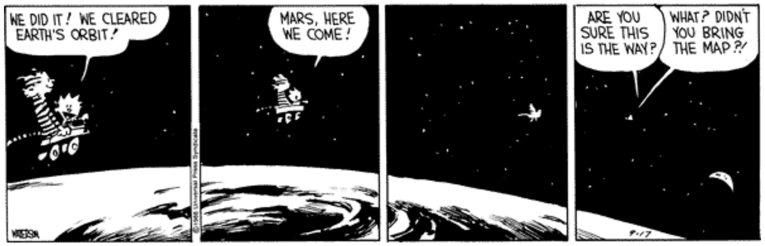
Observational ISM and Star Formation



<u>This Class (Lecture 18):</u>

Christian Luca & Nick Hakobian
(Bergin et al.)

<u>Next Class:</u>

Jake O'Keefe & Woojin Kwon
(Meyer et al.)

Music: *Who's There* – Smash Mouth

Outline

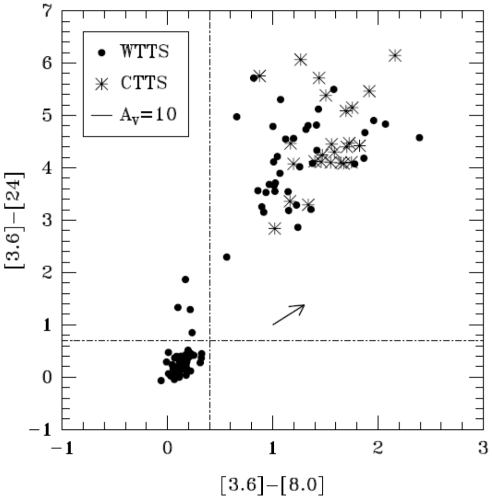
- How do disks evolve?

SEDs

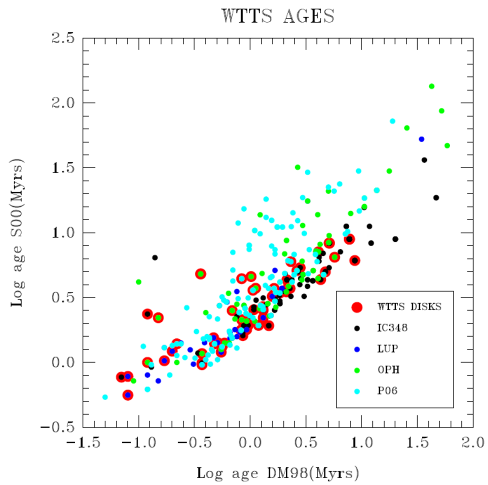
- We discussed the importance of SEDs
- It is better to resolve disks…but
- To date, few disks have been resolved, so surveys have been SED modeling
- Still have shown interesting results: disk evolution

Nomenclature of Evolution?

- Starless Core
- Class 0
- Class I
- Class II (T Tauri star)
- Class III
  - In general, surface temp similar to equivalent main sequence star, but they are larger, so more luminous
    - Classical T Tauri Star
    - Weak-Line T Tauri Star (or naked T Tauri Star): lacks strong emission lines in optical spectrum (Hα EW < 10Å; Herbig & Bell 1988)
- Main sequence (maybe with debris disk)

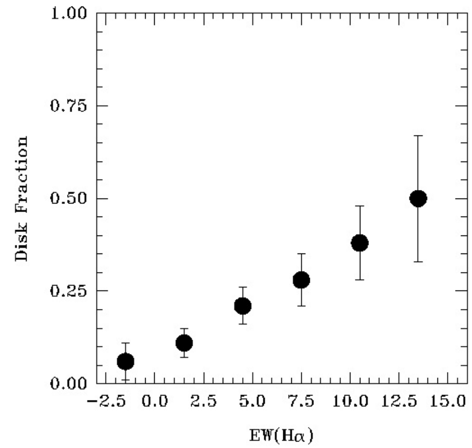


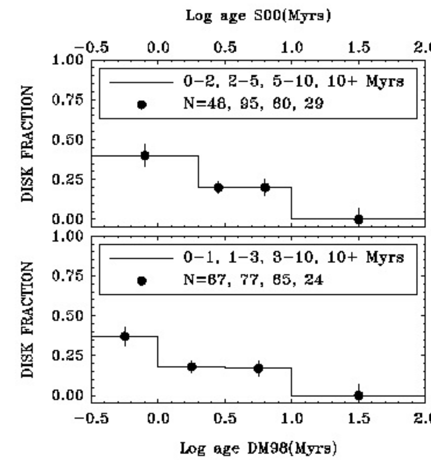
Use SED surveys to probe disk evolution w/time, accretion rate, etc.



Find very few objects with moderate IR excesses, most disk systems are optically thick out to 24 μm.

Disk Fraction Correlations



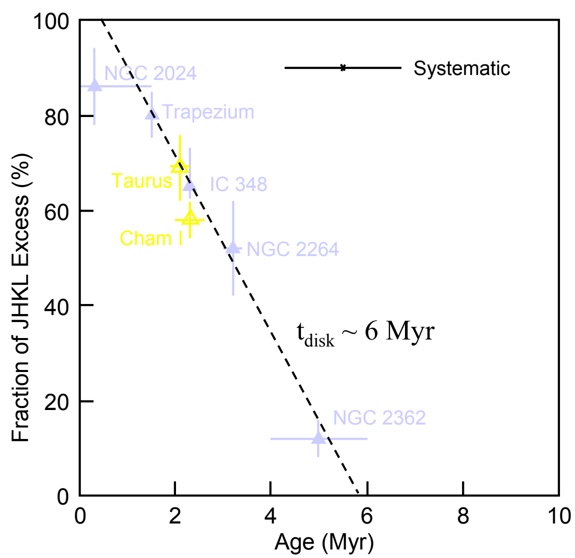


For wTTs sample projected on clouds, disk fraction increases with Hα EW, declines with age.

Cieza et al. 2006

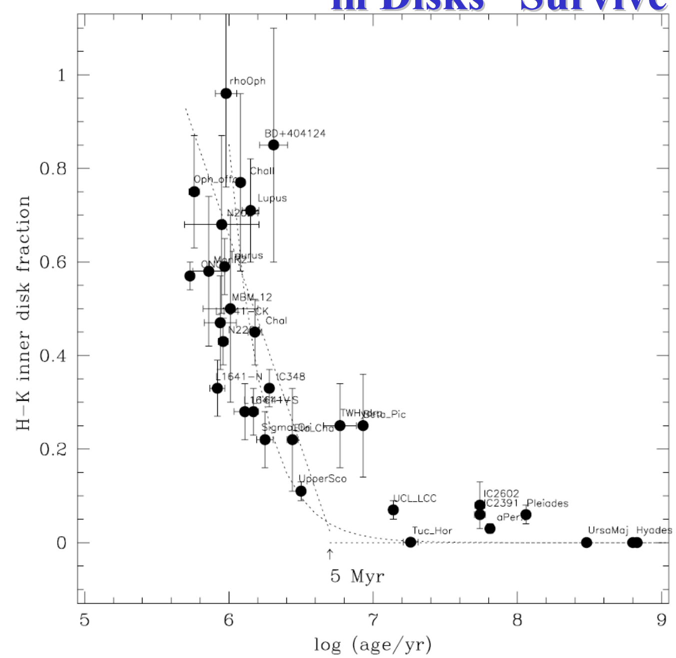
Near- IR Disk Lifetimes

- L-band (3.4 μm) light used as disk proxy
  - 900 K
  - ≥10^{20} g of dust
  - Inner disk (TBD)
- Disk lifetime ~6 Myr
- Principal uncertainty driven by NGC 2362
- Are outer and inner disk lifetimes the same?



Haisch, Lada, & Lada 2001

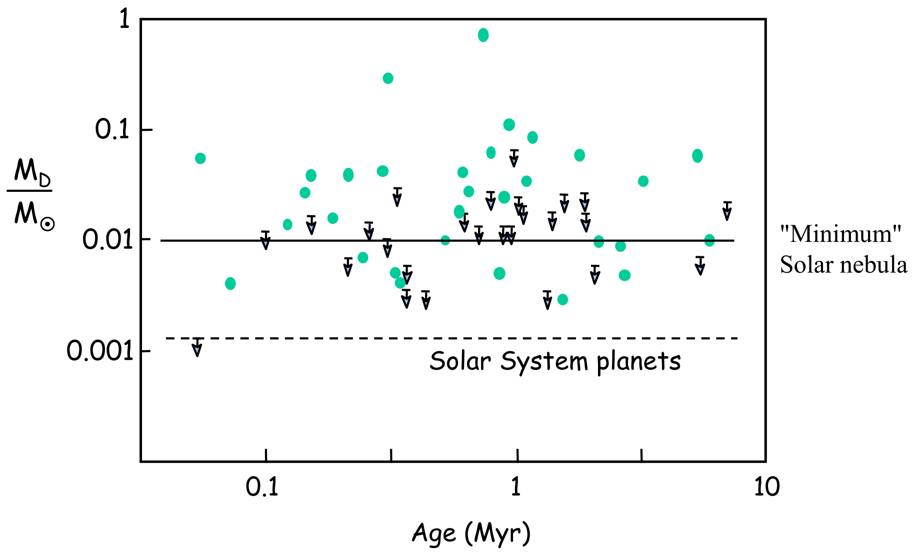
Statistically, How Long Do Dust Grains in Disks "Survive"?



Basic result:
Disks dissipate within a few Myr, but with a large disp. for any SINGLE system. When they go, however, the dissipation is FAST in comparison with disk "lifetime."

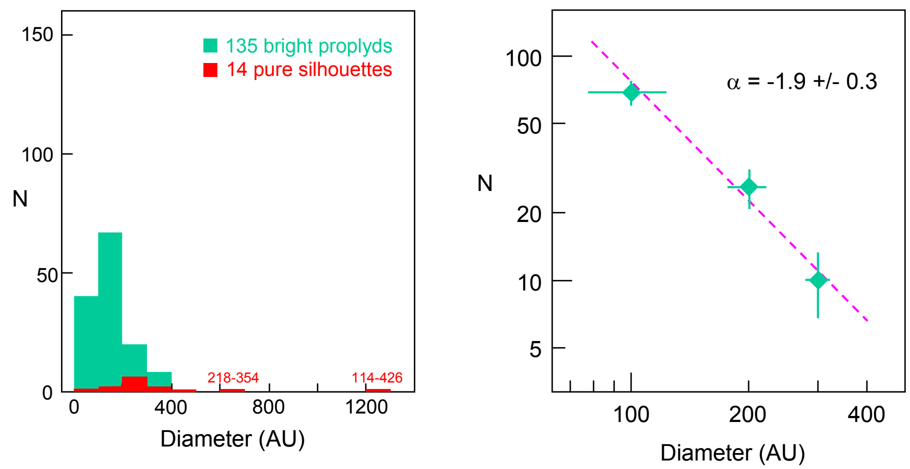
Gas???

Mass Evolution



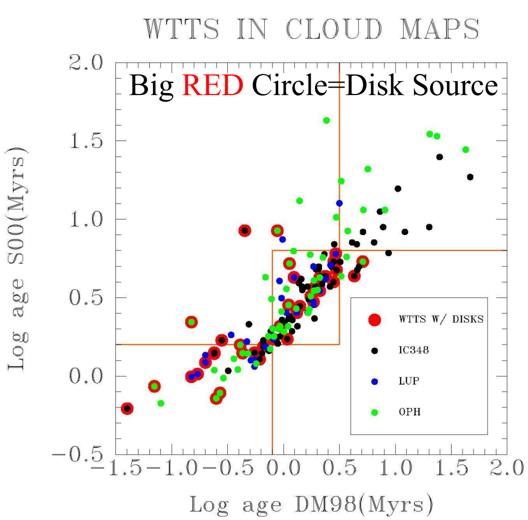
Beckwith et al. 1990

Distribution of Disk Radii: Orion



Vicente & Alves (2005)

Disk Timescales



Some wTTs do have disks, not seen with IRAS.

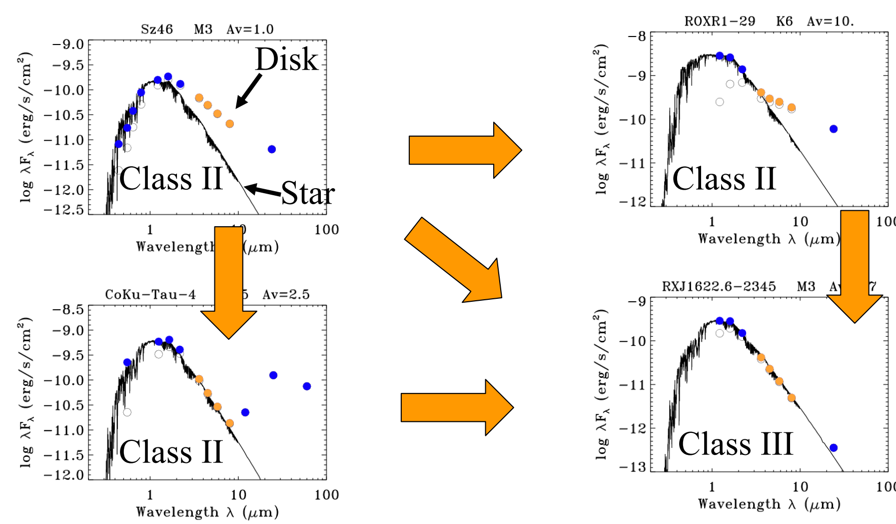
But, only the young ones (age < 3 to 6 MYr)

The ages are uncertain due to models, but ~half the young wTTs lack disks (even at 0.8 to 1.5 Myr).

Thus, time is NOT the only variable. How might disks evolve?

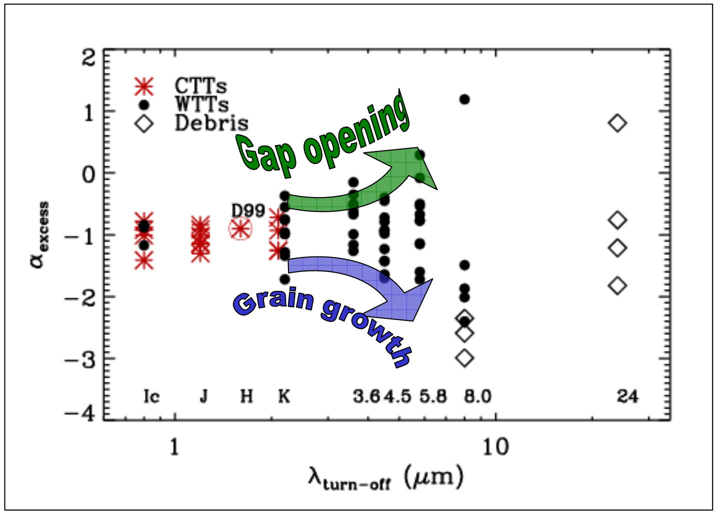
Padgett et al., 2006; Cieza et al., 2006

That is, are there multiple paths from optically thick to optically thin disks?



Mapping Evolutionary Paths?

Evolutionary sequence: cTTs ➡ wTTs ➡ Debris



α is the slope of the IR excess, λ_{t-o} where the star and disk contribute equally to the SED.