Core Accretion vs. Disk Instability: Observable Discriminants

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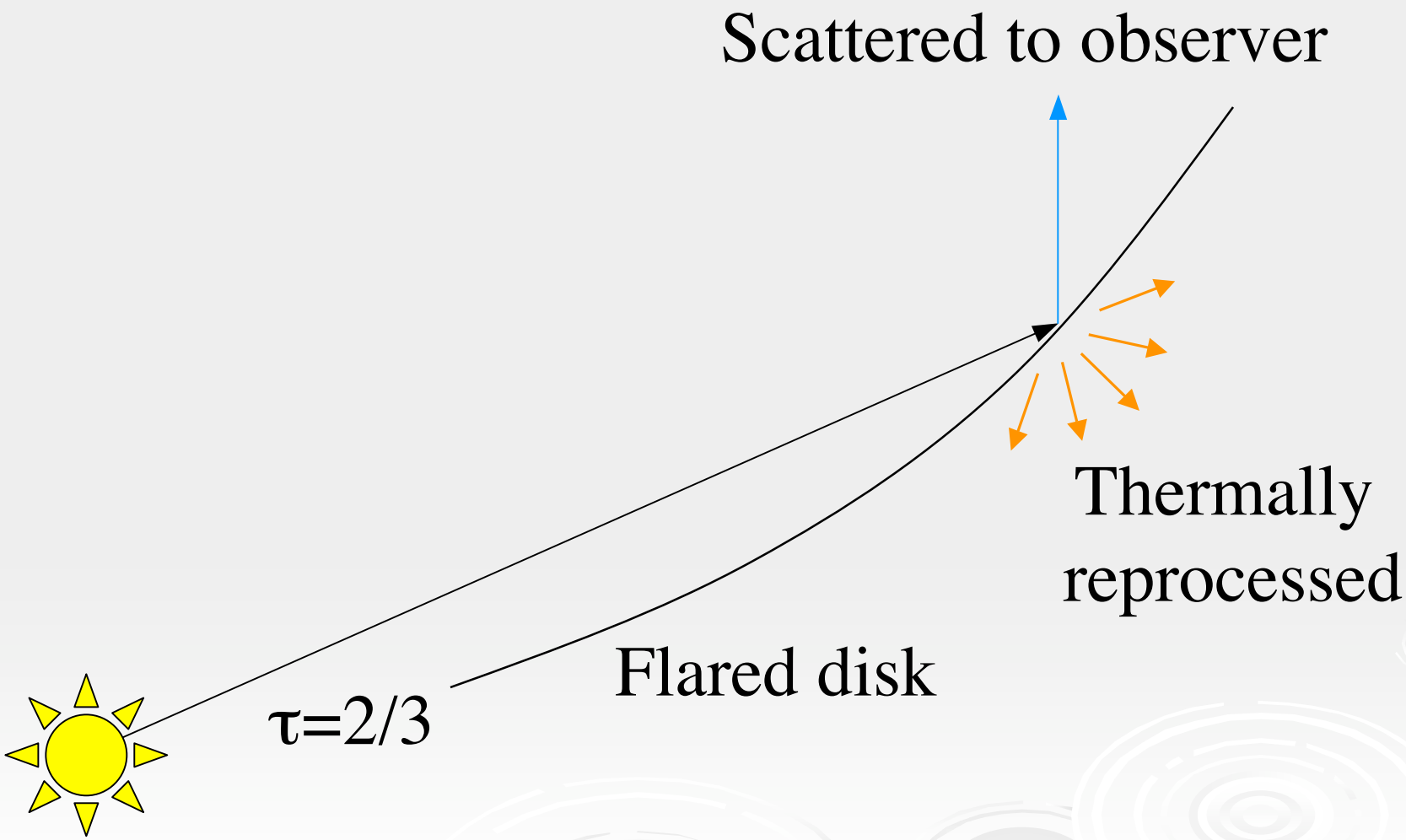
Motivation

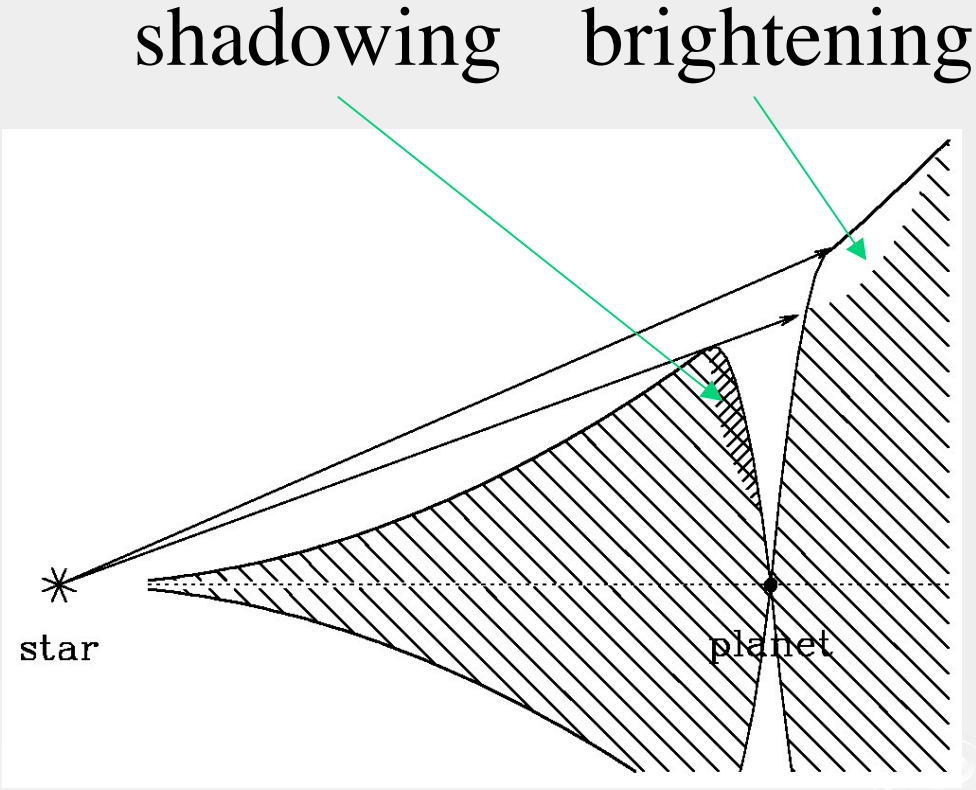
- Core Accretion vs. Disk Instability
- Formed planet : forming planet :: smoking gun : caught in the act
- **Method**: calculate radiative transfer on disk surfaces to predict observations

Radiative Transfer



Core Accretion

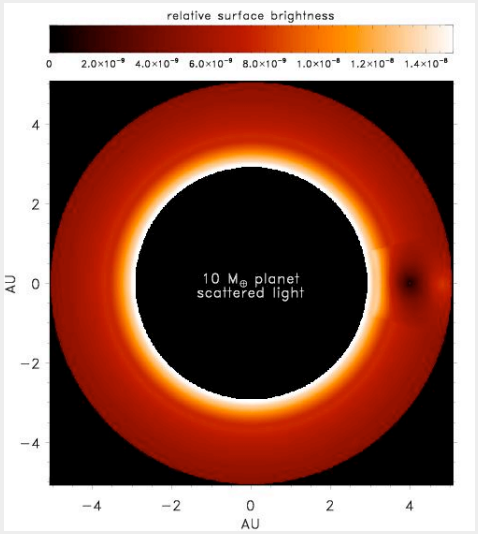
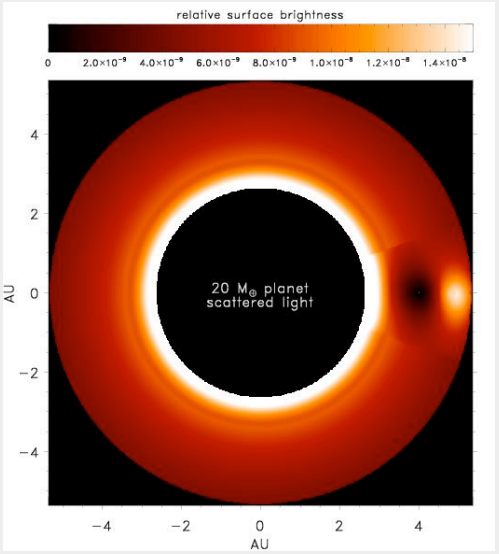
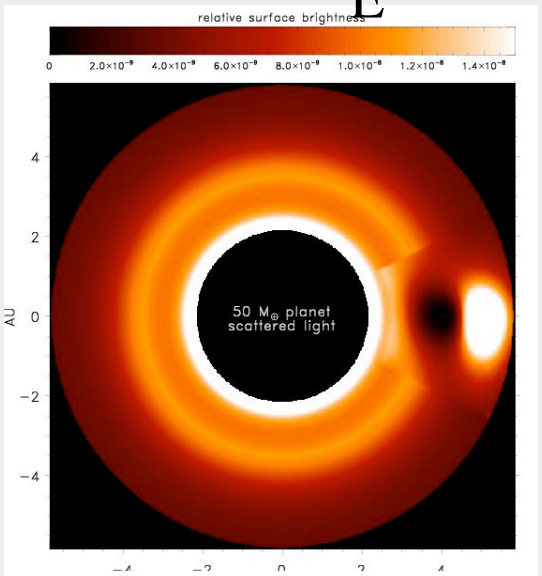
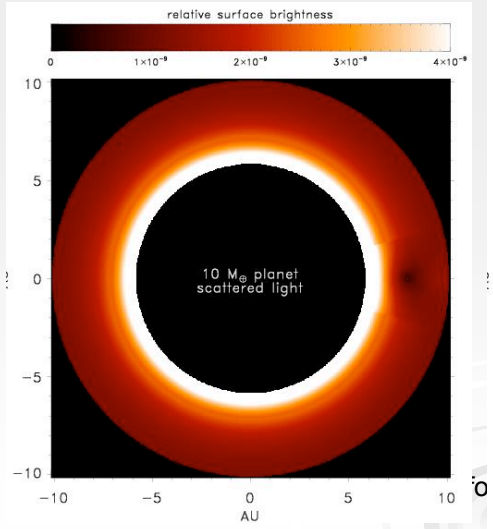
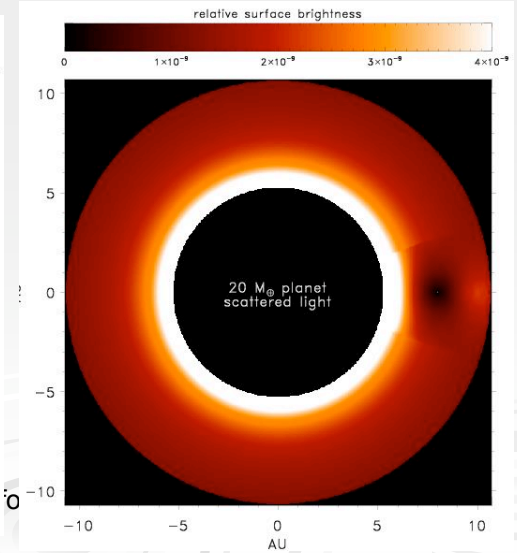
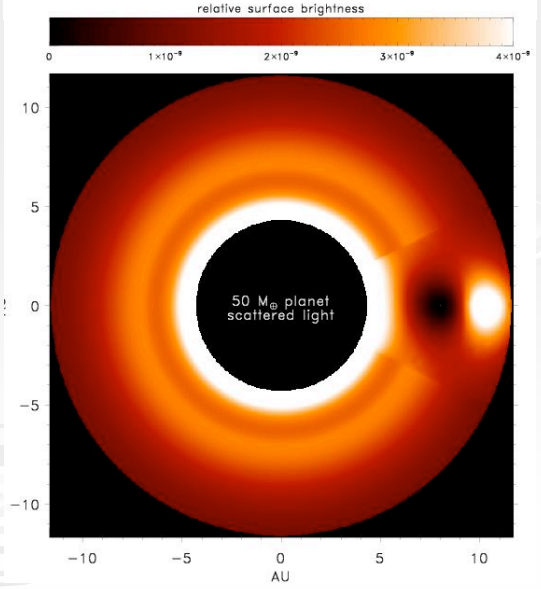
- Steady state
- Hydrostatic equilibrium
- Semi-analytic prescription for radiative heating
- T & ρ iteratively calculated for self-consistency



(Jang-Condell & Sasselov 2003, 2004)

Scattered Light

Jang-Condell, in prep

	10 M_E	20 M_E	50 M_E
4 AU			
8 AU			

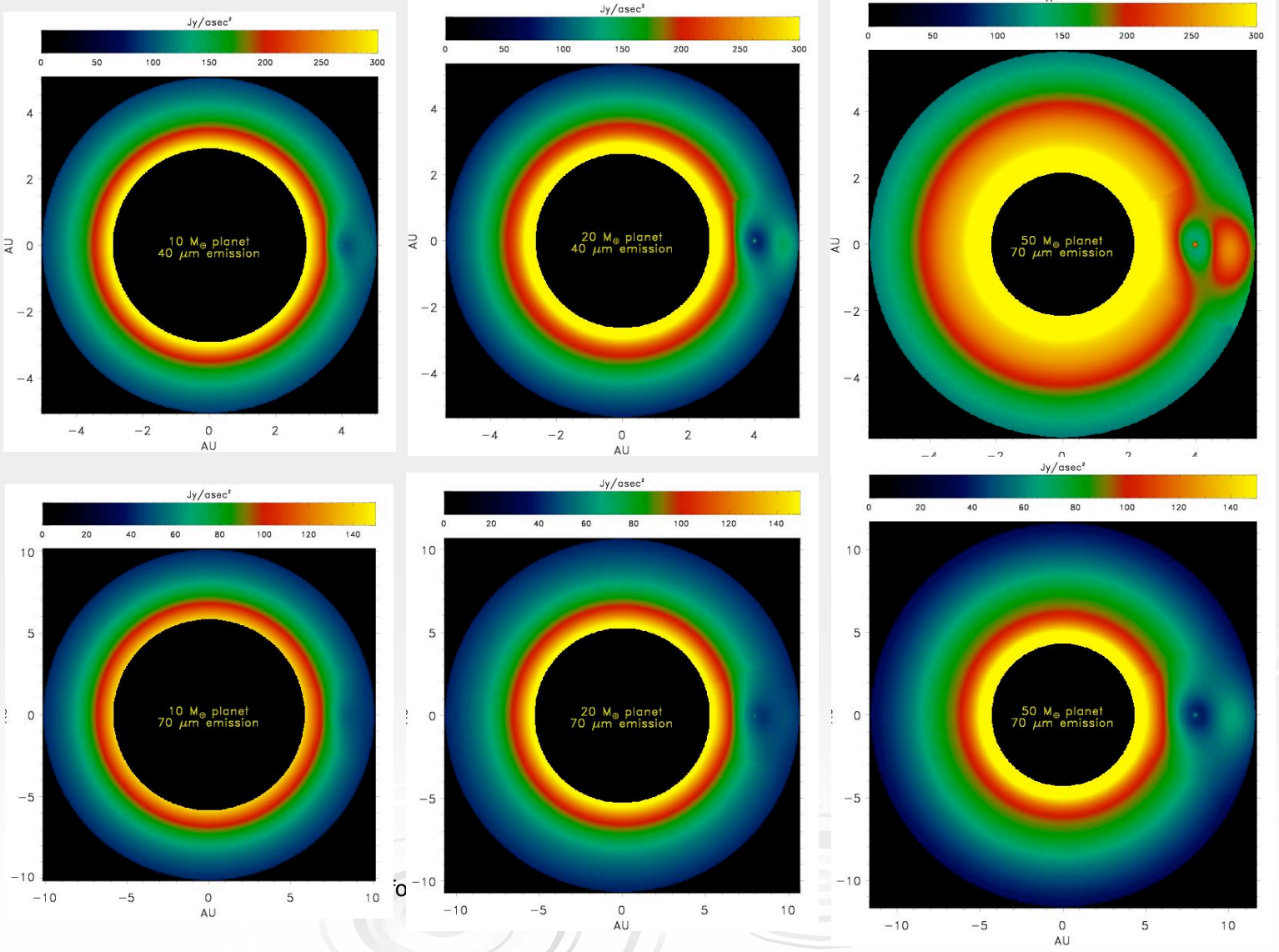
Thermal Emission

Jang-Condell, in prep

10 M_E | 20 M_E | 50 M_E

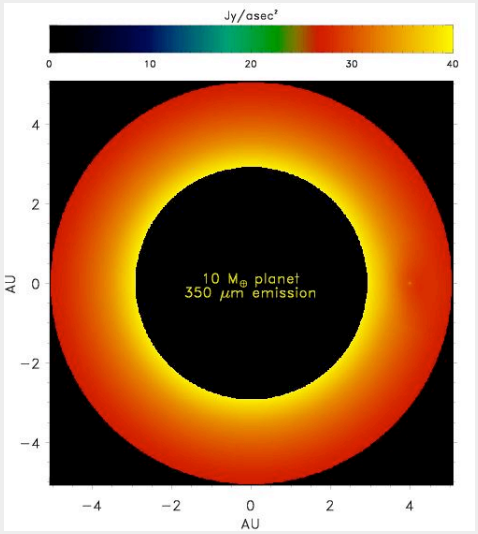
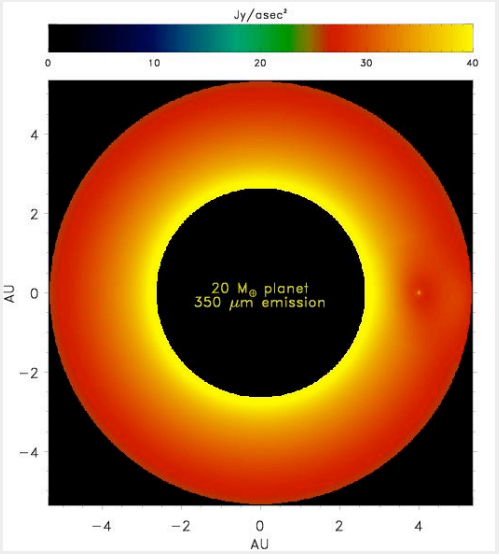
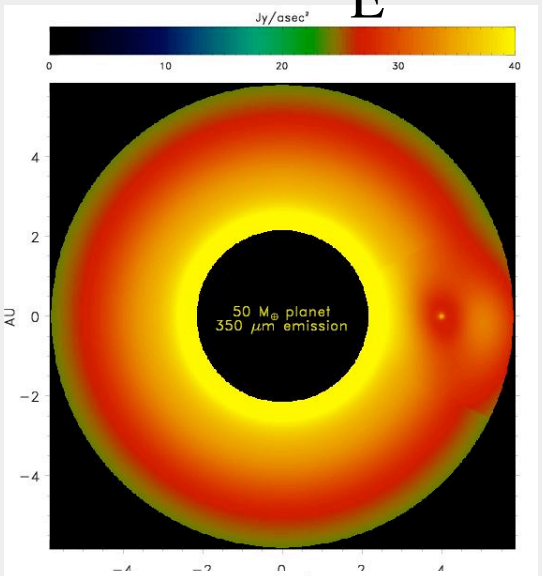
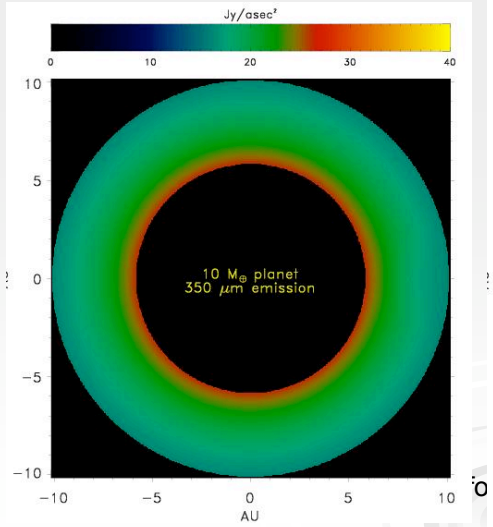
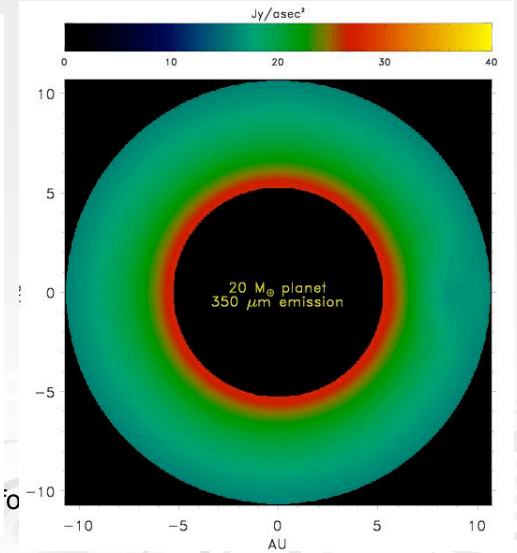
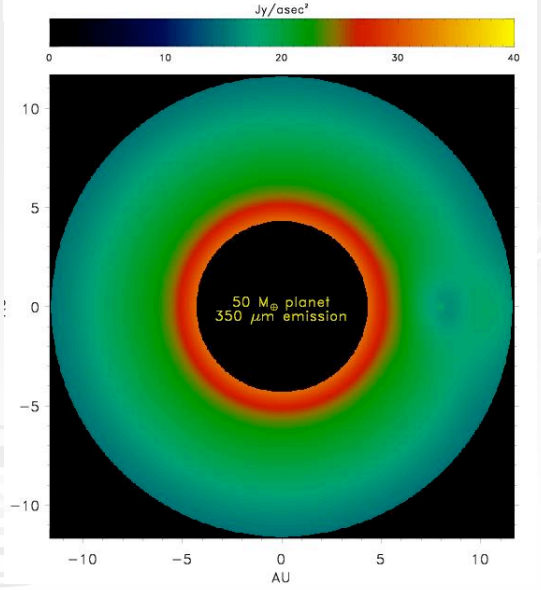
4 AU
40 μm

8 AU
70 μm

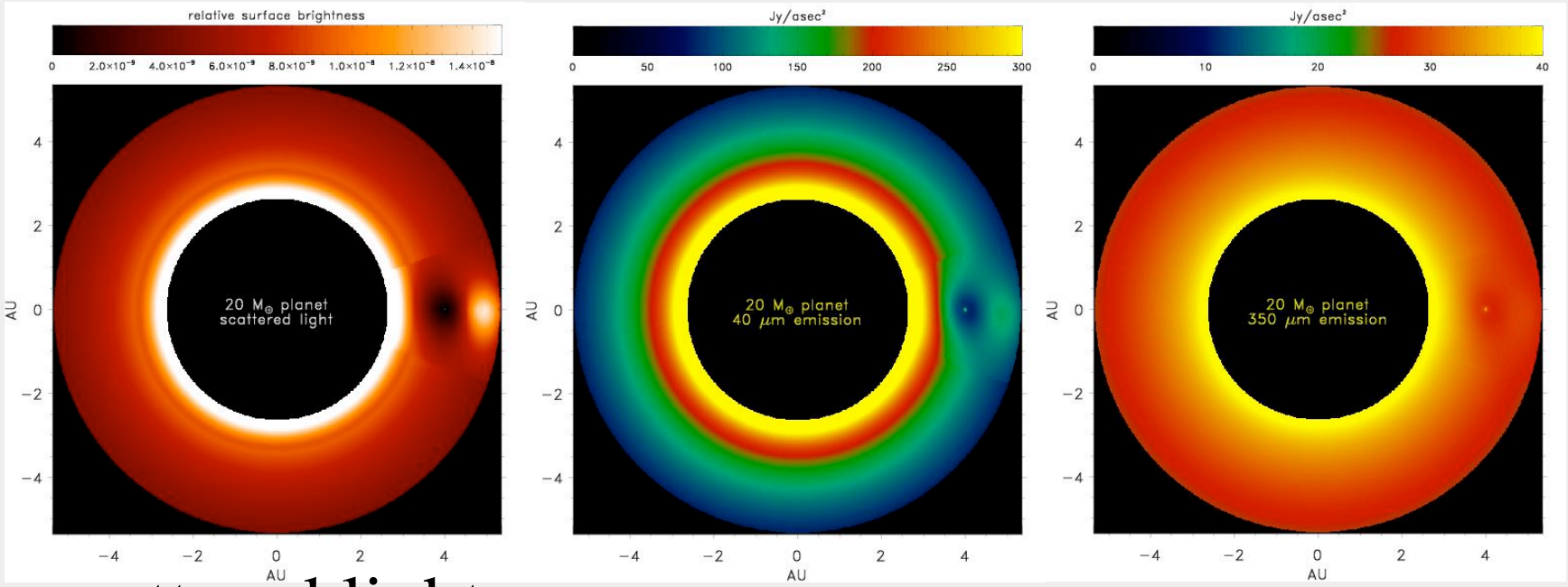


0.35 mm (≤ 40 Jy/”^{2})

Jang-Condell, in prep

	10 M_E	20 M_E	50 M_E
4 AU			
8 AU			

20 M_{Earth} Core at 4 AU



scattered light mid IR sub-mm

- Paired shadowing/brightening at surface (short λ)
- Effect diluted toward midplane (long λ)
- ~ 1 AU perturbation - 0.01” resolution at 100 pc

Disk Instability

- 3D hydrodynamic simulations of disk instability
- Self-gravitating clump formed
- Simulated images:
  - Hydrodynamics
  - Stellar irradiation
  - Scattered light

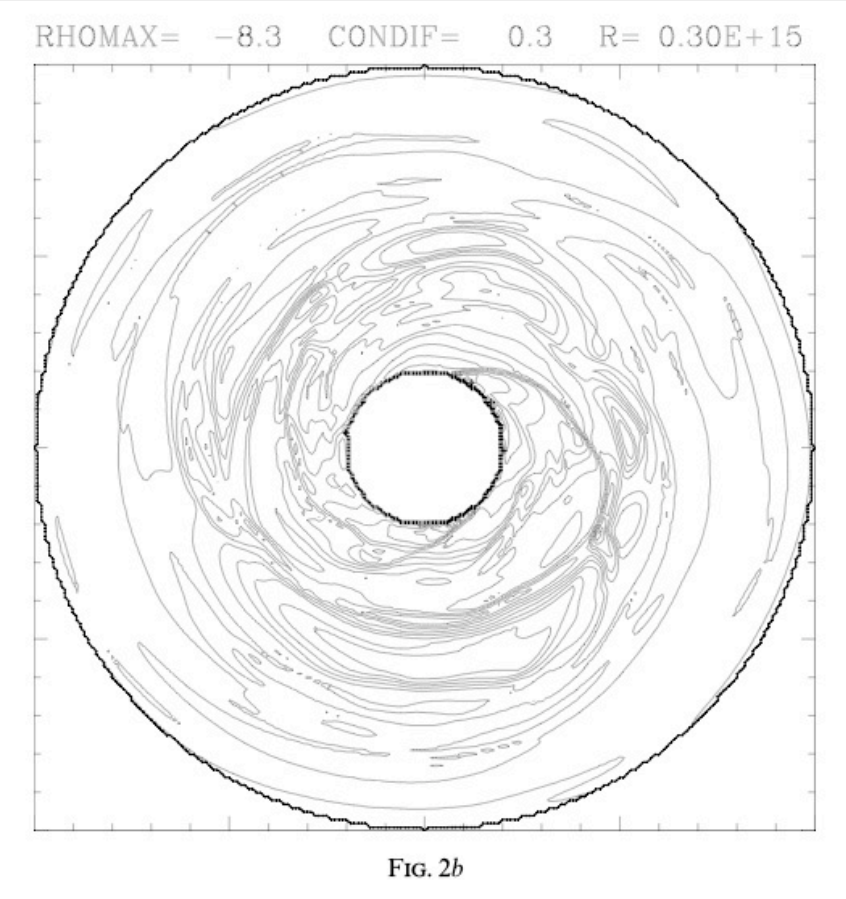
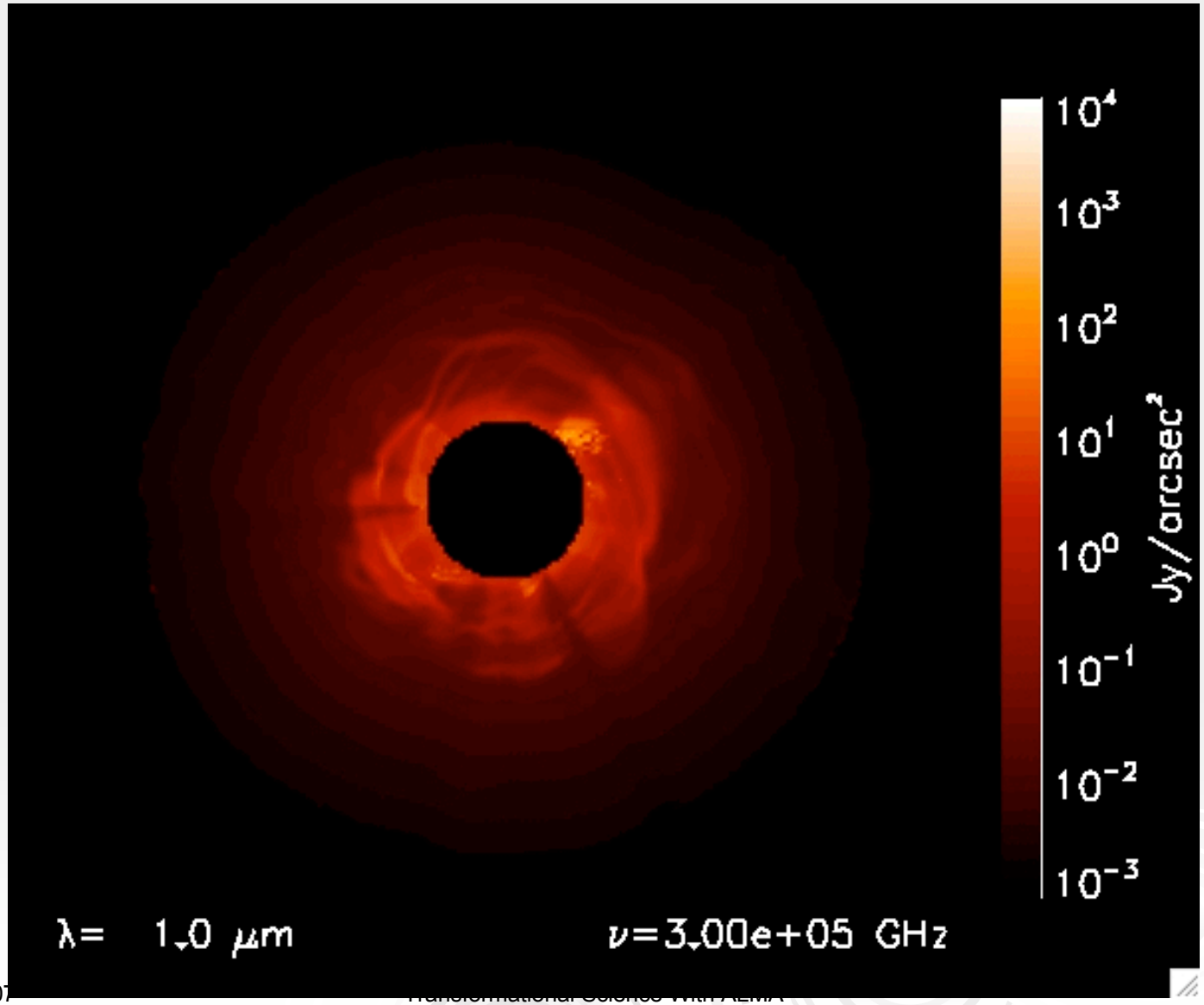


FIG. 2*b*

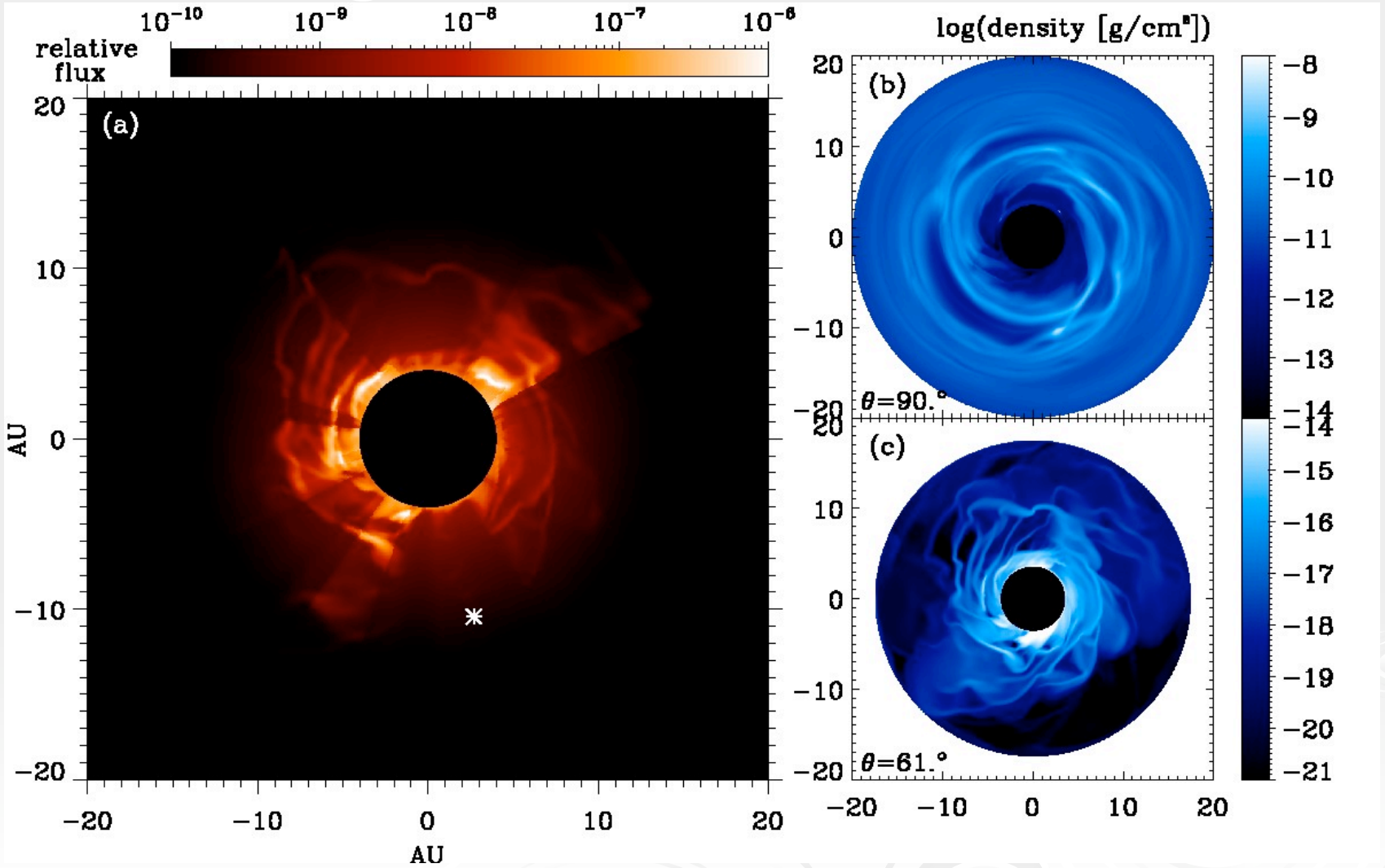
Boss 2001

Scattered + Continuum

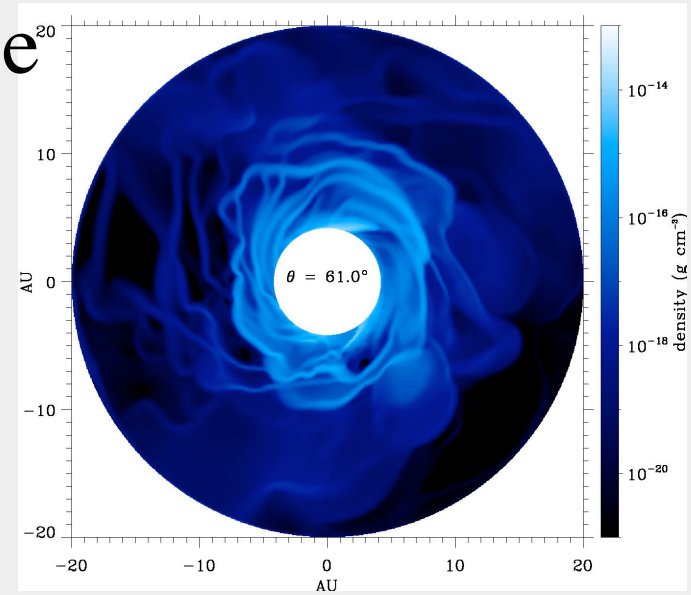


J-C & Boss, in prep

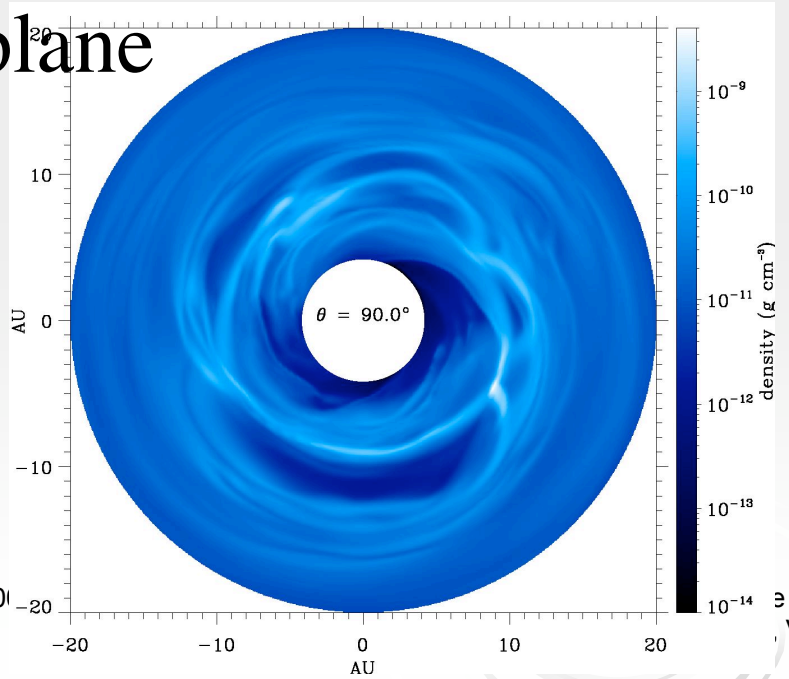
Jang-Condell & Boss 2007

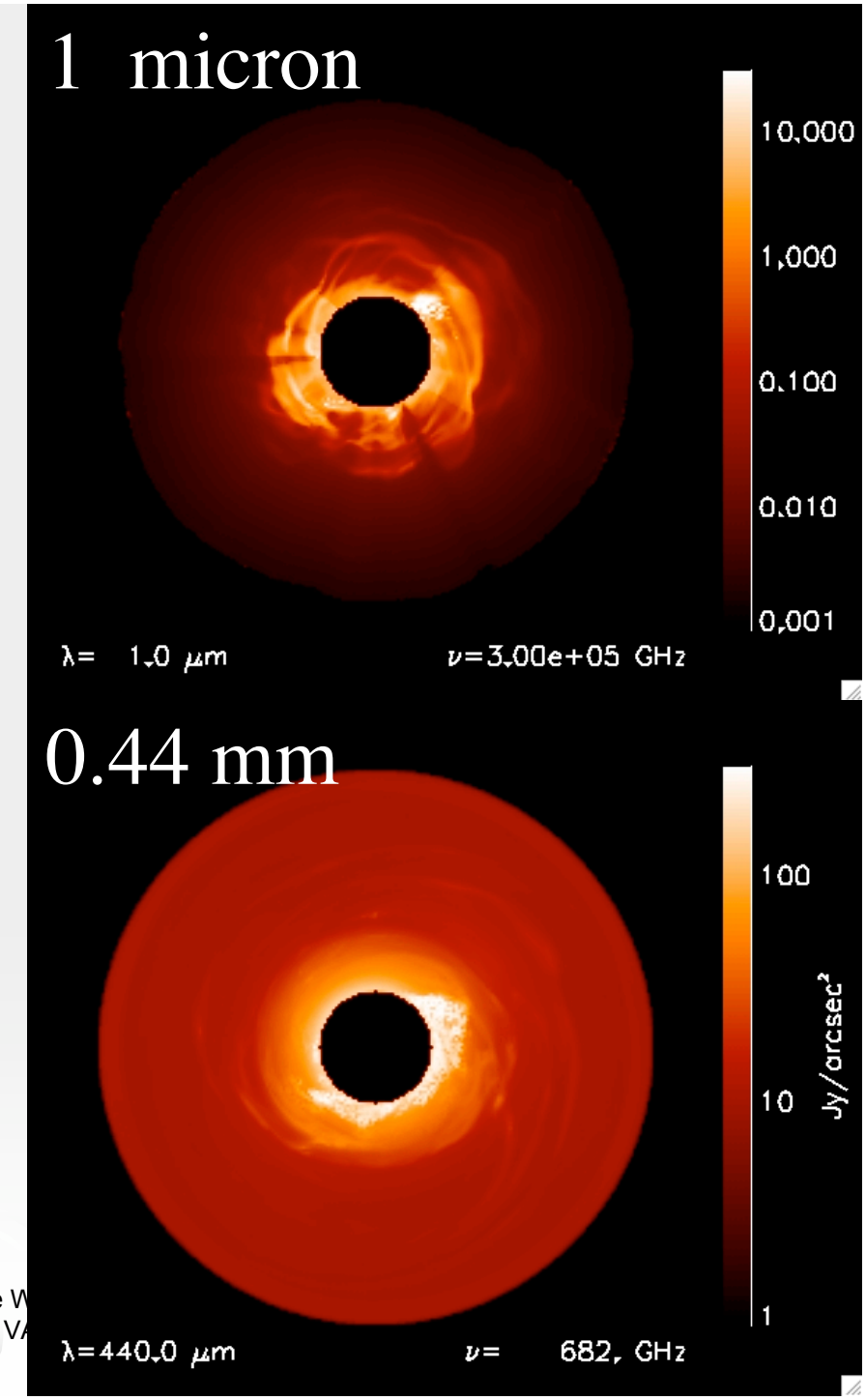


surface

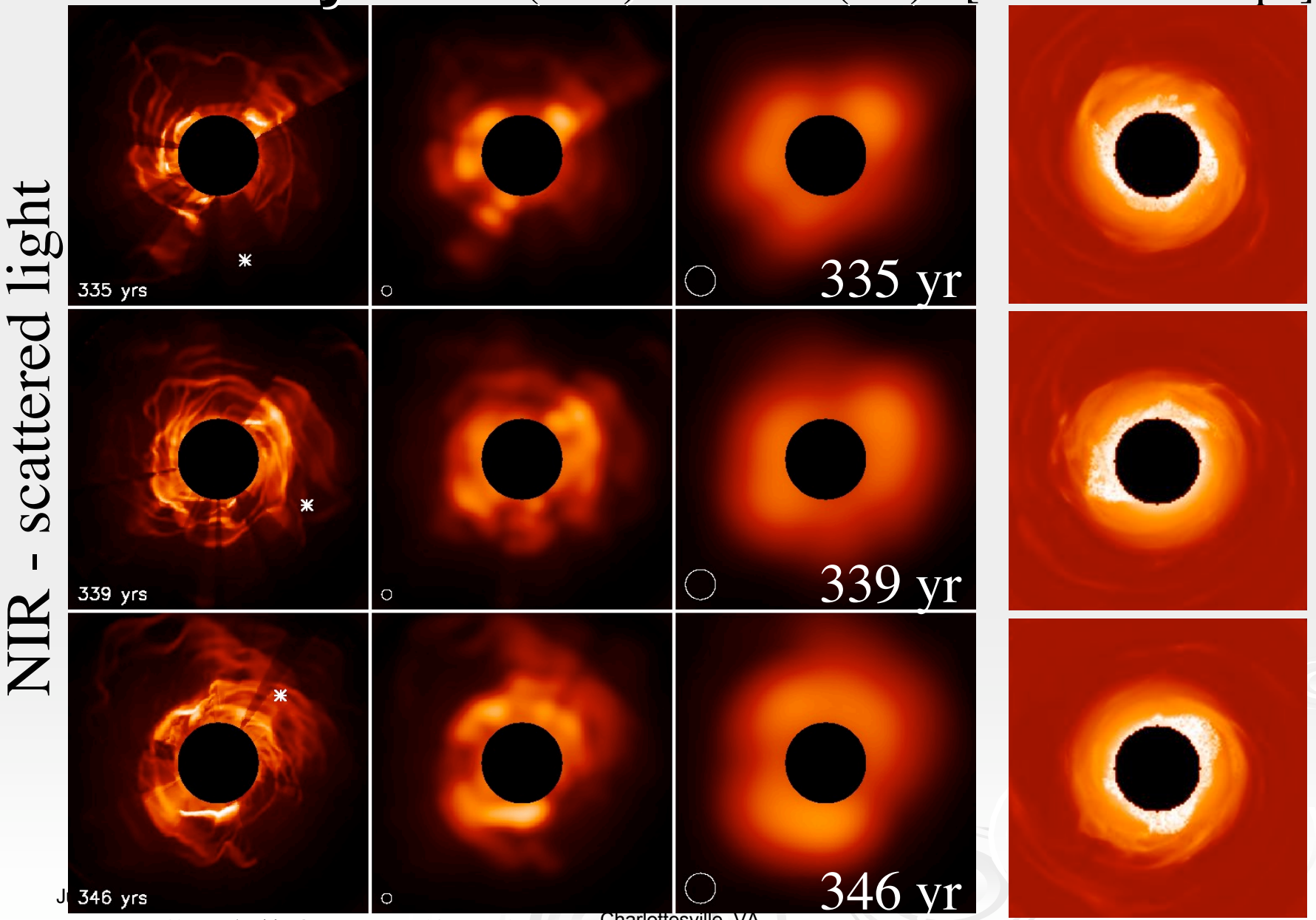


midplane





Variability



Jang-Condell & Boss (2007)

Comparison

Core Accretion	Disk Instability
Later YSO (Class II) Disk ~0.01 $M_{sun,}$ ~10^{-7} M_{sun}/yr	Early YSO (Class I) Disk ~0.1 $M_{sun,}$ ~10^{-5} M_{sun}/yr
Quiescent, stable structure	Turbulent structure, highly variable
IR feature at planet pos.	Planet unseen in IR
Location of planet may be determined in radio	

Multi-wavelength observations are vital

Very high resolution: ~0.01” - GMT/TMT, **ALMA**

Future Work

- Inclined disks
- Shadowing and illumination on partial gaps
- Include hydrodynamics in core accretion scenario
- Chemistry, molecular line emission