Circumbinary Ring, Circumstellar Disks and Accretion in the Binary System UY Aurigae

Ya-Wen Tang 湯雅雯
Academia Sinica, Institute of Astronomy and Astrophysics

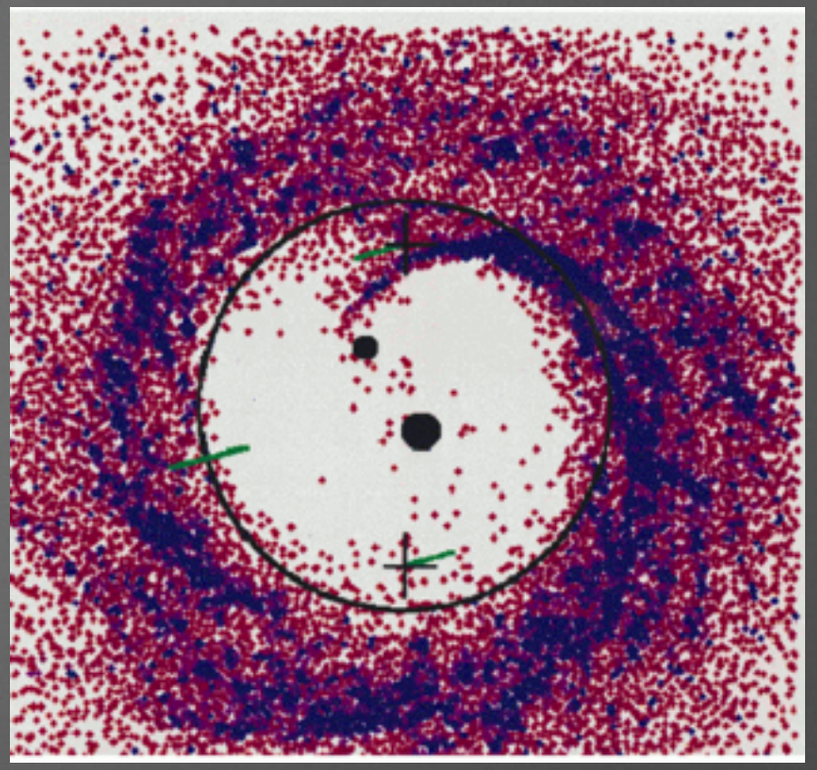
Tang, Dutrey, Guilloteau et al. 2014, ApJ

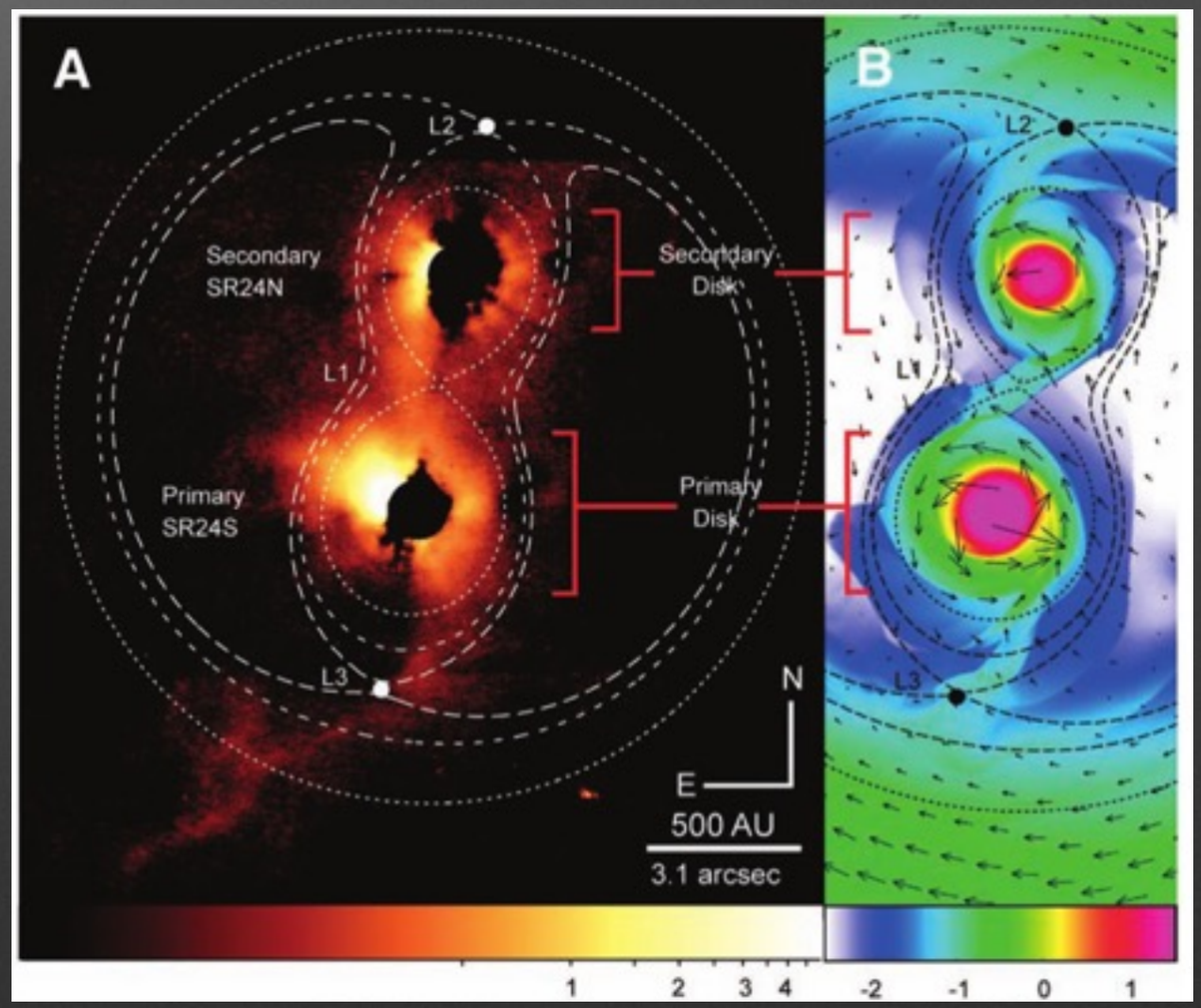
Image credit: NAOJ based on Pyo+2014

theoretical predictions in the binary system

- In binary system, both circumstellar (CS) disks and circumbinary (CB) disk are expected. CB disk feeds the binary through streams (Artymowicz+1996)

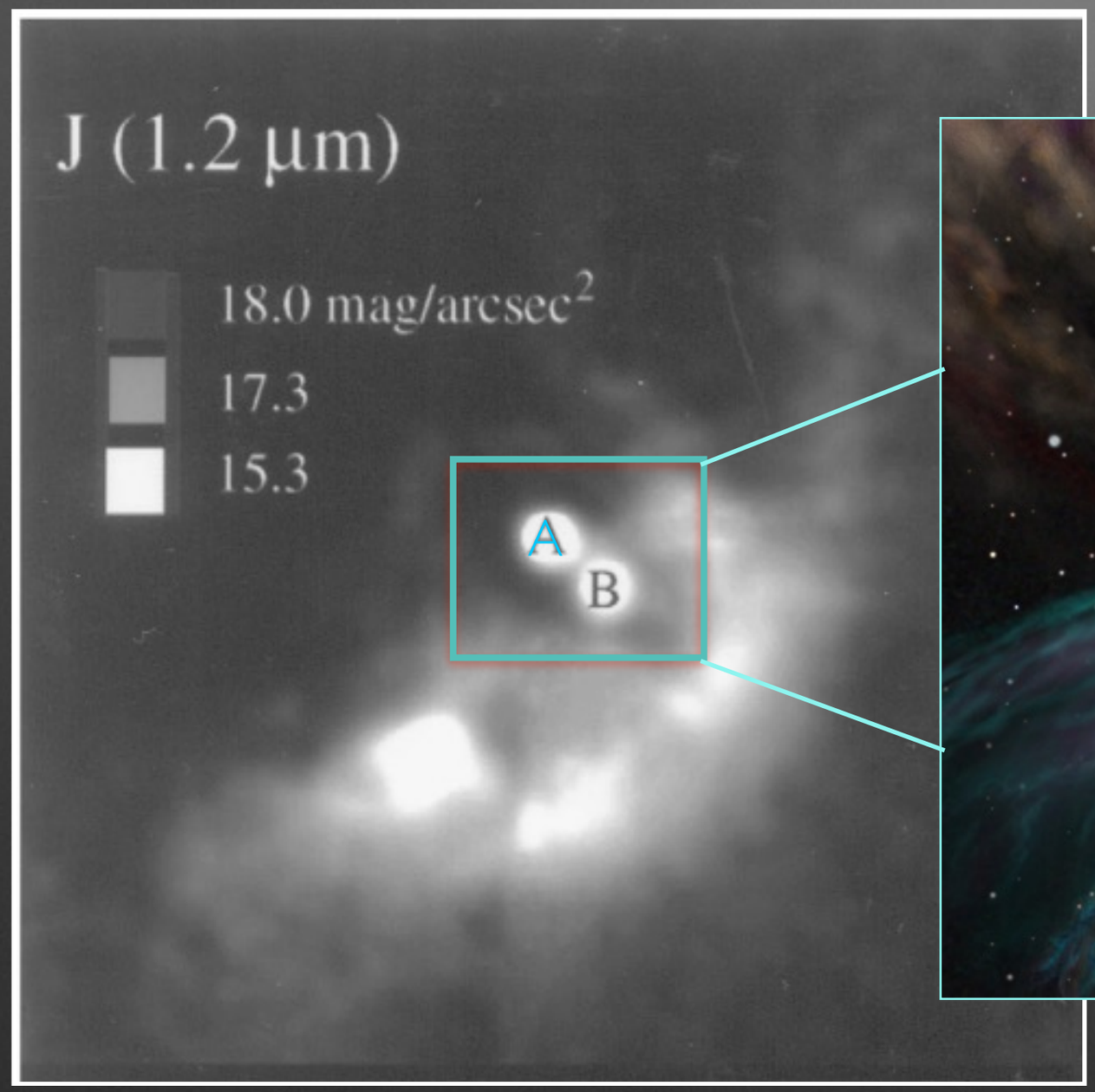
- Accretion rate is larger toward the primary (Ochi 2005) or secondary (Bate 1997) or even long time and short time variability (Hanawa 2010)

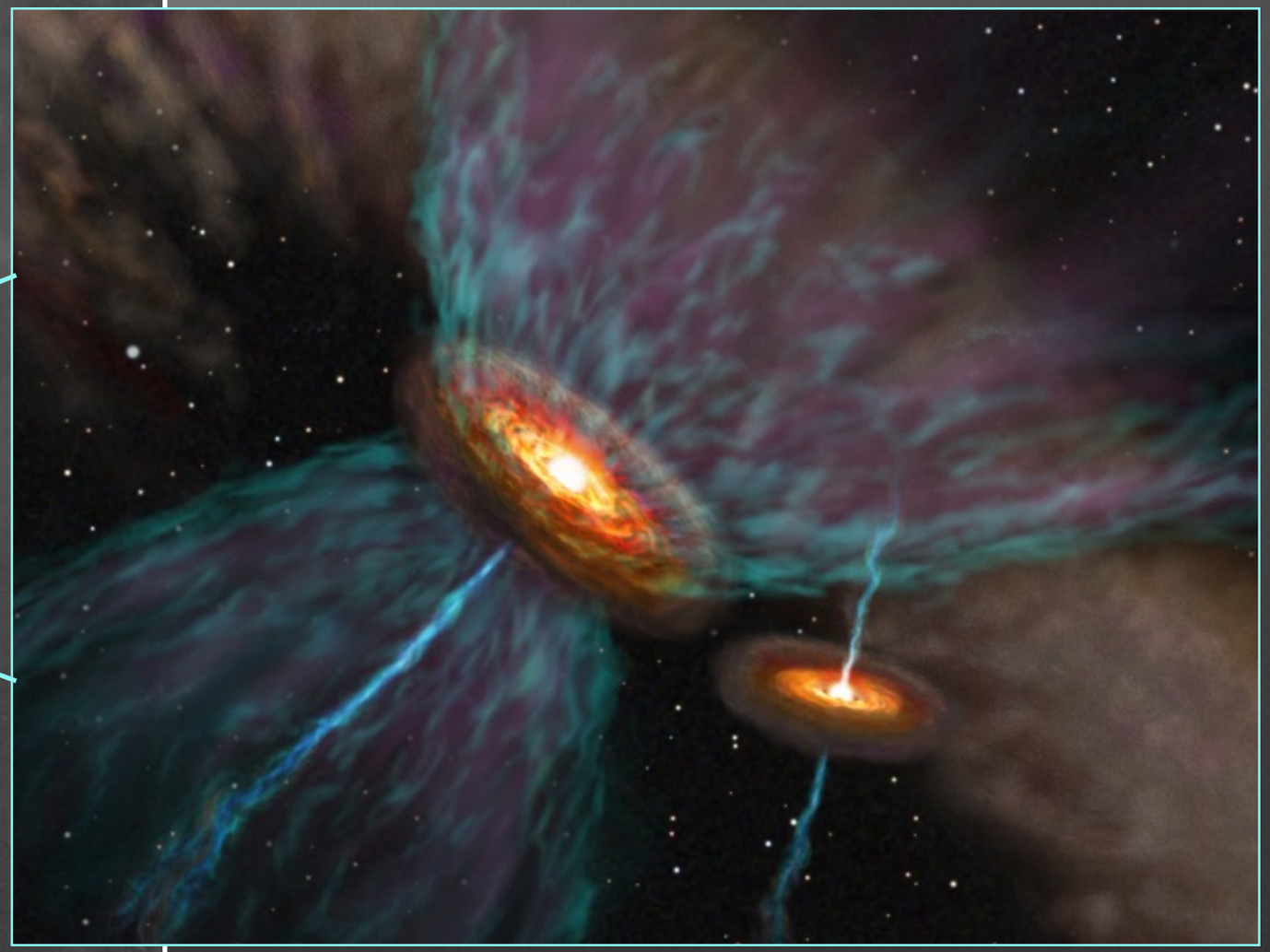




Mayama+2010

T Tauri binary UY Aur

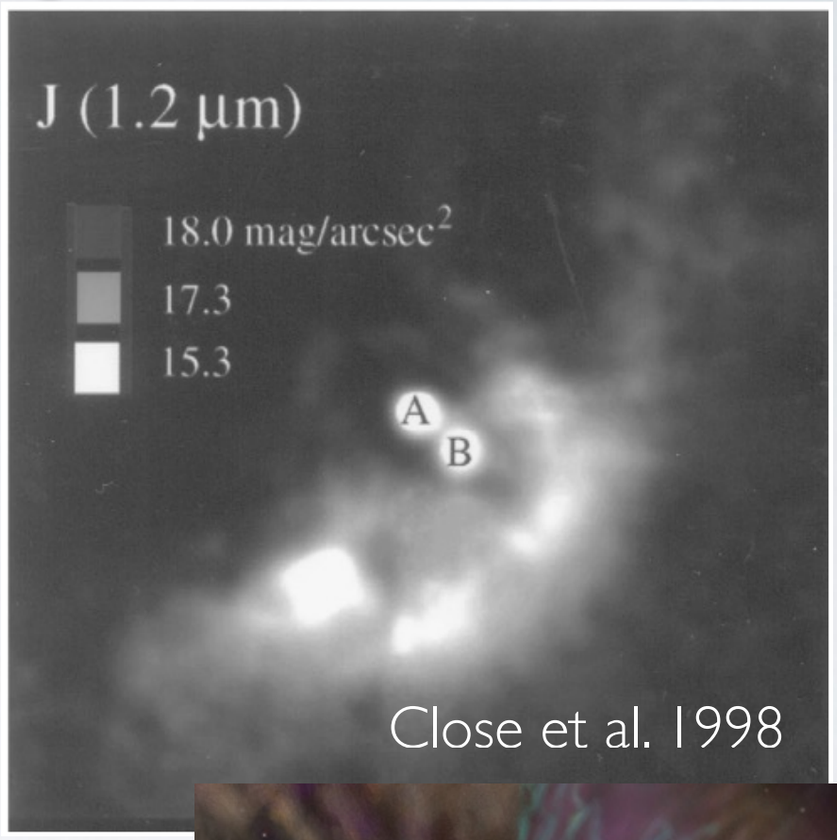




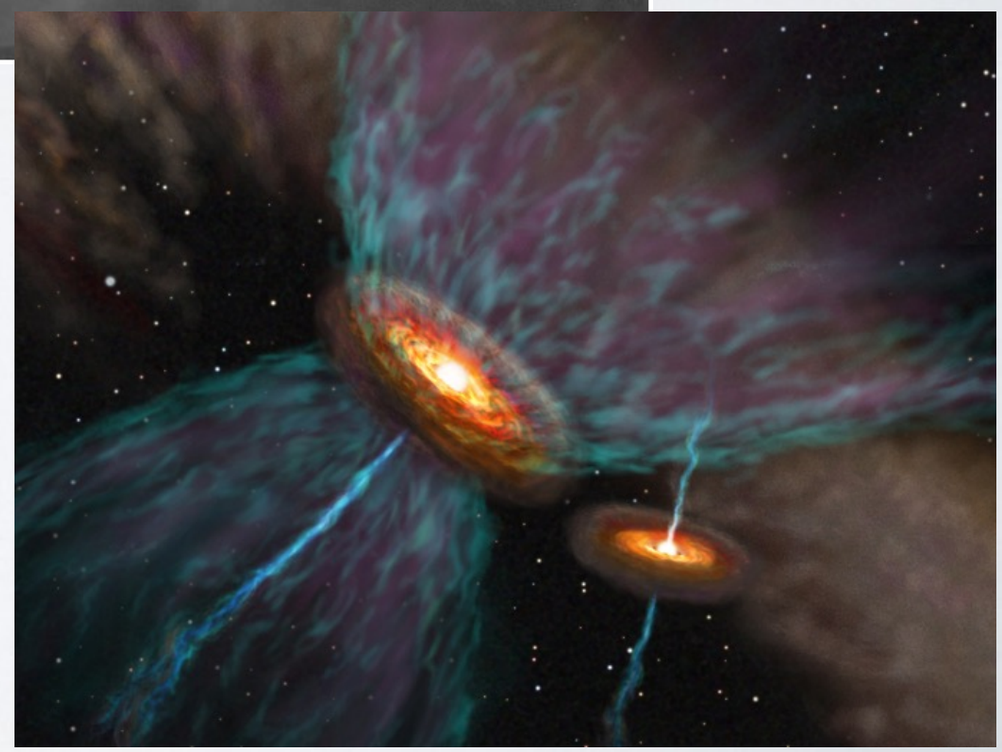
Close et al. (1998)

T Tauri binary UY Aur

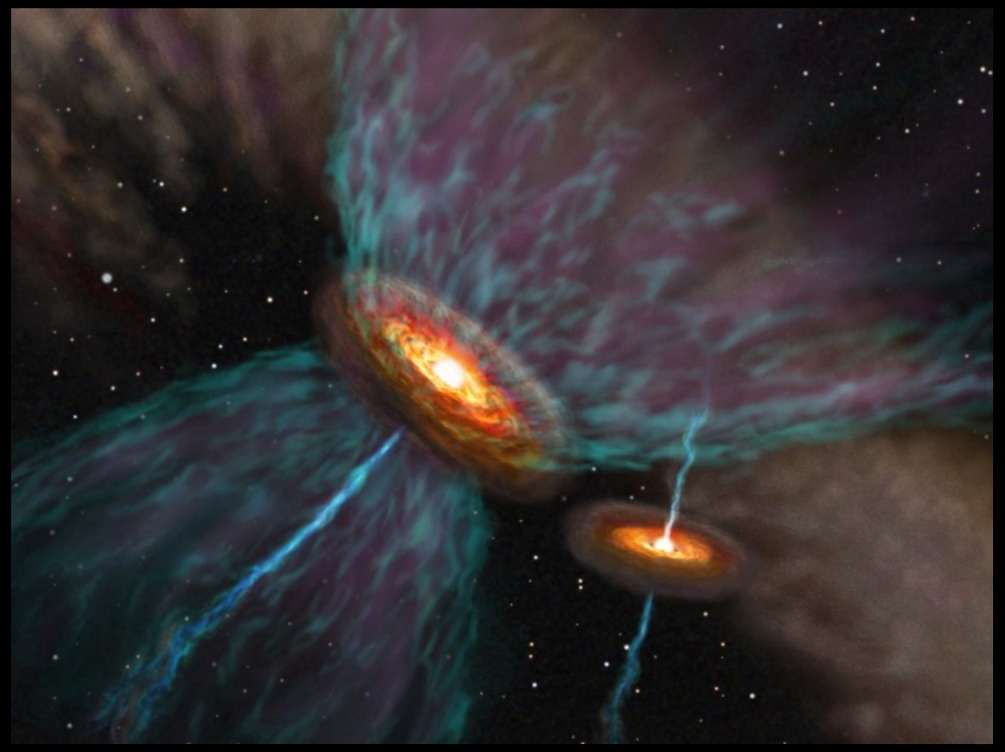
- T-Tauri binary system with a separation 0.88" (120 AU)
- the primary:
  - K7 (0.95) or M0 (0.6) $M_\odot$
  - brightness is relatively stable
  - Accretion rate: ~2×10^{-8} $M_\odot$/yr
  - pristine ISM-like dust
- the secondary:
  - M0 (0.6) or M2.5 (0.25) $M_\odot$
  - brightness varies by 5 mag. in the R band over 50 yrs
  - Accretion rate: ~6×10^{-8} $M_\odot$/yr
  - silicate dust



Close et al. 1998

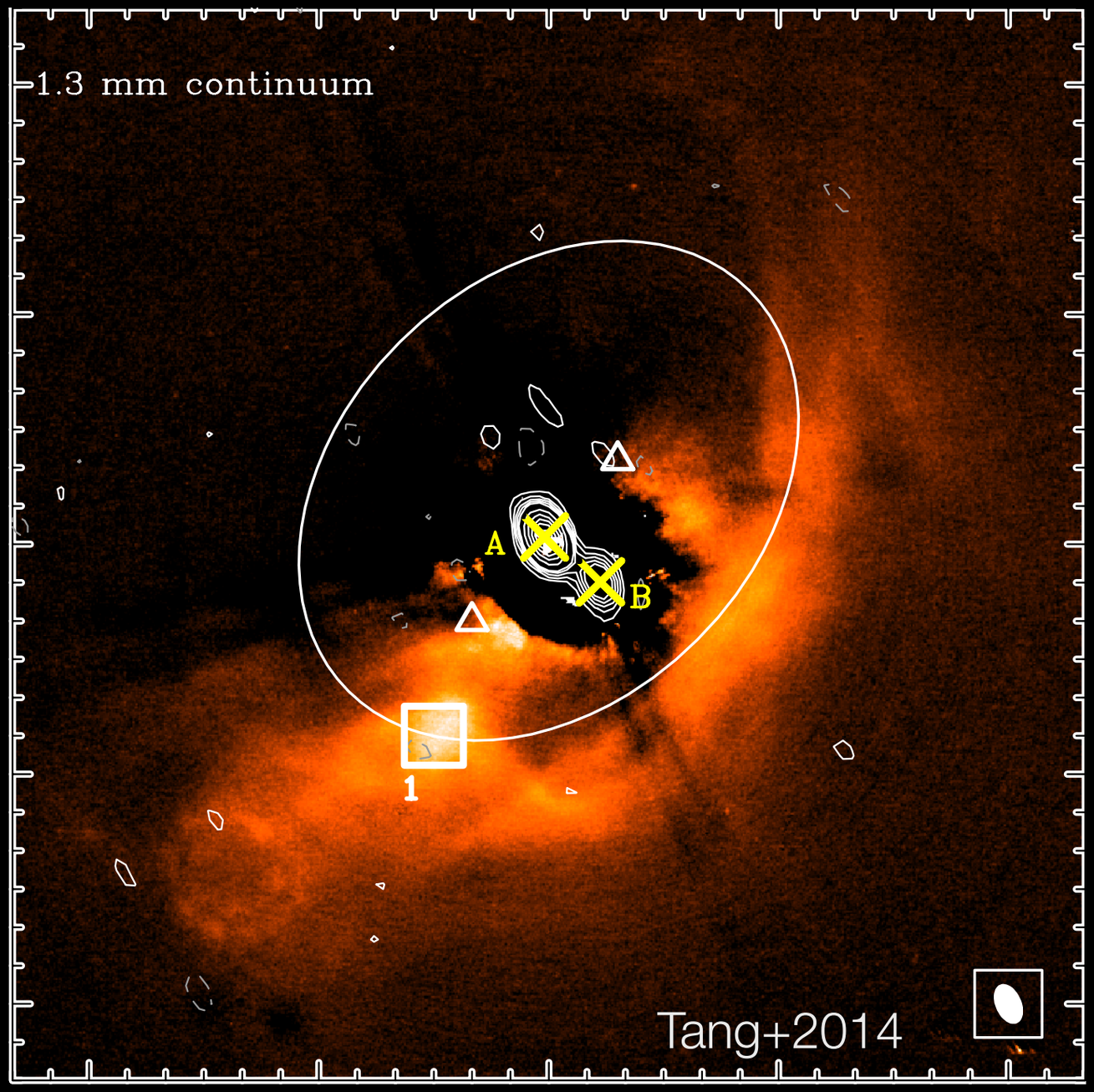


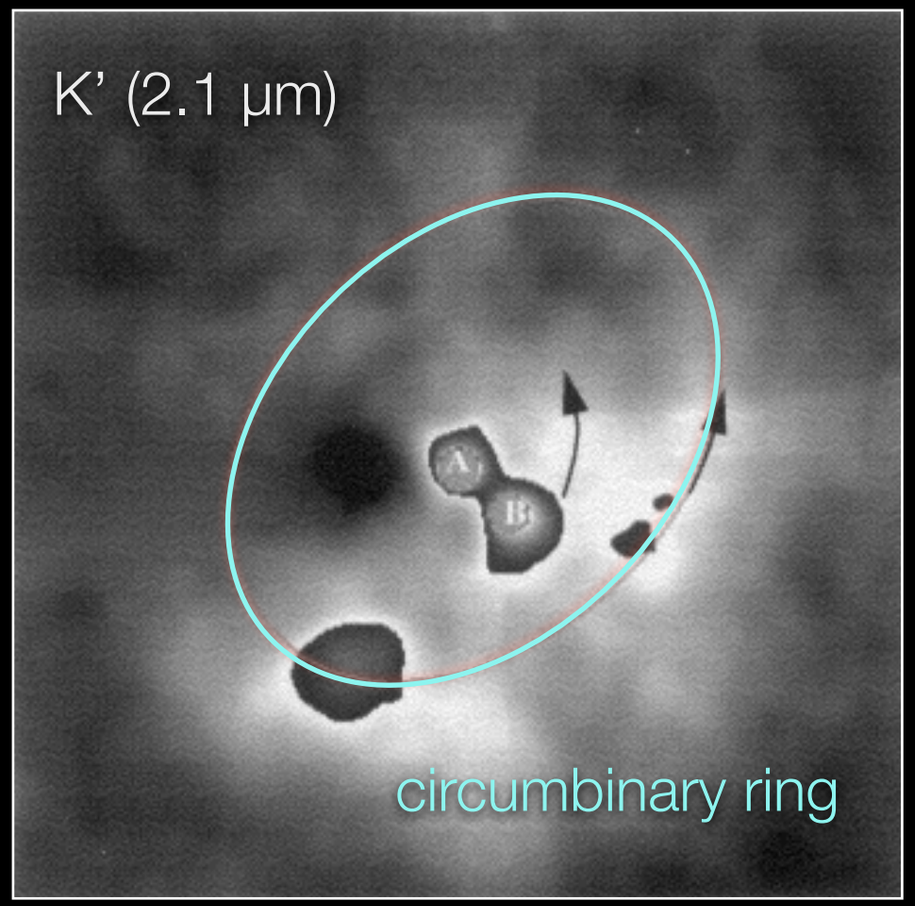
Circumstellar disks

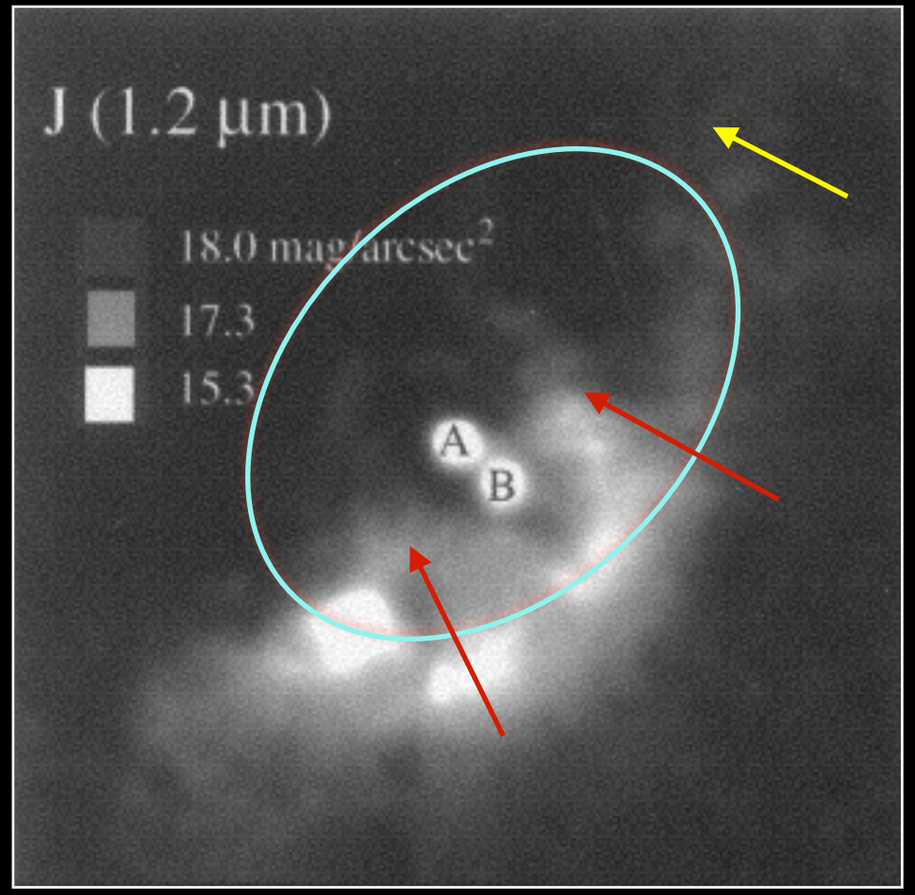


- detected and resolved at 1.3 mm
  - Primary: 0.22” (30 AU)
  - Secondary: 0.34” (50 AU)

- Spectral index $\alpha \sim 1.6$ between 6 cm and 0.88 mm
  - a combination of free-free emission with thermal dust emission







Close et al. 1998

Circumbinary material

In scatter light

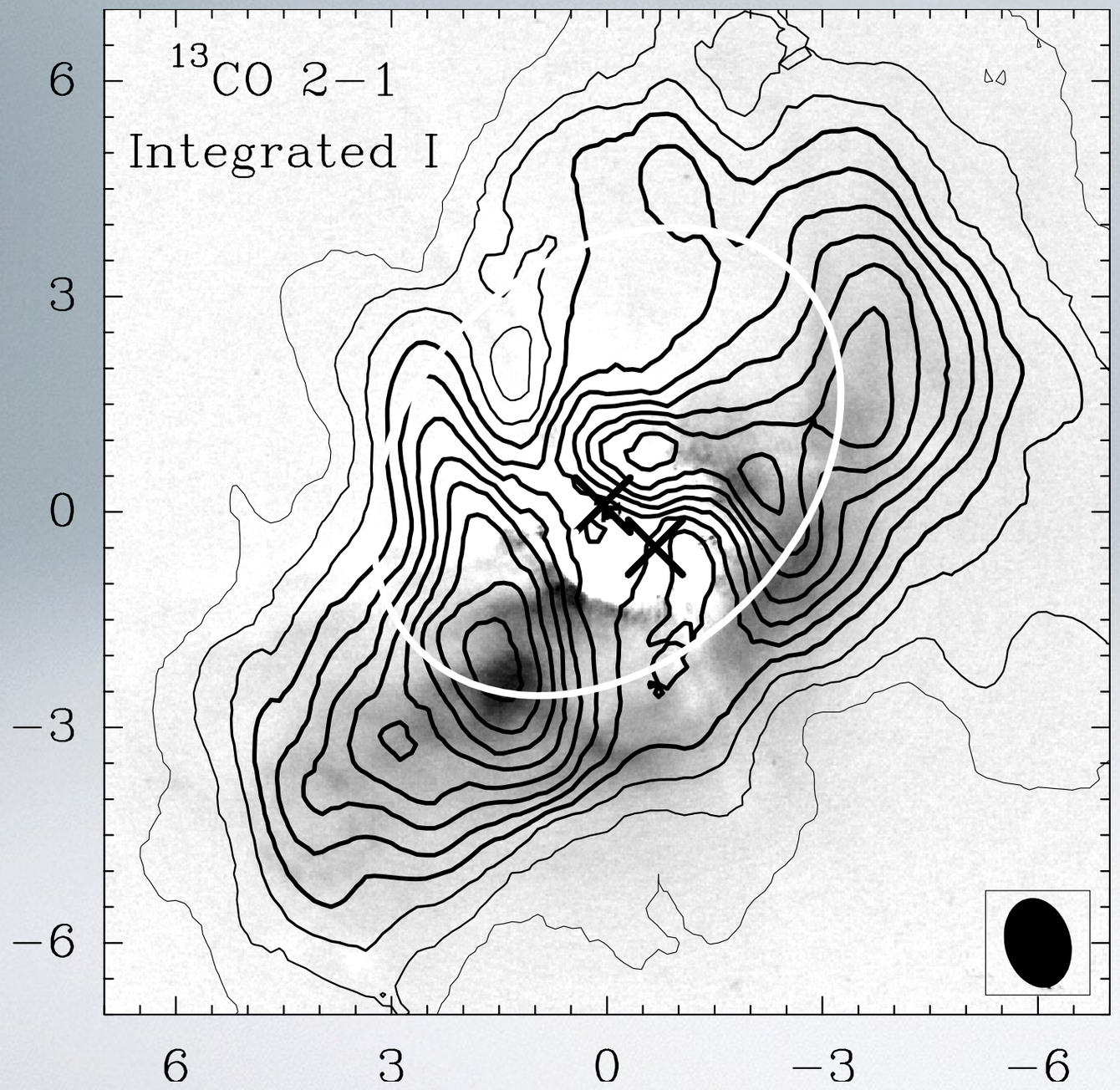
- A circumbinary ring is identified in K' band
  - inclination = 42°
  - PA=135°

- "spiral-like" structures
  - two accreting spirals toward the binary

- an extended armlike structure

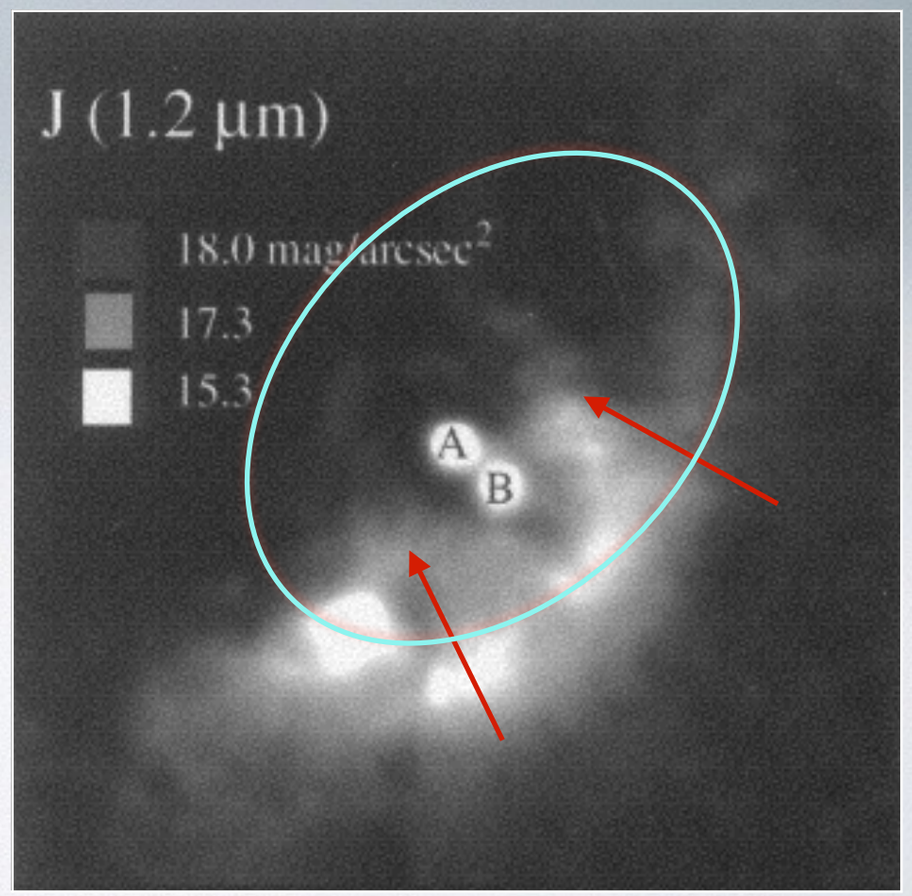
Circumbinary material:

New PdBI ^{13}CO 2-1 observations (contour)



Tang et al. 2014

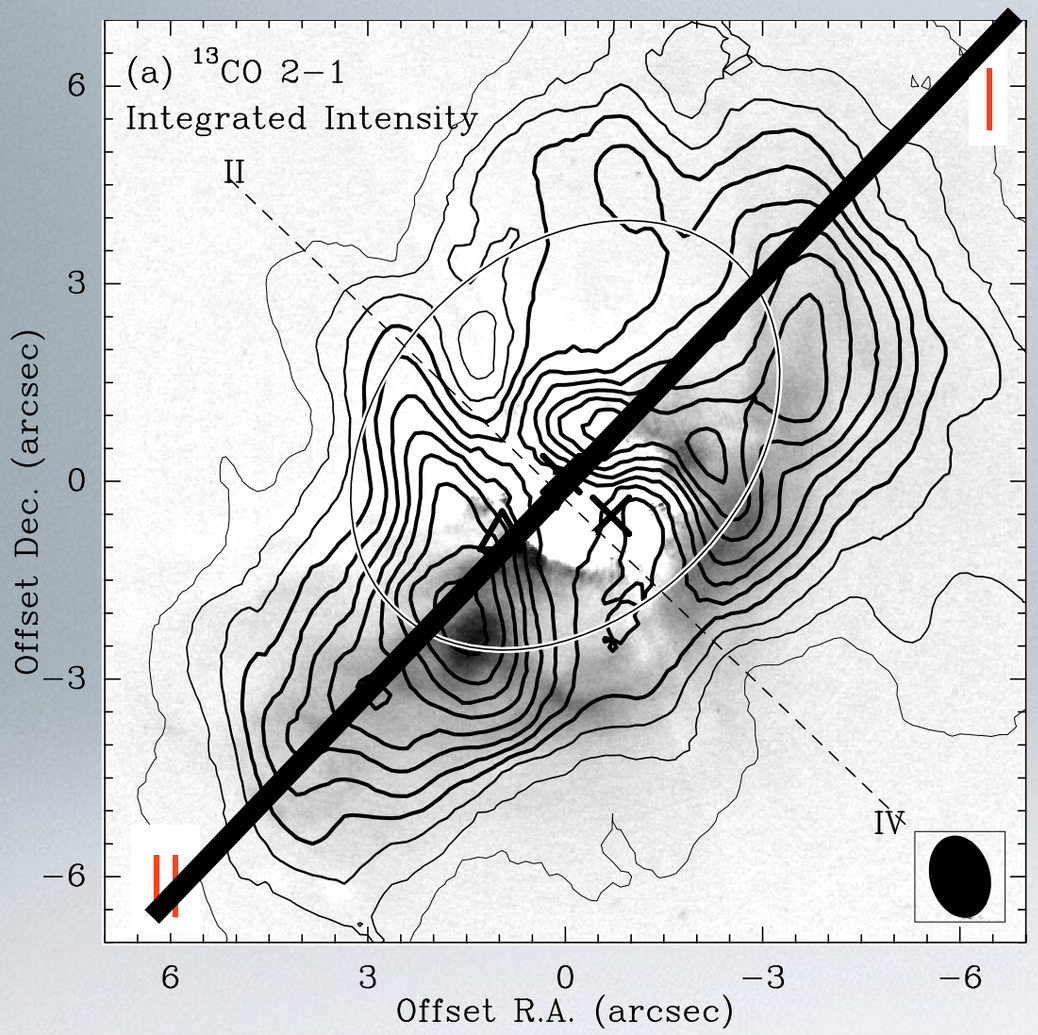
- Circumbinary disk/ring
- spiral-like streamers (accreting spirals)
- extended arm-like structure

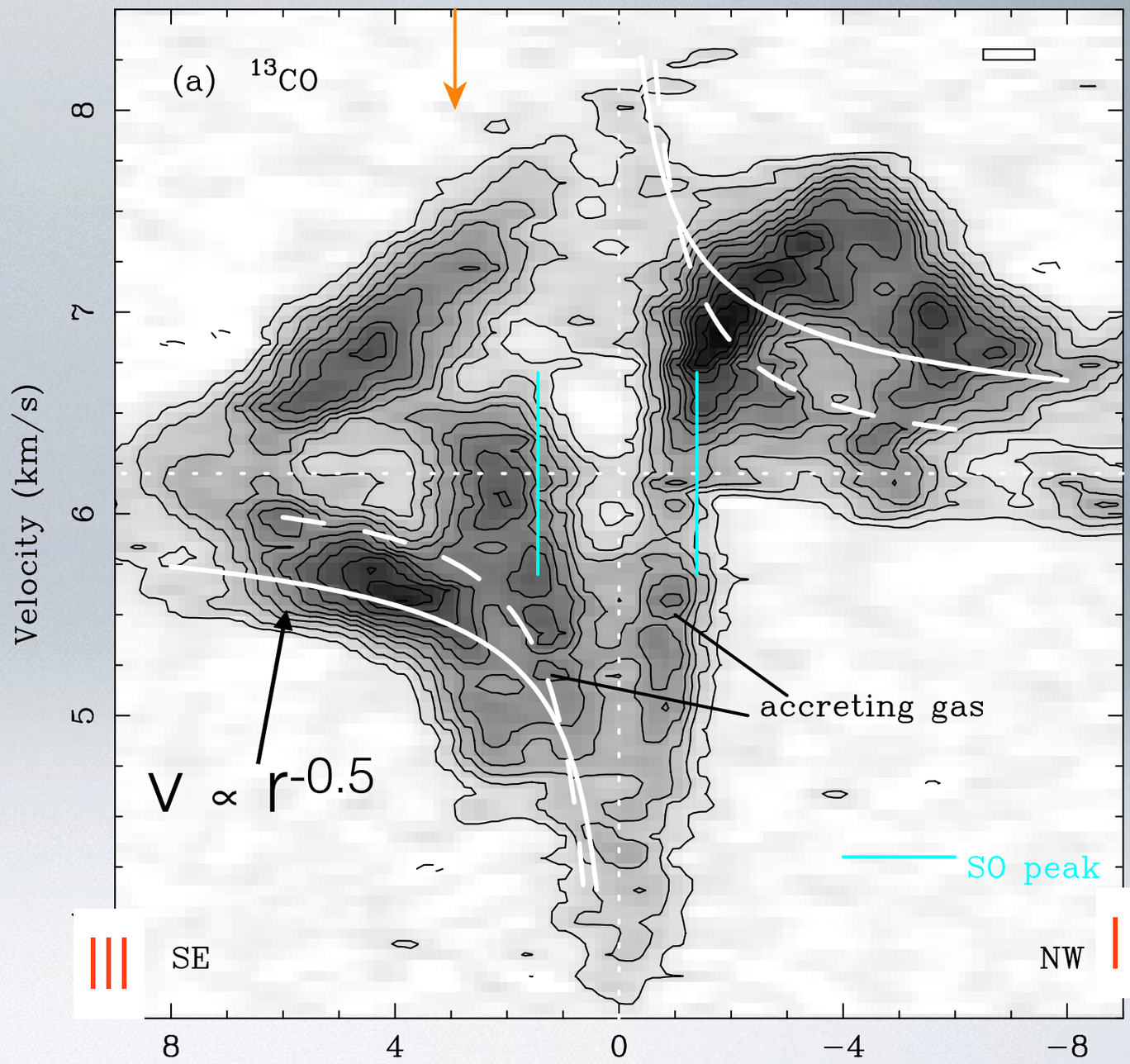


Circumbinary material:

New PdBI ^{13}CO 2-1 observations

Tang et al. 2014

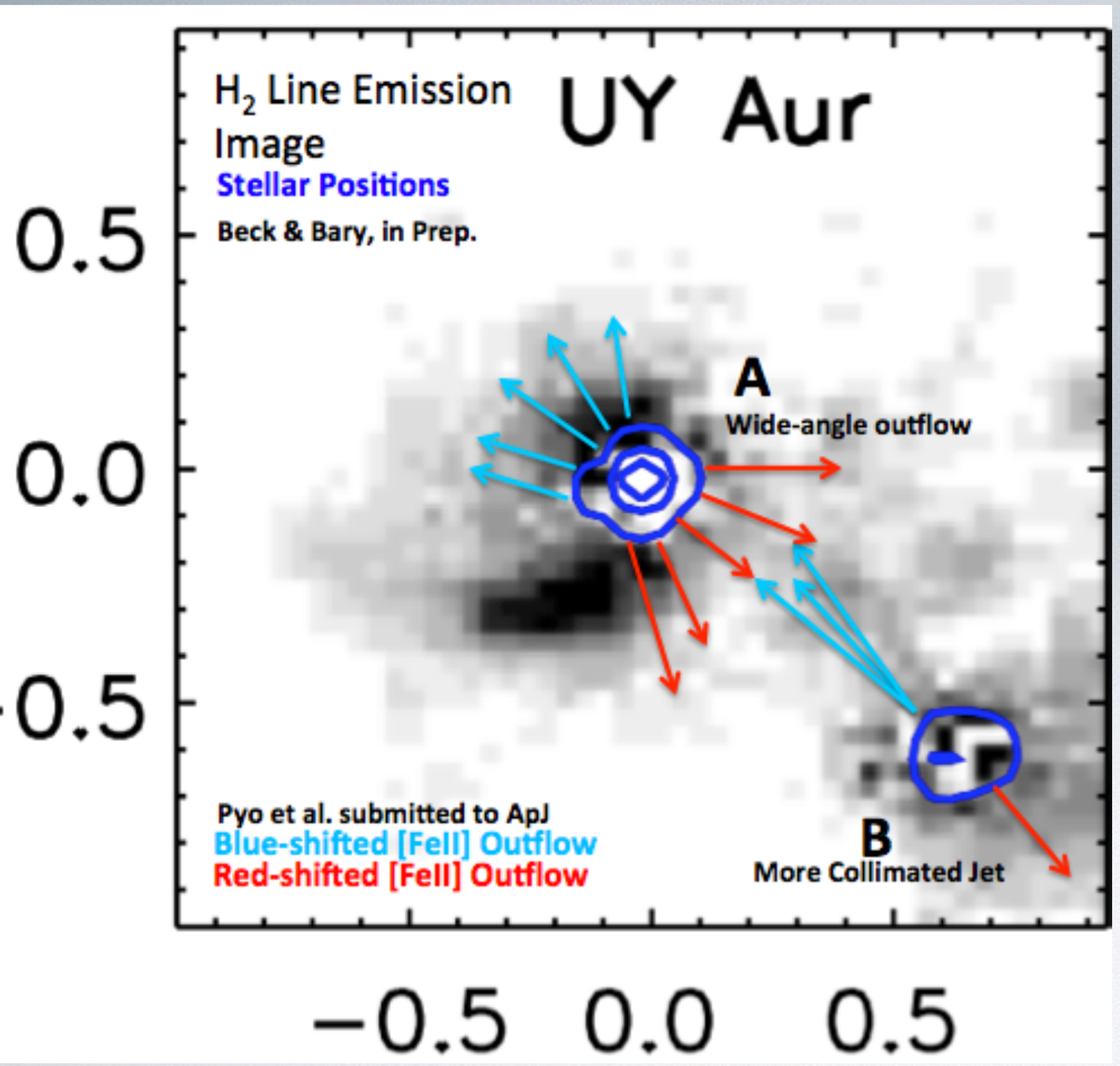




- kinematics can be analyzed
- evidence of accreting spirals in both integrated intensity map and the position velocity diagram

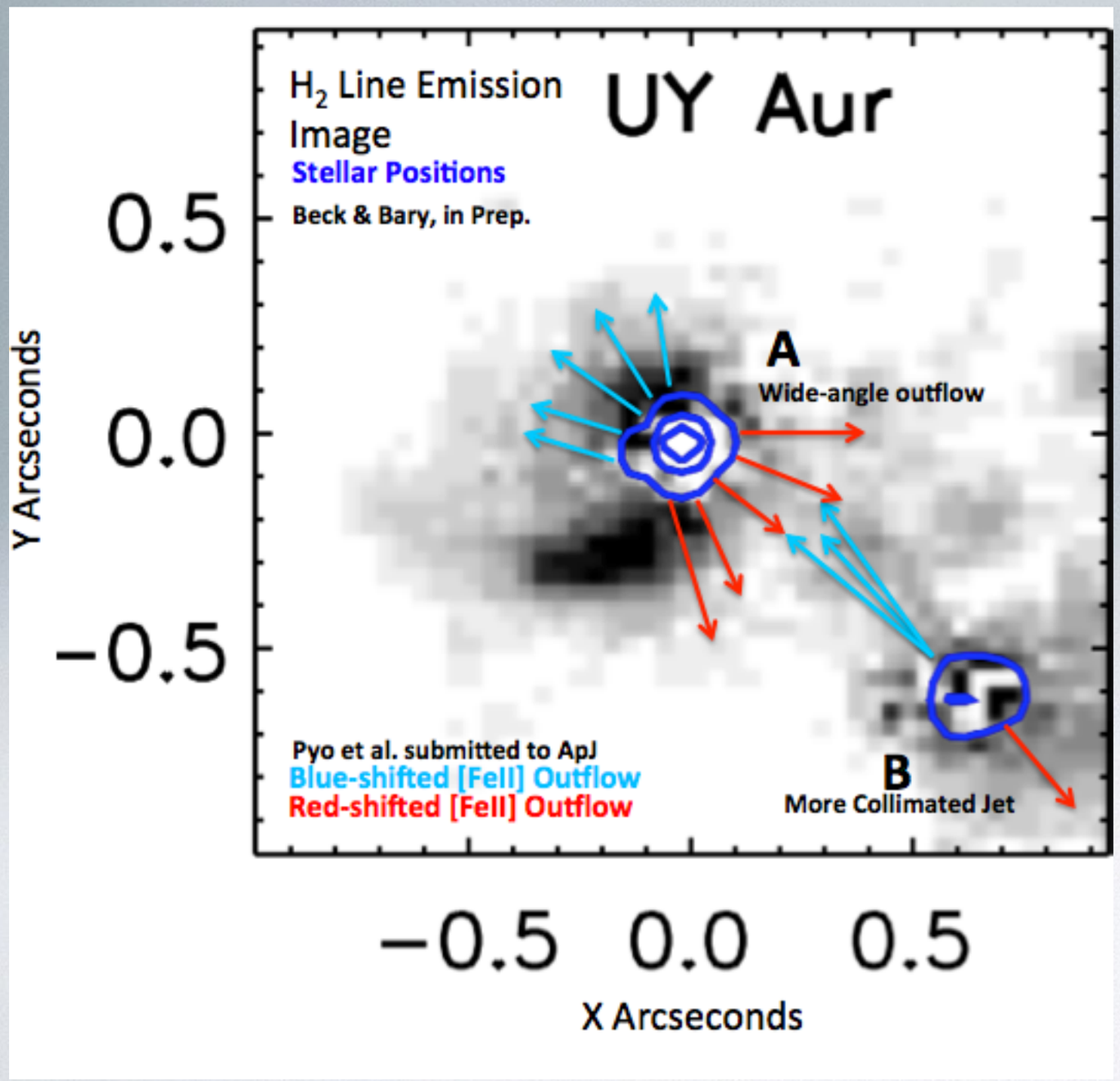
Circumbinary material:

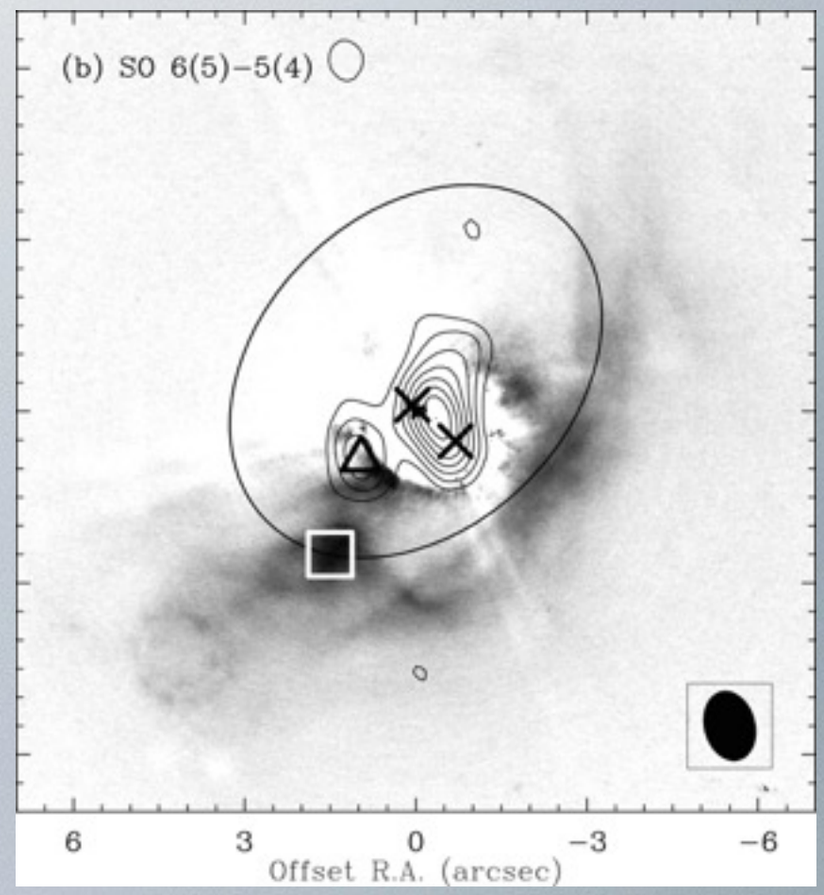
New PdBI ^{13}CO 2-1, SMA CO 3-2, SO 5(6)- 4(5)

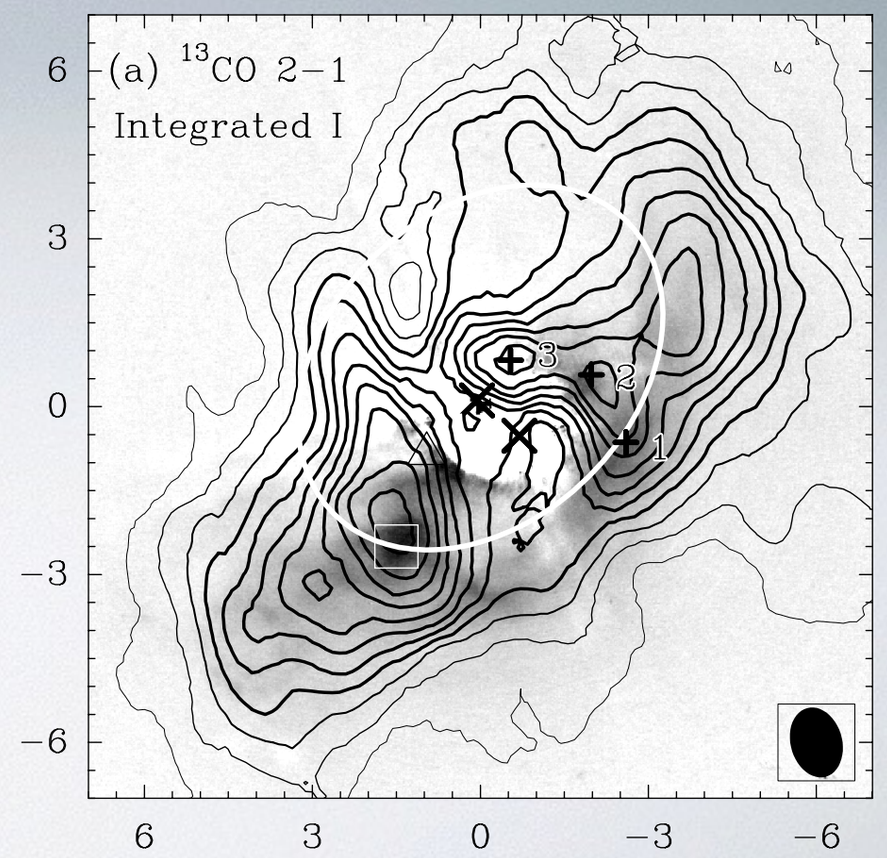


- the suggested scenario of accreting spirals is further supported by the new H_2 2.12 μm line
- high velocity wings are seen in the spectra of ^{13}CO 2-1 and ^{12}CO 3-2 toward the binary
- … and, there is SO 5(6)-4(5) detected toward the bases of the accreting spirals

Circumbinary material: ...and, there is SO







Summary

- Circumstellar disks are detected and resolved at 1.3mm
- the T Tauri binary system is still actively interacting with the surrounding envelope through a circumbinary disk
- evidences of streaming gas between the circumbinary disk and the binary stars are found
- the accretion rate toward the primary and secondary can not be determined with current data
- Angular momentum transfer…