A BIPOLAR JET FROM RY TAU.

P. Bastien, *Département de physique & Observatoire du Mont-Mégantic, Université de Montréal, Montréal, Québec, Canada (bastien@astro.umontreal.ca)*, G. St-Onge, *Dorval Astronomy Club, Dorval, Québec, Canada*.

We are pleased to report the discovery of a bipolar jet coming from the classical T Tauri star (CTTS) RY Tauri. High spatial resolution images have been taken on the Gemini North telescope in February 2005 of RY Tau. The Hα image, with the continuum properly subtracted, shows a jet extending out to at least 31$''$ at a position angle of about 295° from the star. A counterjet extending to at least 3.5$'$ in the opposite direction is also visible. The dynamical age of the knots in the inner part of the jet is estimated to be less than 10 years old. The Herbig-Haro bipolar jet has been labeled HH 938. The orientation of the disk, as given by the average position angle of the polarization, is $\approx 20^\circ$, or almost perpendicular to the direction of the jet.

RY Tau is a CTTS located at 140 pc in the Taurus dark clouds. Its spectral type is K1e IV, V or G2 according to Herbig (1977), Cohen & Kuhi (1979), and Cabrit et al. (1990). It rotates rapidly at about 52 km/s and shows eclipse-like episodes caused by orbiting circumstellar dust, suggesting that its disk is seen close to edge-on. Recently, Gómez de Castro & Verdugo (2007) suspect it to have small-scale outflows coming directly from the star. The usual picture of a MHD disk wind driving an outflow is not supported by an interpretation of UV spectra.

A contest for Canadian amateur astronomers was organized by the Gemini telescopes in 2004 and was won by G. St-Onge. The images taken with GMOS N in February 2005 were combined to produce the beautiful picture that was featured on the Gemini web site (see Press release 2005 May 17 or our poster). Wisps or veil-like structures are clearly seen.

By carefully subtracting the continuum (i') from the Hα image and rotating the two psfs, we found a new bipolar jet, HH 938 (St-Onge & Bastien 2007). Three inner knots are found (HaA, HaB and HaC) and 7 other knots (only 5 of them are shown on Fig 1). They cover a range from 1.5$''$ (210 AU) for knot HaA to 15.3$''$ (2140 AU) for knot Ha5, and out to 31$''$ for knot Ha7 (see poster). A distance of 140 pc to RY Tau is assumed to compute the scale in AU. Assuming a typical outflow velocity of 200 km/s, this means that the material in the inner knots (HaA-HaC) was ejected from the star less than ten years ago! The counter jet (see the poster) extends at least 3.5$'$ in the opposite direction and ends in a bow shock just at the edge of the GMOS N images.

We retrieved images of RY Tau from the HST Archive exposure catalog. There is a faint knot visible in the same direction than the jet. Assuming that this knot corresponds to the brightest knot we detected, Ha2, and assuming that it moves exactly in the plane of the sky, we get a propagation velocity of $\approx$ 170 km/s. Jets from CTTS have typical velocities from a few tens to a few hundred km/s (Eisloffel & Mundt 1998; Bally et al. 2007; Ray et al. 2007). Thus our measured velocity is typical of jet velocities from CTTS.

The average direction of the jet is at a position angle (P. A.) of $\approx 295^\circ$. If the disk is optically thick, then the polarization should be parallel to the disk and perpendicular to the jet (Bastien & Ménard 1988, 1990). Taking an average of published polarization measurements (Bastien 1982), yields P. A. $\approx 20^\circ$, very close to being perpendicular to the jet.

Jets are a by-product of accretion, but their precise formation mechanism is strongly debated. Recently, adaptive optics and spectro-astrometry has been used to probe closer to the stars (Ray et al. 2007). Models suggest that they are accelerated and focused within a few AU from the star. The favored magneto-centrifugal disk winds picture has been questioned recently (Gómez de Castro & Verdugo 2007). The width and velocity field close to the source are crucial to finding more about the ejection mechanism (disk or star). The results of these observations will be discussed further in the context of the models in the poster.

We thank the Canadian Gemini Office at the Herzberg Institute of Astrophysics of the National Research Council of Canada for running the image contest, especially S. Côté for her help, and the Gemini staff for their help with the observations. We acknowledge support by the Conseil de recherches en sciences naturelles et génie du Canada.

References

Bally, J., Reipurth, B., & Davis, C. J. 2007, Protostars and Planets V, B. Reipurth, D. Jewitt, & K. Keil, University of Arizona Press: Tucson, 215

Bastien, P. 1982, A&A, 48, 153 and 513

Bastien, P., & Ménard, F. 1988, ApJ, 326, 334

Bastien, P., & Ménard, F. 1990, ApJ, 364, 232

Cabrit, S., Edwards, S., Strom, S. E., & Strom, K. M. 1990, ApJ, 354, 687

Cohen, M., & Kuhi, L. V. 1979, ApJS, 41, 743

Eisloffel, J., & Mundt, R. 1998, AJ, 115, 1554

Gómez de Castro, A. I., & Verdugo, E. 2007, ApJ, 654, L91

Herbig, G. 1977, ApJ, 214, 747

Ray, T., Dougados, C., Bacciotti, F., Eisloffel, J., Chrysostomou, A. 2007, Protostars and Planets V, B. Reipurth, D. Jewitt, & K. Keil, University of Arizona Press: Tucson, 231

St-Onge, G. & Bastien, P. 2007, ApJL, submitted

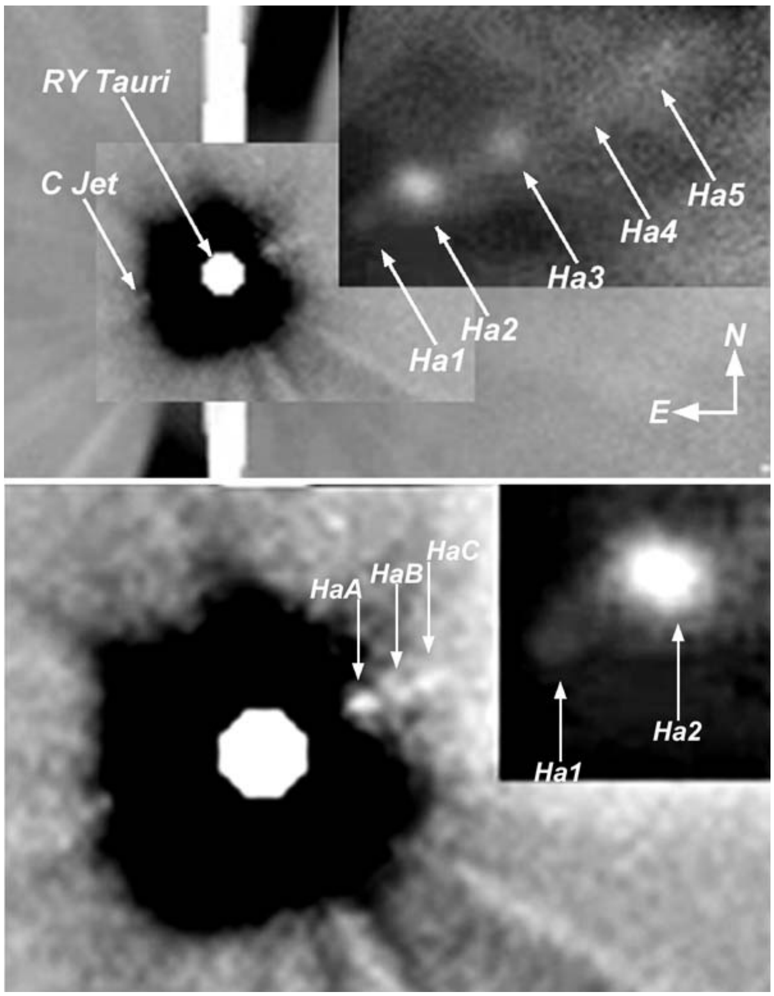

Figure 1: The jet of RY Tau. (a) Top. Composite image showing the subtracted image H$\alpha - i'$ with rotated psf. Short exposures are shown, with superposed long exposures to show the fainter knots further out. A hint of the counterjet is indicated. (b) Bottom. A closer view centered on the star.