NEW RESULTS ON THE BINARY COMPANION OF T TAURI

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We have recently reported the discovery of a cool (650-800 K) low-luminosity companion to the pre-main-sequence star, T Tauri (Dyck et al. 1982). We proposed that the optical star and its infrared companion form a physical pair with a N-S separation of 100 a.u. However, there remained in our 2-5 μm speckle interferometry an ambiguity of 180° in the position angle of the secondary. In addition, Cohen et al. (1982) noted an 800 milliarcsec (mas) offset between the visual and 6 cm radio positions at T Tau. Both of these positional discrepancies have now been clarified by accurate visual and radio astrometry of T Tau, and by further near-IR speckle interferometry.

We have made additional speckle observations of T Tau at the IRTF on Mauna Kea, Hawaii, which confirm our earlier measurements at the University of Hawaii's 2.2 m telescope. The co-added speckle data at 3.8 μm are presented in Figure 1 in the form of a visibility curve, along with a computation for a binary model with separation 590 mas and magnitude difference $\Delta m = 1.47$. The slight high frequency roll-off of the visibility curve at its second maximum indicates that one (or both) of the binary components may be spatially resolved at ~100 mas (16 a.u.), but more observations are needed to confirm this. The binarity of T Tau is also quite clearly evident in N-S scans formed by shifting and stacking individual rapid scans obtained on IRTF.

New radio observations have been made with the VLA at 1.3, 2, 6 and 20 cm. Our preliminary reductions of the 6 cm observations (representing almost 180 min. of observing) are shown in Figure 2. The coordinates are for equinox 1950.0 (epoch 1982.482) and have been determined with reference to nearby quasars, for which K. J. Johnston has established accurate offsets from the nearby FK4 star, Algol. At 6 cm T Tau is clearly seen to be a radio binary, with a N-S separation of 540 mas. The two radio sources are unresolved at our resolution of 250 mas (FWHP). The 6 cm flux of the strong southern peak is 4.3 ± 0.5 mJy; the northern source is nearly 10 times fainter, although significantly above our peak-to-peak noise level of 0.1 mJy per beam.

P. B. Byrne and M. Rodonò (eds.), Activity in Red-Dwarf Stars, 505–507.

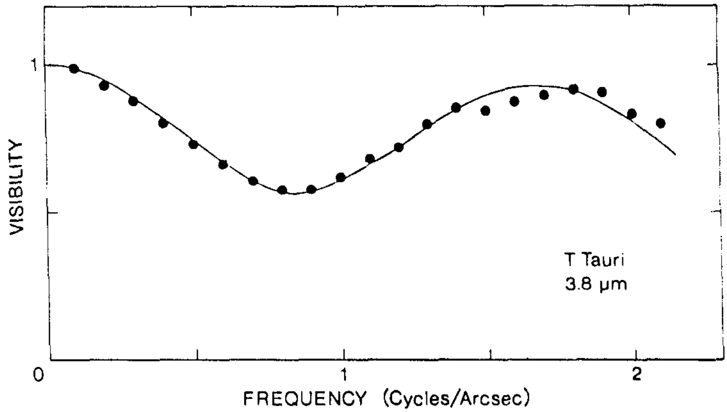

Figure 1. North-South Visibility of T Tau at 3.8 μm. The solid curve is a model with a binary separation of 590 mas and Δm = 1.47.

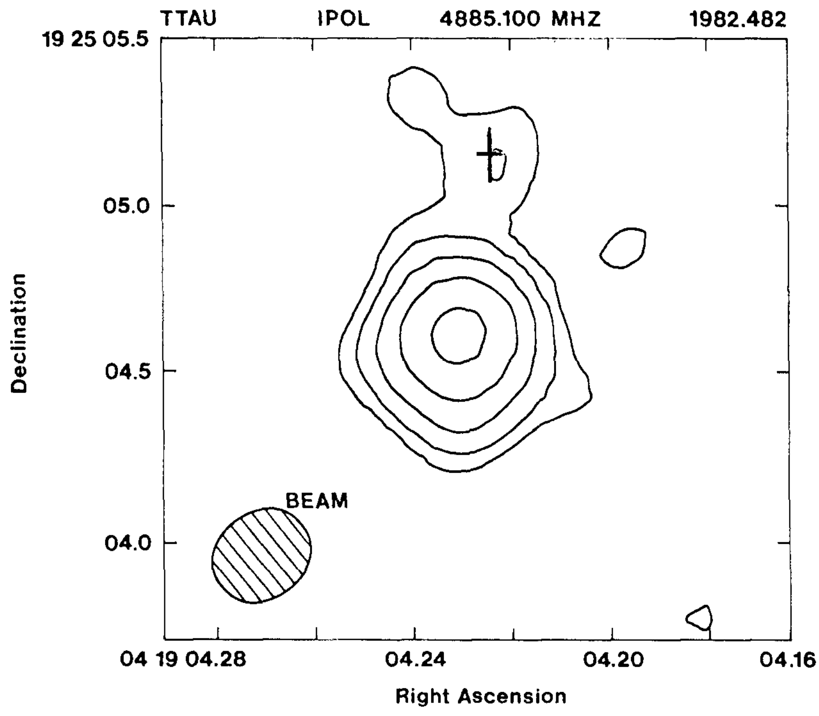

Figure 2. VLA 6-cm Map of T Tau. Coordinates are equinox 1950.0. The cross denotes the optical position and its uncertainty. The absolute radio positions have an uncertainty of 100 mas, or less, in each coordinate. Contour levels are given at 5, 10, 20, 40 and 80% of the peak flux, 3 mJy per beam.

Also shown for comparison is a new visual astrometric position for T Tau, corrected for proper motion to epoch 1982.482, which was kindly communicated by B. Jones and R. Hanson (1982). The exact coincidence of the optical star and northern radio peak confirms the positional discrepancy noted by Cohen _et al._ (1982) and appears to settle the question of the orientation of the binary. We infer that the IR companion lies to the S at the strong radio peak, is fainter at all wavelengths shortward of 5 μm than the primary, and has a near-infrared color temperature of 800 K. If the detected radio emission arises in a stellar wind, then the high mass loss rate previously derived by Cohen _et al._, $\dot{M} = 4 \times 10^{-7}\ M_\odot\ yr^{-1}$, must be associated not with the optical star, but the IR companion. A lower $\dot{M}$ for T Tau(opt.) is consistent with the Alfven wave driven wind model of Hartmann _et al._ (1982), but this theory leaves unexplained the potency of the wind from the $\sim$1.5 $L_\odot$ IR companion of T Tau.

A complete version of this paper is to be submitted to the _Astrophysical Journal._

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