On the nature of the planetary mass companion candidate in the FW Tau system

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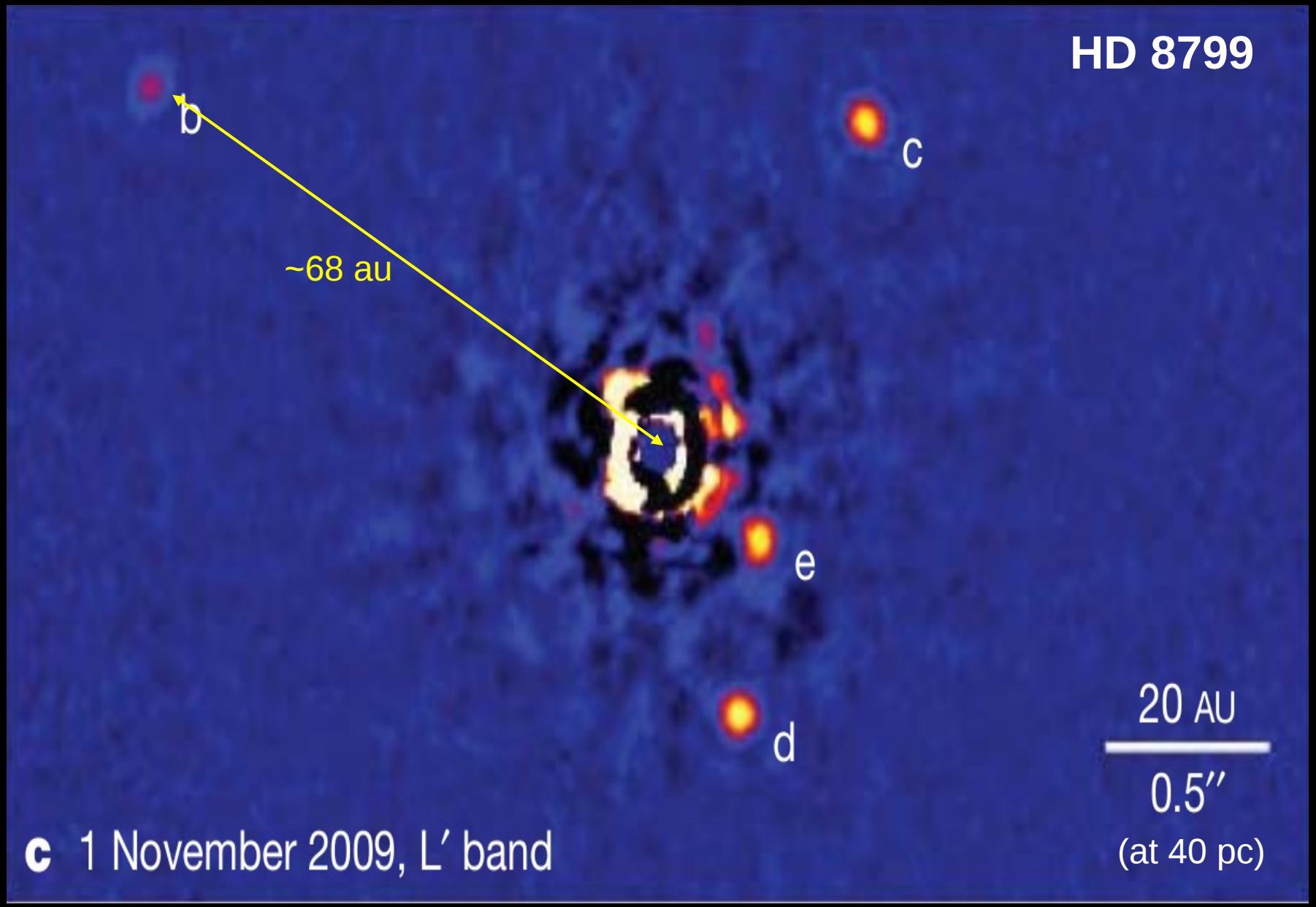
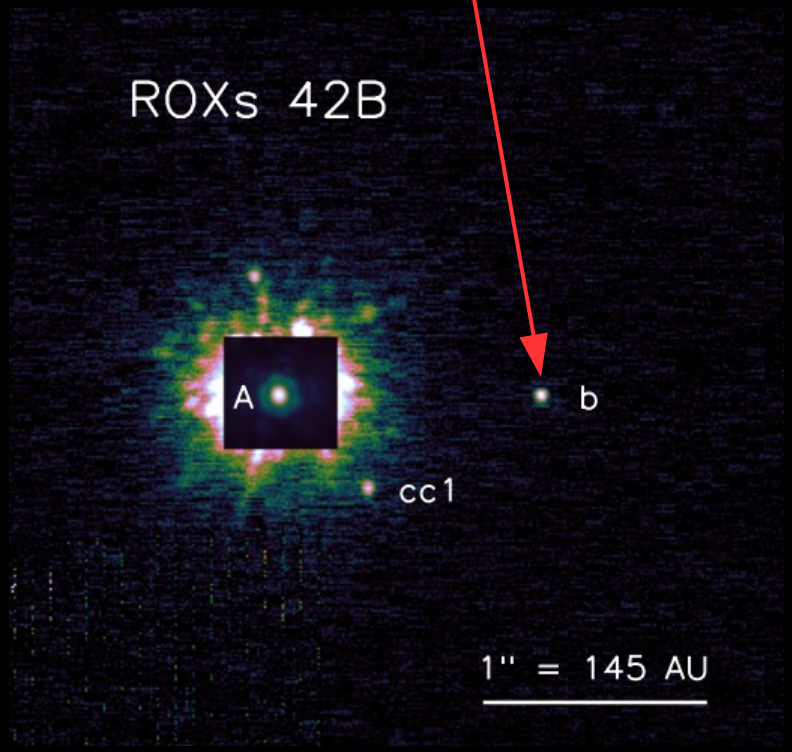
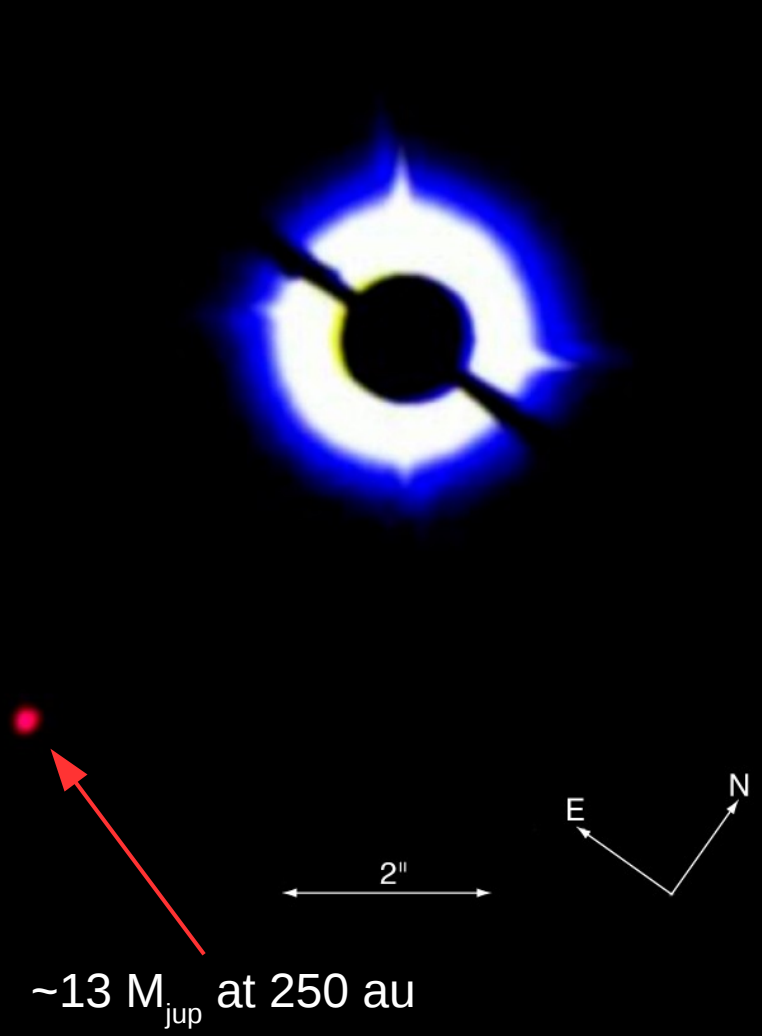
What do I mean with planetary mass companion?



Marois et al. (2010)

What do I mean with planetary mass companion at large separations (PMC)?



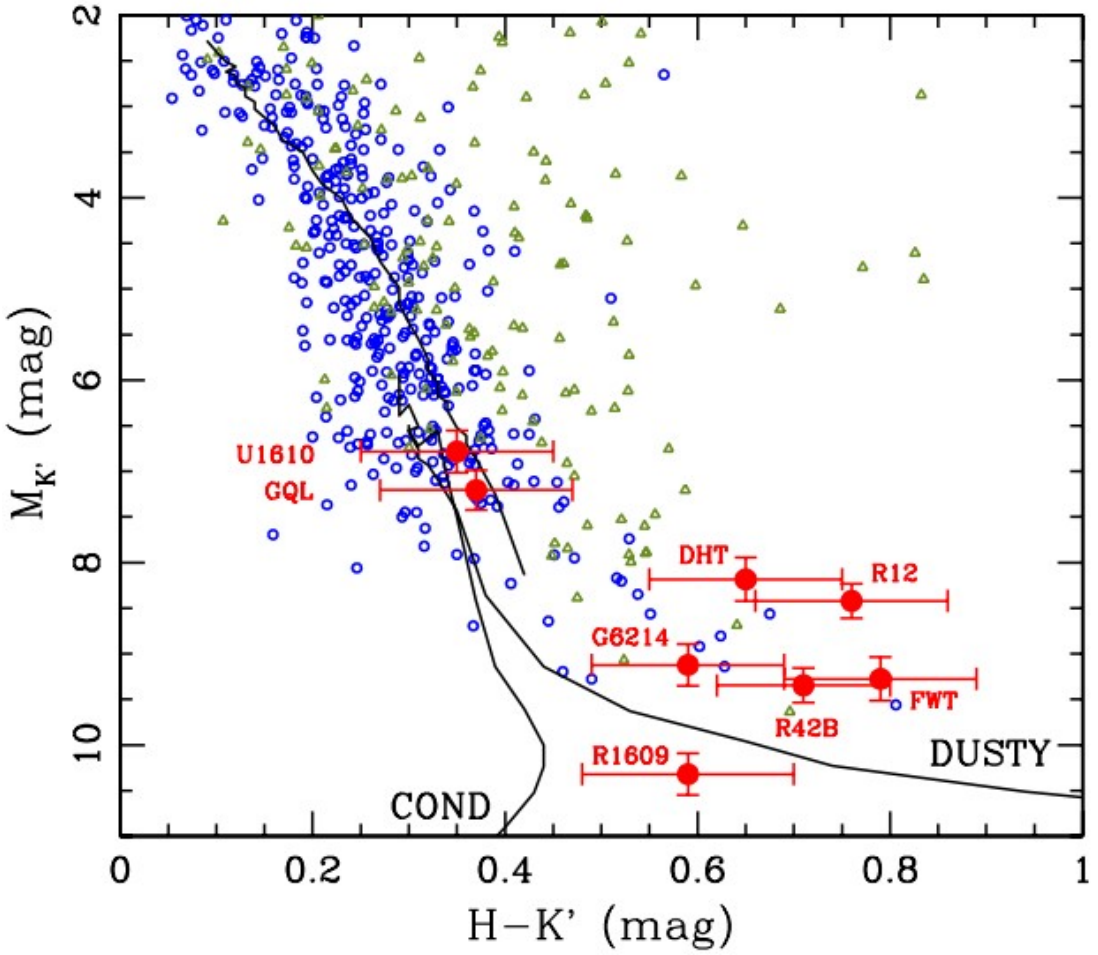


A small population of PMCs at large separations

Roughly 20 to date, with a > 100 au

All are giant planets

Large fraction are very young (<10Myr)



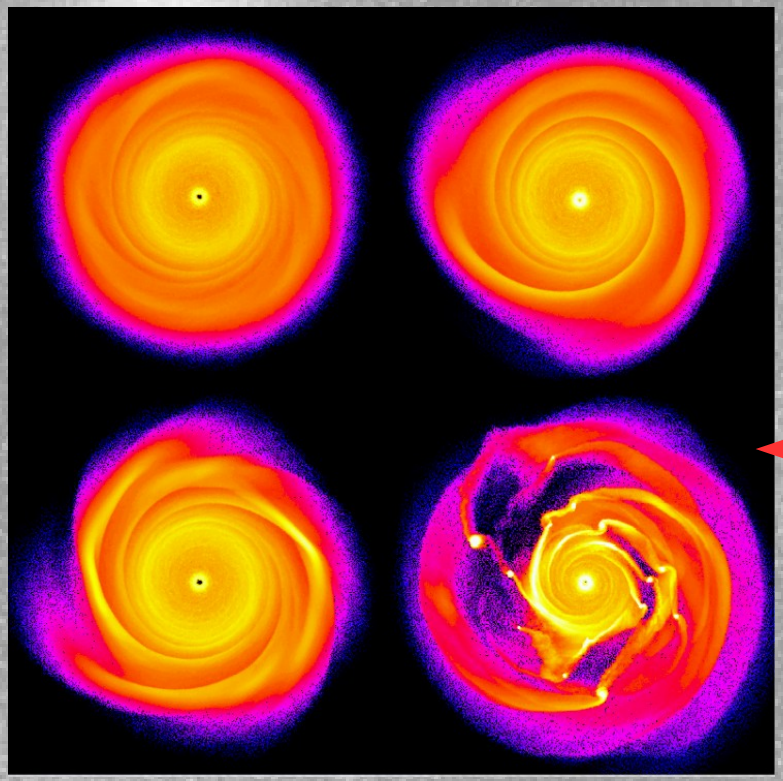
Kraus et al. (2014)

PMC formation scenarios

Core accretion

$$dR/dt \approx 50\ \mathrm{m\,yr^{-1}} (r/\mathrm{AU})^{-2}$$

Predicts giant-planets at small separations <50 au (but very slow)



Mayer et al. (2002)

Gravitational disk instability

$$Q \equiv \frac{\Omega c_s}{\pi G \Sigma} < 1$$

Predicts giant-planets at intermediate separations <100 au

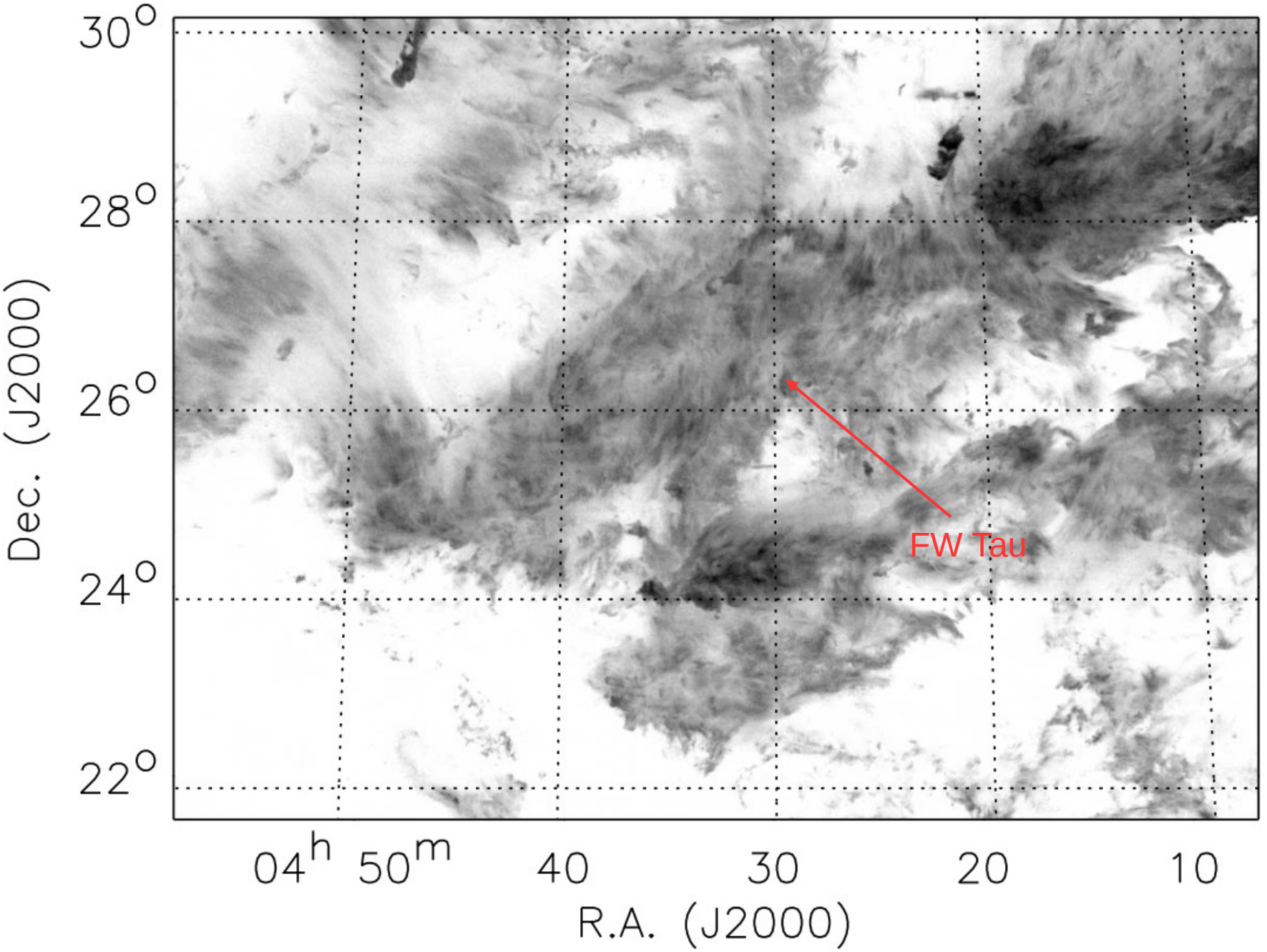
Disk fragmentation

$$t_c \sim \frac{\Sigma c_s^2}{\sigma T_{eff}^4}$$

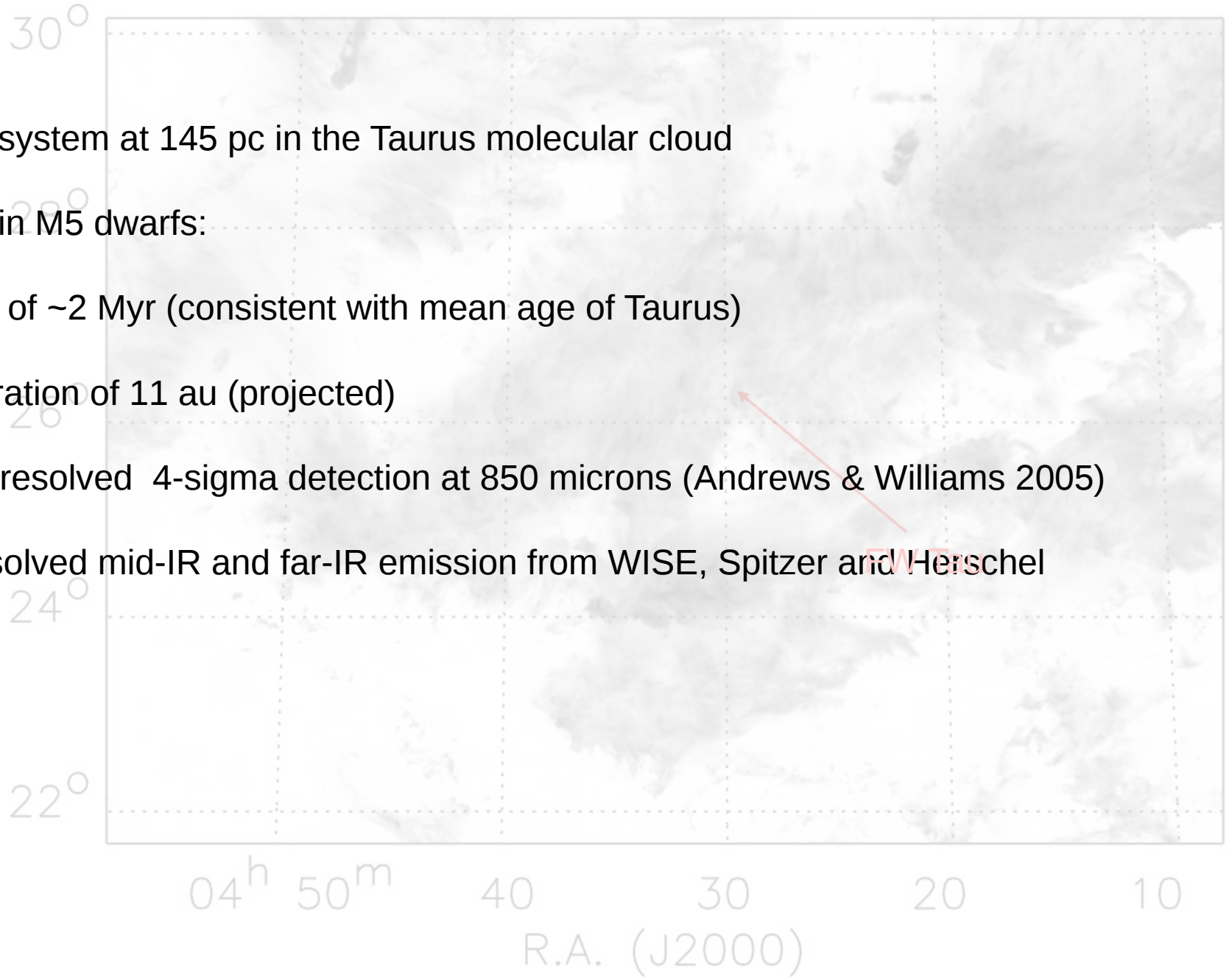
Cooling time needs to be shorter than thermodynamical scale

If acting at class 0/I, predicts planetary mass objects at large separations > 100 au (Kratter et al. 2011)

The FW Tau system



The FW Tau system



Binary system at 145 pc in the Taurus molecular cloud

Two twin M5 dwarfs:

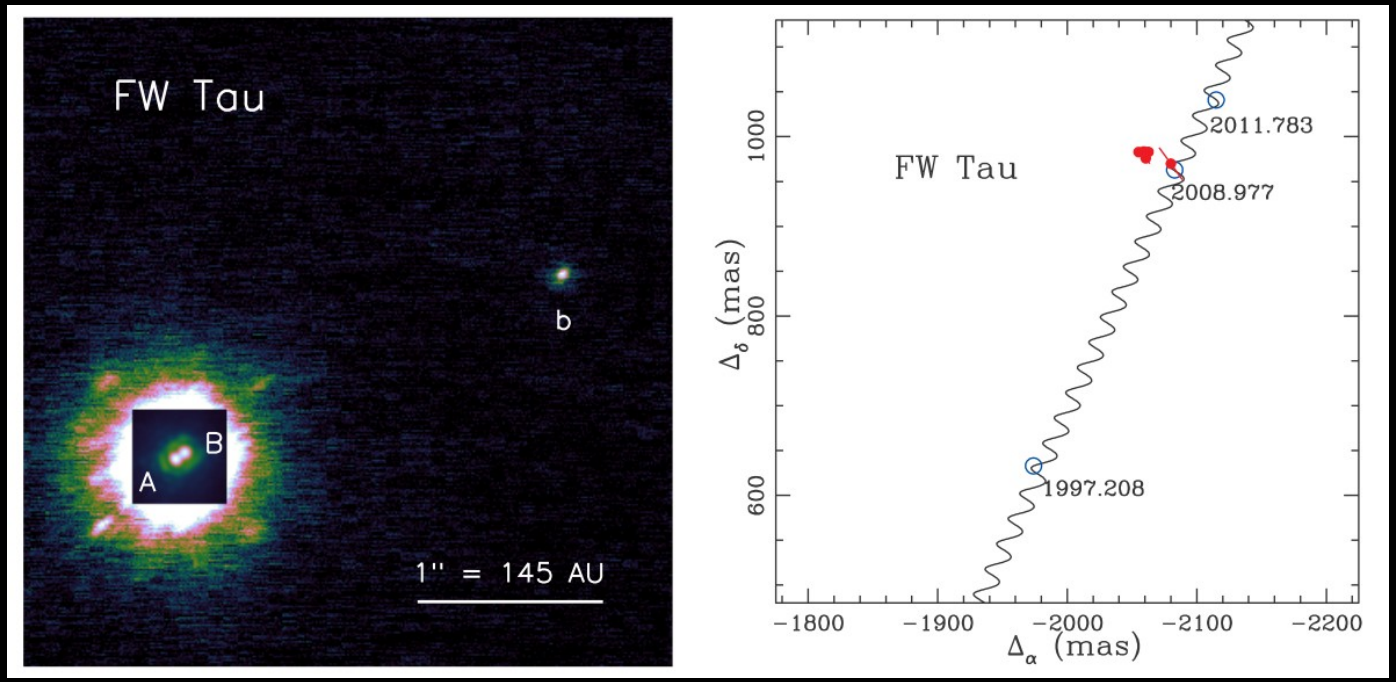
- Ages of ~2 Myr (consistent with mean age of Taurus)

- Separation of 11 au (projected)

- An unresolved 4-sigma detection at 850 microns (Andrews & Williams 2005)

- Unresolved mid-IR and far-IR emission from WISE, Spitzer and Herschel

The third component in the FW Tau system

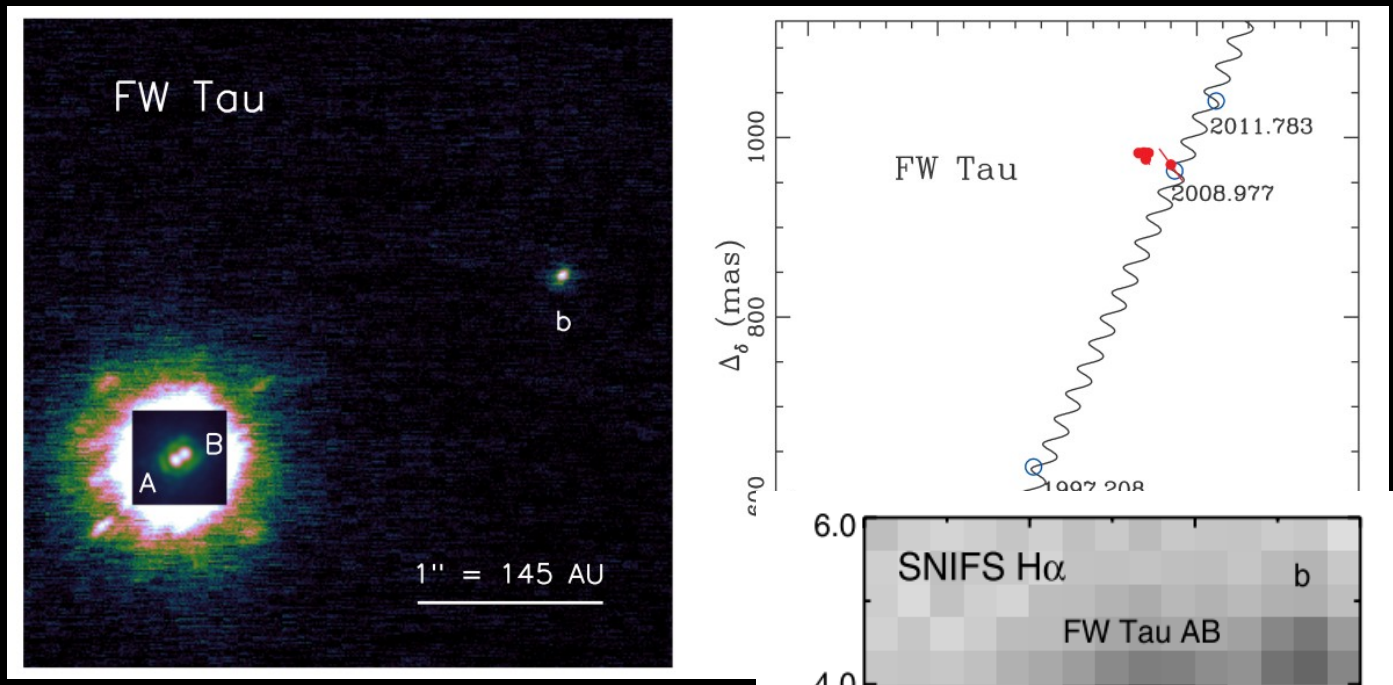


Kraus et al. (2014)

Projected separation of ~300 au

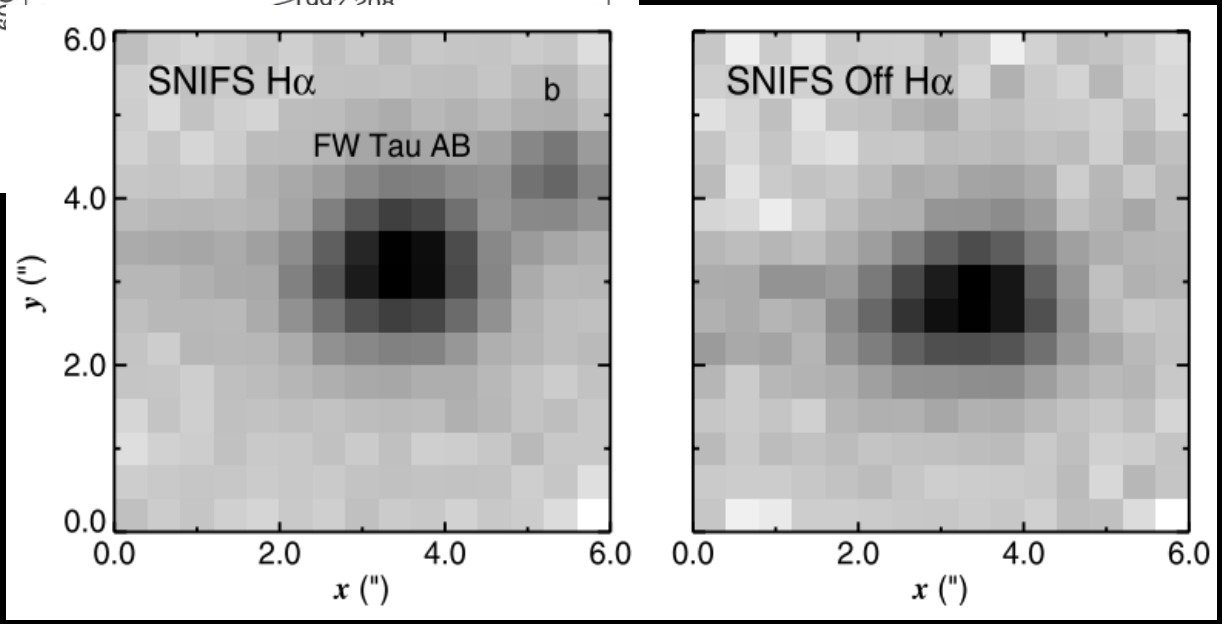
It looks like its position lies in the orbital plane of the binary.

The third component in the FW Tau system



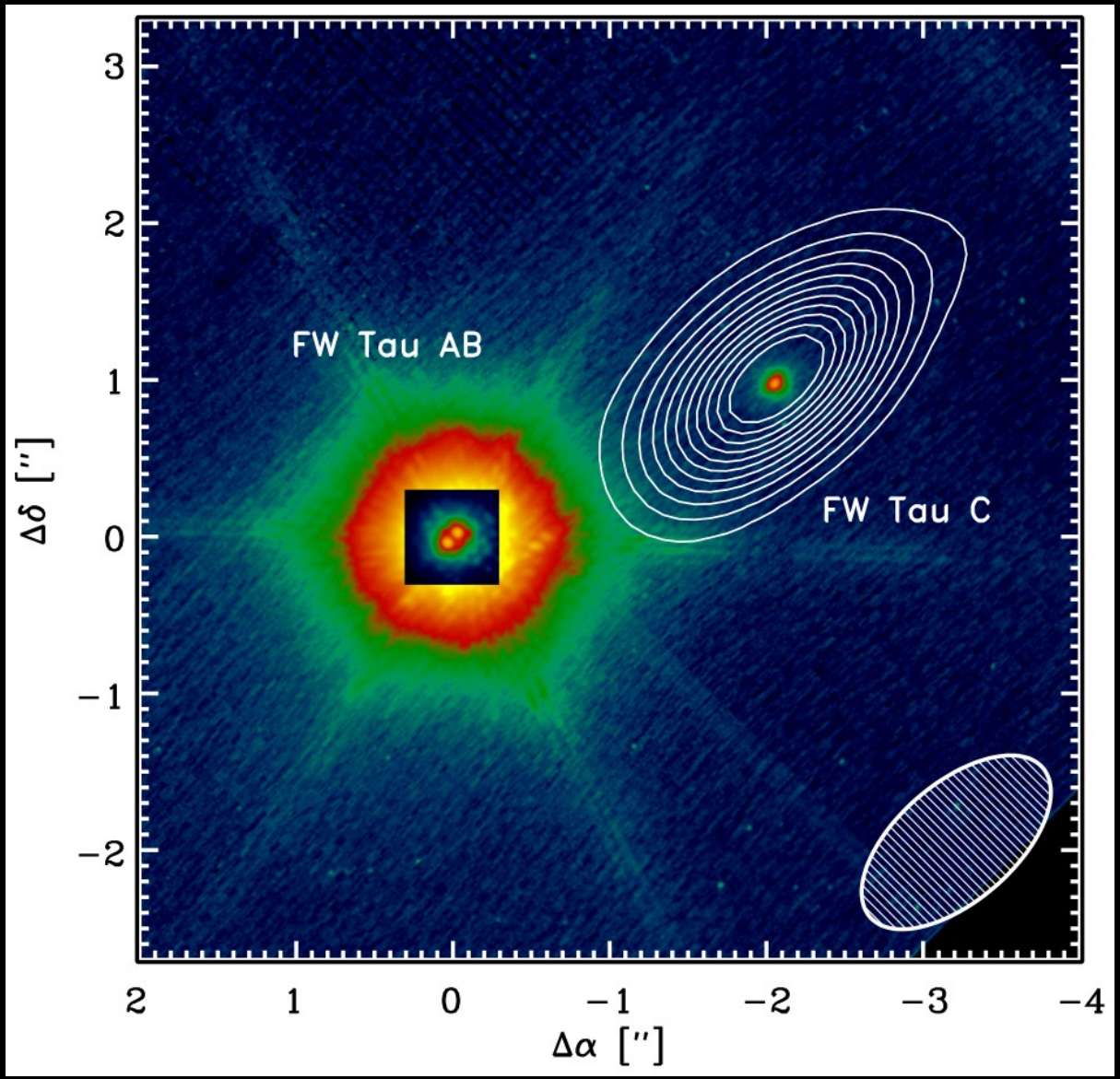
Kraus et al. (2014)

Accreting nature



Bowler et al. (2014)

An ALMA dust detection



Kraus et al. (2015)

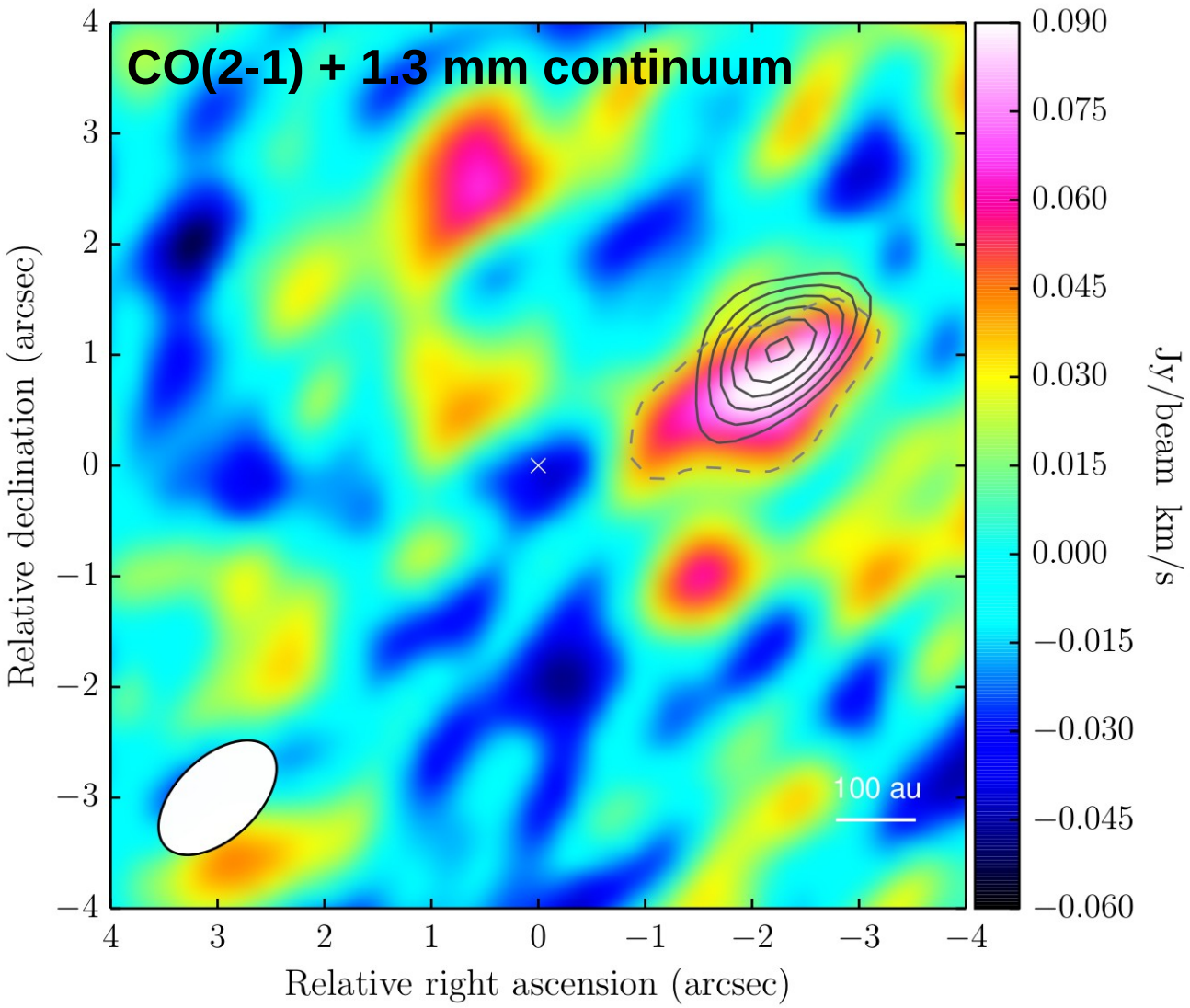
An ALMA gas detection

Cycle 1 observations in Band 6

Sensitivity:
- 0.1 mJy in 7.5 GHz bandwidth (continuum)
-20 mJy in 0.6 km/s bandwidth (gas)

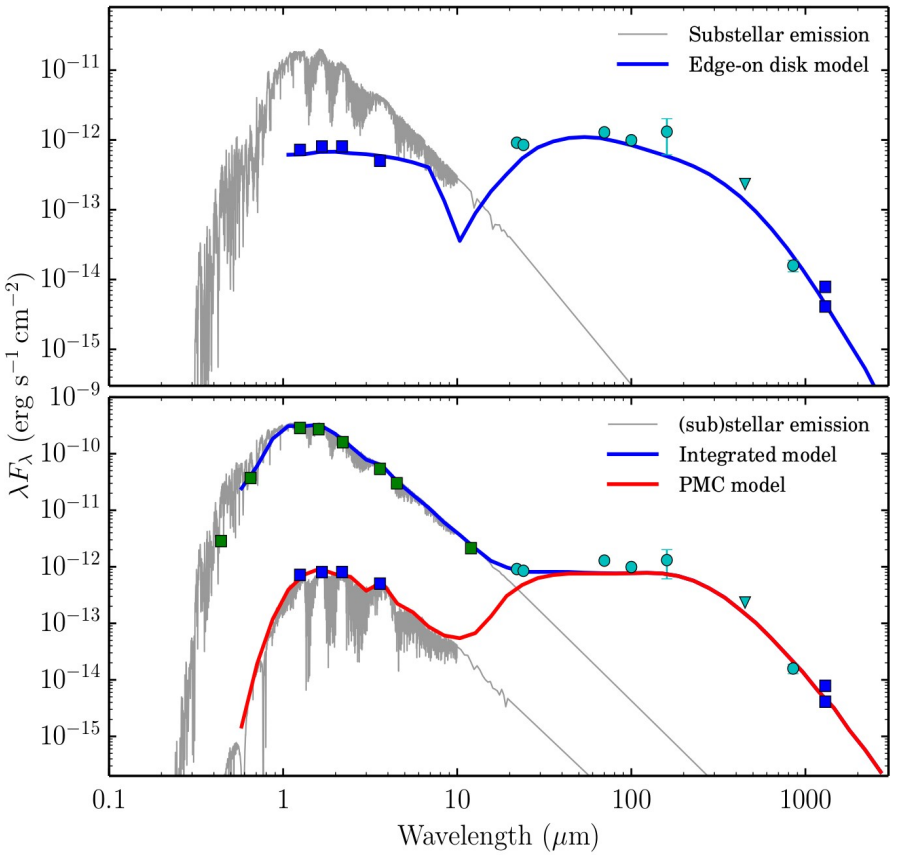
Results:
- Detected dust at 1.3mm

- Detected CO(2-1) line



Caceres et al. (2015)

SED modeling: a circumplanetary disk around FW Tau b?



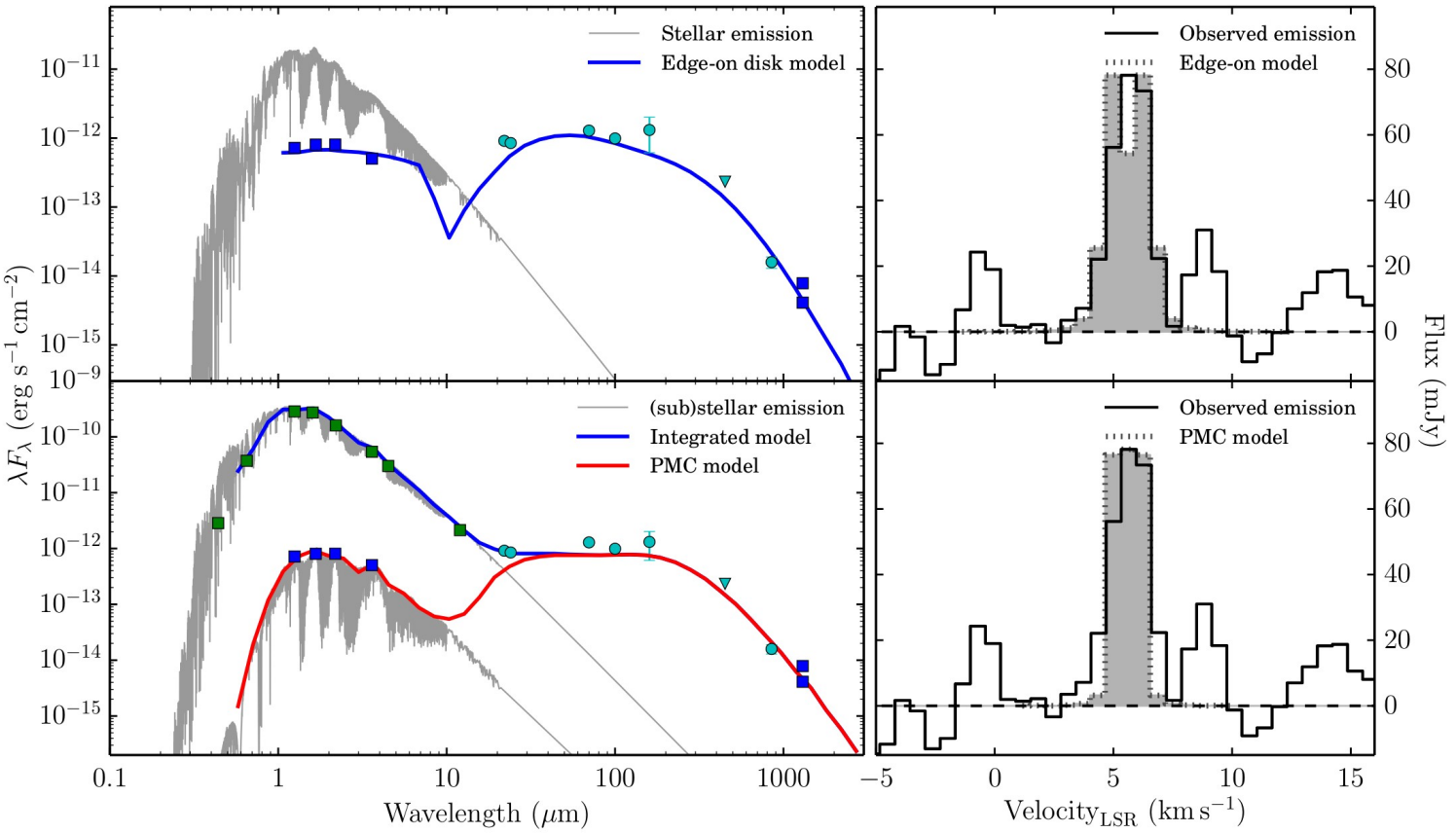
Brown-dwarf in edge-on disk and giant planet in face-on disk can explain the SED

Only 2-3 M_{earth} are require to explain the dust detection.

Disk size and composition are unconstrained

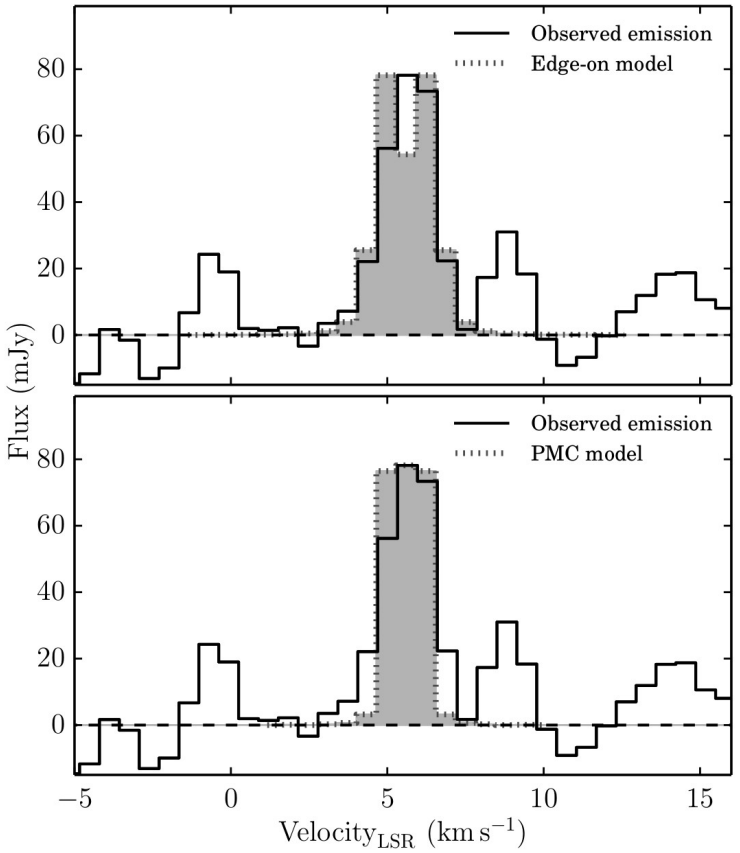
Planet or brown-dwarf?

… and line detection as well...



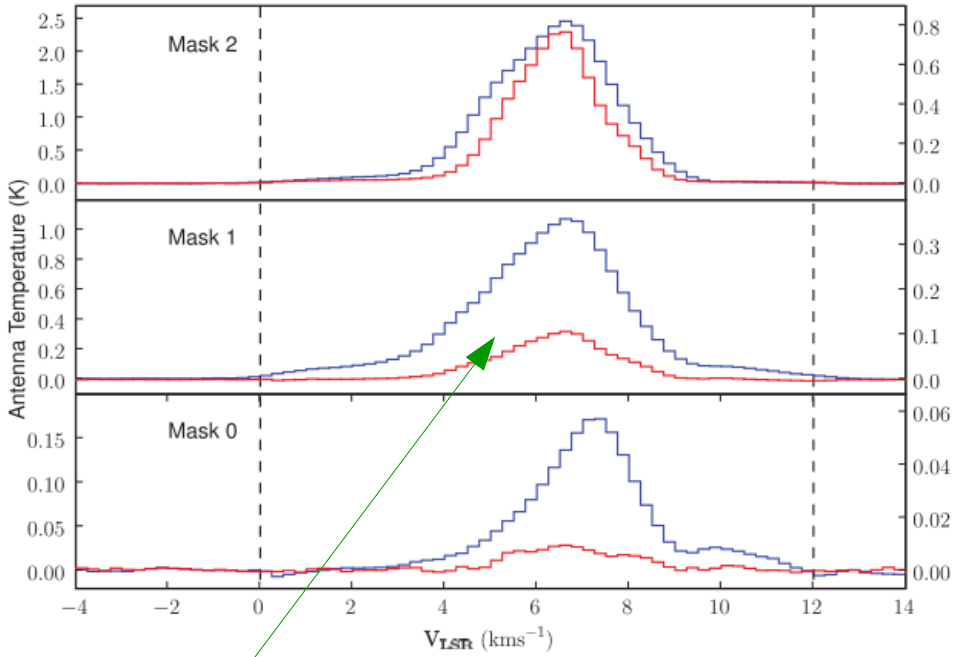
Caceres et al. (2015)

Planet or brown-dwarf?



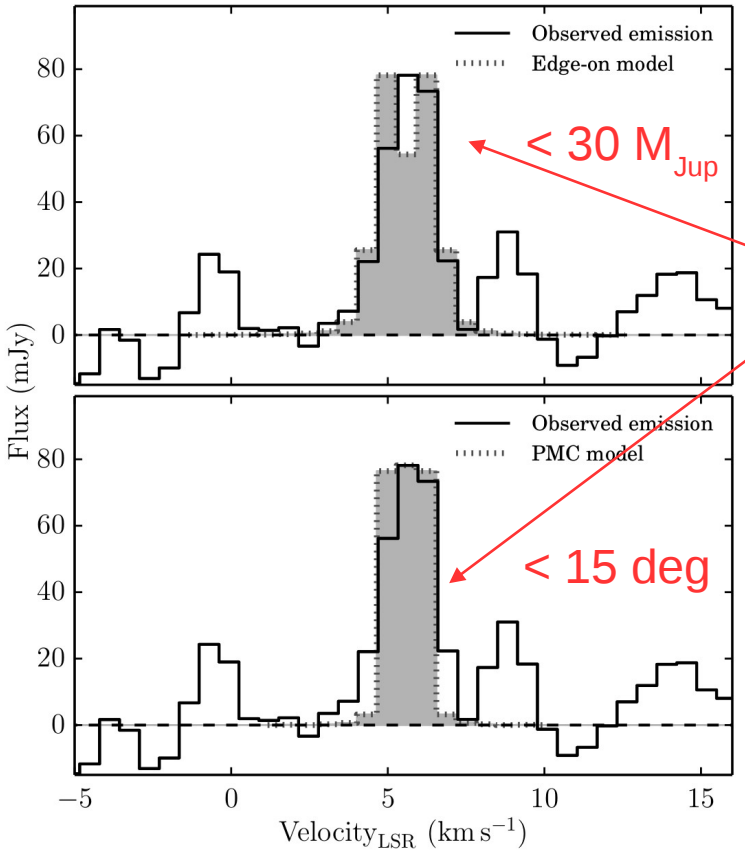
Single-peaked CO line origin:

- Cloud contamination (filtering)



Velocity distribution in Taurus

Planet or brown-dwarf?



Single-peaked CO line origin:

- Cloud contamination (filtering)

- Inclination/Mass effect

- Low SNR?

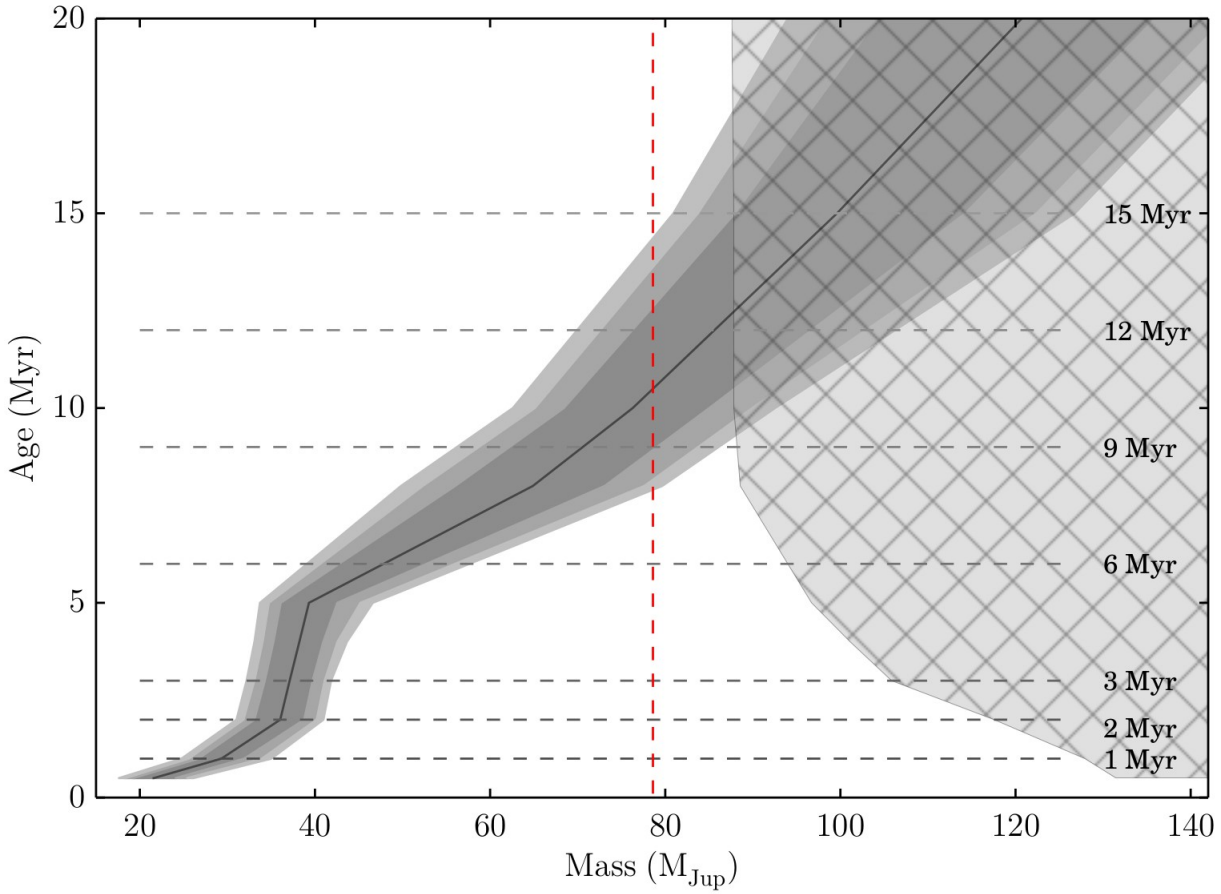
Also to consider: faint emission.

- Small gas-to-dust mass ratio (photodissociation?)

- Cloud effects

- Very small disk

Limits to the possible brown-dwarf



Caceres et al. (2015)

Take home message

FW Tau b or C... still unknown.

- Evidence for both a face-on disk (planetary nature) and edge-on disk (brown-dwarf nature).

- A confirmation of the circumplanetary nature of the disk is required!

Thank you!