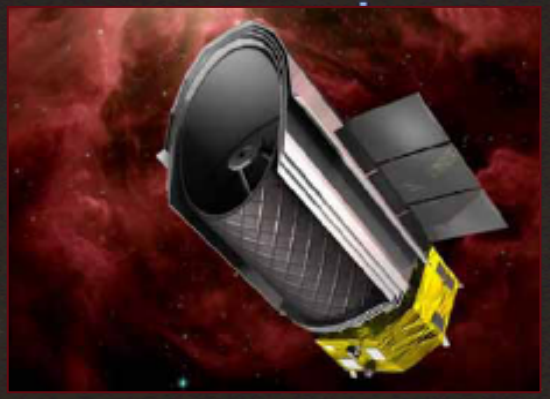
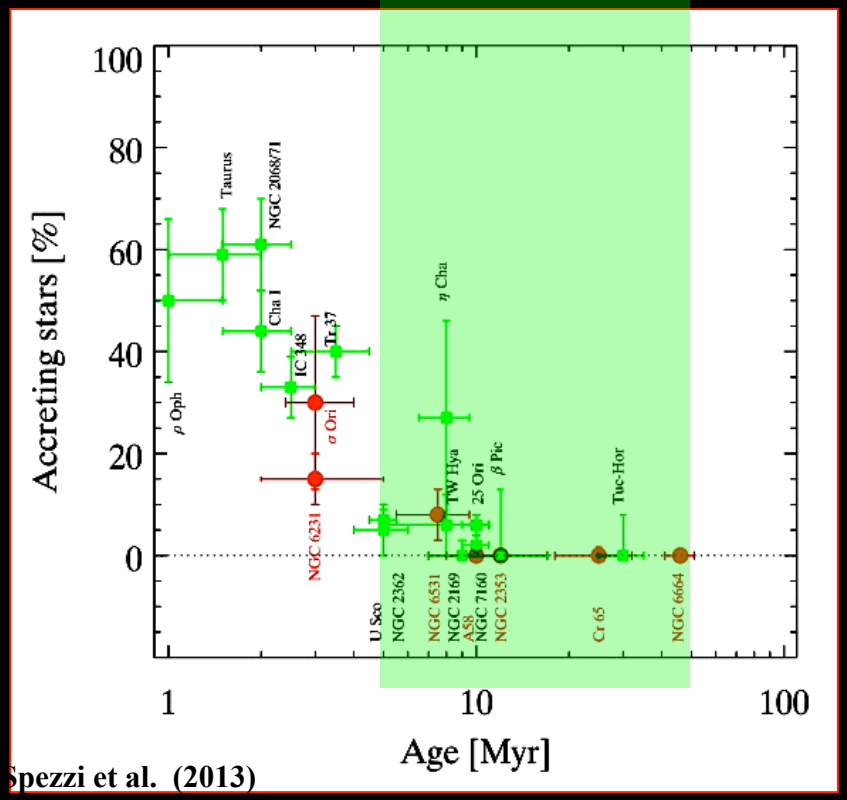
Protoplanetary disks
From Spitzer to SPICA



Juan Manuel Alcalá
INAF- Napoli

Disc/Envelope evolution

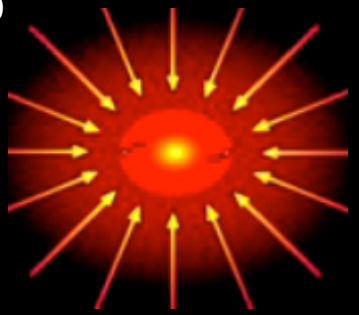
SPICA

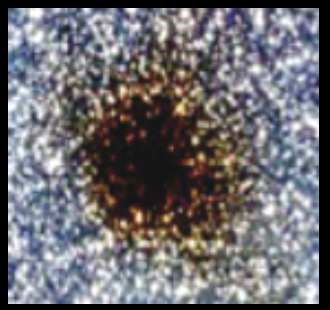


Spezzi et al. (2013)

≈ 10 Myr

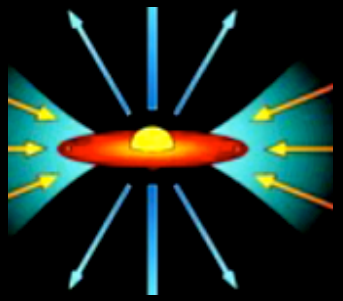
t=0





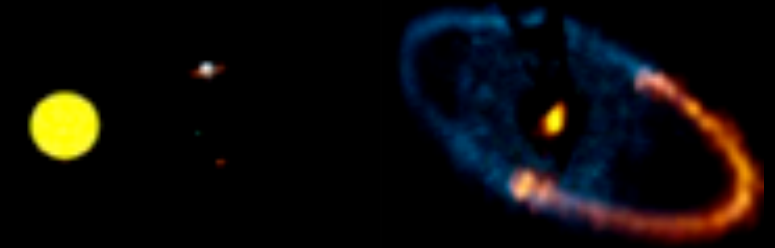
cores

t=10^5-10^6 yr



Disc / envelope

t > 10^7 yr

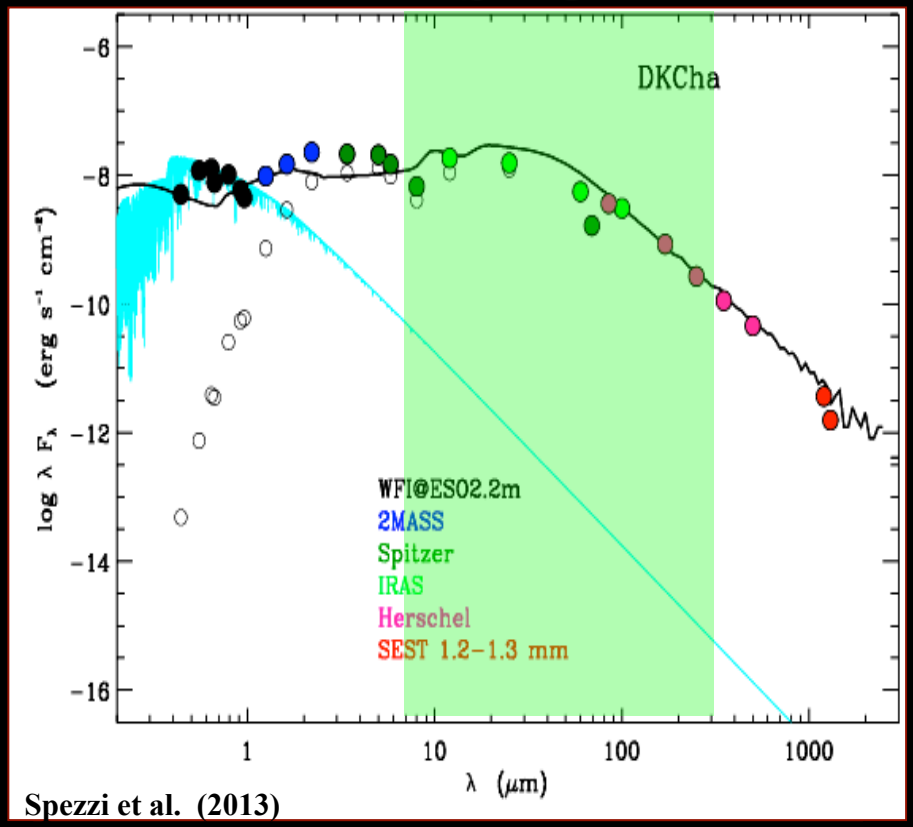


Debris disc

- IR luminosity decrease with age
- the L_{IR} / L_{star} ratio is a good proxi for disk evolution
- evolution of spectral diagnostics

Disc/Envelope evolution

SPICA



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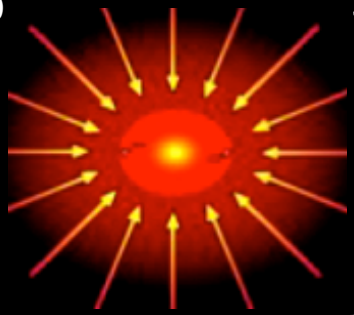
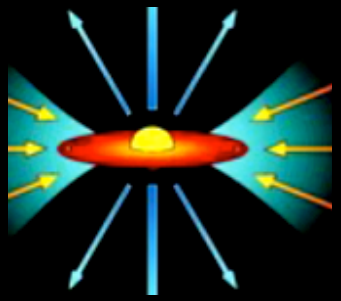
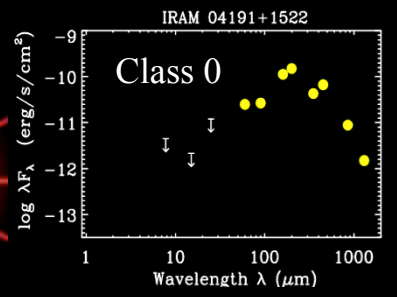
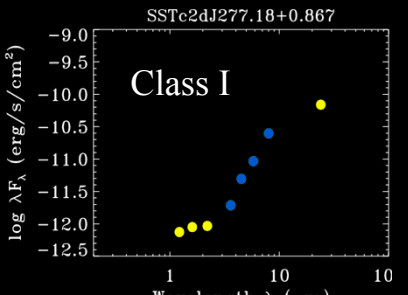


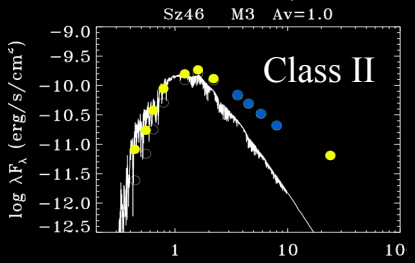
t=10^5-10^6 yr

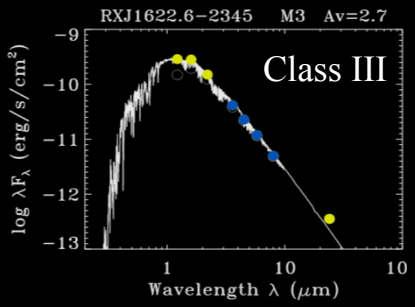


t > 10^7 yr









cores

Disc / envelope

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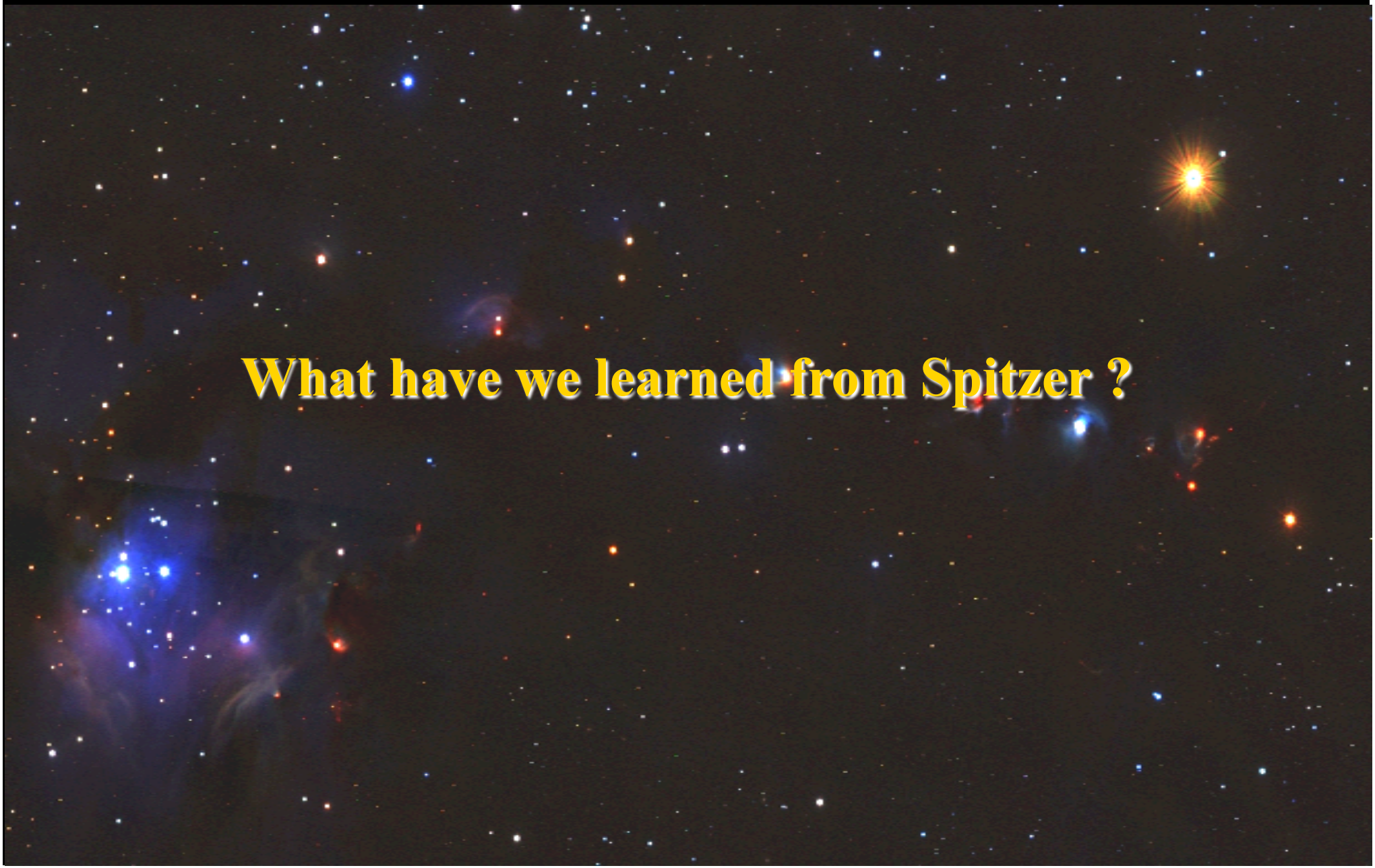
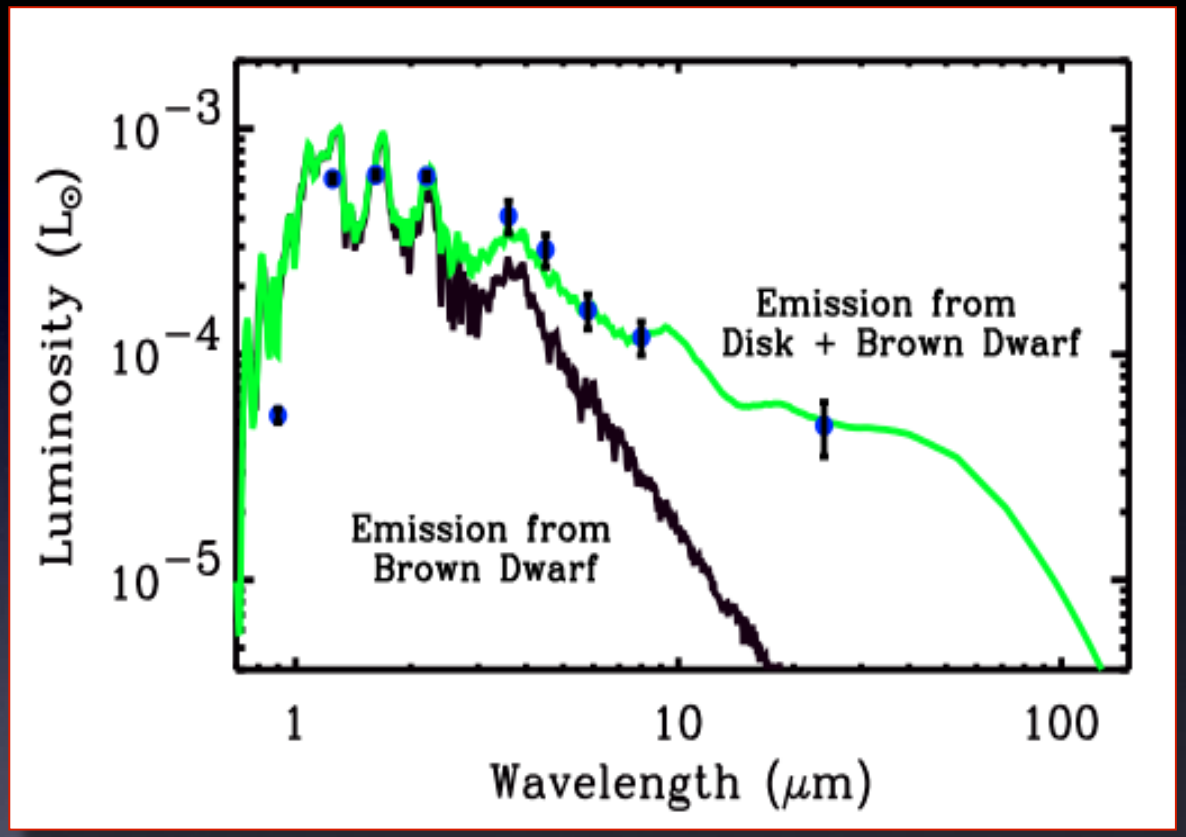

What have we learned from Spitzer ?

Discs throughout the entire mass spectrum, down to brown-dwarf regime



Allers et al. (2006)

NIR fits model atmosphere of 3 Myr old brown dwarf:

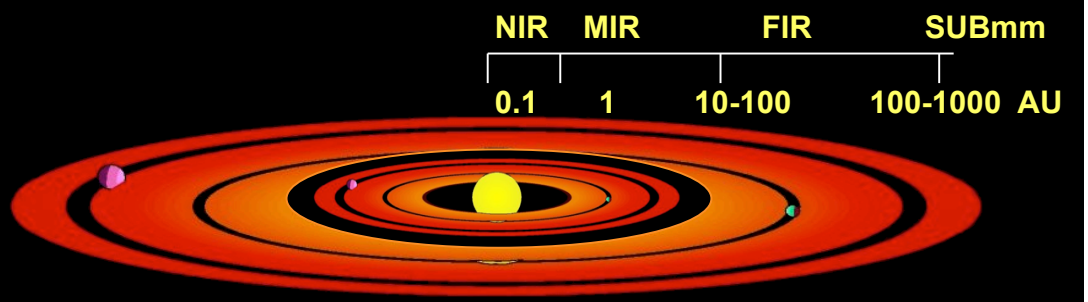
- T_{eff} = 2100 K
- M~10 M_{jup}

Fits model of disk:

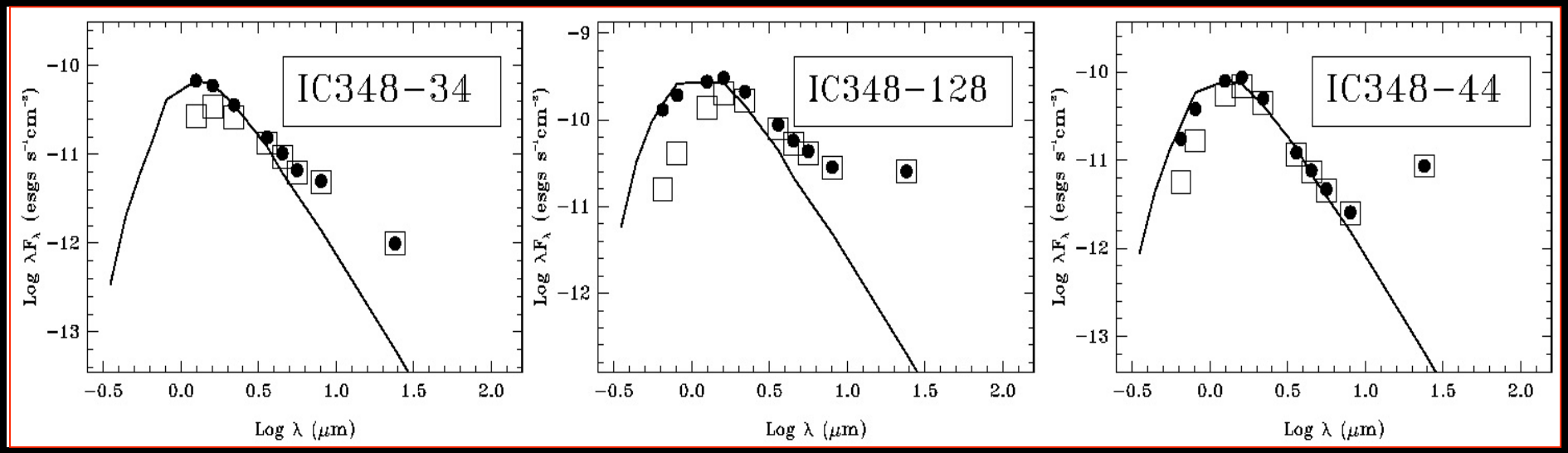
- M_d = 0.03 M_{BD}
- R_d = 5 AU
- i = 40 deg

Spitzer: Transitional discs

$$r_{probe} = 0.01 \cdot \lambda^2 \cdot L_{star}^{0.5} \text{ AU}$$

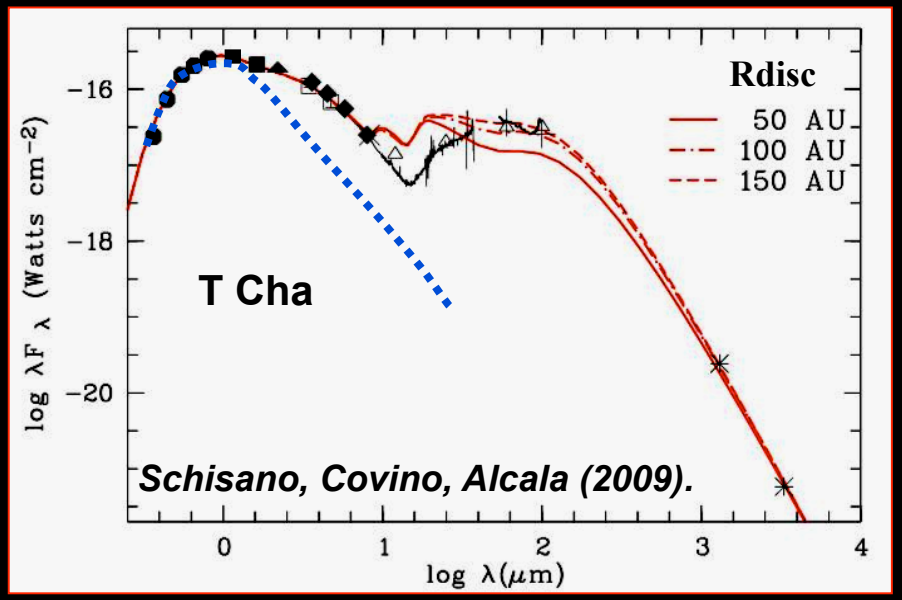


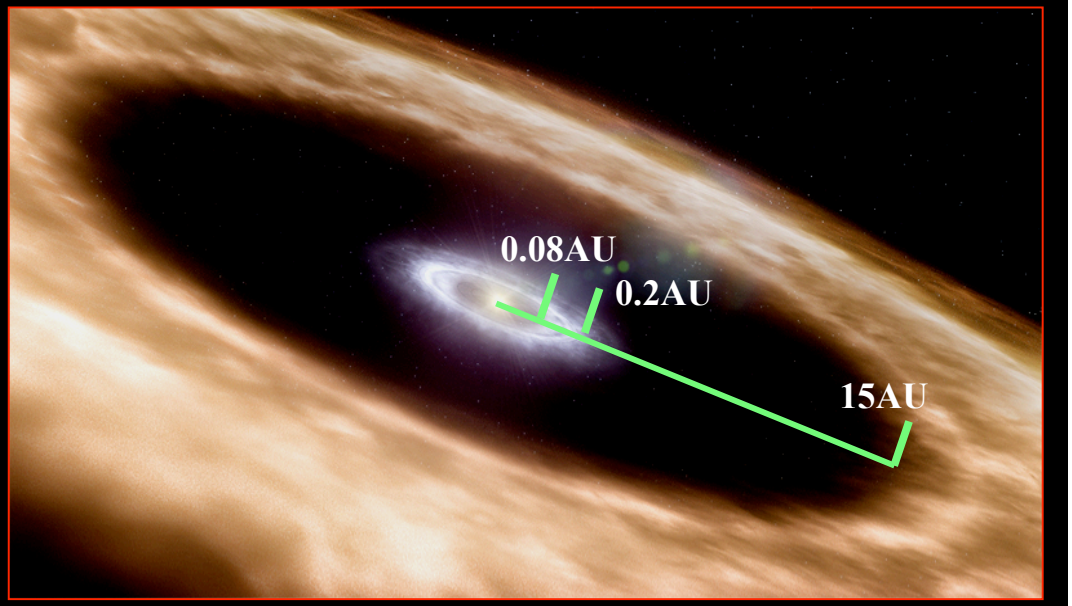
- Different wavelengths probe different locations in the disk
- NIR: ~0.1 AU ; MIR: ~1AU ; FIR: ~30 AU ; SUBmm: ~1000 AU



- some excesses start only at long wavelengths but are substantial: cold disks.
- *traditional* transition from II to III does not capture the diversity seen in disk SEDs.

Transitional discs with gaps

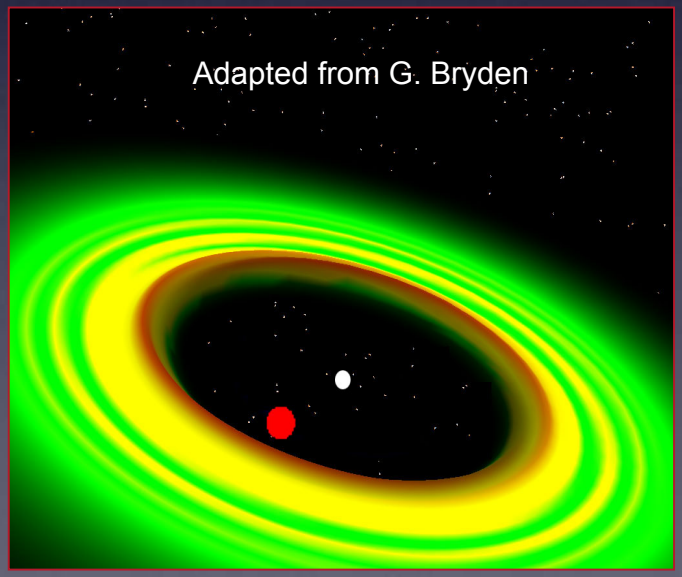




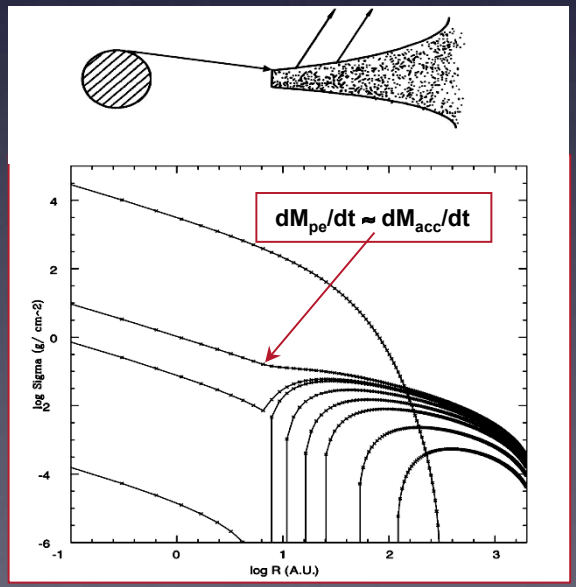
Spitzer results on transitonal disks

- Transition objects are a diverse class
  - Variable inner hole sizes, ranging from 1-25 AU (so far!)
- The diversity of these objects probably reflects
  - diversity among their presumed precursors, the T Tauri stars, and
  - consequent multiple paths to forming planetary systems
- Production of an inner hole by

a) giant planet: rapid draining from inner disc

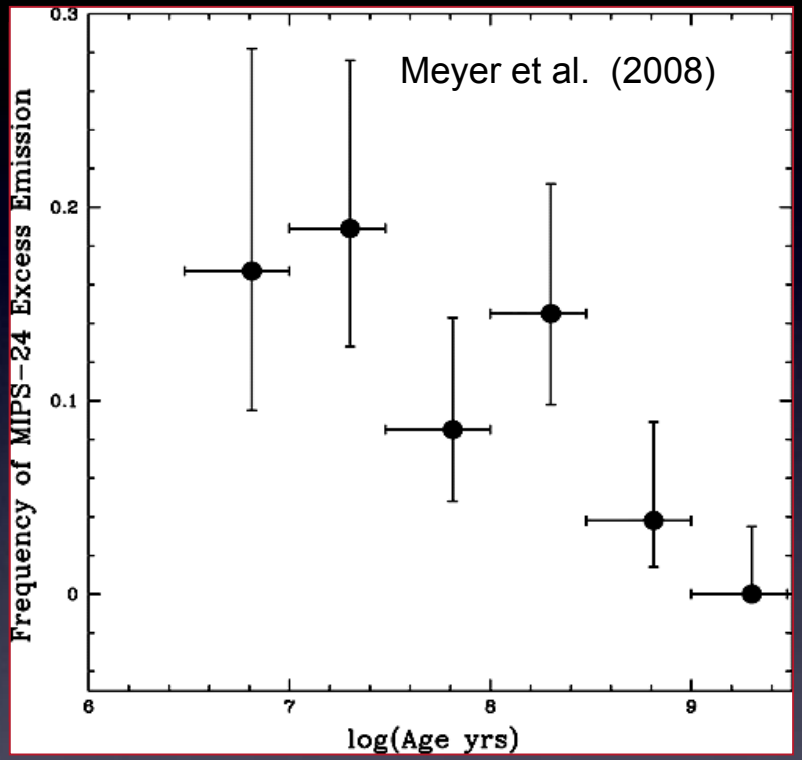


b) photoevaporation ≈ accretion



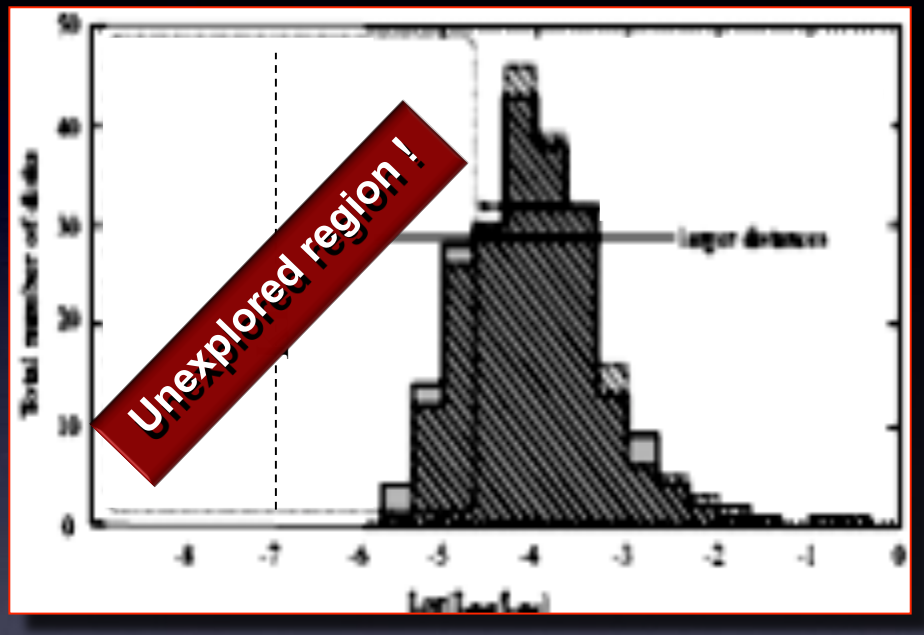
Spitzer results on debris discs

Spitzer FEPS legacy survey



- 309 stars ($0.7 < M/M_{\odot} < 2.2$)
- 8.5% - 19% at age < 300 Myr
- < 4% for older stars

- $\langle L_{IR}/L_{Star} \rangle \approx 10^{-4}$



Kuiper belt-like structures still to be investigated