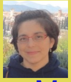

ALMA Imaging of a Dwarf Transitional Disk around XZ Tau B

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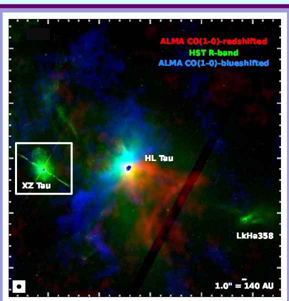
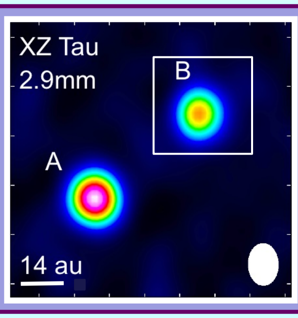
(Osorio et al. 2016, ApJL, 825, L10)

Abstract

We report the discovery of a dwarf protoplanetary disk around the star XZ Tau B that shows all the features of a classical transitional disk (cavities, asymmetries) but on a much smaller scale. The face-on disk has been imaged with ALMA, revealing that its dust emission has a small radius of ~3.4 au and presents a central cavity of ~1.3 au in radius that we attribute to clearing by a compact system of orbiting (proto) planets.

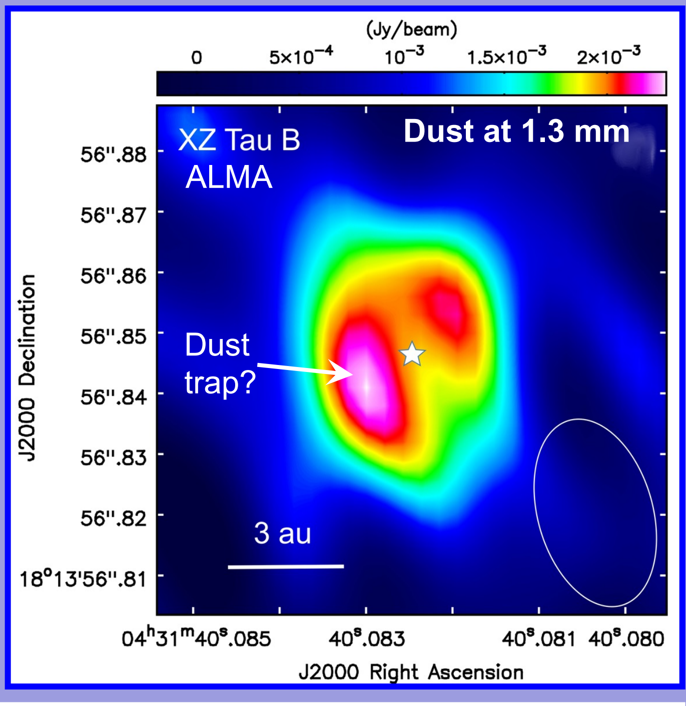




XZ Tau B was observed at 2.9 and 1.3 mm during the ALMA Long Baseline SV Campaign, in a field centered on HL Tau. XZ Tau B was reported only as an unresolved continuum source at 2.9 mm (ALMA Partnership et al. 2015, ApJL, 808, L3).

Despite the source is ~24□ away from the phase center, where the response of the primary beam is low (1/19) at 1.3 mm, the extraordinary sensitivity of ALMA allowed us a good signal-to-noise imaging.

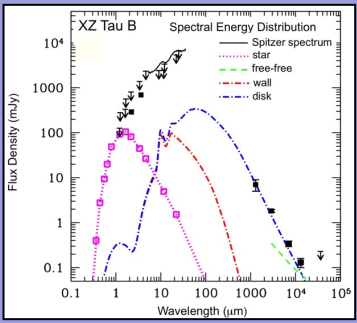
At 1.3 mm XZ Tau B is angularly resolved. It appears as a compact source with a radius of only 3 au, showing a decrease of emission towards the center, and an azimuthal asymmetry (see Figure). We interpret the source as a tiny disk of dust with a central cavity (i.e, a transitional accretion disk) and a possible dust trap.



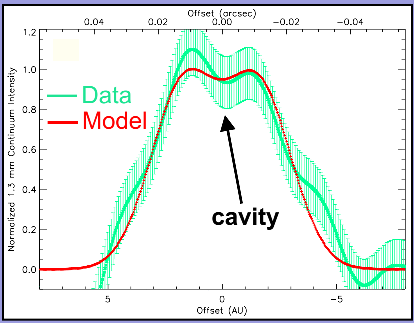
Modeling

To support the disk interpretation, we modeled the SED and the 1.3 mm radial intensity profile adopting irradiated α–accretion disks models (D'Alessio et al. 2006, ApJ, 638, 314). We conclude that models in which the disk is relatively massive and optically thick at 1.3 mm are required to fit the data.

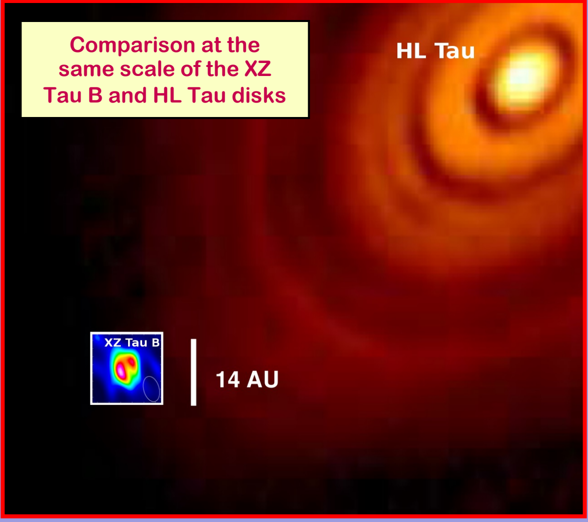
Spectral Energy Distribution



1.3 mm radial intensity profile



XZ Tau B Disk	Classical Disks
Disk Radius = 3.4 au	50-100 au
Cavity Radius = 1.3 au	10-70 au
Mass = 9 M_{Jup}	50-500 M_{Jup}
Surface density (1au) = 2700 g/cm^2	100-1000 g/cm^2



- XZ Tau B shows all the features of a transitional disk but on a much smaller scale.
- Given the very small radii involved in the XZ Tau B disk, its evolution is expected to be much faster (observable changes in a few months) than in classical disks (observable changes requiring decades). XZ Tau B, and possibly other similar dwarf disks, might provide important clues to study in real time the planet formation process.
- Dwarf disks are possible precursors of the compact exoplanetary systems discovered by the Kepler Mission.
- Future observations centered on XZ Tau B should reveal its substructure more clearly and allow us to observe disk evolution in very short time scales.