Evidence of a Multi-Component Eccentric Disk Induced by a Planet around CI Tau

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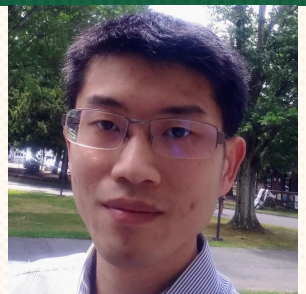
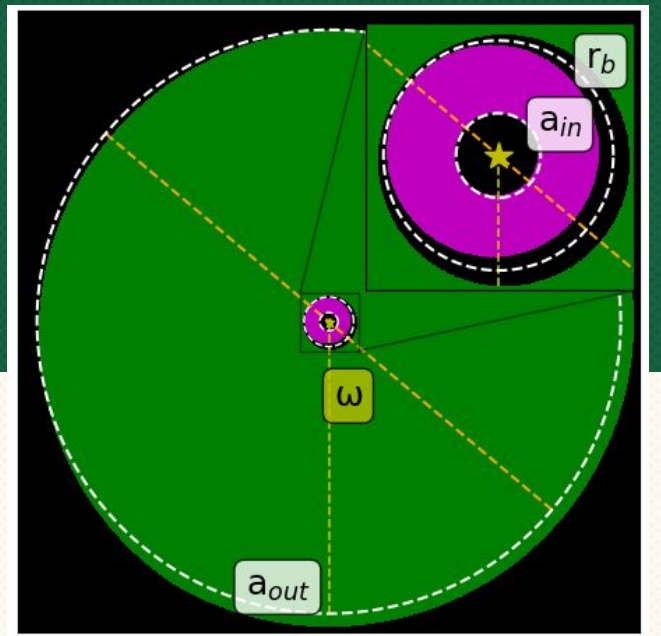
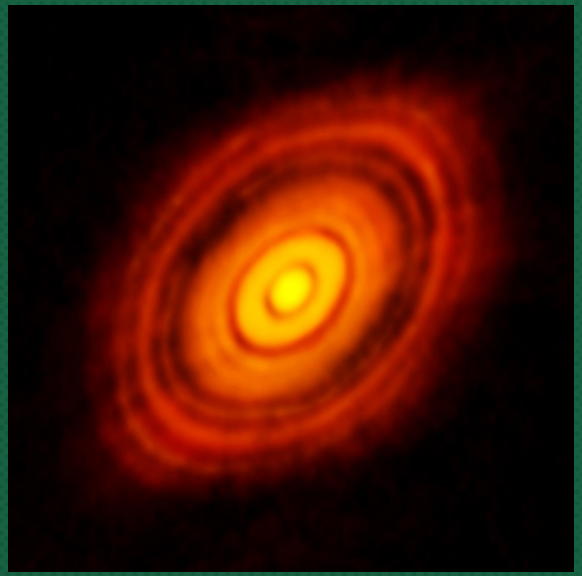




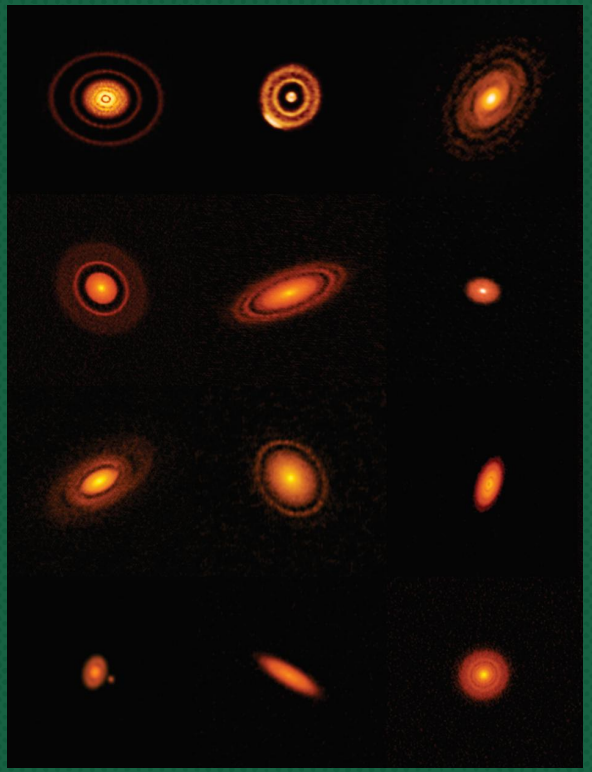
Protoplanetary Disks & Substructures

Substructures are very common
- Rings & Gaps / Cavities

Planets can induce substructures.



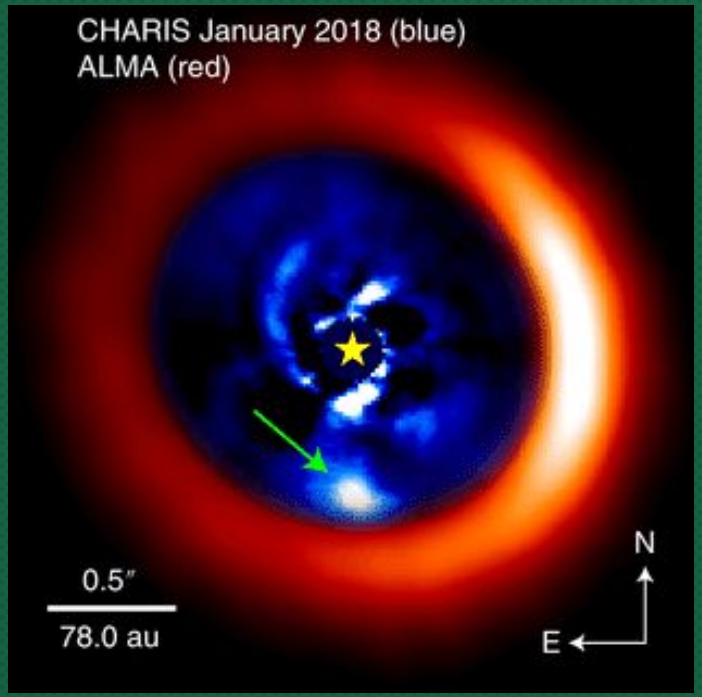
HL Tau; ALMA Partnership et al. 2015



https://public.nrao.edu/gallery/twenty-protoplanetary-disks-imaged-by-alma/

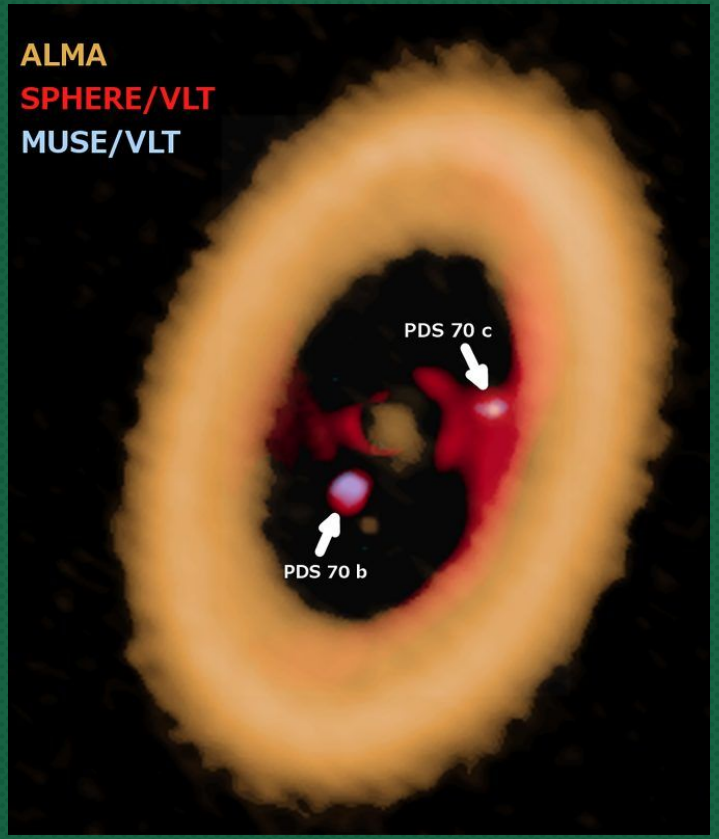
Planet-Disk Interactions

Forming planets have rarely been detected.



AB Aur

PDS70

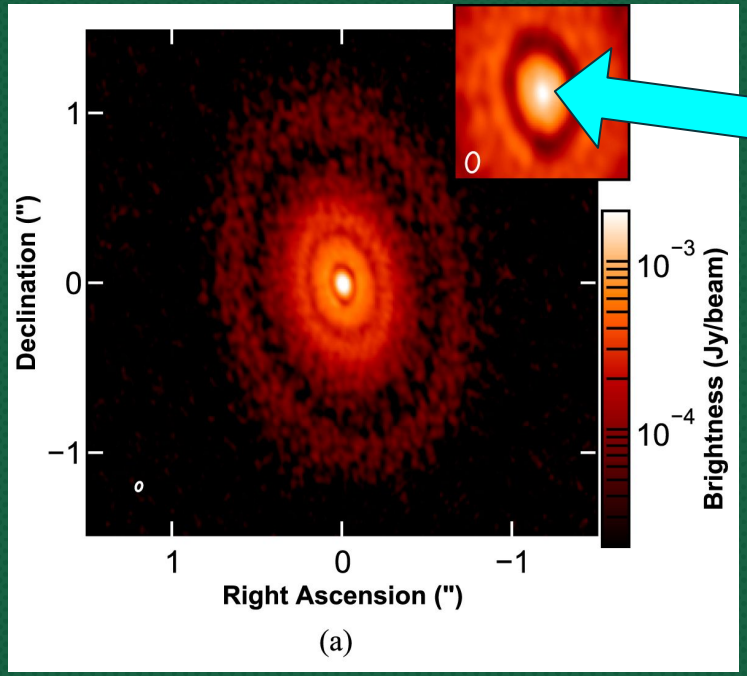


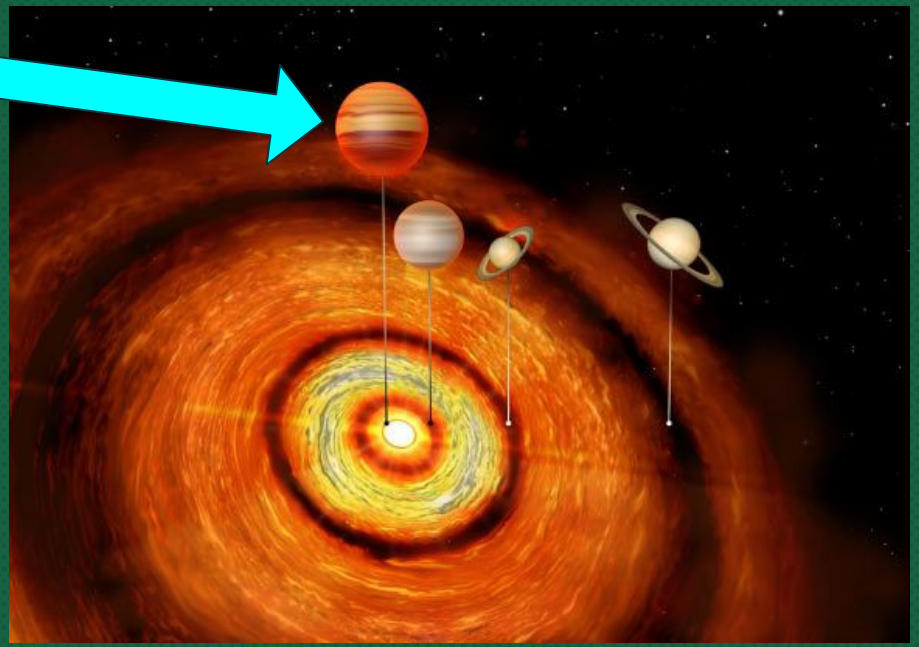
Currie+22

https://public.nrao.edu/gallery/twenty-protoplanetary-disks-imaged-by-alma/

CI Tau – Intro

- Close-in companion (Donati+24,Manick+24)
- Inner protoplanetary disk (McClure+13)
- **Can we attribute disk substructures to the independently verified planet?**

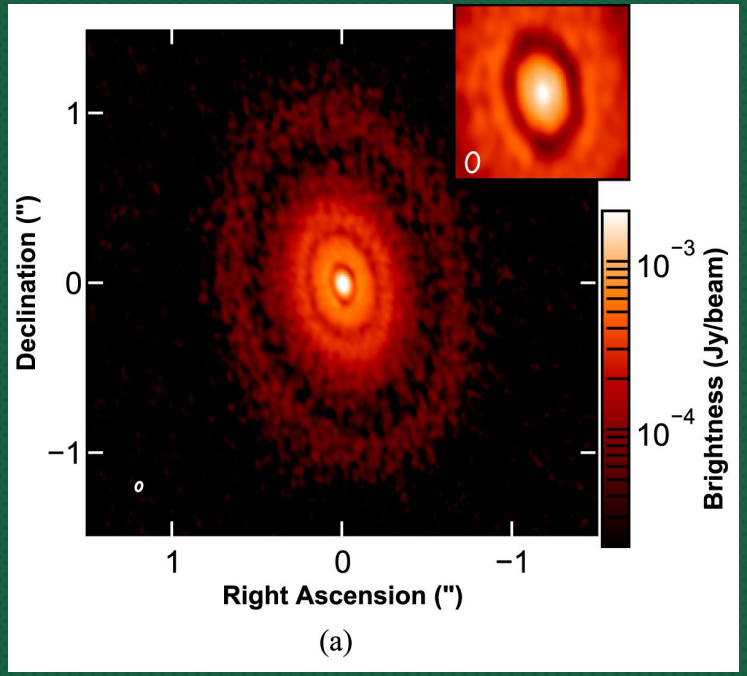


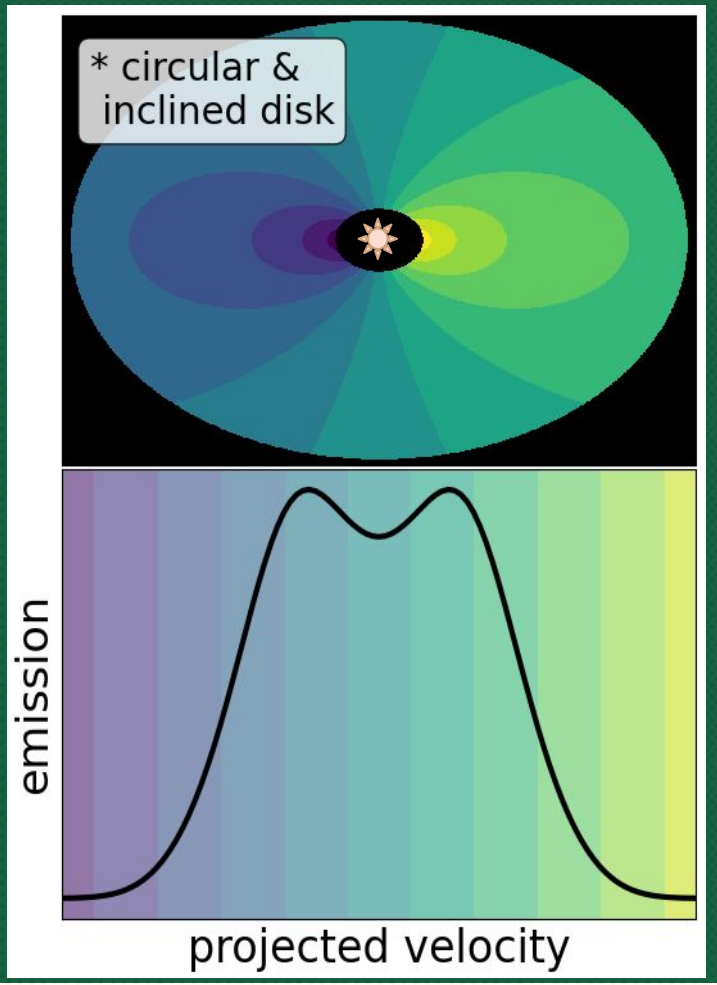


Clarke+18

https://www.sci.news/astronomy/ci-tau-four-gas-giants-06508.html

CI Tau – Kinematics





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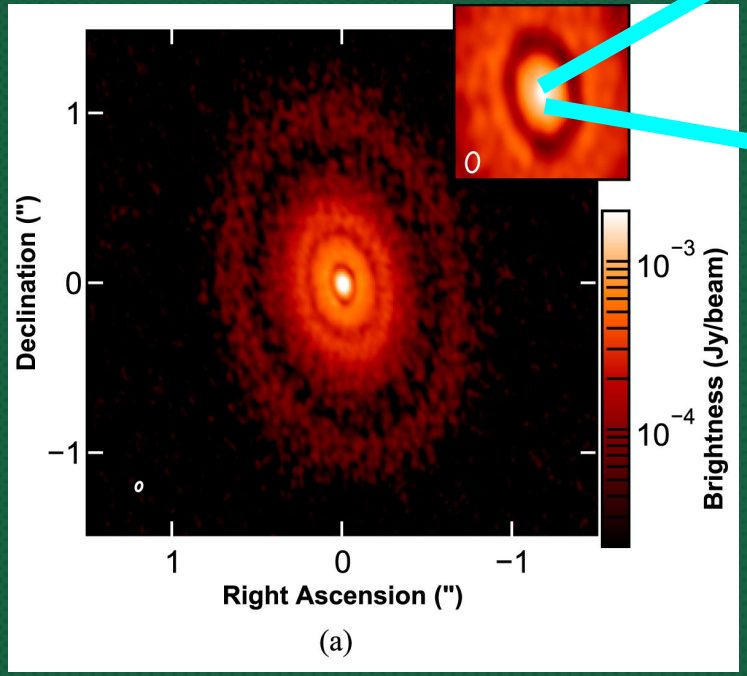
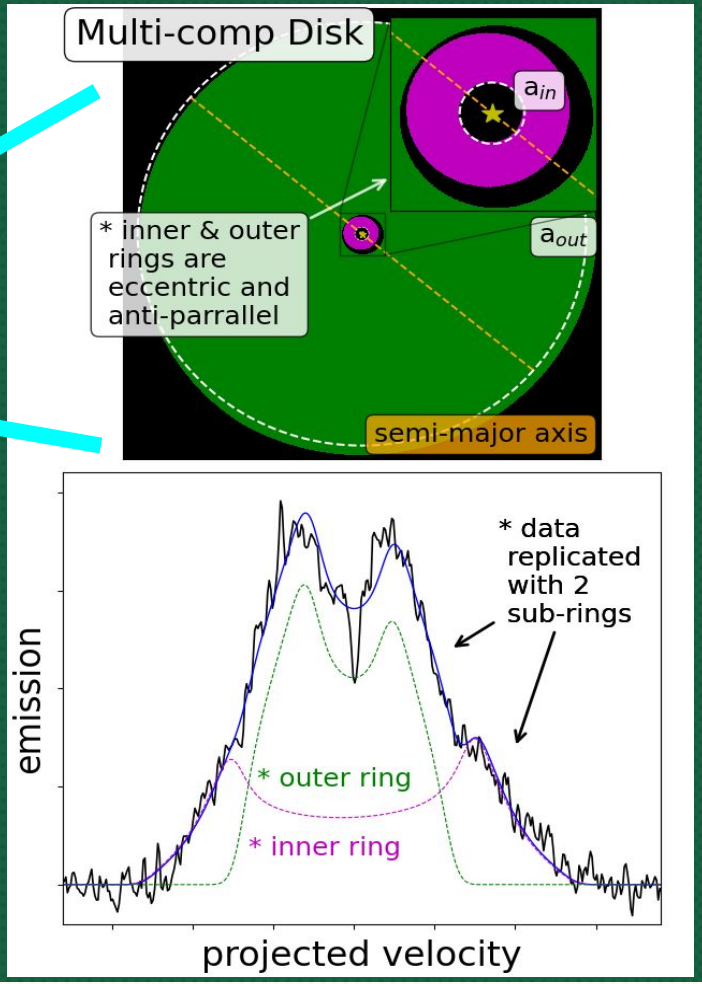
CI Tau – Results





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Kozdon+2023

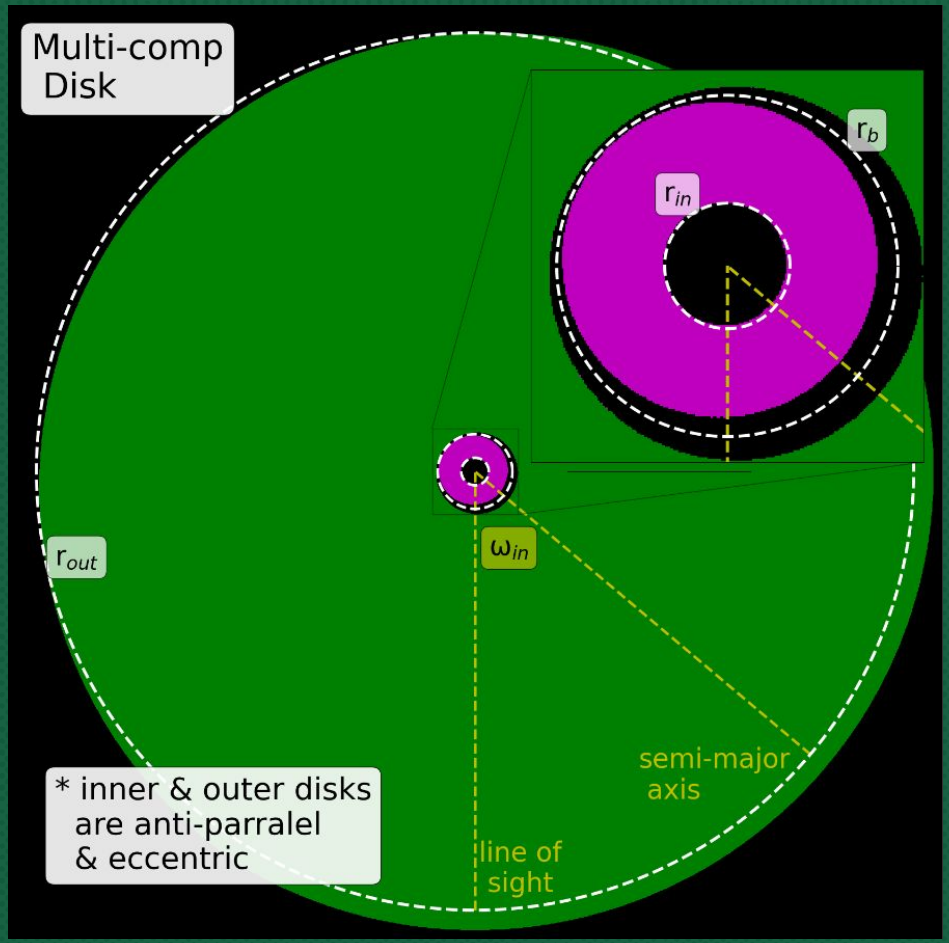
CI Tau – Results

Multi-component disk

- Eccentricities ~0.05

Potential Gap? Planet Location?!

- ~0.14au
- Consistent with Gravity Collaboration et al. 2023, Donati+24, Manick+24.



Kozdon+23

Conclusions

Published in *The Astronomical Journal*

- CI Tau's 12CO average line profile elucidates a ***multi-component disk***
- The discontinuity between components occurs at ~0.14au and potentially ***hints to the presence of a gap & Planet***

Potentially the first empirical evidence of disk eccentricities being induced by an embedded planet.

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Rovibrational Spectroscopy of CI Tau—Evidence of a Multicomponent Eccentric Disk Induced by a Planet

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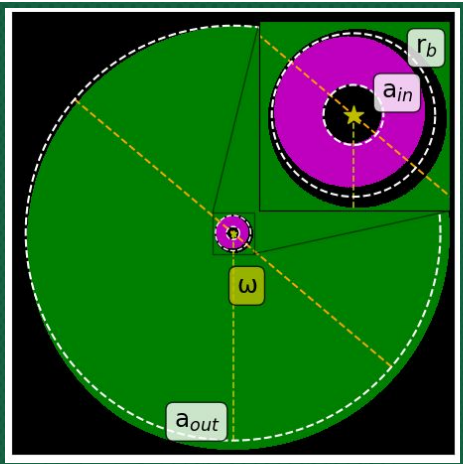
Abstract

CI Tau is currently the only T Tauri star with an inner protoplanetary disk that hosts a planet, CI Tau b, that has been detected by a radial velocity survey. This provides the unique opportunity to study disk features that were imprinted by that planet. We present multiepoch spectroscopic data, taken with NASA IRTF in 2022, of the ^{12}CO and hydrogen Pfβ line emissions spanning nine consecutive nights, which is the proposed orbital period of CI Tau b. We find that the star's accretion rate varied according to that nine-day period, indicative of companion-driven accretion. Analysis of the ^{12}CO emission lines reveals that the disk can be described with an inner and an outer component spanning orbital radii 0.05–0.13 au and 0.15–1.5 au, respectively. Both components have eccentricities of about 0.05 and arguments of periapsis that are oppositely aligned. We present a proof-of-concept hydrodynamic simulation that shows that a massive companion on a similarly eccentric orbit can recreate a similar disk structure. Our results allude to such a companion being located at an orbital distance of around 0.14 au. However, this planet's orbital parameters may be inconsistent with those of CI Tau b, whose high eccentricity is likely not compatible with the low disk eccentricities inferred by our model.

Unified Astronomy Thesaurus concepts: Protoplanetary disks (1300); Circumstellar disks (235); Stellar accretion (1578); Accretion (14); Planetary-disk interactions (2204); Hot Jupiters (753); High resolution spectroscopy (2096); Infrared spectroscopy (2285)



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