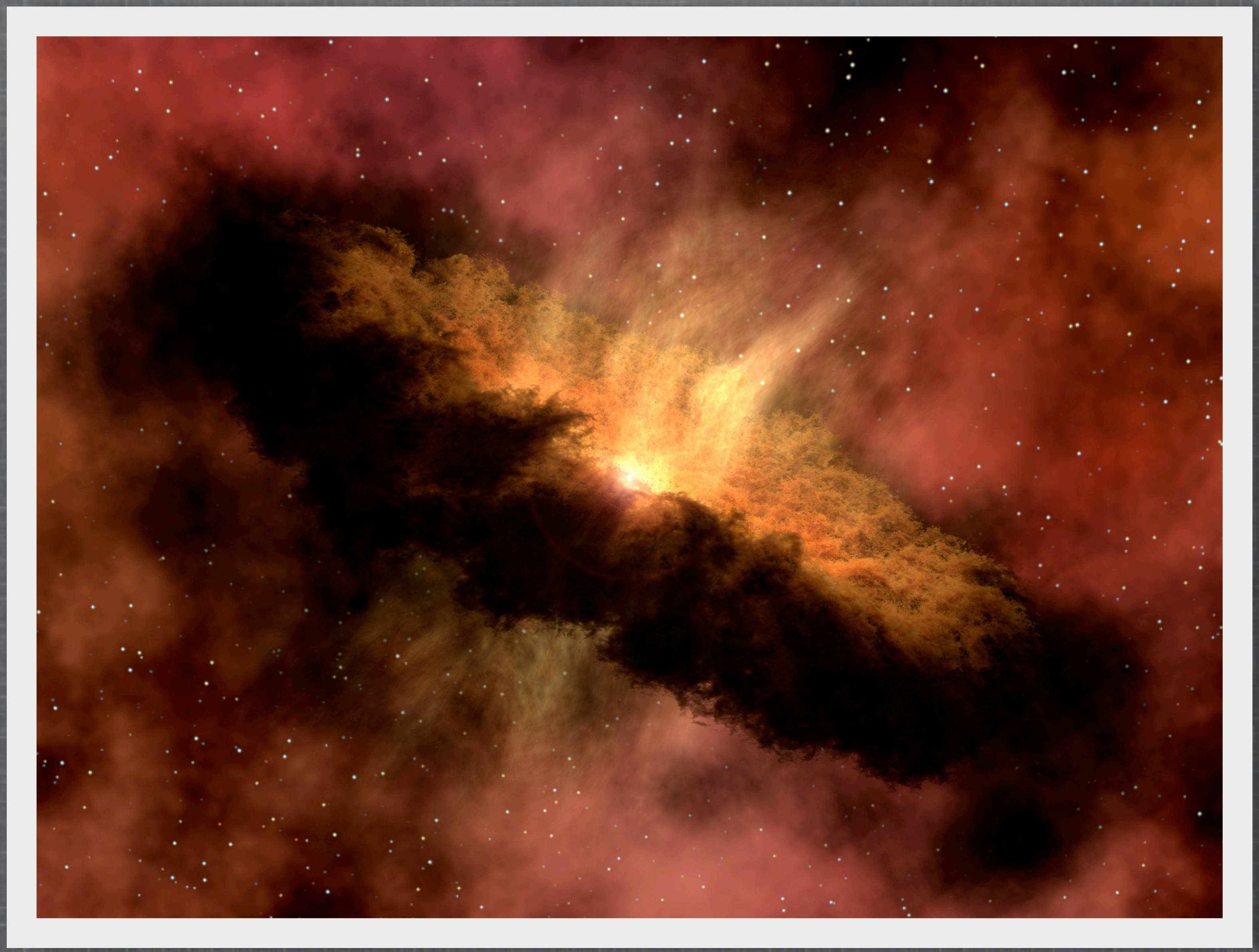
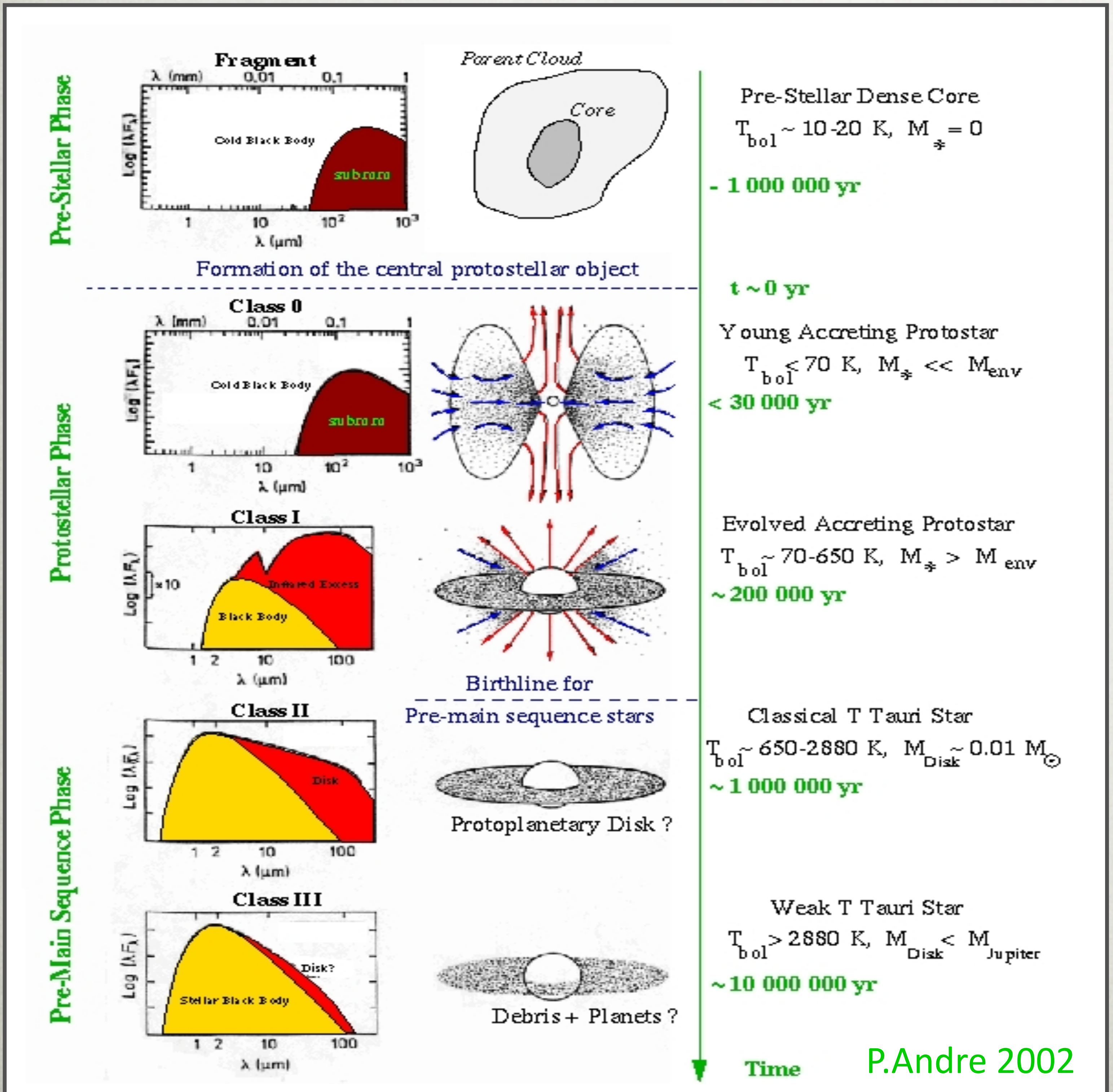
MEASURING DISK MASSES OF CLASS I PROTOSTARS

Patrick Sheehan and Josh Eisner



CARMA Symposium 2013

Part I: Introduction



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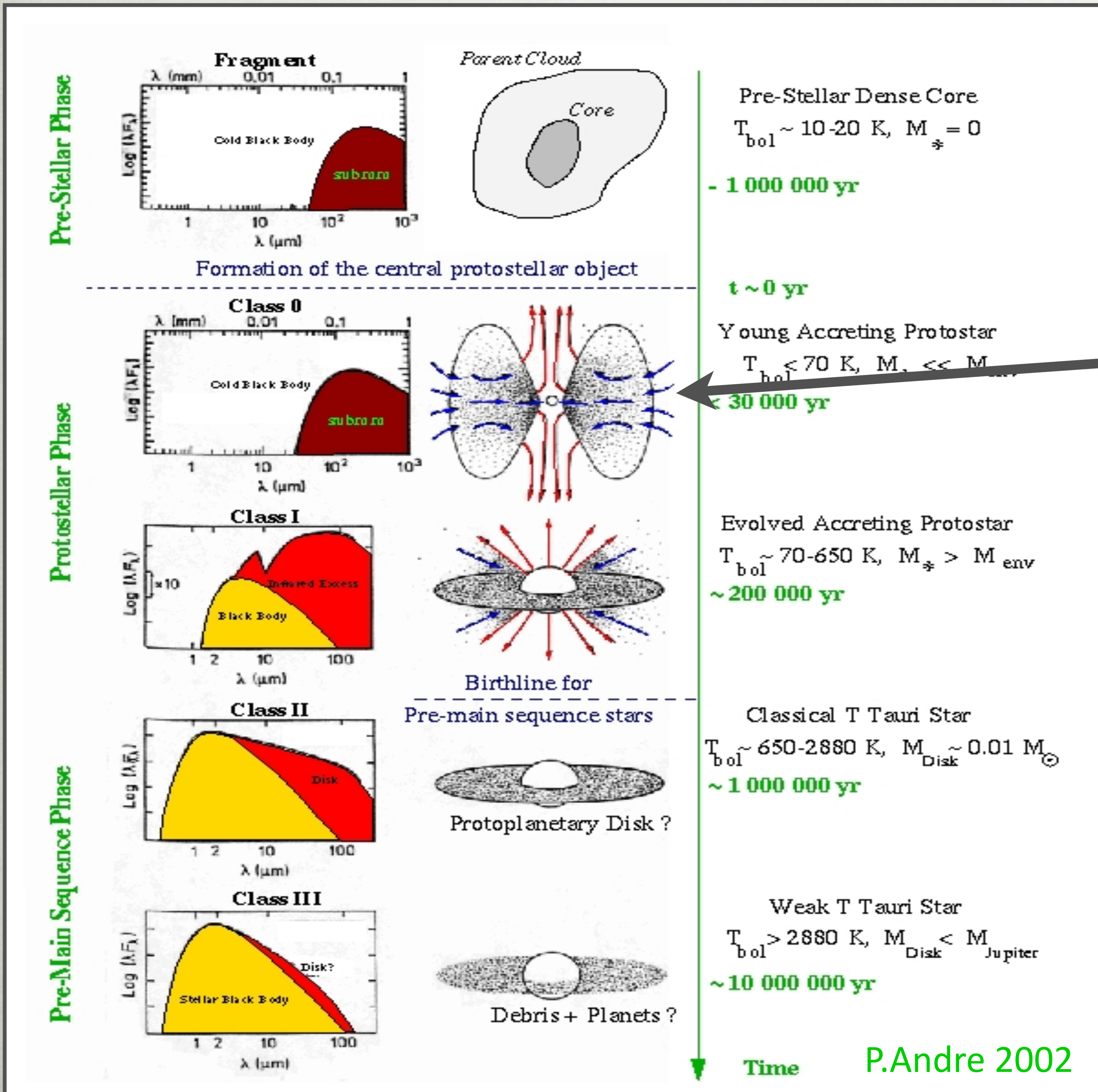
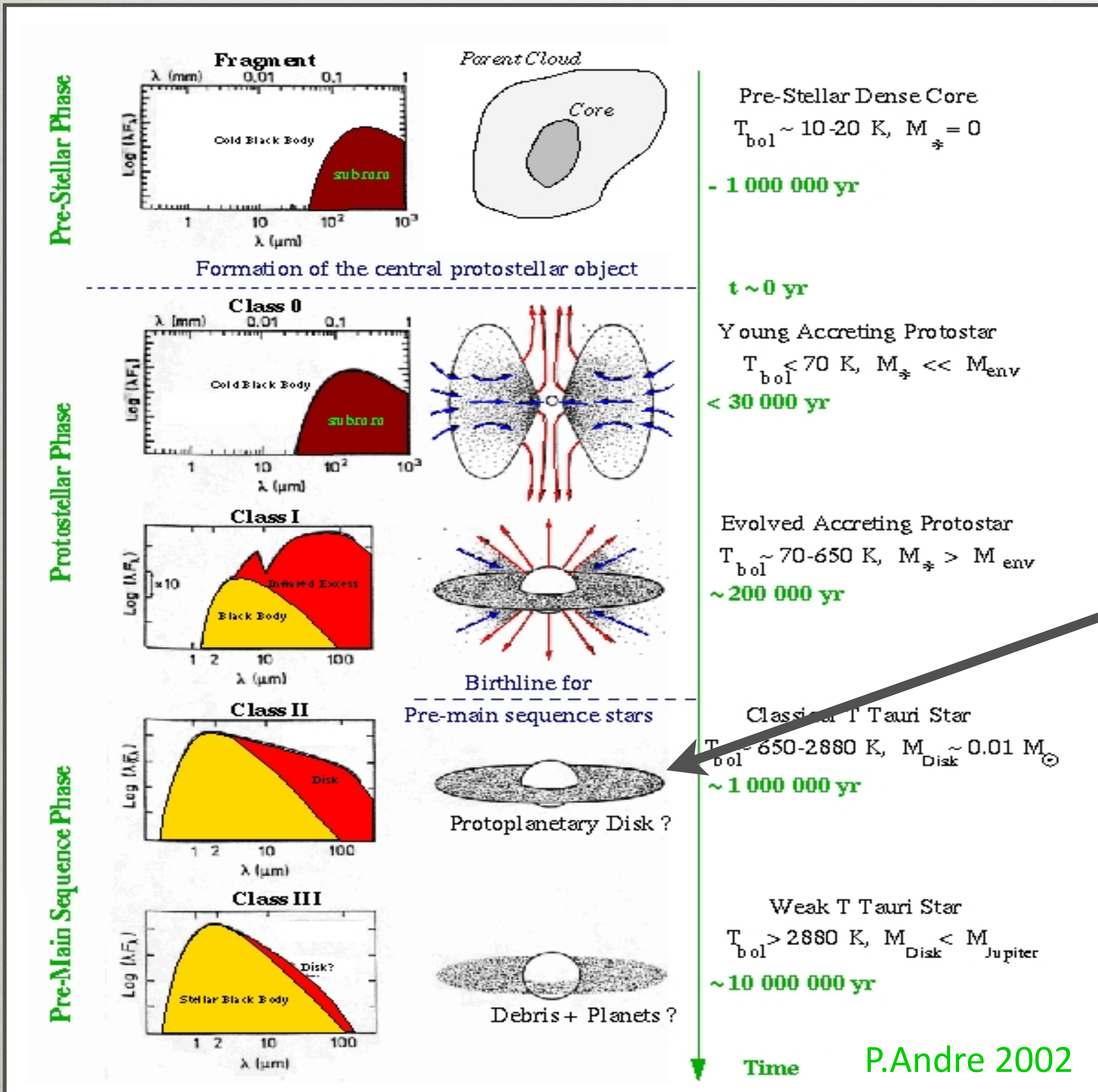


$$Q = \frac{\varkappa \sigma}{3G\Sigma}, \quad Q < 1$$

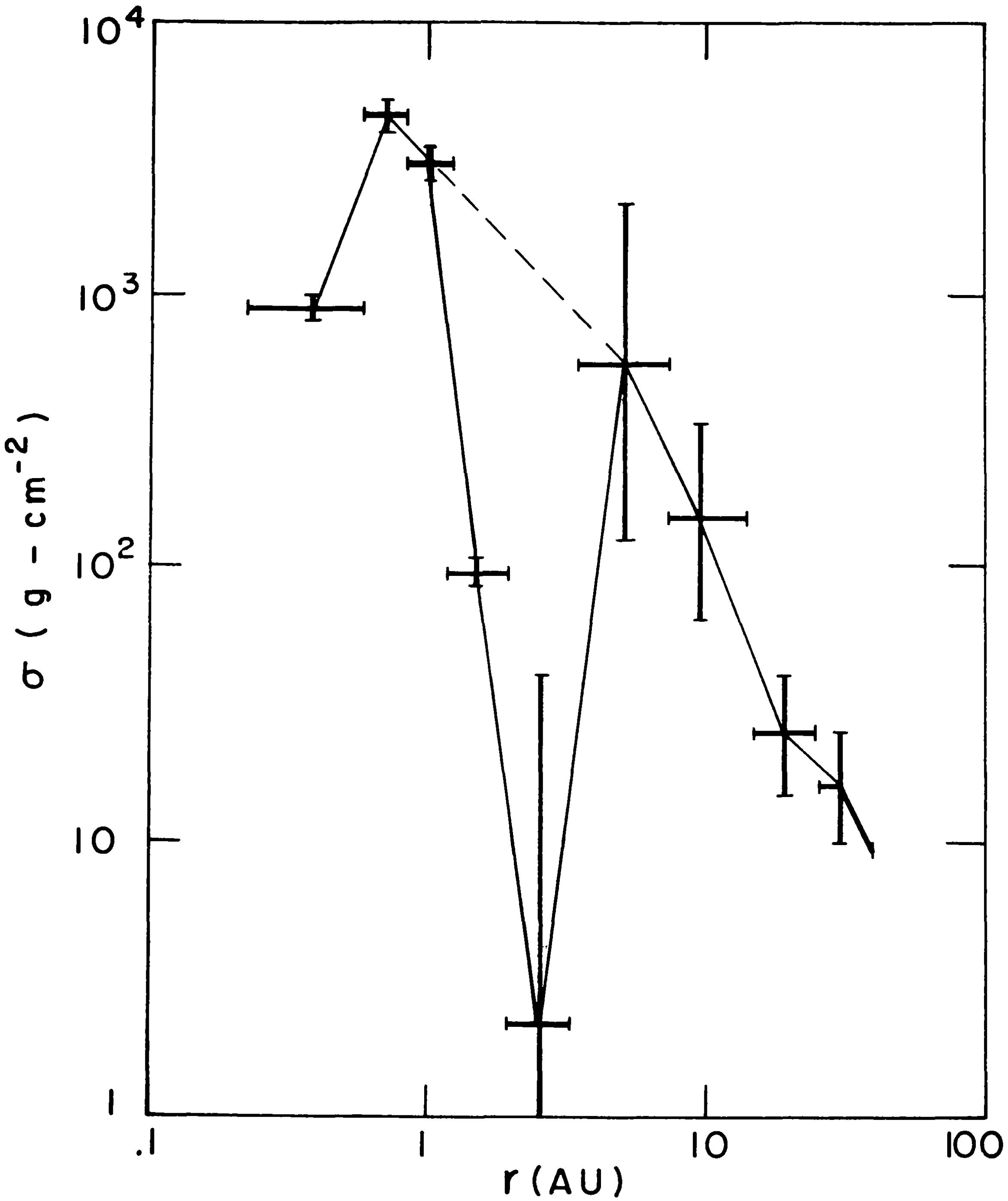
Gravitational Instability

Part I: Introduction



Gas disk begins to dissipate

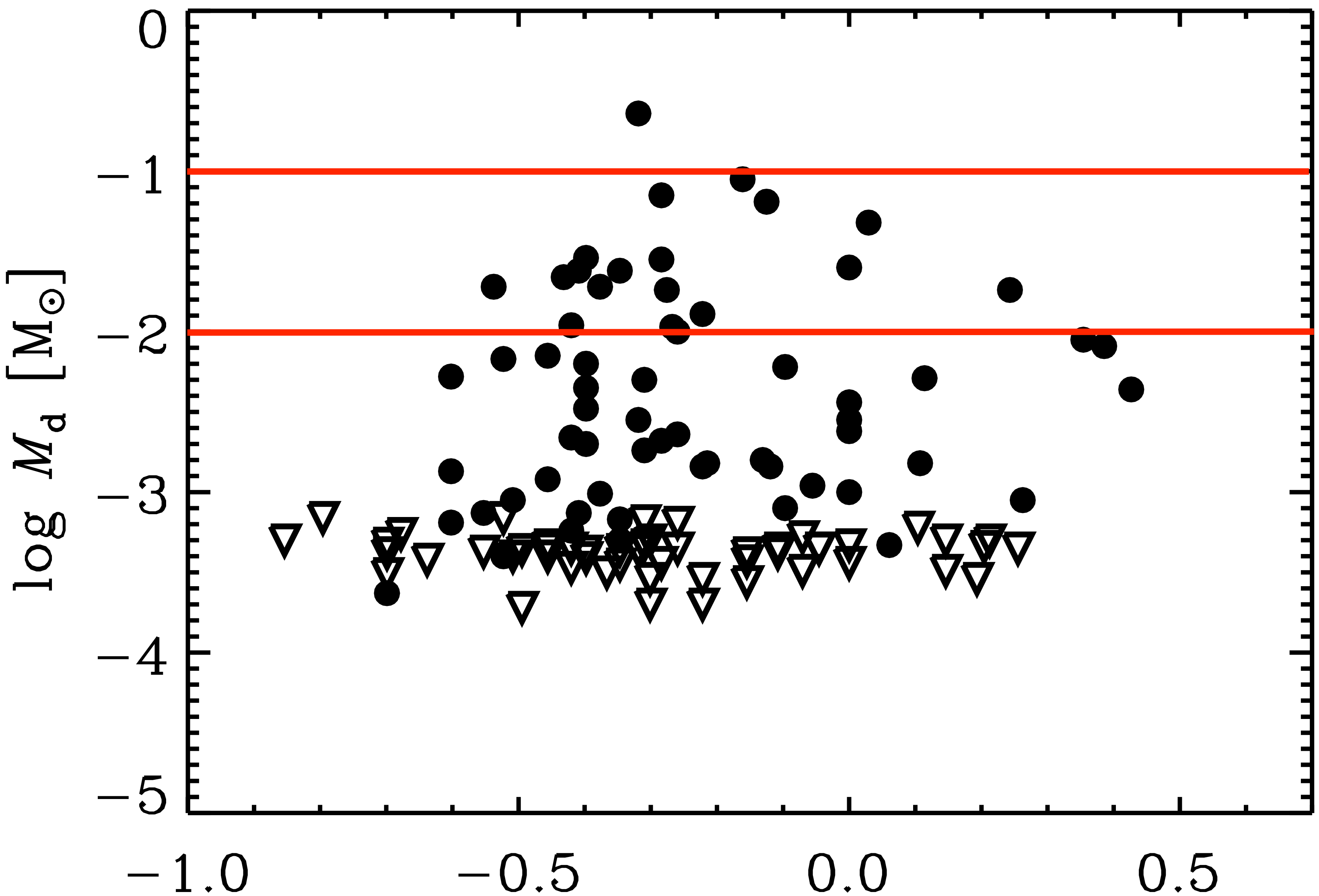
Part I: Introduction



Weidenschilling 1977

MMSN ~ 0.01 - 0.1 M_sun

Part I: Introduction



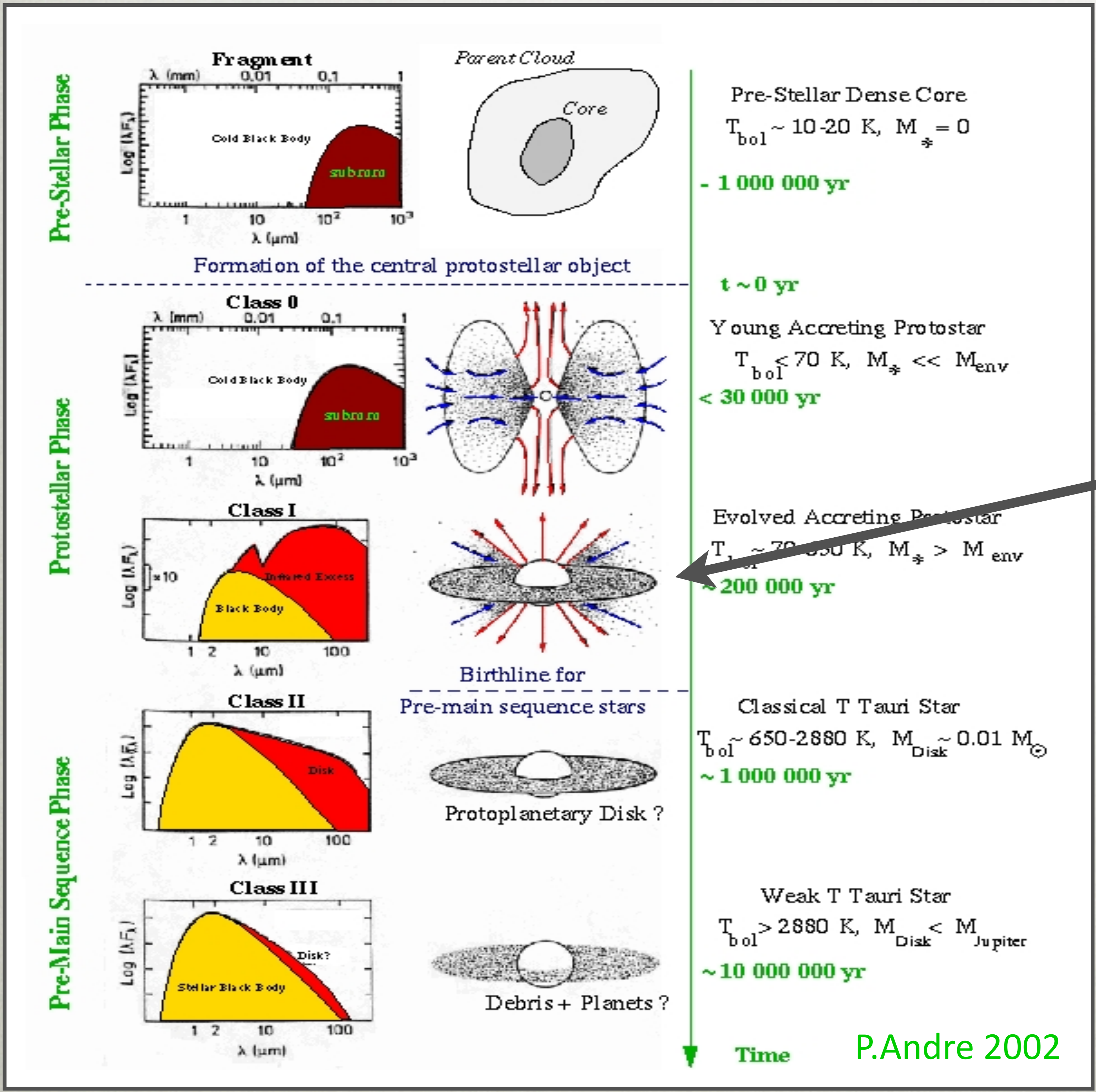
Andrews & Williams 2005

Class II disks:

- 13% have $M_{disk} > 0.01$ M_{sun}
- 1% have $M_{disk} > 0.1$ M_{sun}

(Andrews & Williams 2005, Eisner 2008)

Part I: Introduction



Just right?

Part II: Methodology

How do we calculate disk masses?

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$$\boxed{M_d = \frac{d^2 F_\nu}{\kappa_\nu B_\nu(T_c)}}$$

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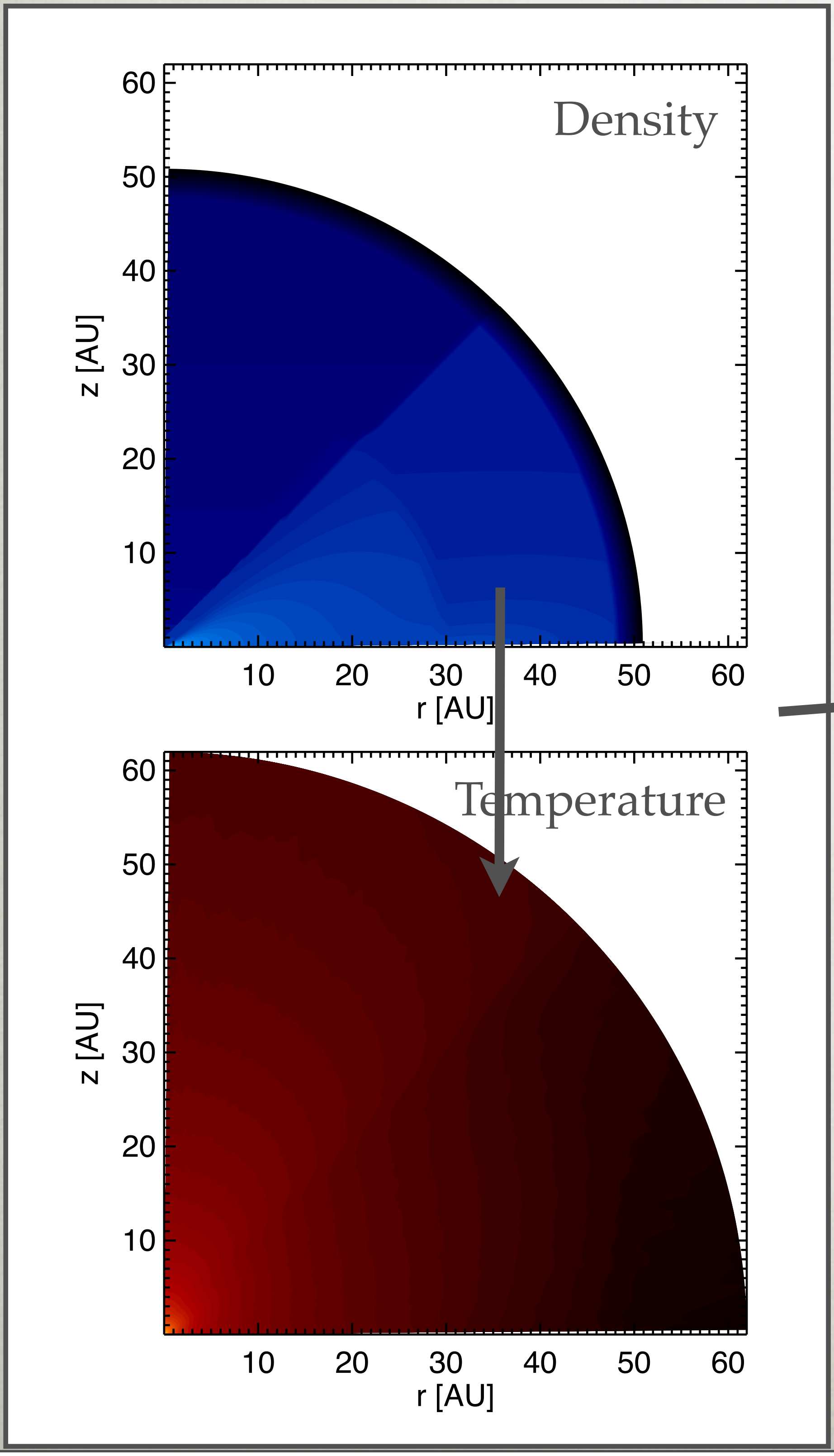
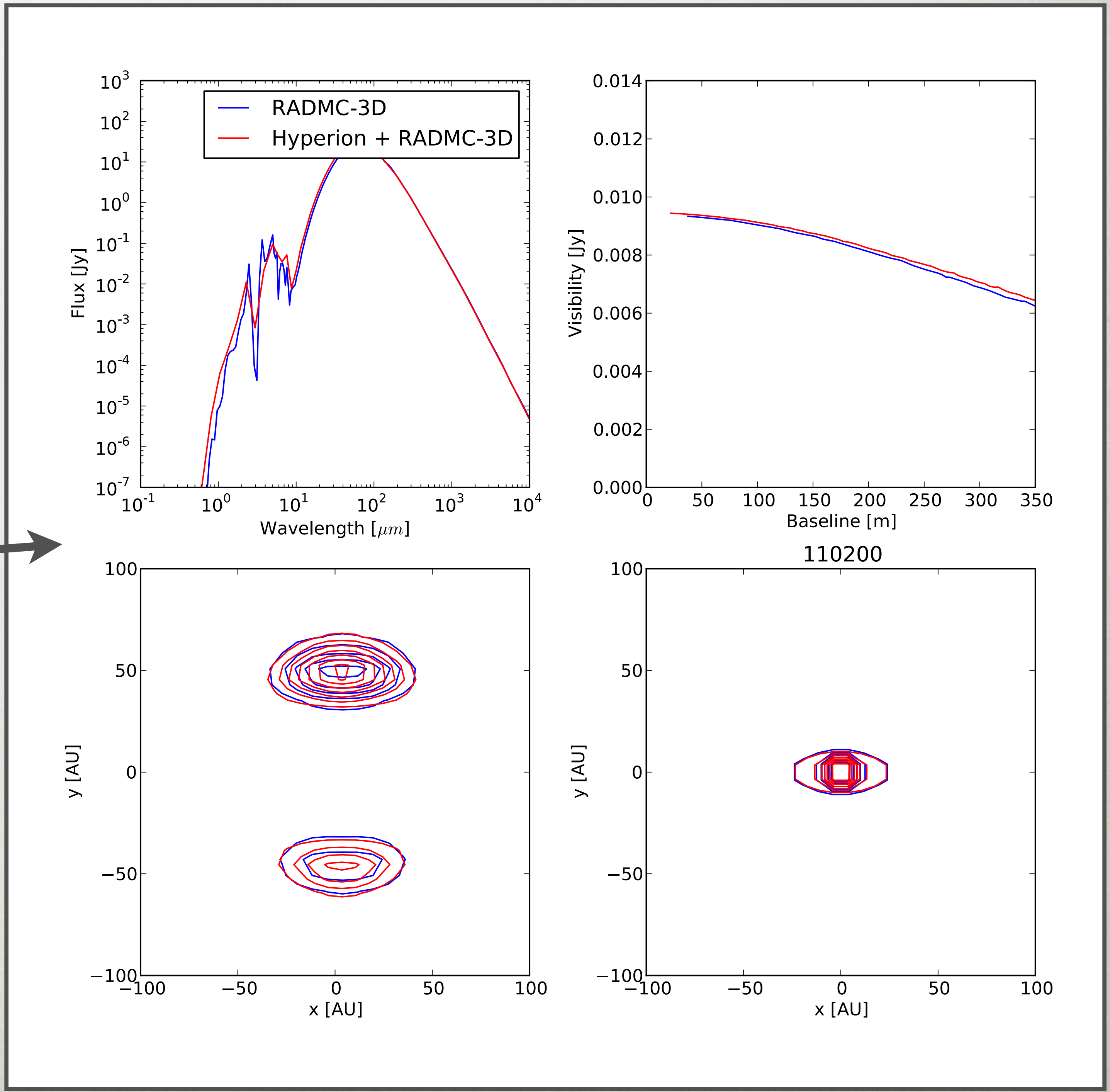
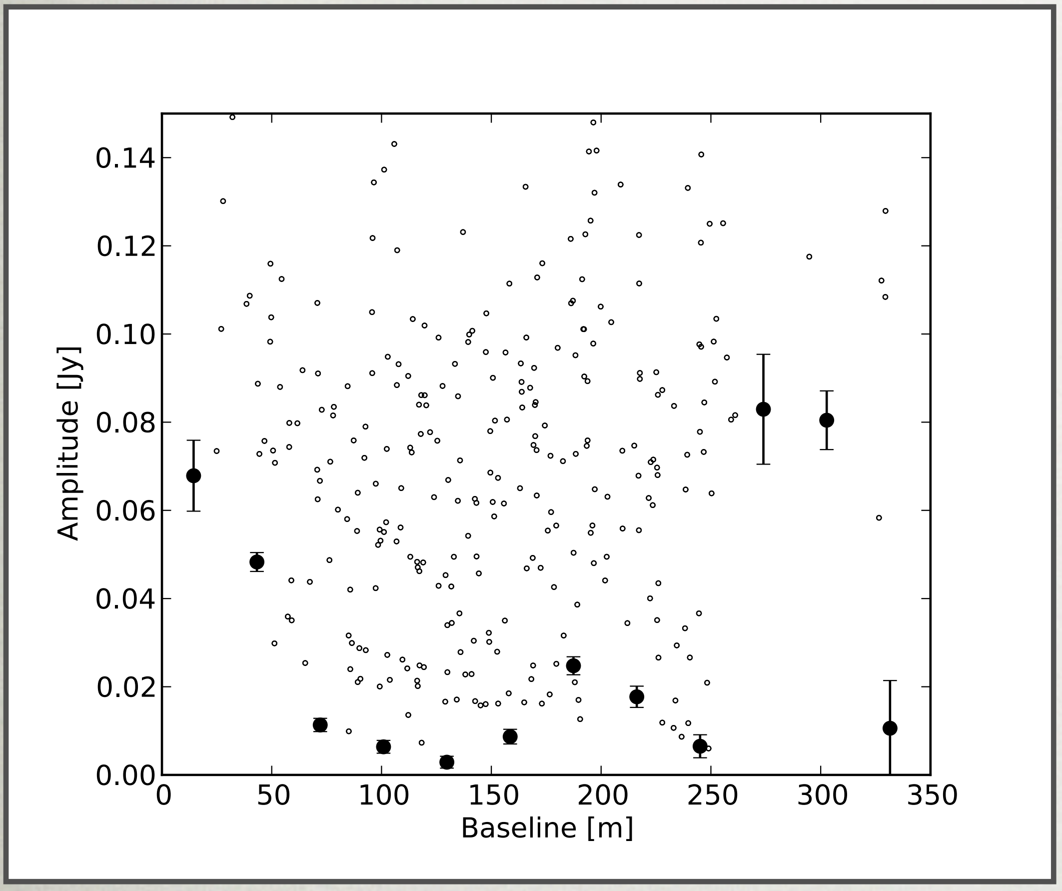
Not quite that easy!

Part II: Methodology

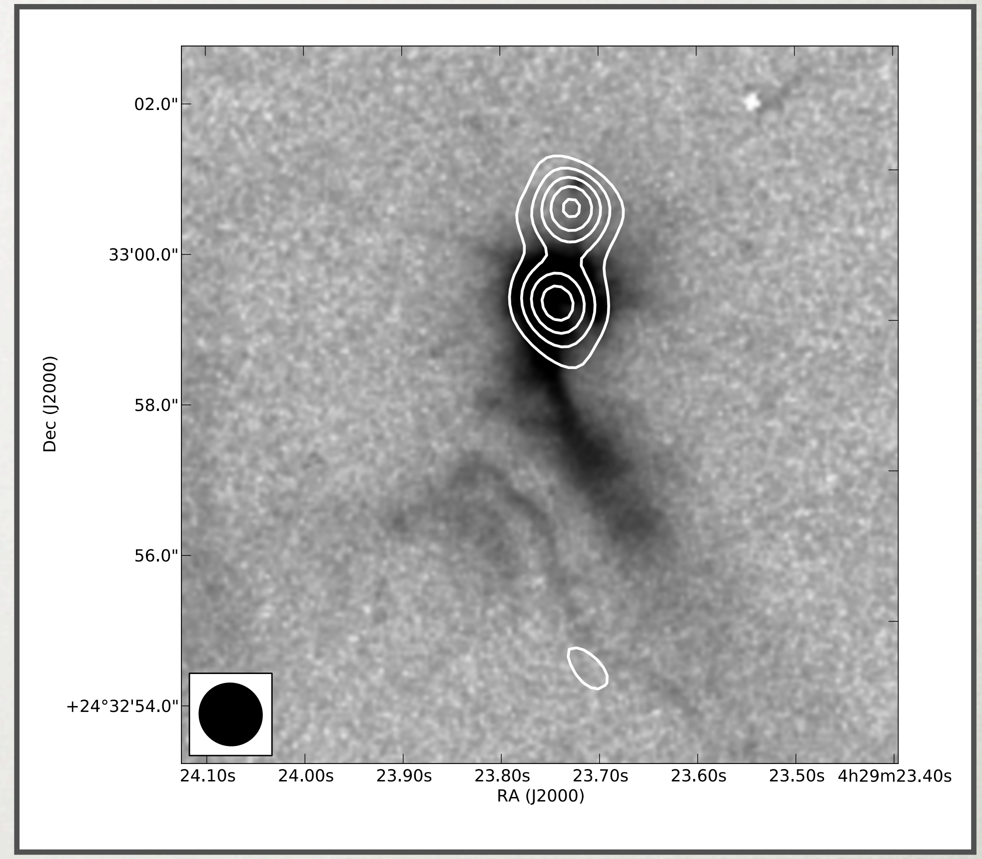


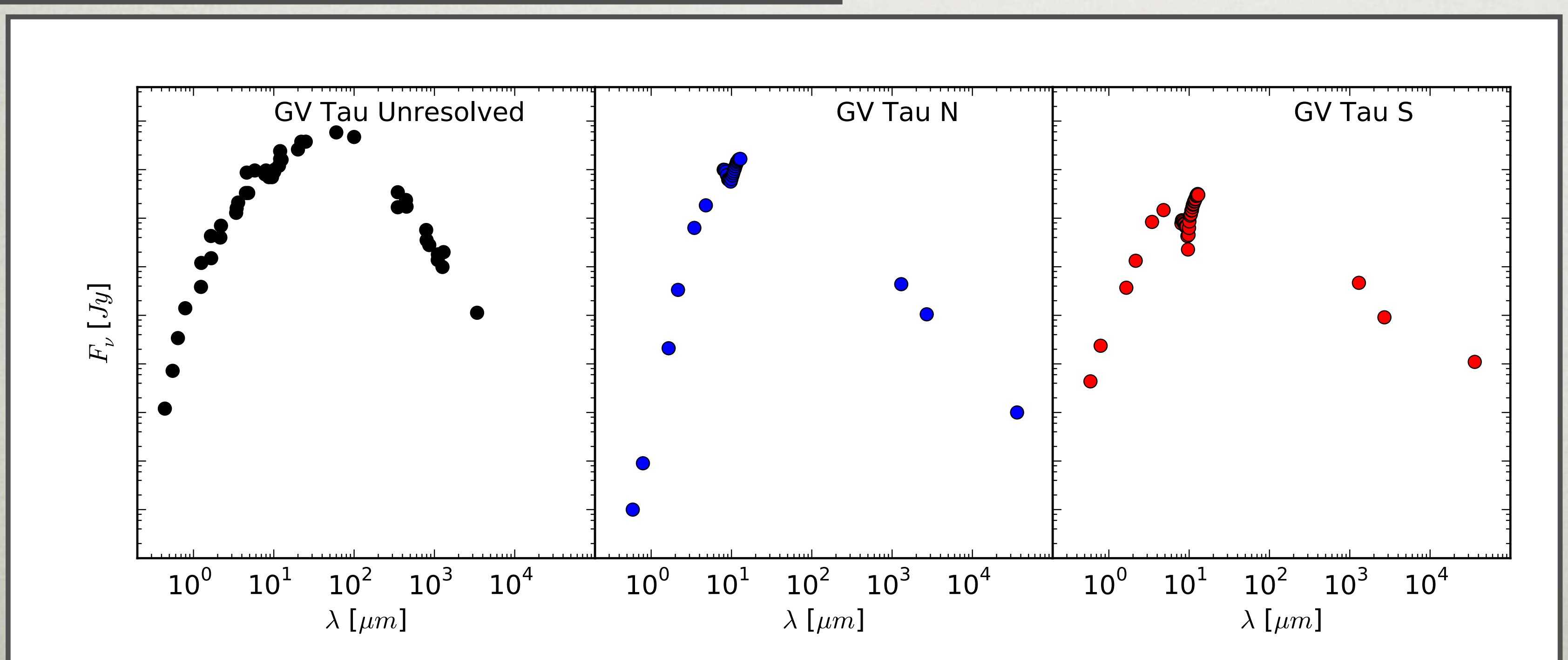


Part III: Analysis



GV Tau

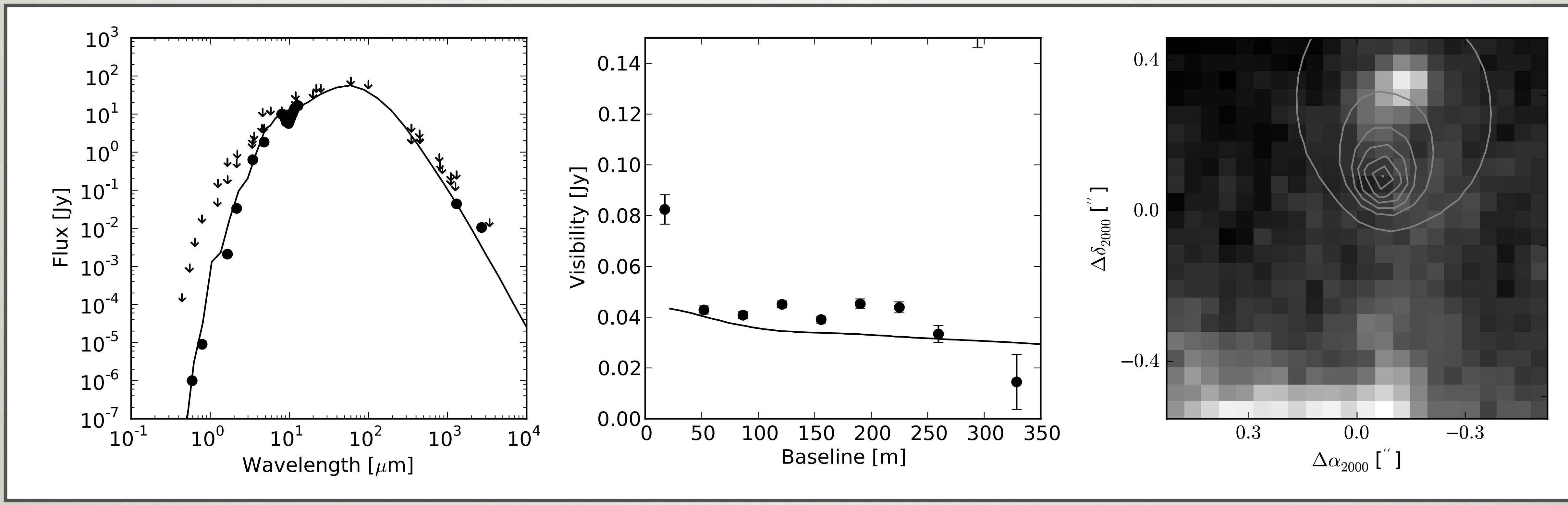




Sheehan & Eisner, in prep.

Part III: GV Tau

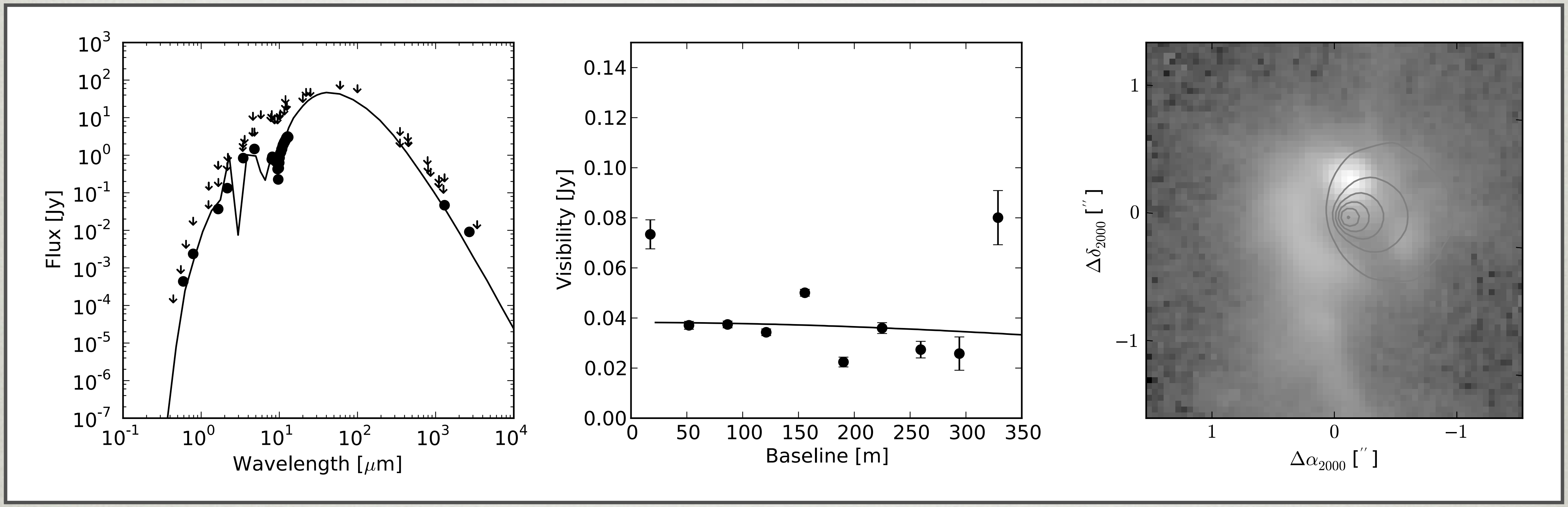
GV Tau N:



- M_{disk} = 0.01 M_sun, M_{env} = 0.01 M_sun, R_{disk} = 30 AU,
- R_{env} = 1000 AU, L_{star} = 3 L_sun, f_{cav} = 0.2-1, i = 35^o, pa = 350^o

Part III: GV Tau

GV Tau S:



- M_{disk} = 0.01 M_sun, M_{env} = 0.01 M_sun, R_{disk} = 30 AU,
- R_{env} = 1000 AU, L_{star} = 6 L_sun, f_{cav} = 1, i = 55^o, pa = 280^o

Part III: Analysis

- For sample of 10 Class I protostars from Eisner 2012 and Sheehan & Eisner, in prep we find:
  - Median disk mass = 0.008 M_{sun}
  - 20% of disks have $M_{disk} > 0.01\ M_{sun}$
  - 10% of disks have $M_{disk} > 0.1\ M_{sun}$
- Class I disks appear to be more massive than Class II disks.
  - Dust grain processing has occurred between the two stages.
- Class I disks still may not be massive enough to form giant planets.
  - May need to look even younger to find the initial mass budget for planet formation.

Part IV: Future Work

- Obtain a larger sample:
  - CARMA C Array has ~140 AU (1″) resolution
  - We want to go to higher resolution with CARMA B (0.4″) and A (0.2″) Arrays.
  - Compact configuration to constrain envelope.
  - Multiple wavelength datasets to constrain dust grain properties.