Evolution of disks around low mass stars and brown dwarfs in the context of the Lambda Orionis Star Forming Region

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OPSII, Vitacura

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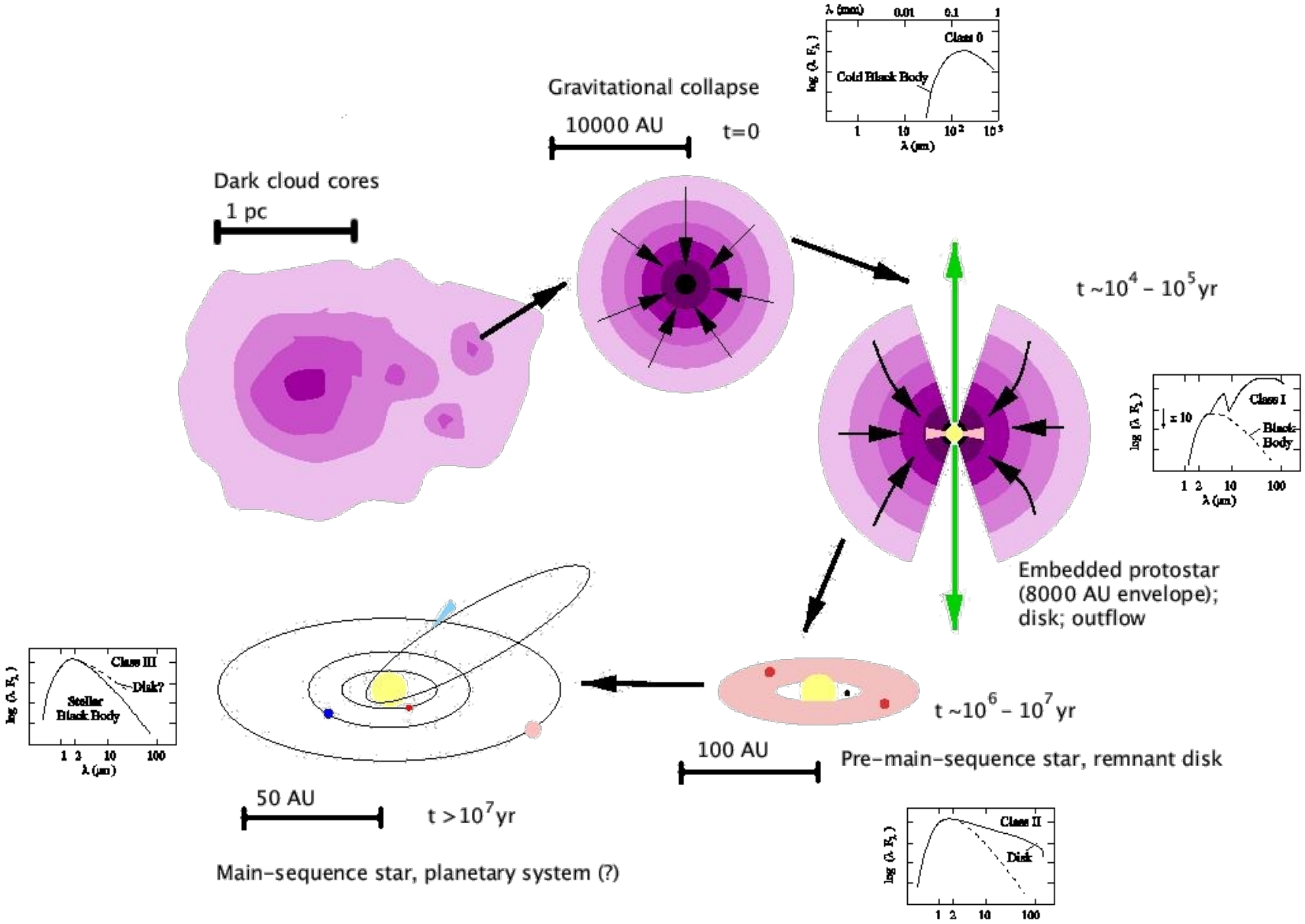
Low mass SF Theory (I)



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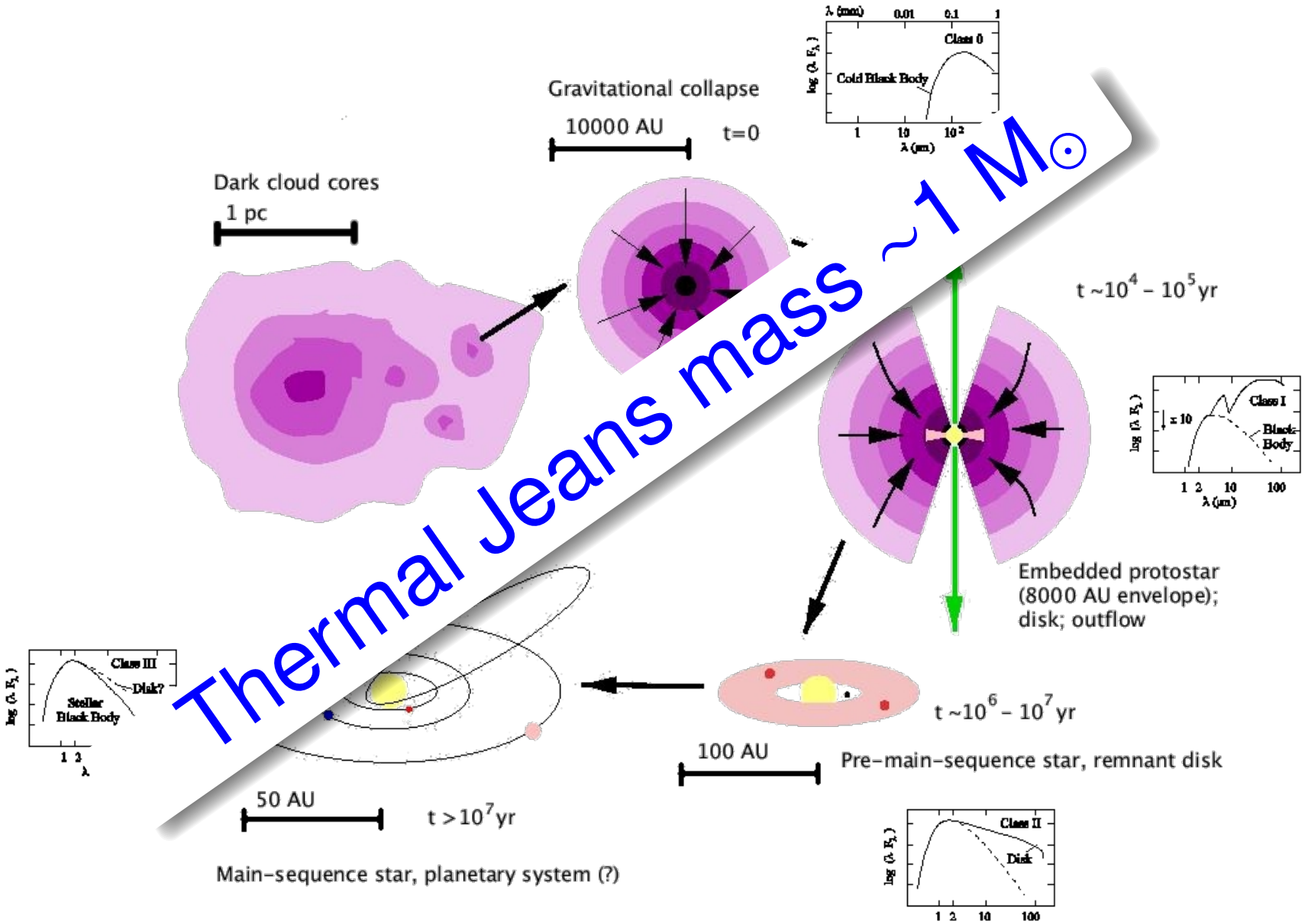

Low mass SF Theory (II)

Turbulent fragmentation *(Padoan & Nordlund, 2002; Hennebelle & Chabrier, 2008)*: density enhancements → decrease the Jeans mass

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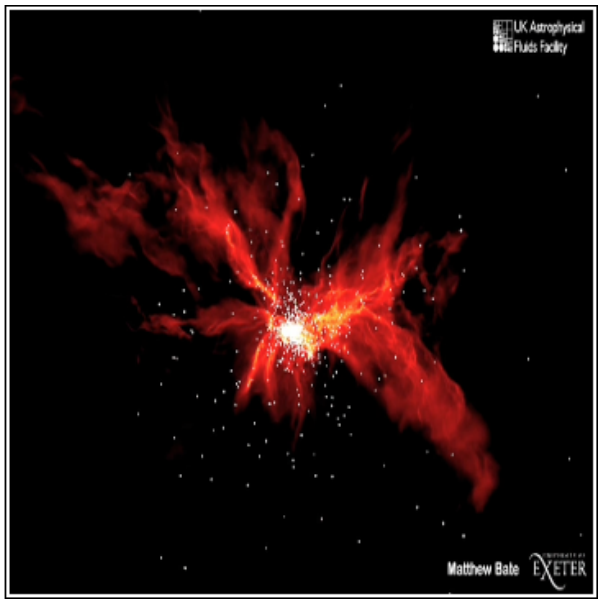
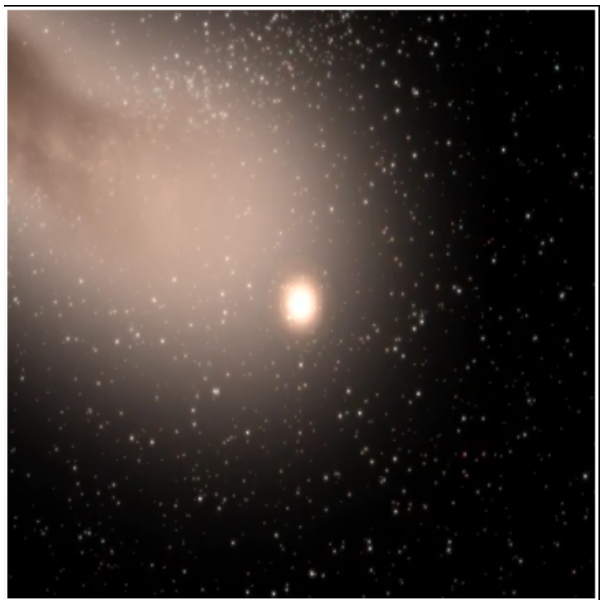
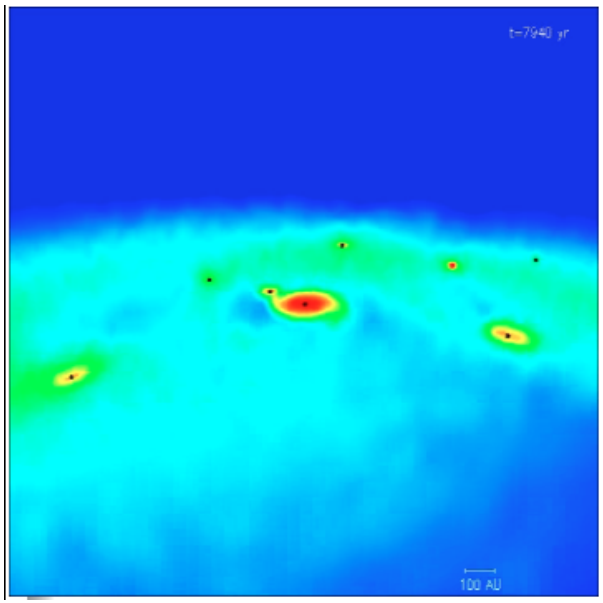


Ejection scenario *(Reipurth & Clarke 2001)*: distribution of BDs different than stars?

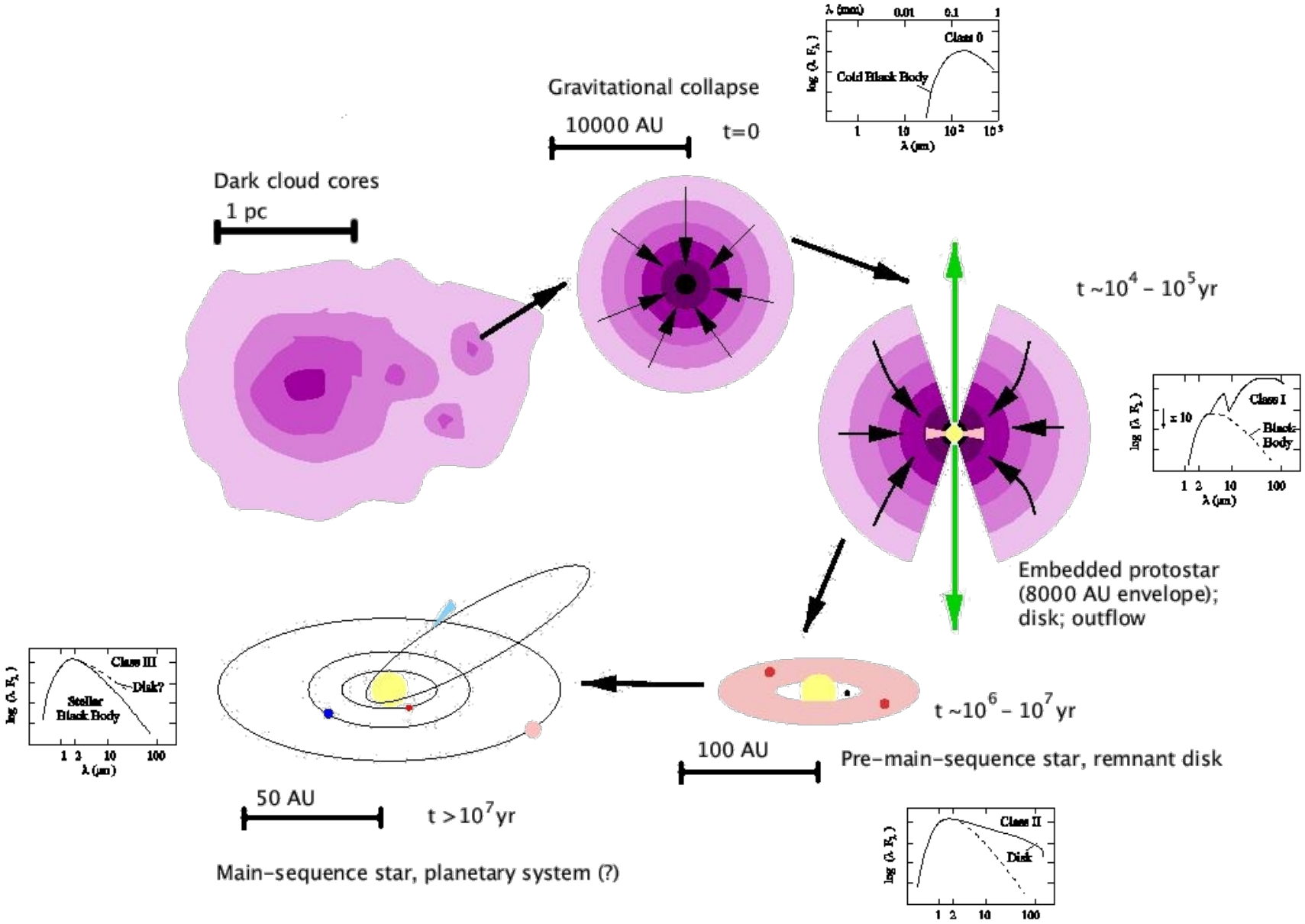


Photoevaporation *(Whitworth & Zinnecker 2004)*: BD/star depend. on environment?

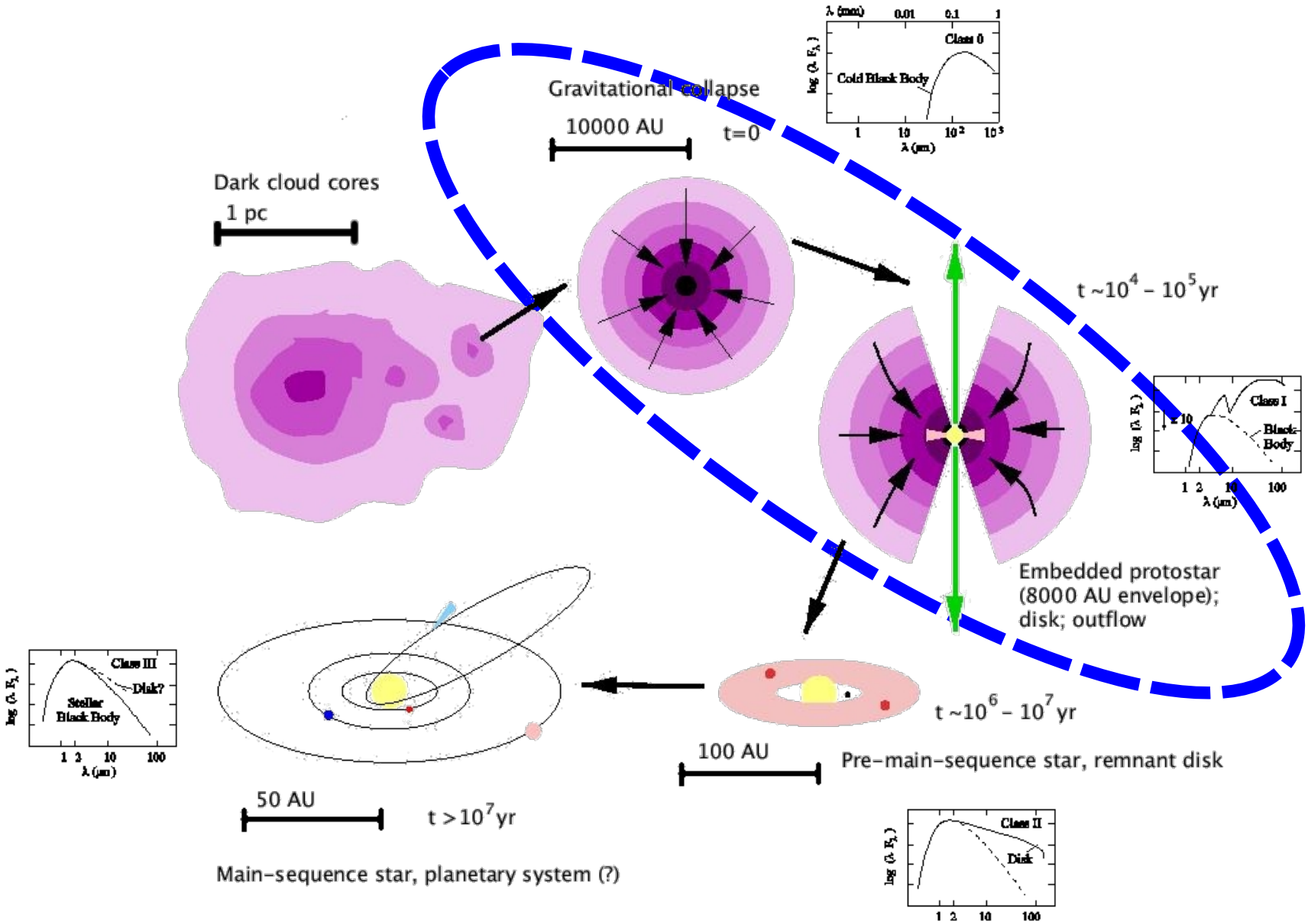


Disk fragmentation *(Goodwin & Whitworth, 2007; Stamatellos et al 2007)*: scaled up version of planets

Low mass SF Theory (III)



Low mass SF Theory (III)



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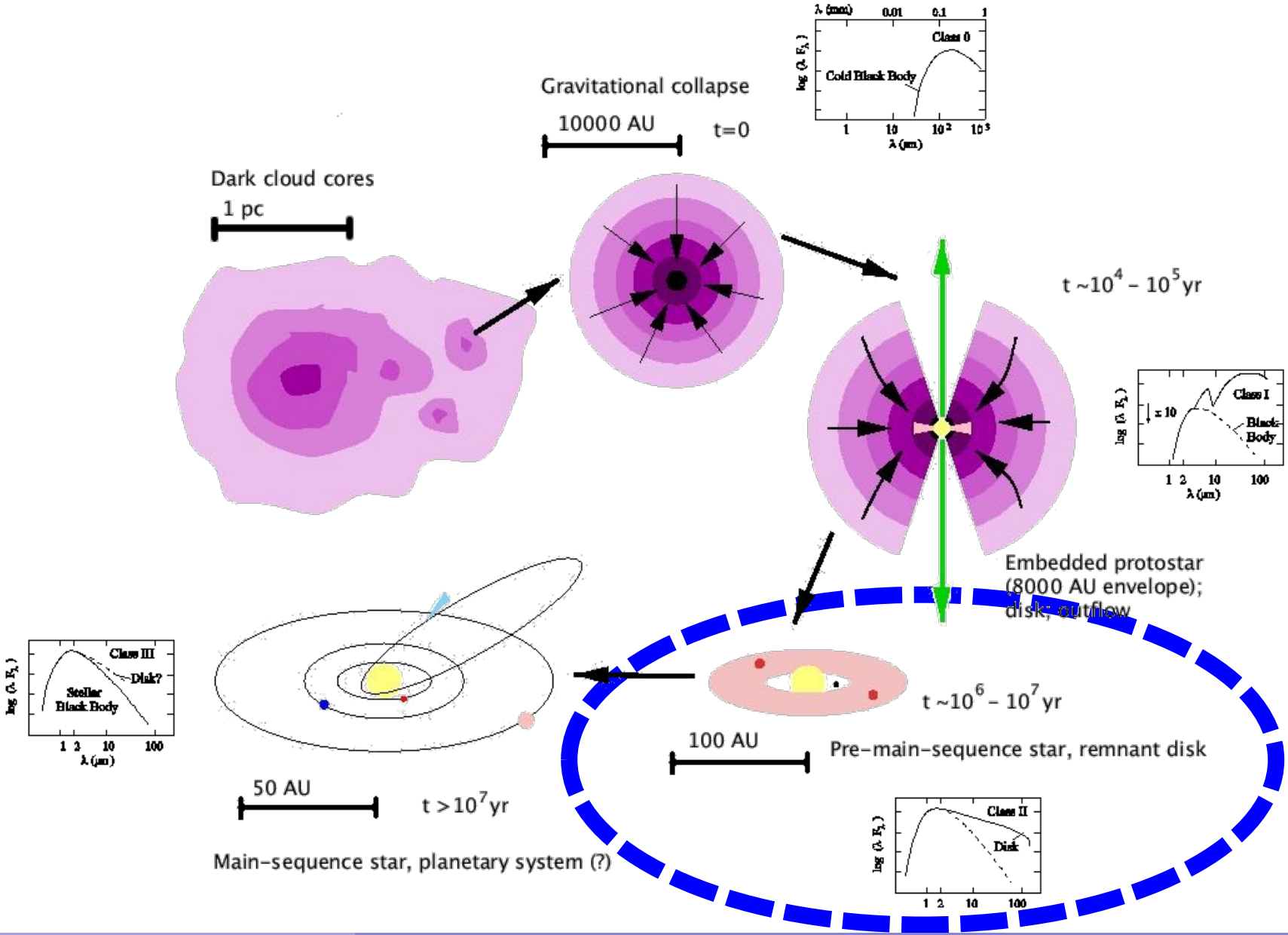
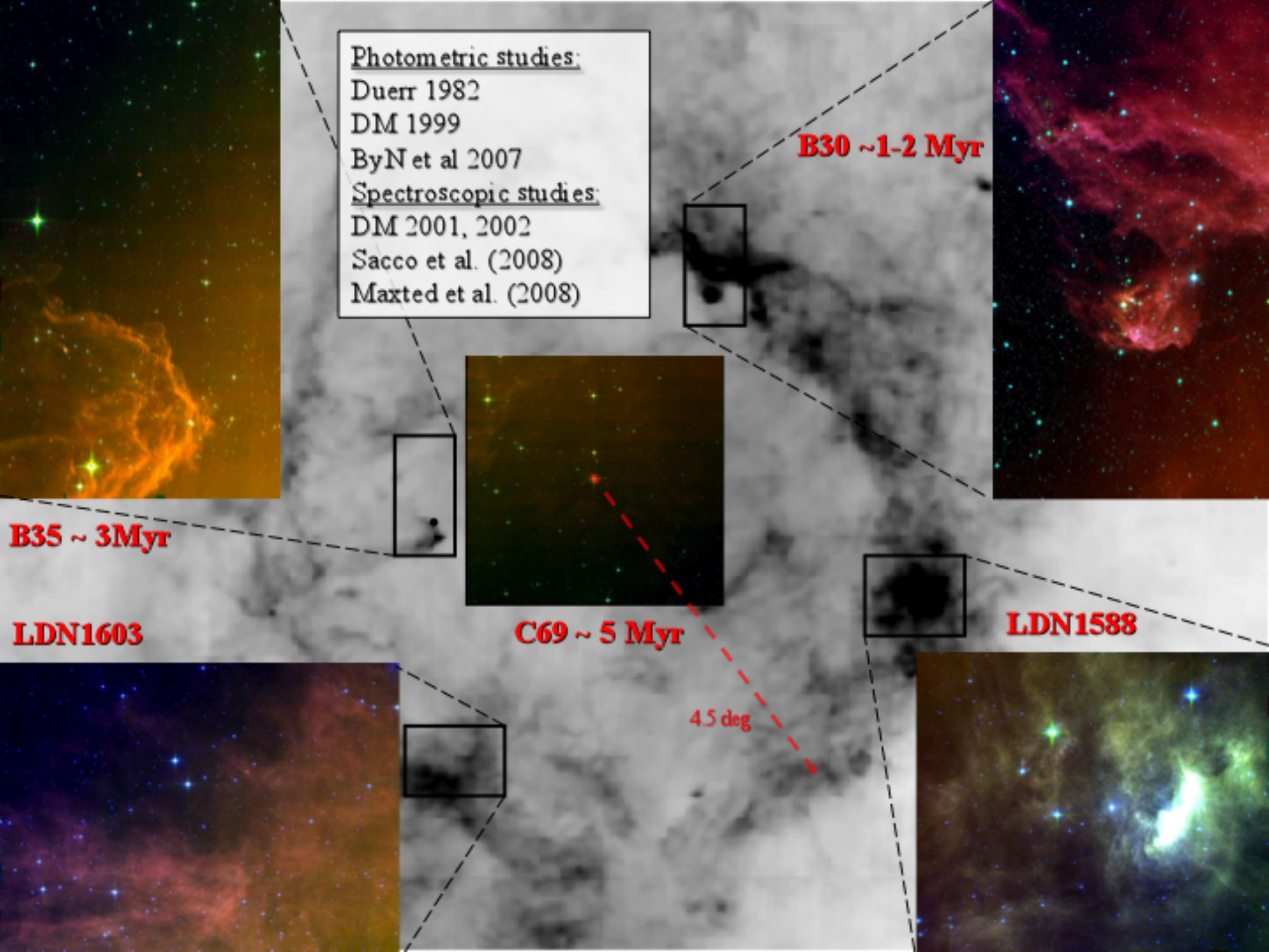
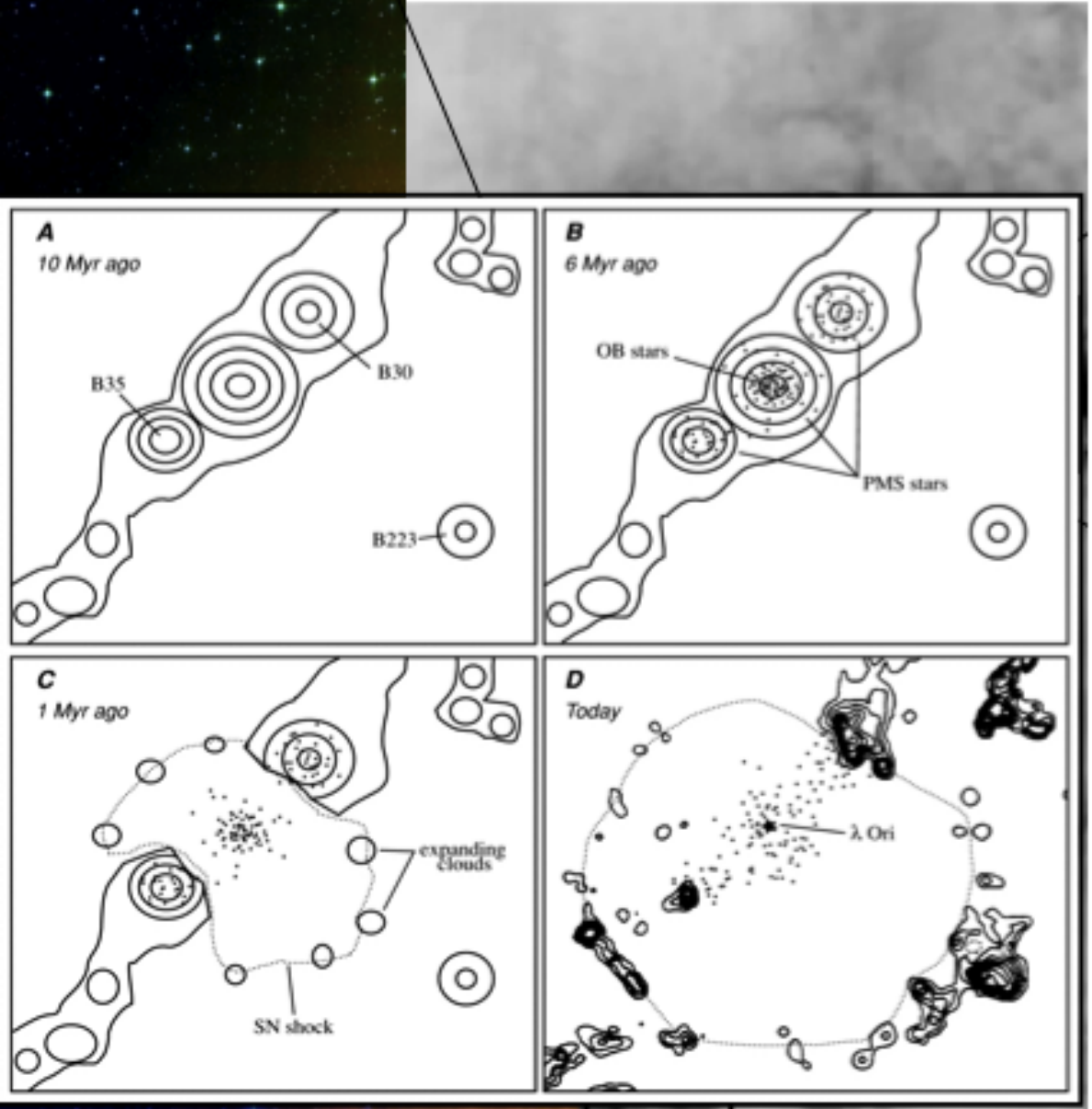



Photometric studies:
Duerr 1982
DM 1999
ByN et al 2007
Spectroscopic studies:
DM 2001, 2002
Sacco et al. (2008)
Maxted et al. (2008)
B30 ~1-2 Myr
B35 ~ 3Myr
C69 ~ 5 Myr
LDN1603
LDN1588
4.5 deg



Dolan & Mathieu (2002)

A. ~8–10 Myr ago, the λ Ori region was composed of a starless, roughly linear string of dense molecular clouds.

B. Over the next few Myr, stars began to form in the densest portions of this cloud chain. 6 Myr ago, a dozen OB stars formed near λ Ori's present-day position while low-mass stars formed in all productive areas of the star-forming complex.

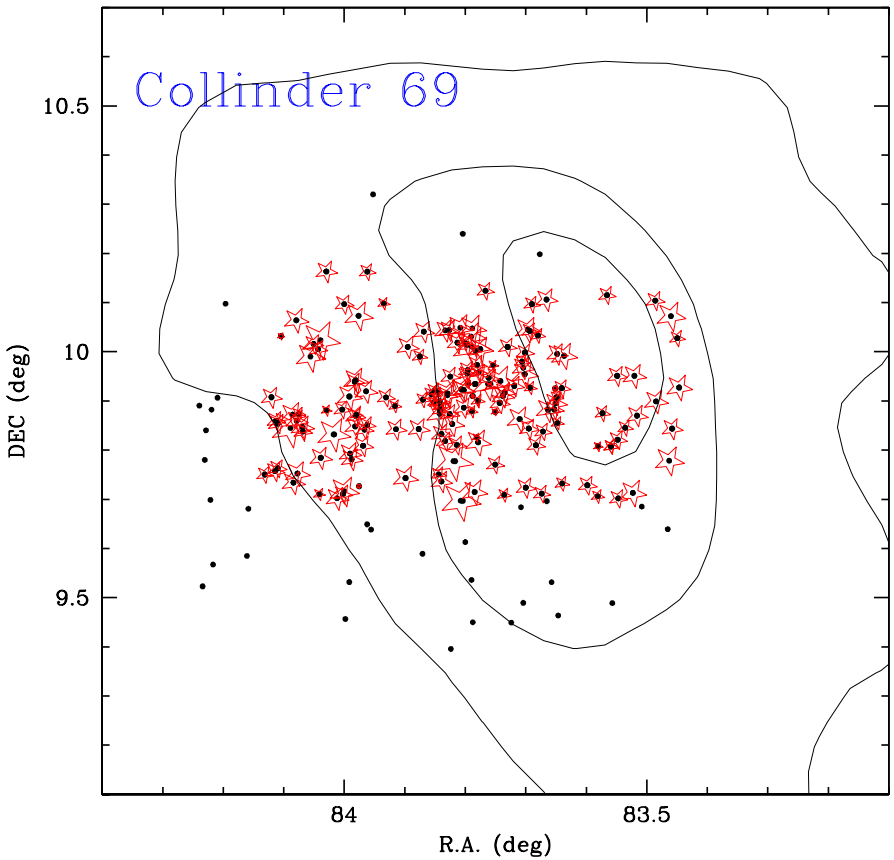
C. ~1 Myr ago, one of the O stars became a supernova. The blast quickly dispersed all of the parent core, creating the molecular ring, the large HII region, and the nearby HI structures.

D. Today we see the fossil distribution of young stars within the molecular ring, as well as the remnants of the B30 and B35 clouds within the ionized region.

Aims

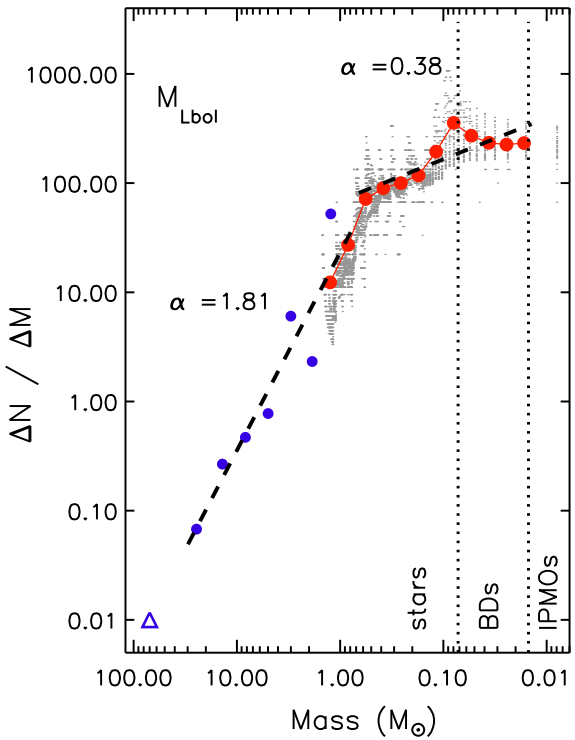
- Study accretion, activity and rotation for a wide set of (spectroscopically) confirmed members of Collinder 69.
- Draw analogies and/or differences between the brown dwarf and stellar populations of this cluster.
- Compare with other star forming regions of similar and different ages to address environmental effects.

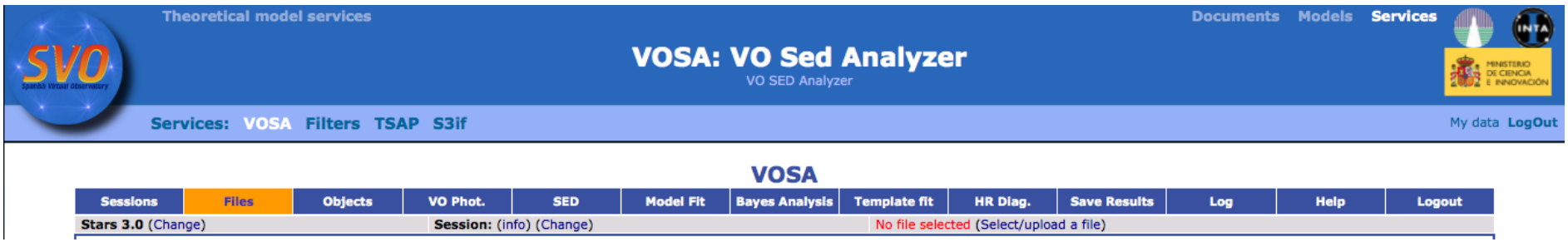
A very complete census



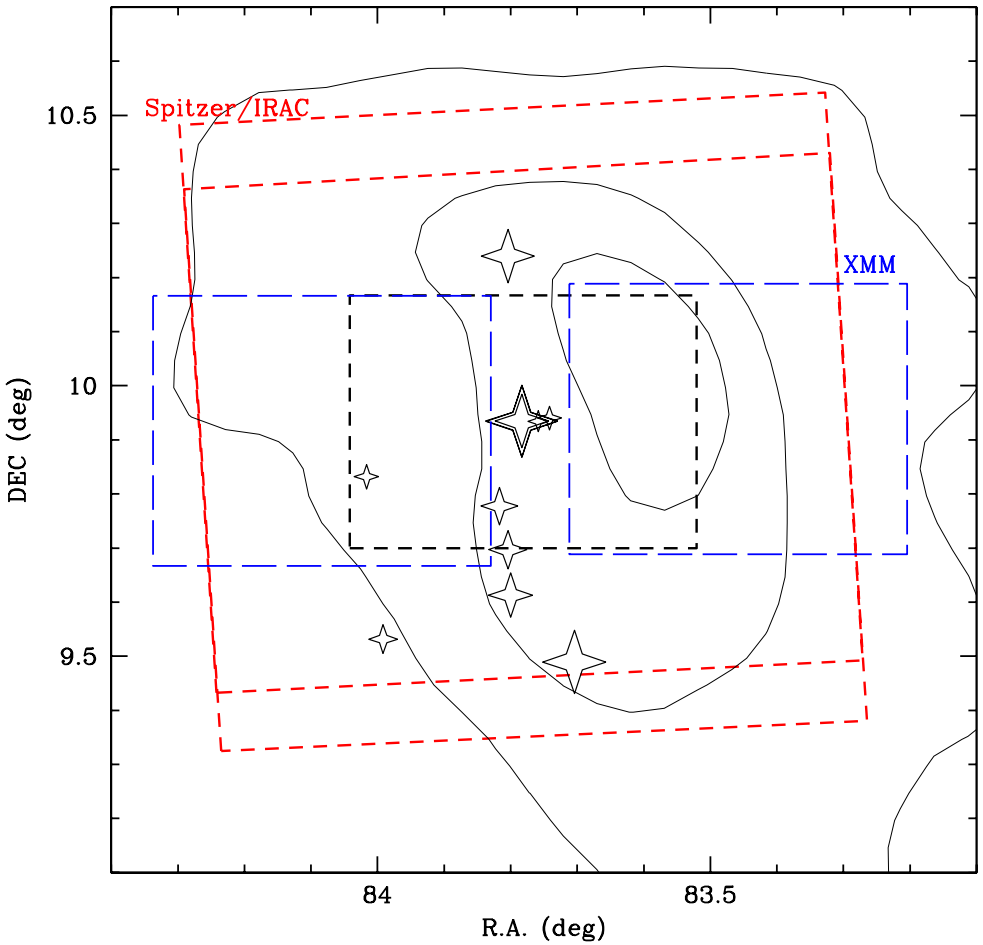
Complete over 3 orders of magnitude

Bayo et al. 2011





MIR photometry and X-rays



IRAC & MIPS (MIR)

Barrado et al. 2007, Morales-Calderón PhD

XMM-Newton (X-rays)

Barrado et al. 2011

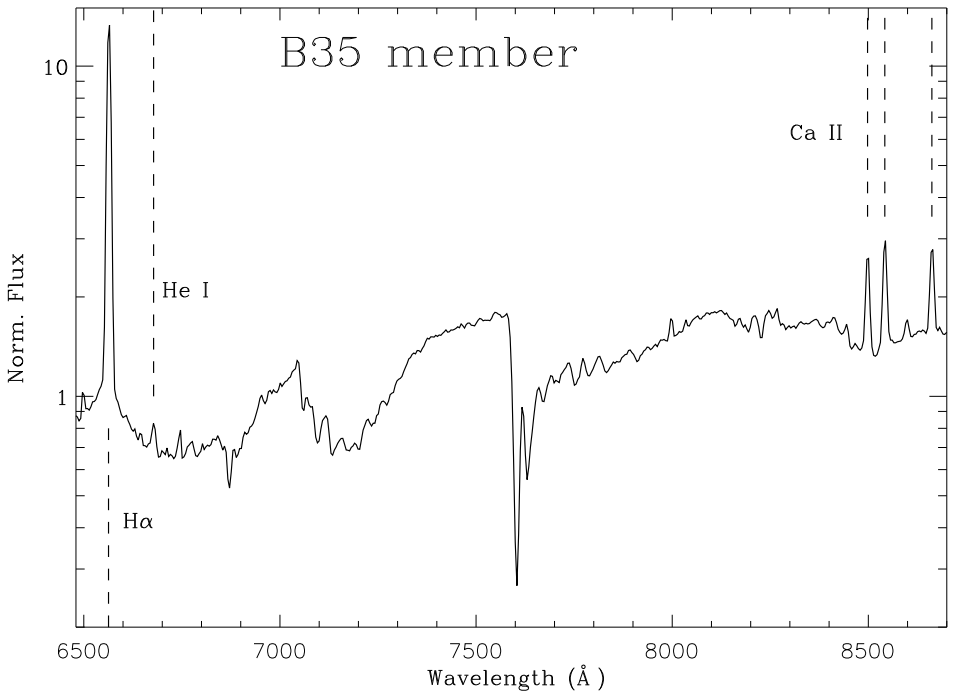
XMM- Newton (X-rays)

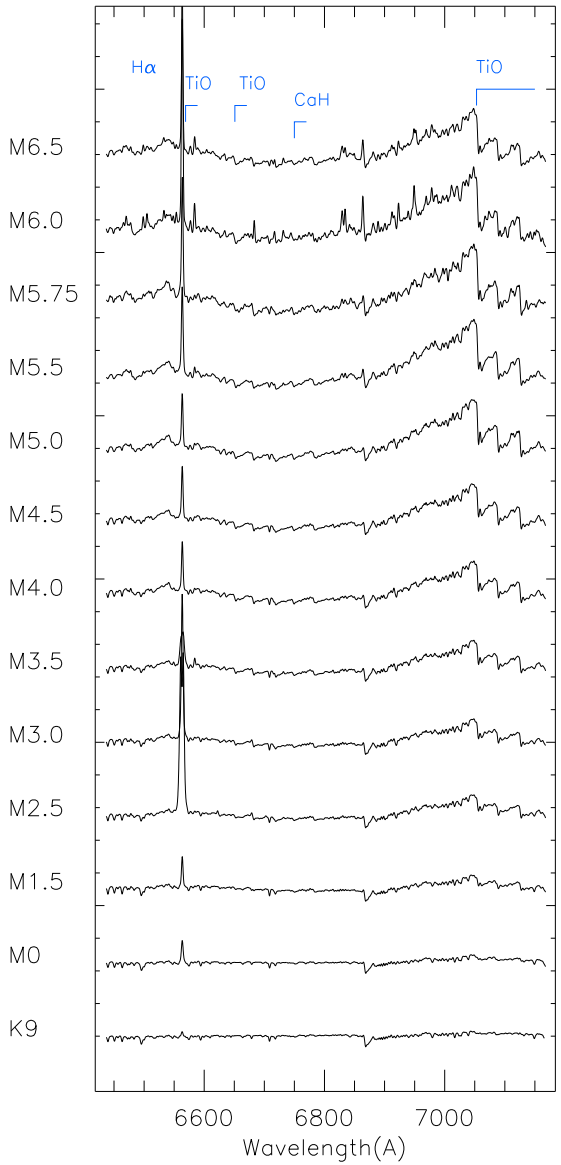
Franciosini & Sacco 2011

Spectroscopic survey

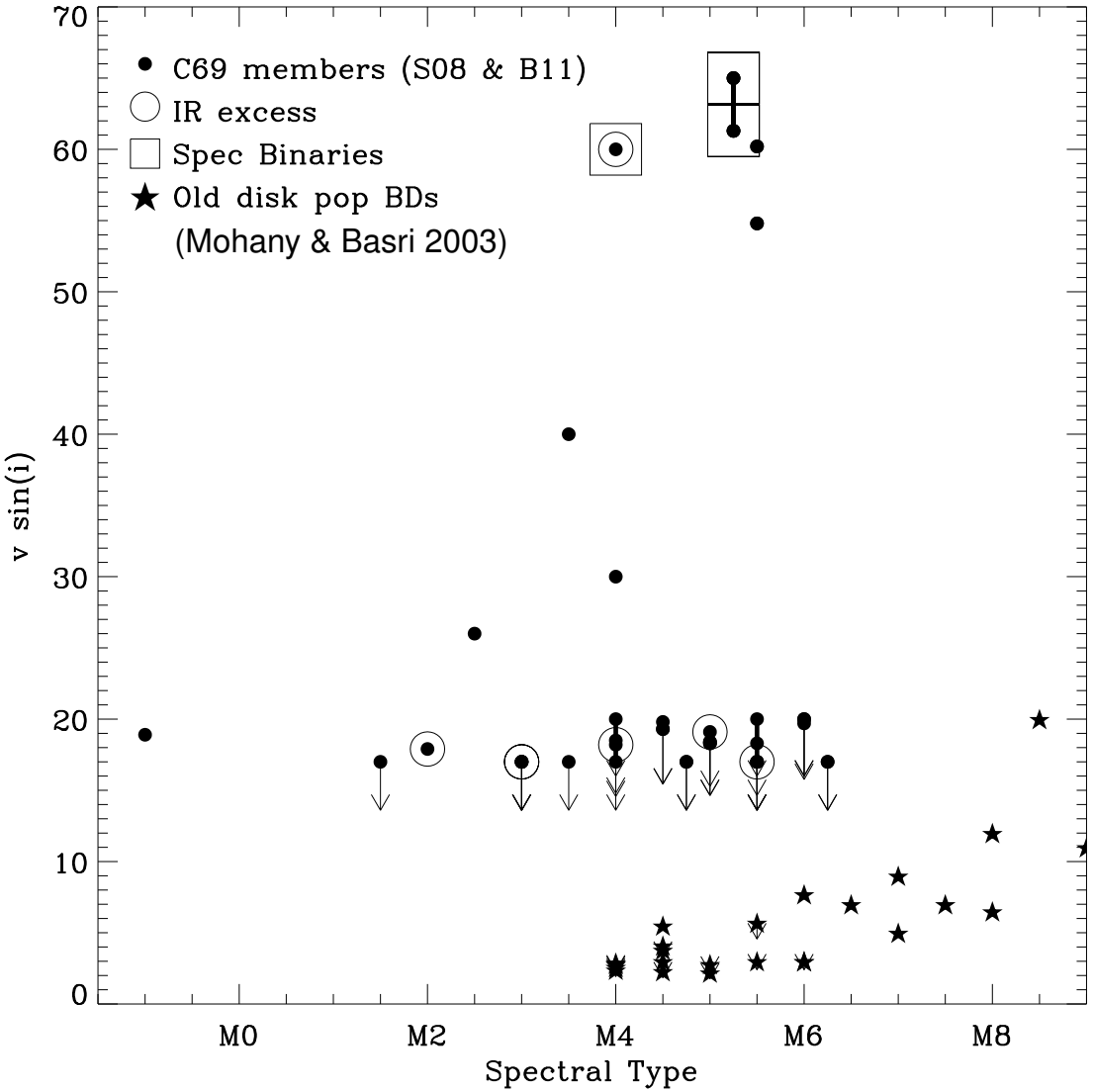
Bayo et al. 2011

- Rotational velocities
- Emission lines ⇒ activity and accretion





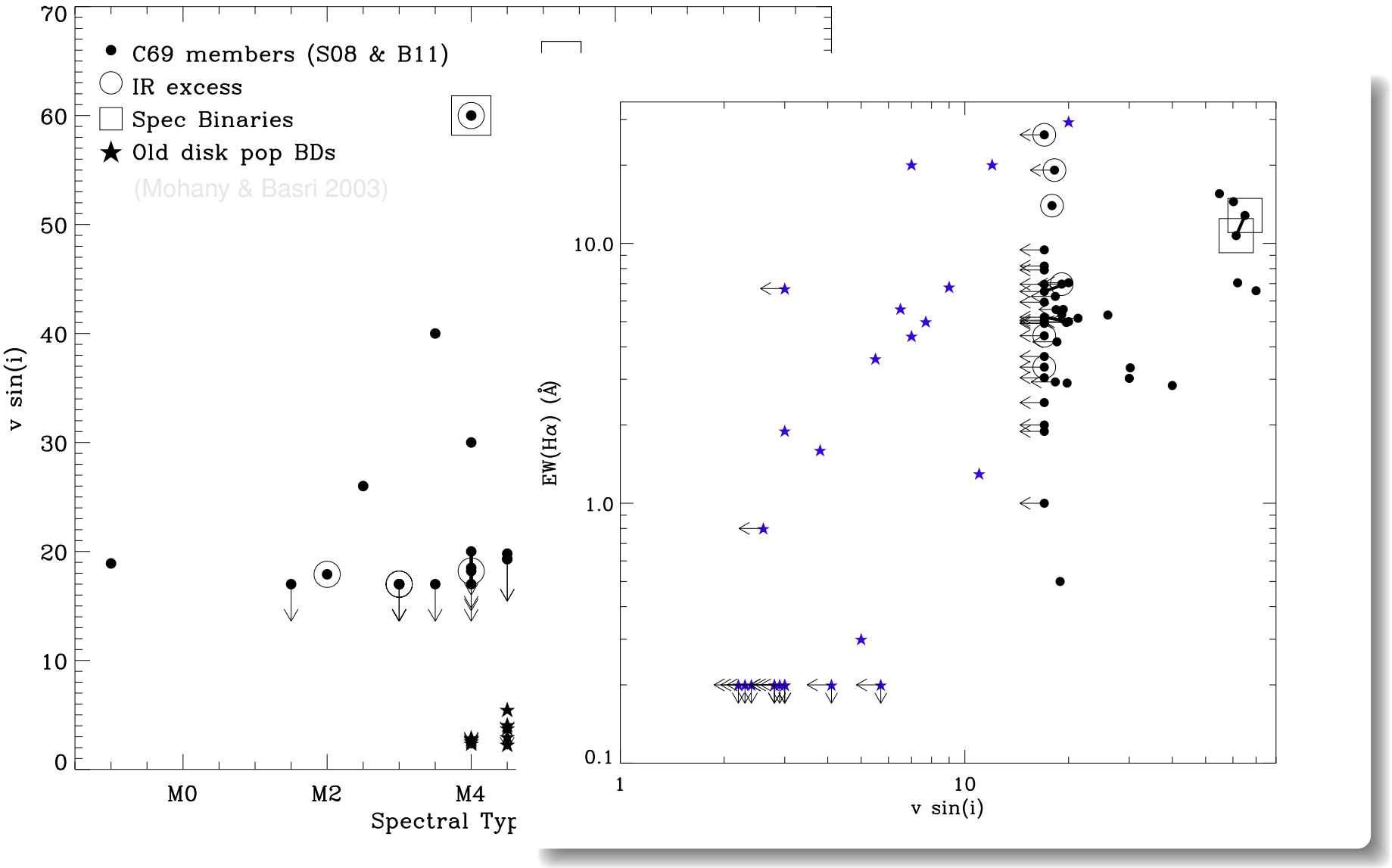
Rotation in Collinder 69



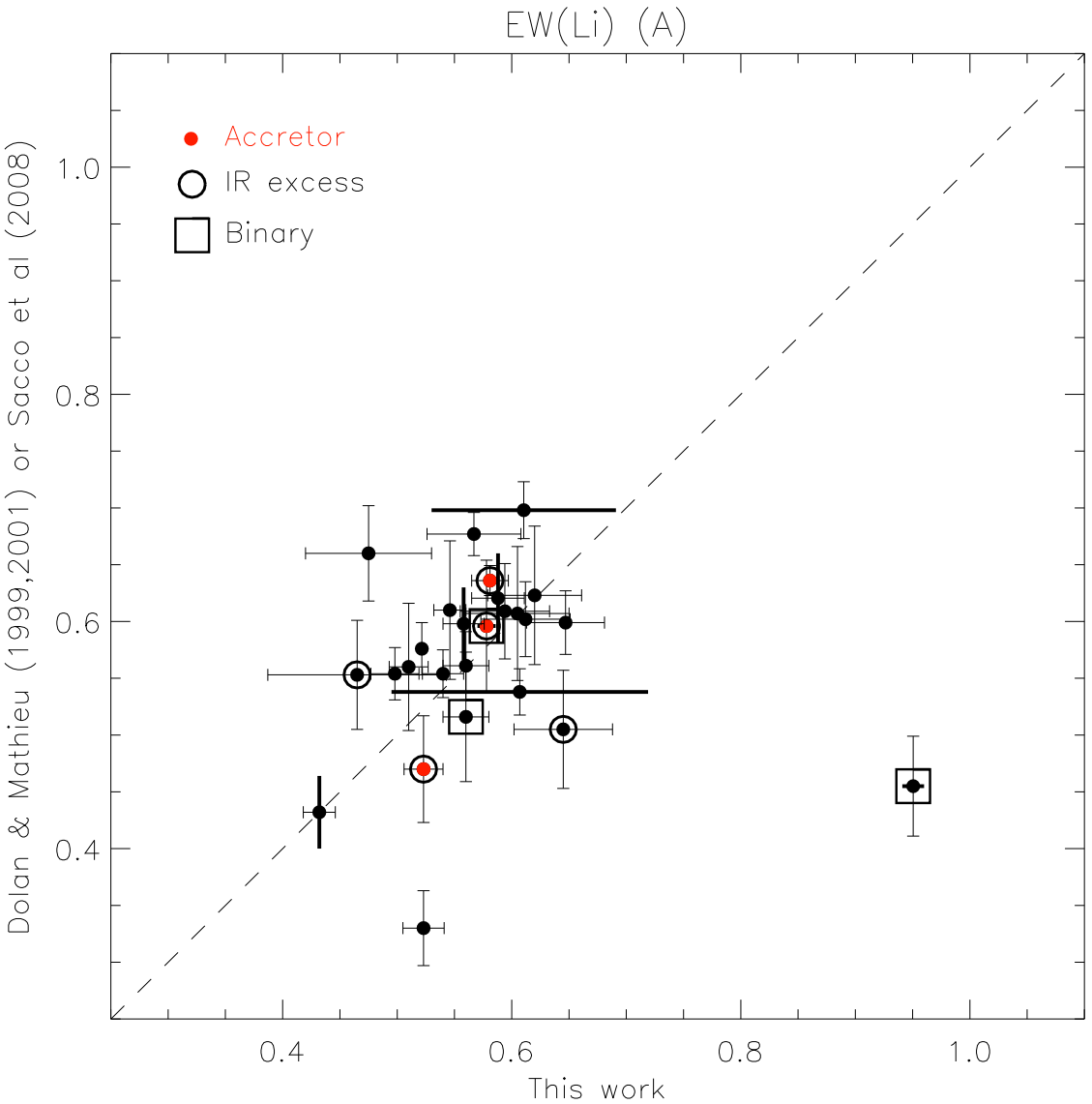
- Faster rotators than old disk population BDs
- Disk locking

  Bouvier et al. 1997

Rotation in Collinder 69



Activity: alkali variability

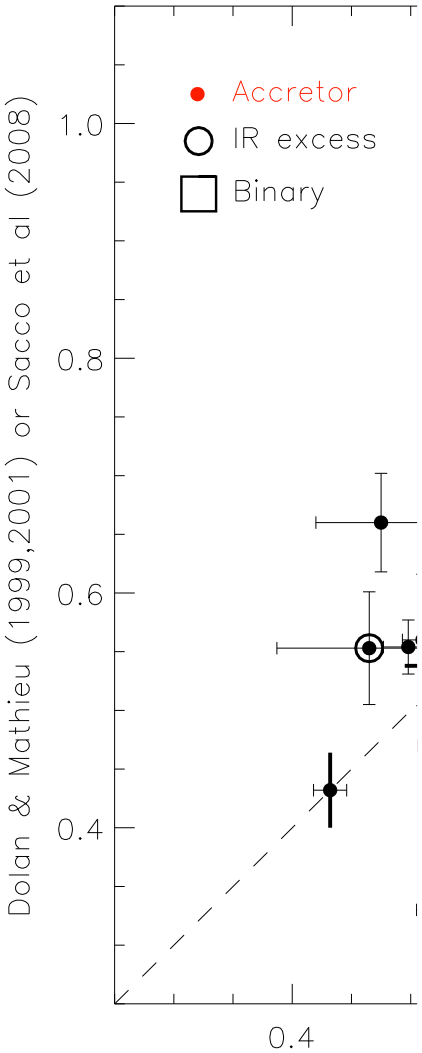


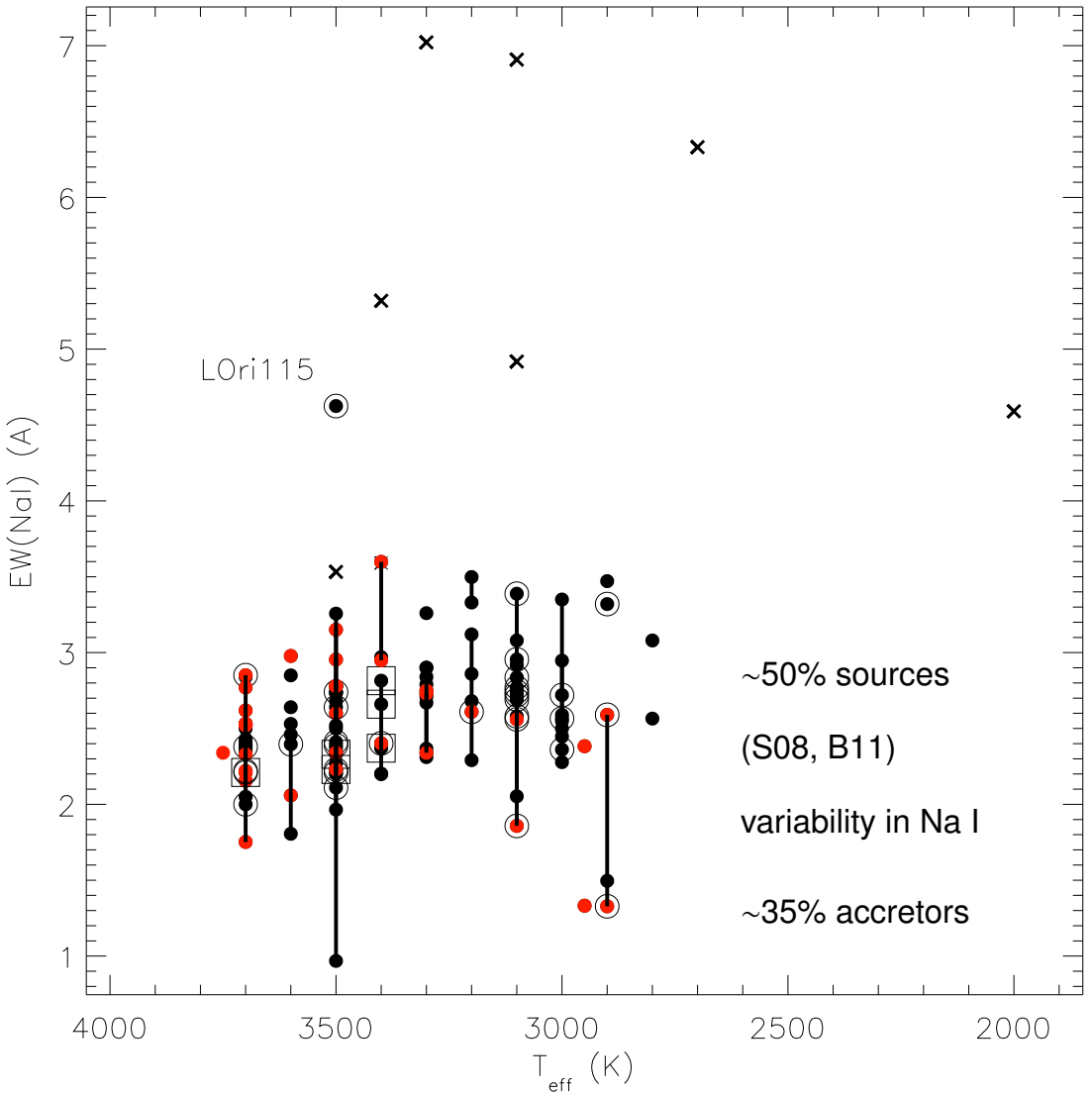
~30% sources (DM, S08, B11) variability in Li I

All active stars (Xrays or Hα variability)

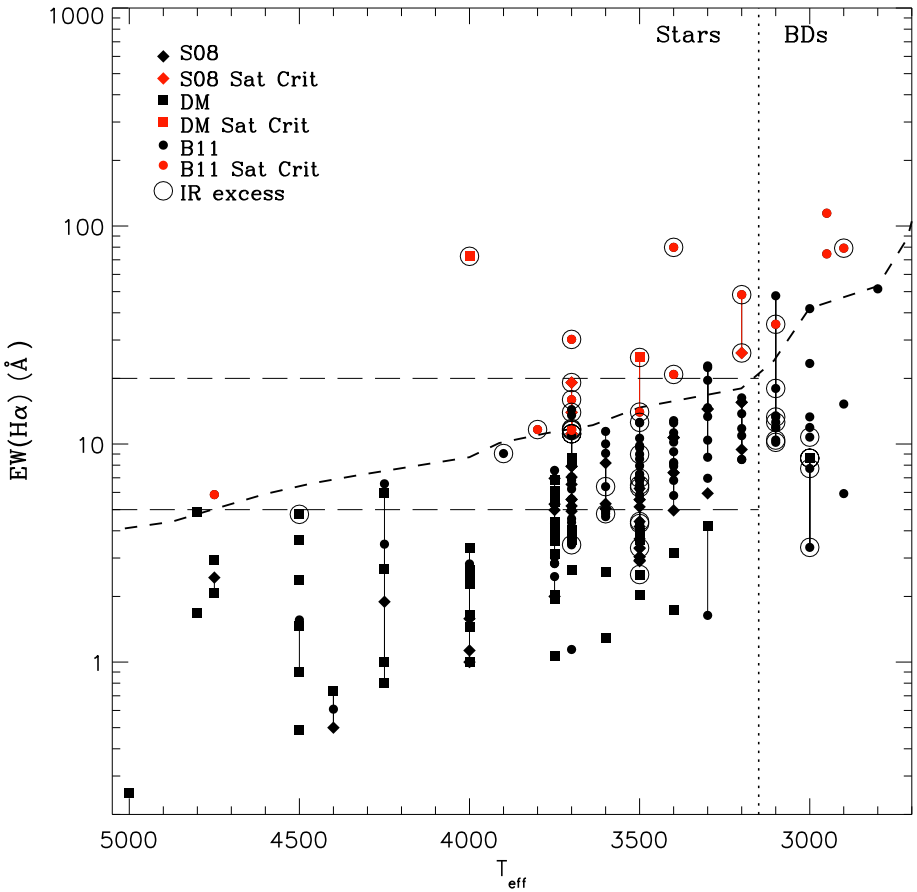
Soderblom et al. 1993, Barrado et al. 2001, Stauffer et al. 2008

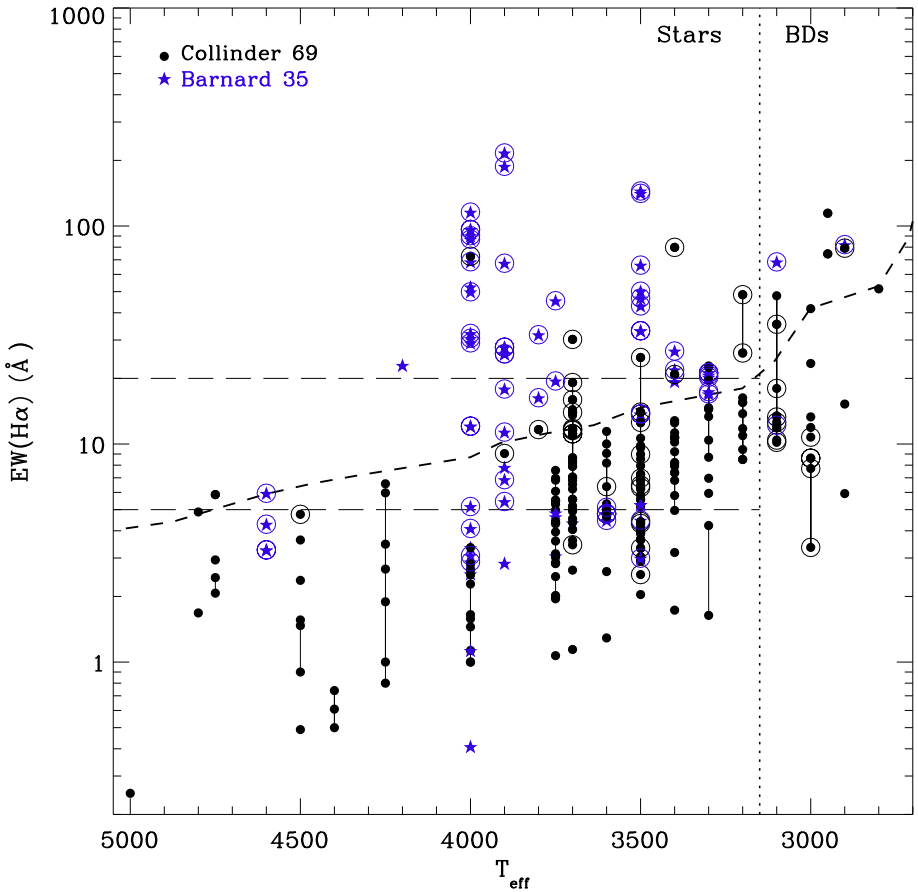
Activity: alkali variability





Distinguishing between accretion and activity





Saturation criteria Barrado y Navascués & Martin (2003)

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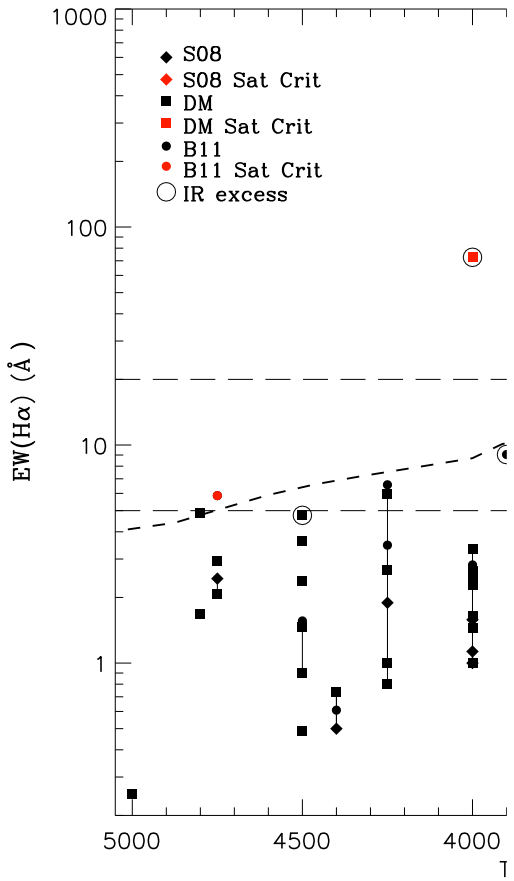
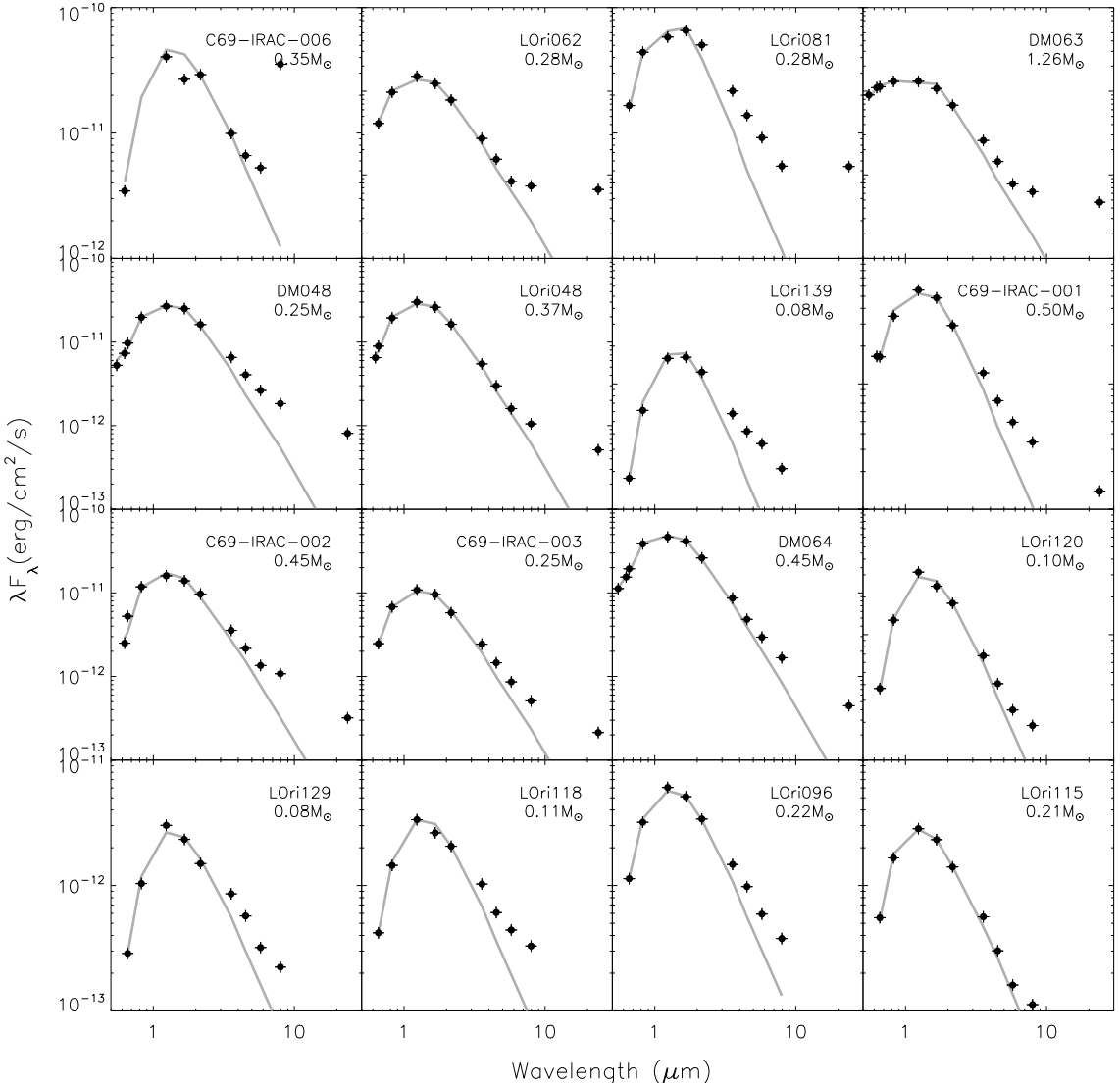
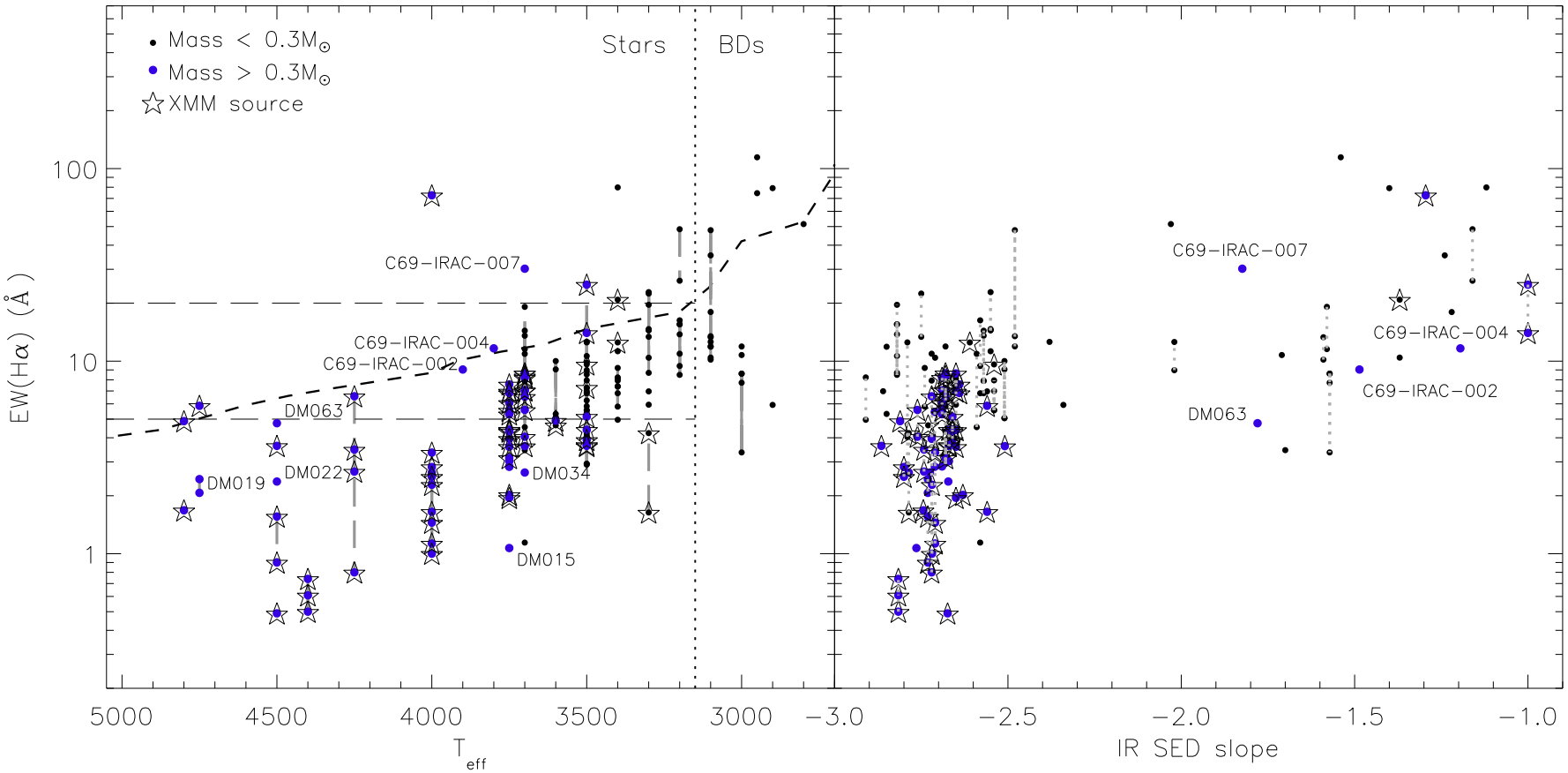




Saturation criteria I

Distinguishing between accretion and activity

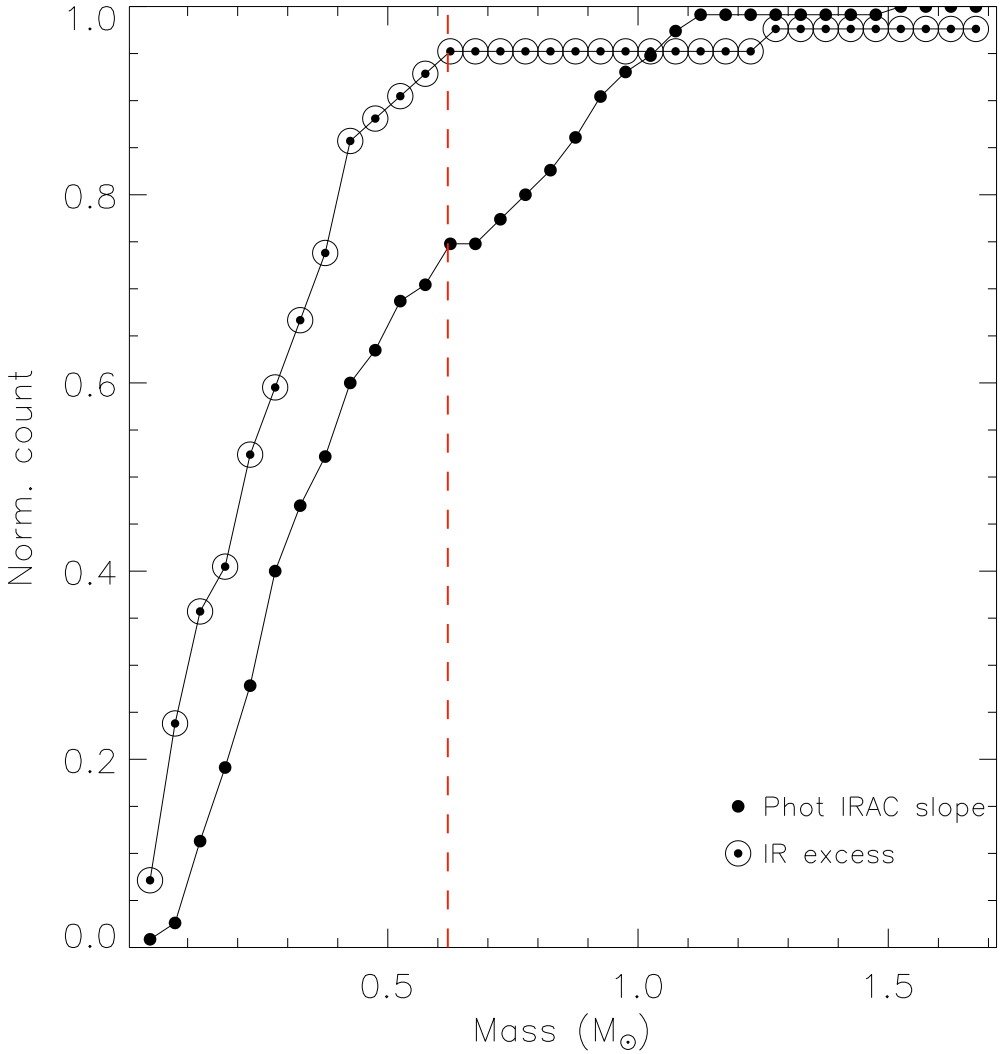
X-ray crucial for activity



Saturation criteria Barrado y Navascués & Martin (2003)

Disks Properties

Dramatic change at $0.6M_{\odot} \Rightarrow$ M2 SpT



Stellar disk fraction 28.5%

Sub-stellar disk fraction >30%

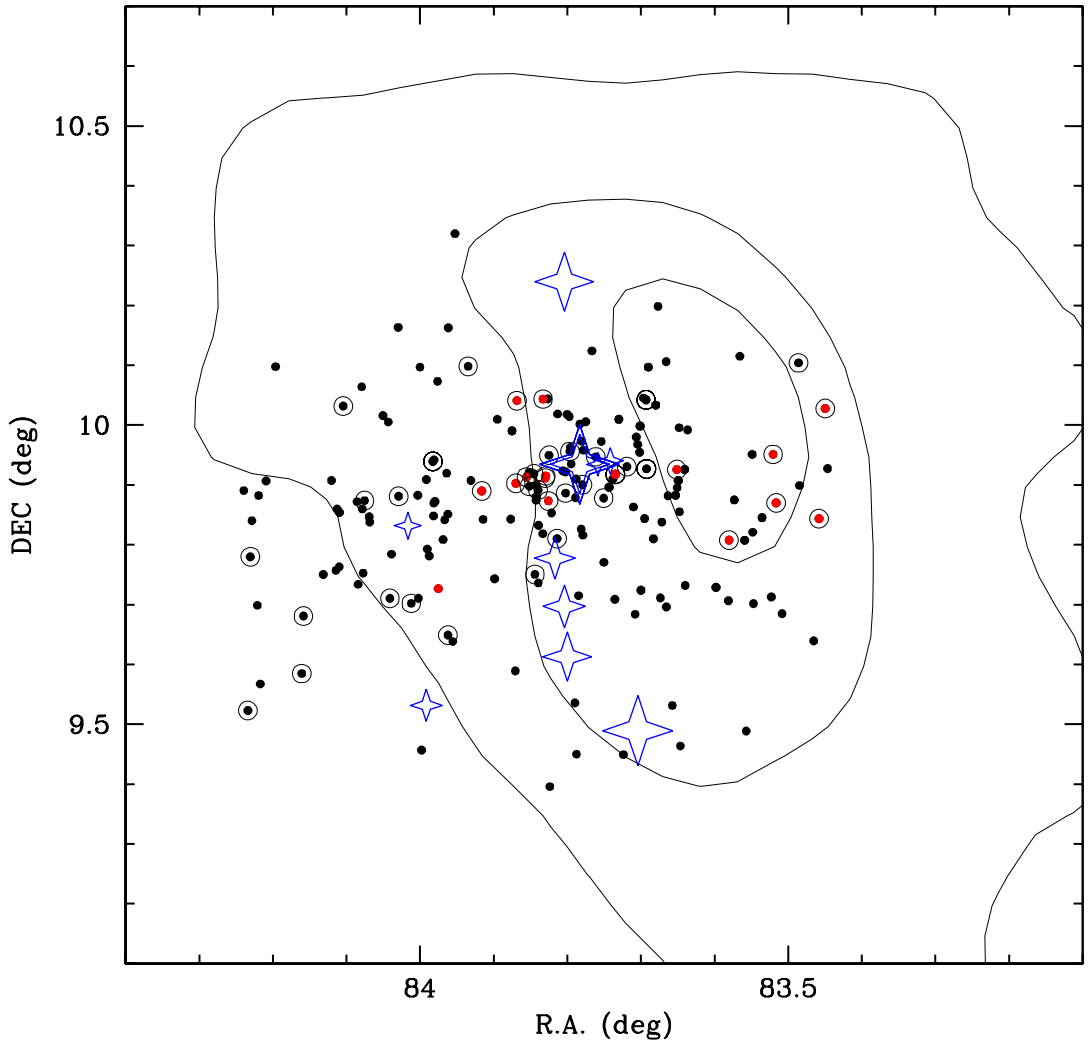
Barrado y Navascués et al. (2004) 40%
Scholz et al. (2007) 37.9% for Upper-Sco

Sub-stellar acc. fraction ~18%

Scholz et al. (2007) 31% for Upper Sco (low-mass and sub-stellar)

Disks: spatial distribution

- Distribution of disk and diskless populations different ⇒ Caveats to the SN hypothesis.
- Mass dichotomy



Conclusions

- Very high member rate showing variability in alkali lines $\Rightarrow$ related to activity.
- Large fraction of “quiet" disks when compared to the other associations in the complex (awaiting for completeness in the weak line TTauri sample).
- Drastic change in the disk fraction at $\sim 0.6 M_{\odot}$
- Study of the disks distribution: Not consistent with the distribution found for more massive members in DM02

THANK YOU!!!