The 3-dimensional structure of the prototypical young triple system T Tauri

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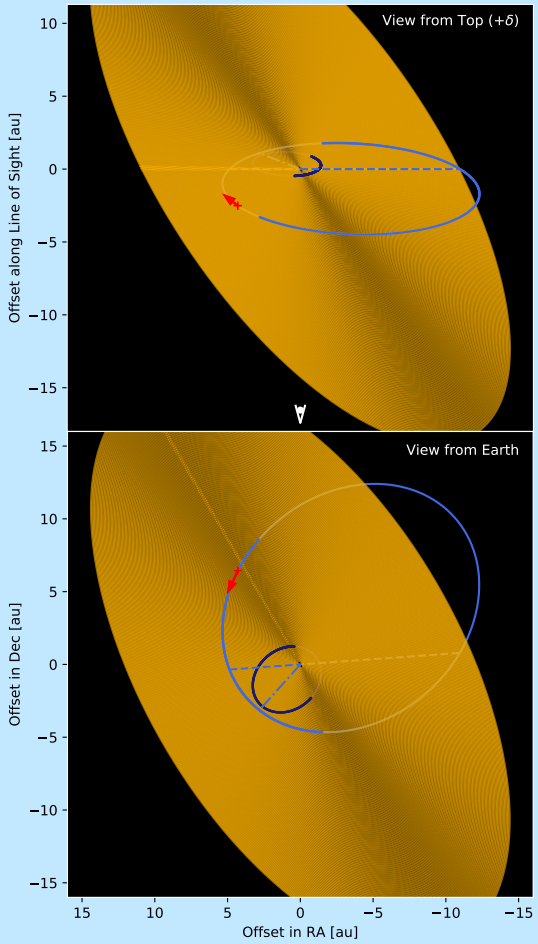

The orbits of T Tau Sa and Sb around their center of mass, and the inner part of the circumbinary disk.
Top panel: the system seen from the positive declination axis, with the observers on Earth located at the bottom. In this view, the left edge of the disk is in front.
Bottom panel: the system as we see it from Earth. Here, the right edge of the disk is in front.
The dashed line is the line of nodes. The dashed-dotted line marks T Tau Sb's periastron. The red cross and arrow indicate its position on 1. Jan. 2020 and the direction of motion.

Introduction

T Tauri is the best-observed member of the class of stars named after it, but astronomers are still debating what exactly is happening in the system.
We know it is a triple system, it contains the close binary T Tau Sa/Sb and the third component T Tau N about 0.6 arcsec to the North. All three stars have circumstellar disks and outflows.

The Orbits

We used a Monte Carlo Markov chain sampler to study the orbits in the system, based on the available astrometric observations (Schaefer et al. 2020 and references therein). To determine the orientation along the line of sight, we rely on radial velocity measurements in Hartmann et al. (1986) and Duchêne et al. (2005).
The figure on the left shows the binary T Tau S, seen from two directions to show its 3D-structure. Also displayed is the inner part of the circumbinary disk proposed by Köhler & Kubiak (2020), and the extinction caused by it.
The figure on the right contains two views of the entire T Tau N/Sa/Sb triple. Because of the limited orbital coverage, the outer orbit (T Tau N around T Tau S) is highly uncertain. The orbit depicted in the figure is the best fit for the observations, with a period of 2730 years. However, the MCMC sampler found possible solutions with periods between ∼1000 and 46 000 years.

Conclusions

Beck et al. (2020) presented a 3-dimensional model of the T Tauri system. They placed T Tau N ∼620 AU behind the T Tau S binary. Our orbit solution predicts that T Tau N is actually in front of T Tau S. However, given the uncertainty of the radial velocity measurements, we cannot exclude that our orbit is wrong and Beck et al. are right. Still, our best orbit predicts a separation along the line of sight of less than 200 AU. It is unlikely that the separation is in fact more than three times larger.

References

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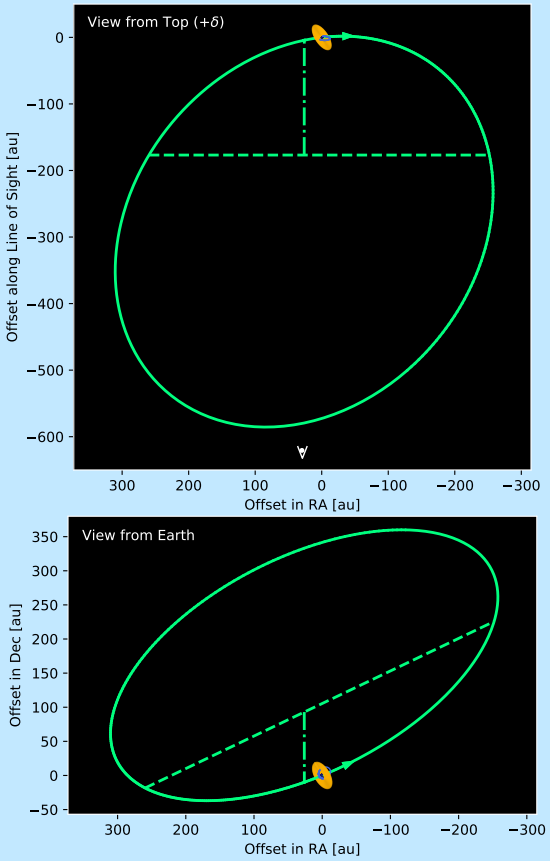
Schaefer, G. H., Beck, T. L., Prato, L., & Simon, M. 2020, AJ, 160, 35



All three orbits in the T Tau system, and the circumbinary disk around T Tau S. Like in the figure on the left, the top panel shows the view from the positive declination axis, and the bottom panel as seen from Earth. The orbit of the center of mass of T Tau S is shown in green, with T Tau N in the center of the orbit. T Tau S is drawn at its position on 1. Jan. 2020. Its direction of motion is indicated by the green arrow. The orbits of T Tau Sa and Sb around their center of mass are shown in blue, and the circumbinary disk in orange.

For more information about T Tauri including some cool animations, go to
http://www.rainerkoehler.com/TTau