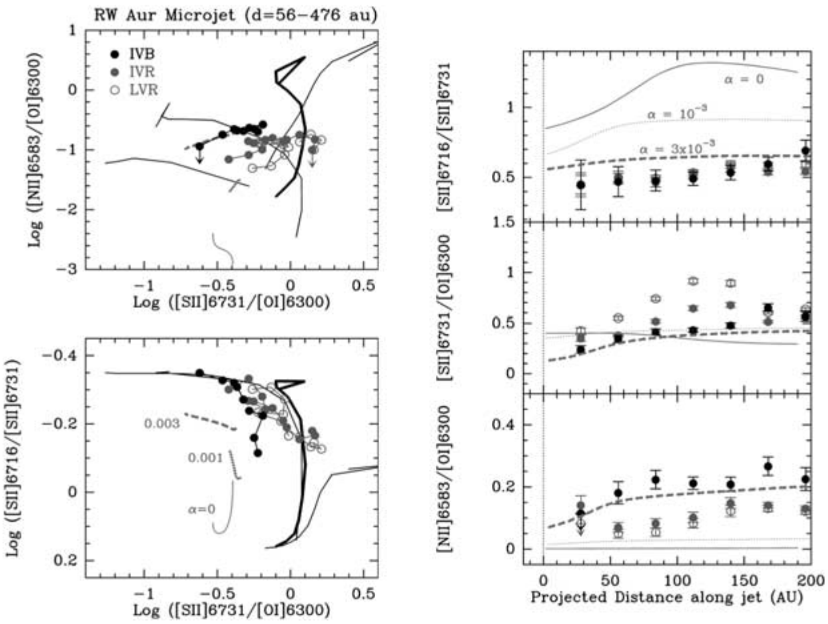

Figure 2. Left: **Line ratio diagrams.** RW Aur line ratios sampled every 28 AU in 3 velocity intervals (IVB:-210 to -110 km s^{-1}, IVR:110 to 210 km s^{-1}, LVR: 10-110 km s^{-1}) compared with predictions from J-type shocks (solid blue), cold disk winds (magenta) with Macc = 10^{-6} $M_{\odot}$ yr^{-1} and α=0 (solid),0.001 (dotted),0.003 (dashed). *Right*: **Variation of line ratios with distance.** RW Aur line ratios compared with *cold* disk wind models. Same symbols as left pannel.

4. Kinematics

We searched for rotation signatures in the RW Aur microjet, similar to the ones reported for DG Tau by Bacciotti et al. (2002). Figure 3 compares observed and predicted transverse velocity shifts between symetric positions on either side of the jet axis. Cold disk winds, extending radially out to 1 AU, predict transverse shifts of 30-40 km s^{-1}, that should be clearly detectable at the resolution of our OASIS observations, at odds with the observations. The detection of rotation signatures therefore appears as a powerful tool to discriminate between wind solutions.

5. Conclusions

We presented a detailed comparison of the collimation, kinematics and excitation properties of the RW Aur microjet on scales $<$ 200 au with predictions from stationary self-similar cold disk winds. Observed ionization fractions and temperatures in the blueshifted jet appear well reproduced by cold disk winds with moderate mechanical heating. However, predicted total jet densities are too low and rotation velocities too large. This detailed study reinforces the conclusions of

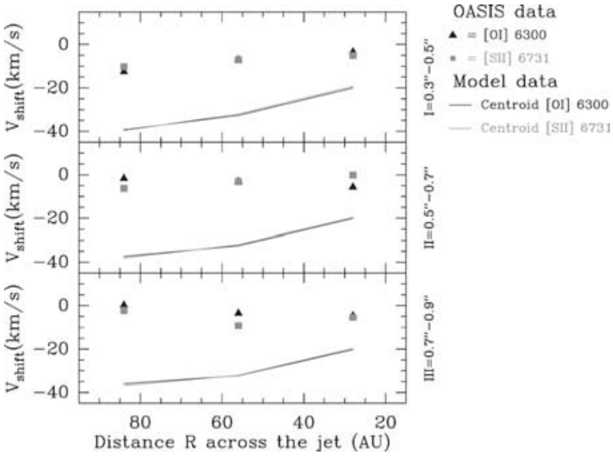

Figure 3. **Rotation signatures**. Comparison of observed (*symbols*) and predicted (using cold disk wind model A, *lines*) transverse velocity shifts at different distances along the jet axis.

Garcia et al. (2001) based on the analysis of the global properties of the forbidden line emission in T Tauri stars. Warm disk solutions, allowing a higher mass loading on field lines, may help solve this discrepancy. Both the detailed analysis of a larger sample of microjets, and comparison with similar predictions from other classes of wind models, including warm disk wind (Casse and Ferreira, 2000), stellar winds (Sauty et al., 2002) and X-winds (Shang et al., 2002), are critically required before deriving general conclusions on the origin of mass-loss in young stars.

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