# Disks around Young Stellar Objects

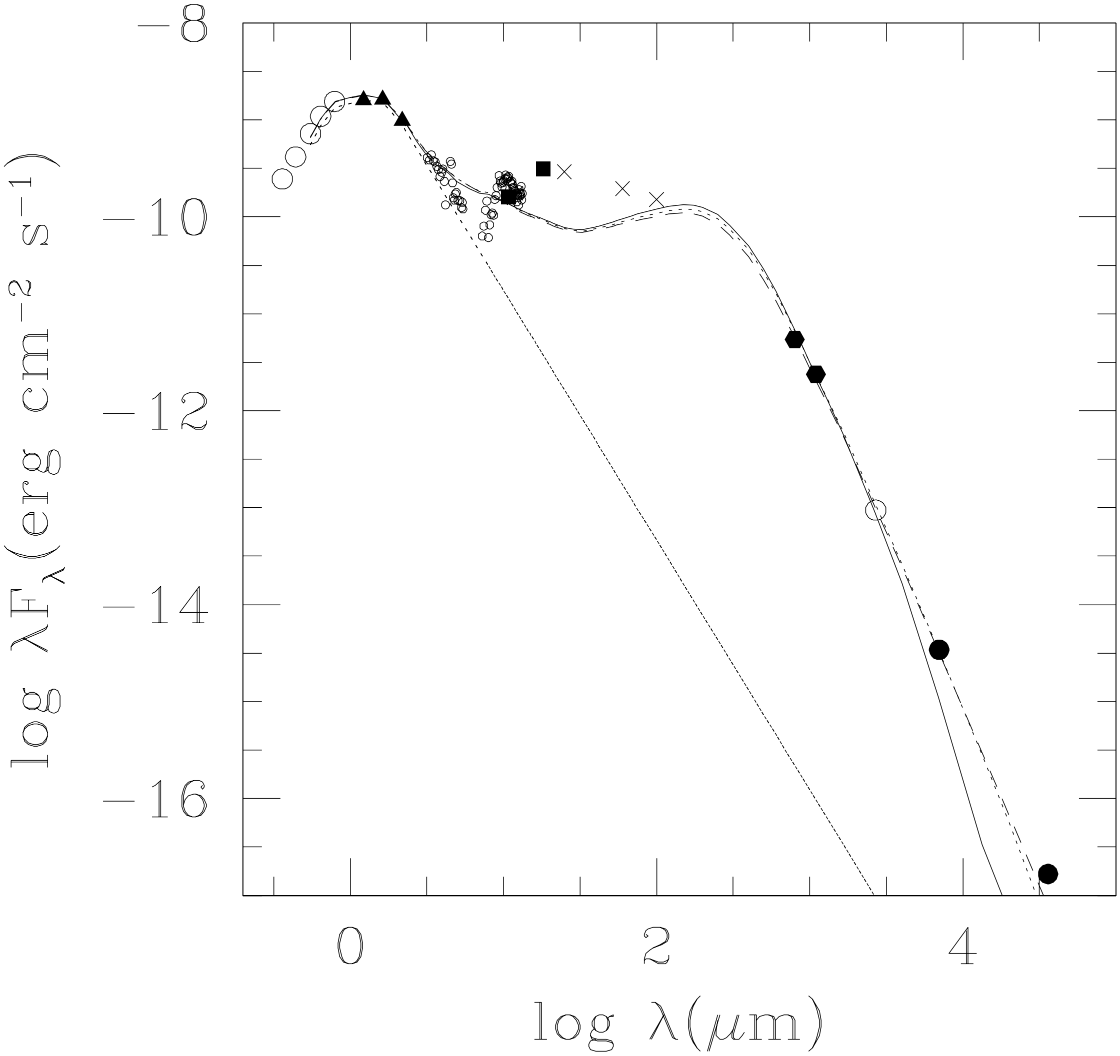
- Relevance of disks:
  planet building processes
  physics of mass accretion
  connections to distant systems

- Natural multi-wavelength targets:
  wide range of temperatures, densities,
  $f(r, \phi, z)$: interiors, atmospheres,

- New regime for ALMA/GSMT:
  $\sim$20 mas angular resolution
  ALMA: $\theta = 18$ mas $\times$ (850 $\mu$m/10 km)
  GSMT: $\theta = 18$ mas $\times$ (2.2 $\mu$m/30 m)
  and collecting area to make use of
  $< 1$ km s$^{-1}$ velocity resolution

- $\exists$ large samples at 150 pc (20 mas $\approx$ 3 AU):
  100's of disk targets, esp. in southern sky

• Example: TW Hya (at 56 pc)



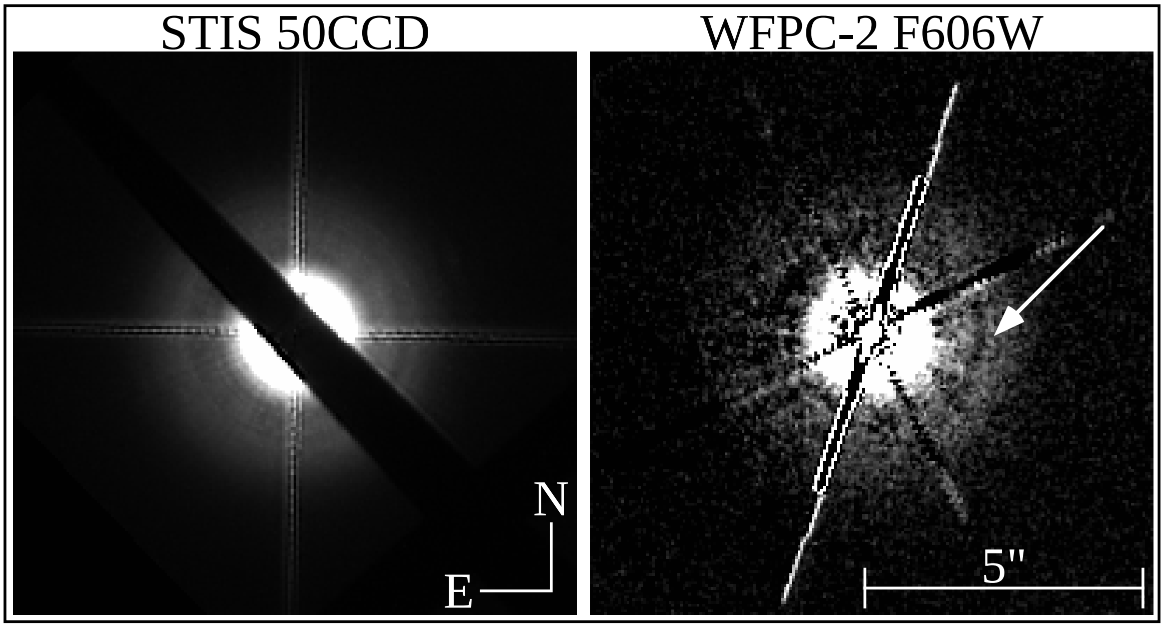

Spectral energy distribution of TW Hya (Calvet et al. 2001). The curves show models with gas dust well mixed and extending to the magnetospheric radius for various maximum dust grain sizes. Note the flux deficit at 5 to 10 $\mu$m, and the flux excess at longer mid-infrared wavelengths. One model that accounts for these features invokes a developing gap with radius $\sim$ 3 AU.

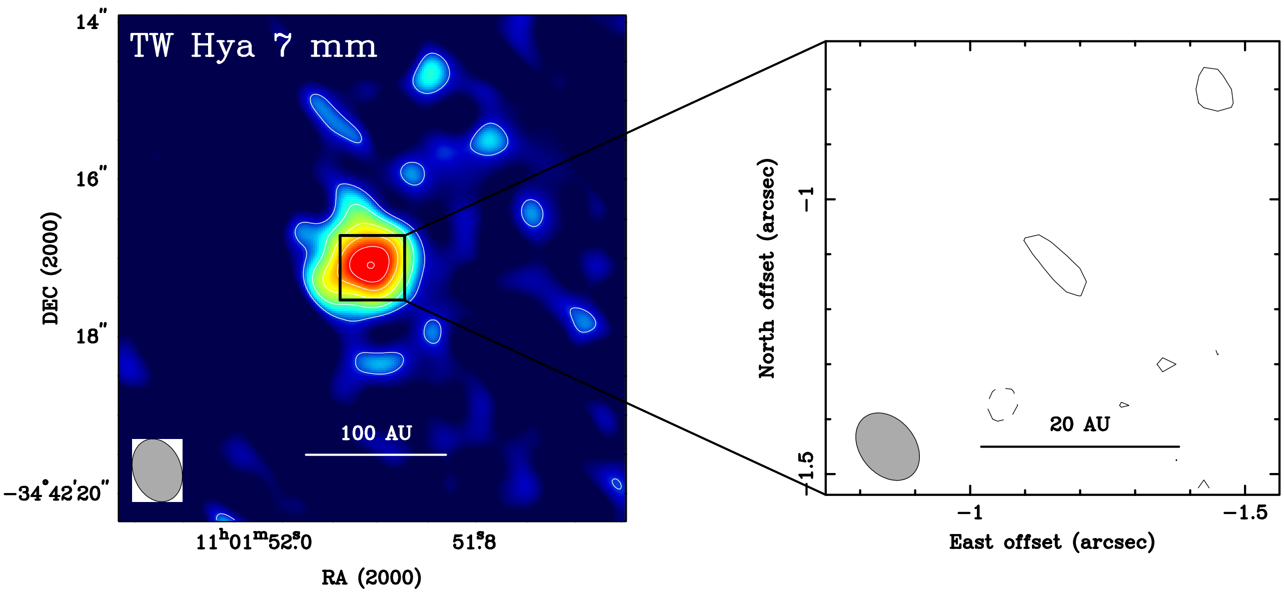
• Evidence for a developing gap?

• Dust coagulation and settling? Protoplanet?

• Key spectral regions: mid-ir & millimeter

- State-of-the-Art images:




Upper: Hubble Space Telescope observations (Schneider et al. 2001).
Lower: Very Large Array millimeter observations (Wilner et al. 2000).

- GSMT: $>10\times$ sharper, extend to mid-ir
- ALMA: improve cont. sensitivity by factor $>3\times(850\ \mu\text{m}/7\ \text{mm})^3 \approx 2000$

- Solids:
  resolved images of grain diagnostics
  ALMA: thermal emission, $\kappa_\lambda$
  GSMT: solid-state features, scattering

- Gas:
  ALMA: image many trace molecules
  e.g. CO, HCN, $HCO^+$, $H_2CO$, ...
  GSMT: $H_2$, dominant mass constituent
  e.g. J=3-1 S(1) at 17.0 $\mu$m

  - probe detailed nebular chemistry

  - measure precise kinematics
  e.g. deviations from Keplerian rotation

- e.g. TW Hya:

  CO J=2-1 at 1300 $\mu$m $\sim 13$ Jy km s$^{-1}$
  $\rightarrow$ ALMA can resolve over $\sim$1000 pixels

  J=1-0 S(1) $H_2$ at 2.2 $\mu$m $\sim 10^{-15}$ erg/s/cm$^2$
  $\rightarrow$ GSMT can resolve over $>$100 pixels

- Complementarity with space facilities:

  SIRTF & Herschel:
  exquisite disk SEDs, but no spatial resolution

  NGST:
  extended $\lambda$ coverage, to 28 $\mu$m?
  lines/features inaccessible from ground,
  esp. J=0-0 S(0) $H_2$ at 28 $\mu$m (cool gas)

  *marginal* spatial resolution for disks

  SIM:
  indirect detection of mature planets

- Some issues for discussion/study:

  comprehensive source models, vis/ir/mm
  (self-consistent, informed by theory)

  translation to GSMT instrument requirements?