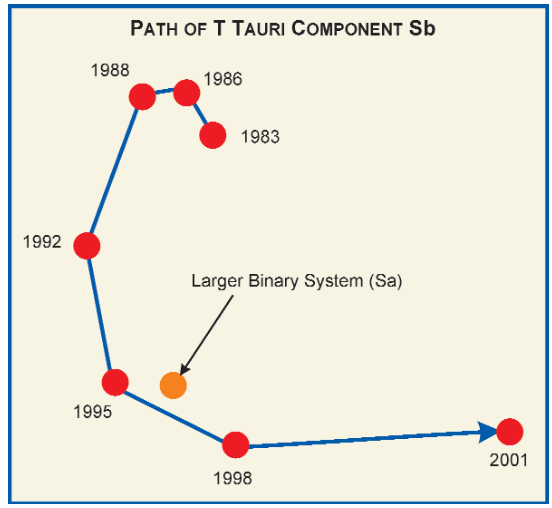
Ejection in Taurus?

Over the last two decades, the Very Large Array has been used to observe in several epochs many of the nearby regions of low-mass star formation, like Taurus or Ophiuchus. In these observations, the members of binary and even multiple systems of embedded young stars are sometimes detected as compact radio sources. The detection is believed to be the result of free-free emission from the stellar outflows or of gyrosynchrotron emission from active magnetospheres. Our group has started to take make use of this unique database to search for proper motions in these young multiple systems that are detectable in the radio. Up to now, we have studied in detail five systems. In three of them (L1527, L1551 IRS5, and YLW 15) we found proper motions that imply gravitationally-bound orbits and total masses for the systems in the range of 0.5 to 2 solar masses (Loinard et al. 2002, Rodriguez et al. 2003, Curiel et al. 2003). This is an important result on its own: simply, there is no other techique available to estimate the masses of extremely obscured young stars. In another source, IRAS 16293-2422 (Loinard 2002), it is still unclear if the large relative motions observed reflect an orbital path in a bound system, or unbound motions possibly associated with high velocity ejecta.

In an attempt to check our techniques, we decided to include in our analysis a fifth object: T Tauri, the star that gives its name to the class of T Tau stars. There are optical and near-infrared results for T Tau that were expected to allow a comparison with the radio results. T Tau is known to consist of at least three components: T Tau N (the well-known bright variable star) and T Tau Sa and Sb (an infrared binary system some 0.7 arcsec to the south of T Tau N). The VLA detects T Tau N and T Tau Sb; T Tau Sa has never been detected in the radio. The VLA archives included centimeter data of good quality and high angular resolution from 1982 to 2001.

As we advanced systematically in time we found that, besides the proper motion of the whole system with respect to the Sun, we could clearly measure the motion of T Tau Sb with respect to T Tau Sa. Our analysis of the radio data was complemented with recent speckle and adaptive optics near-infrared images that allowed us to determine the position of T Tau Sb with respect to T Tau Sa.

The results of our analysis (Loinard et al. 2003) are shown schematically in Figure 1. With respect to T Tau Sa, T Tau Sb described from 1983 to 1995 what appears to be a bound, elliptical orbit that followed Kepler's second law. However, between 1995 and 1998, T Tau Sb derailed from its previous orbit and started to move rapidly (20 km/s) to the west. Remarkably, this change of orbit happened at the closest approach between T Tau Sa and T Tau Sb. Our interpretation is that T Tau Sa is a tight binary system that in a three-body interaction imparted some of its orbital energy to T Tau Sb, casting the latter away.



Schematic description of the orbit of T Tau Sb with respect to T Tau Sa. From 1983 to 1995 the notion can be described as a bound, elliptical orbit. However, between 1995 and 1998 T Tau Sb appears to have changed its orbit as it is ejected from the system. Since this can only happen in an interaction between 3 or more bodies, it is proposed that T Tau Sa is a close binary.

One problem with this interpretation is the low probability of witnessing such event. Independently, a group from the US Naval Observatory had analyzed the data and proposed that the orbit of T Tau Sb is bound (Johnston et al. 2003), although the total mass required for this, about 5 solar masses, seems too large for the known luminosity of the system. The issue should be settled in the next few years as we see the motion of T Tau Sb progress with time.

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