ET Cha - a single T Tauri star with a disk of radius ≈ 5 AU ?

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1. ET Cha

ET Cha is one of three well-known nearby, gas-rich, T Tauri-type protoplanetary disks older than 7 Myr (the other two being TW Hya and PDS 66), hence crucial for our understanding of late stages of disk evolution. ET Cha, situated in the η Chamaeleontis cluster, has no known companions down to the brown dwarf level, has a clear near-mid IR excess, with optical and near-IR gas emission lines detected, but previous attempts to detect its disk in the sub-mm (both continuum and CO) have failed. Based on previous multi-λ modelling (Woitke et al. 2011, before the new ALMA data) we concluded that ET Cha must be very small (R < 25 AU), with (R ~ 6-9 AU) being most likely.

2. ALMA - observations

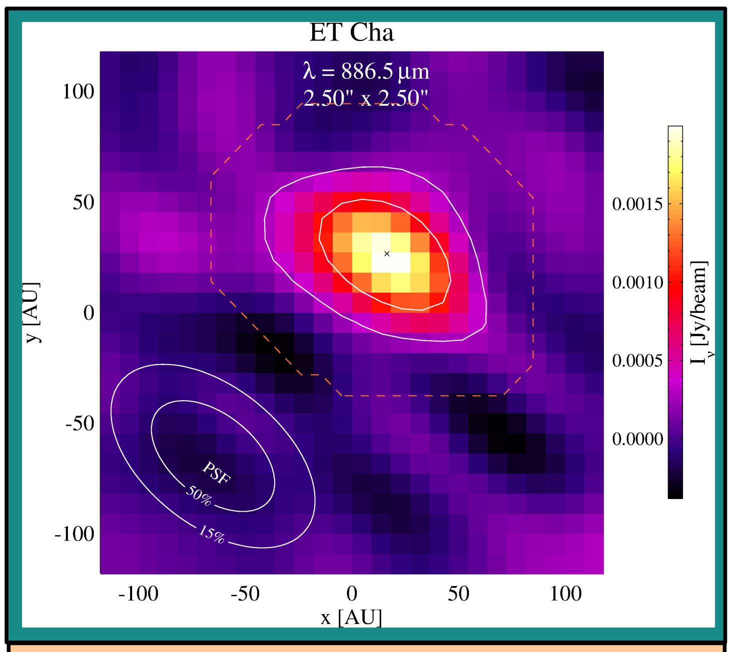


Fig. 1: ALMA cycle-0 continuum observations of ET Cha at 885 µm. The source is safely detected (S/N ~ 16) but spatially unresolved (R < 40 AU).

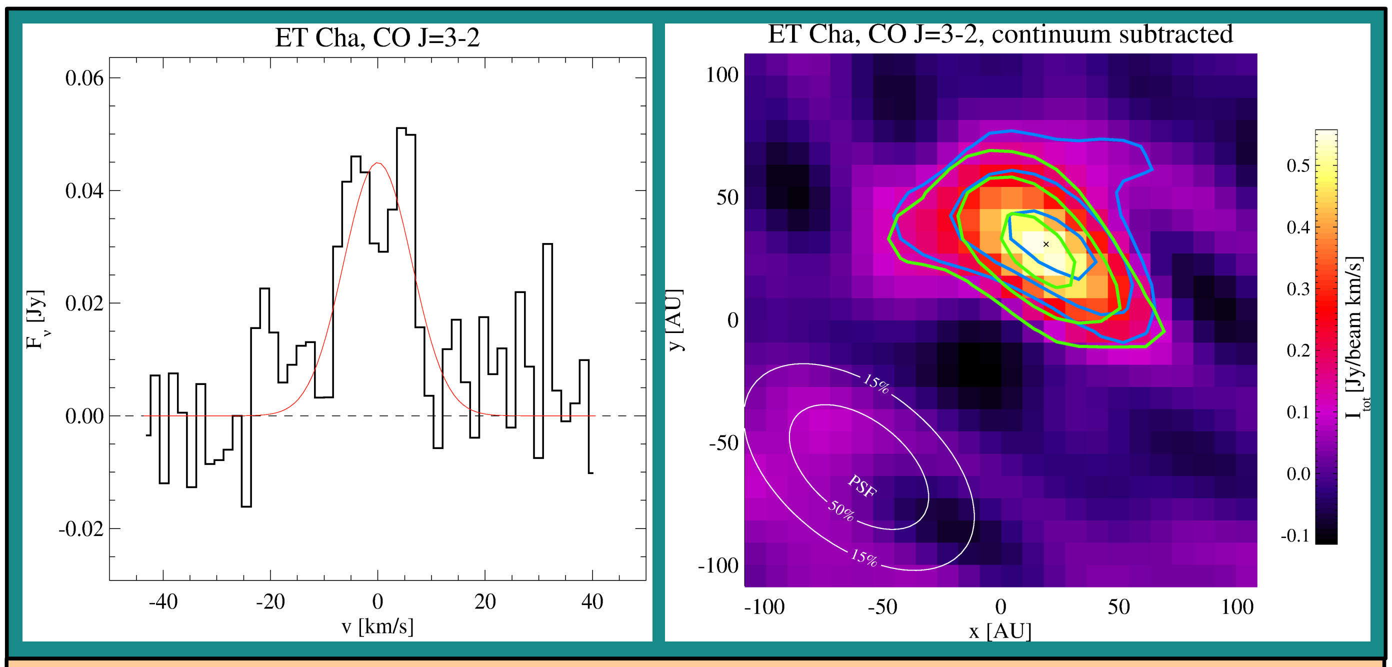


Fig. 2: The CO J=3-2 line is detected at S/N ~ 8, but spatially unresolved. The spectral profile (re-binned by factor 2) shows a double-peaked profile with FWHM ~ 15 km/s (red line is a Gaussian fit). Blue and red contours on the line intensity map on the r.h.s. indicate the center of line emission in negative and positive velocity channels only, note the small (5-10) AU displacement !

3. Modelling

We use ProDiMo (Woitke et al. 2009, A&A 501, 383) to model the gas and dust in the disc, including 2D continuum (and UV) radiative transfer, gas phase, UV-, and ice chemistry, gas heating and cooling, non-LTE treatment (escape probability) for all atoms and molecules, and formal solutions of the continuum and line radiative transfer problem.

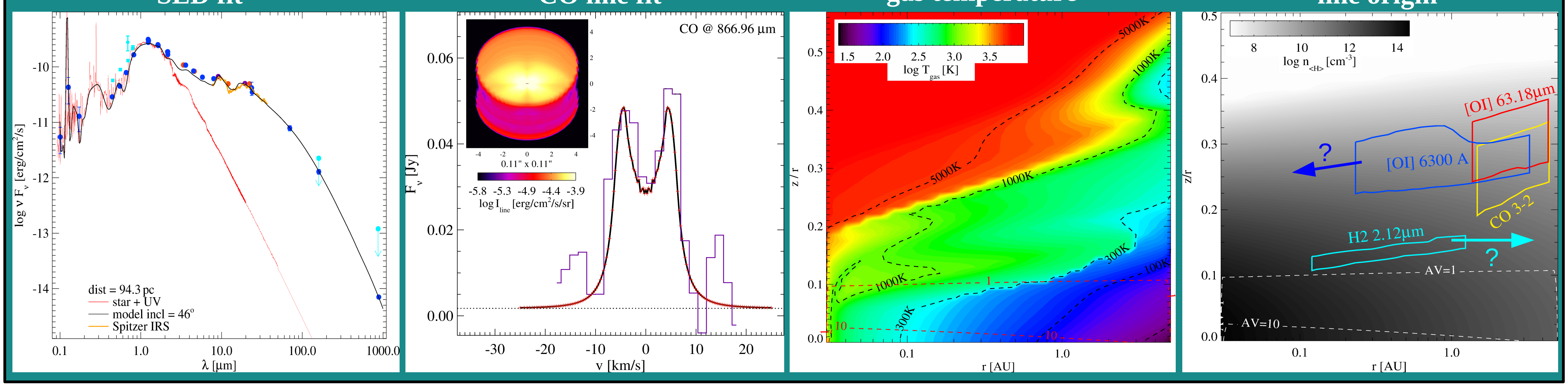
(obs ± err) ***model***	line flux [10^{-18} W/m^2]		FWHM [km/s]	
CO J=3-2 867 µm	(0.0083 ± 0.0014)	***0.0088***	(14.9 ± 2.3)	***11.9***
[OI] 63 µm	(30.5 ± 3.2)	***26***	-	***12.1***
[OI] 6300 A	(65 ± 25)	***65***	(38 ± 15)	***15***
o-H_2 2.122 µm	(2.5 ± 0.1)	***2.5***	(18 ± 1.2)	***29***

4. Conclusions

The observations of ET Cha are consistent with a warm, thick, extremely gas-rich, and tiny protoplanetary disk

- the o-H_2 2.122 µm line requires large column densities of warm H_2-gas. Disk gas mass is of order 3 x 10^{-4} M_{sun}
- the SED analysis suggests small dust particles, but not much of them! Disk dust mass is of order 6 x 10^{-8} M_{sun}, similar to debris disks
- the CO J=3-2 line is double-peaked and exceptionally broad, suggesting an outer disk radius of only ~ 5 AU, consistent with the velocity gradient seen in Fig. 2, a tantalizing suggestion for Keplerian rotation
- the extremely large gas/dust ratio could suggest that most grains have already been converted into large pebbles, which we wouldn't see

SED fit | **CO line fit** | **gas temperature** | **line origin**



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