Exploring the duration of the pre-transition disc phase

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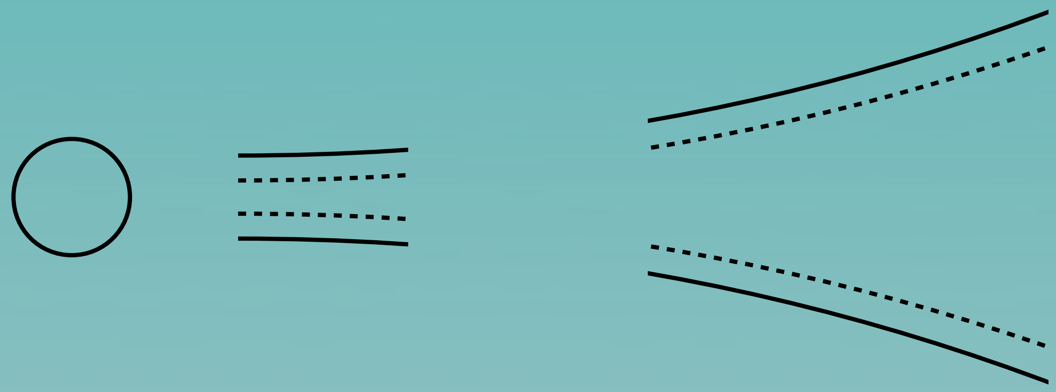
(Pre-)Transition disc definition



Pre-transition disc

Transition disc

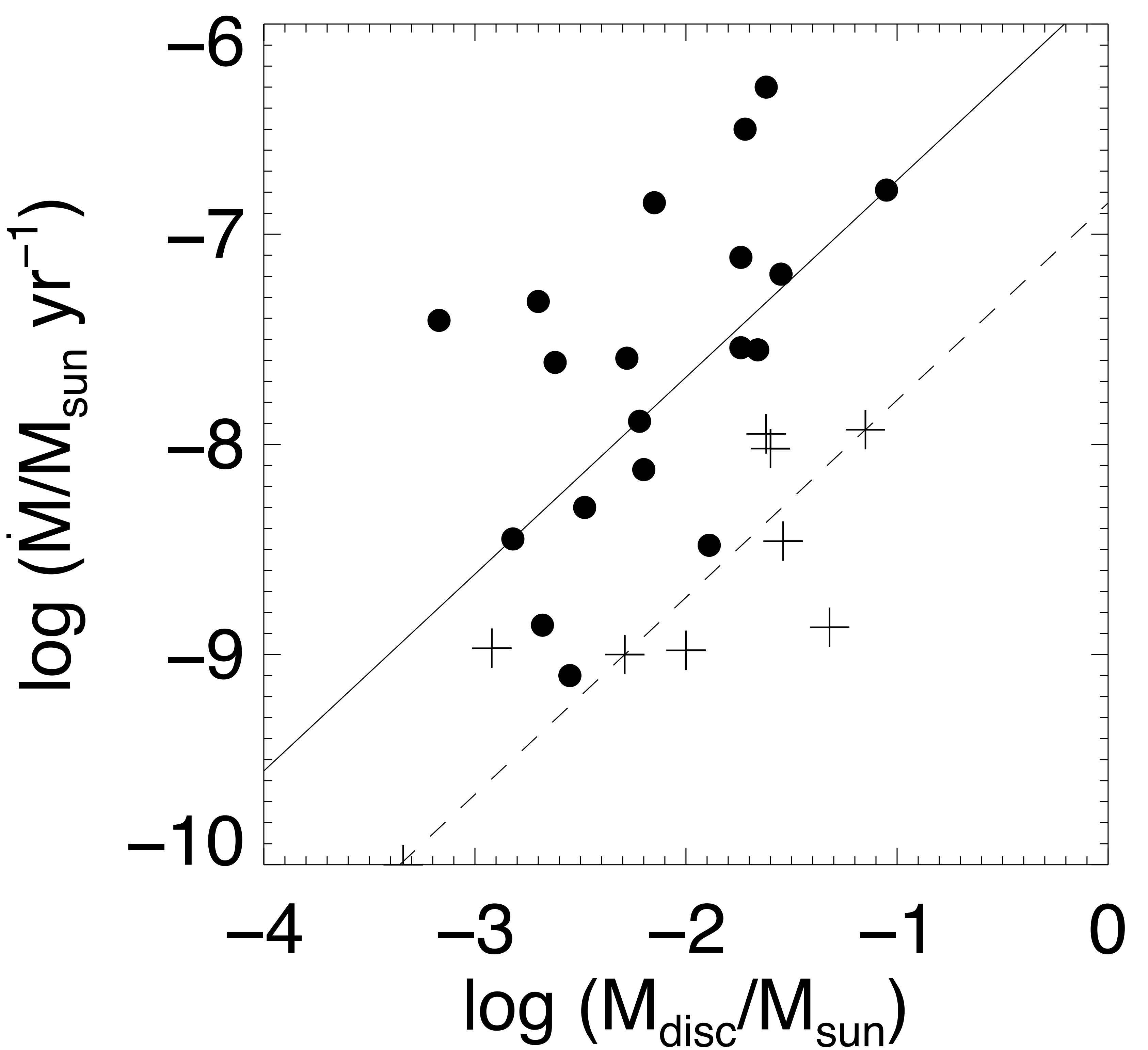
Causes:

- **Photoevaporation**
  (e.g. Alexander & Armitage 2009; Owen et al 2011; see talk by R. Alexander)
- **Binary star**
  (e.g. DQ Tau)
- **Planetary mass object**
  (e.g. Zhu et al 2011, Dodson-Robinson et al 2011; see talks by P Pinilla & J-F Gonzalez)

Pre-transition disc puzzle

- How long does the pre-transition disc phase last?
- How does it depend on the planet properties (e.g. mass and location)?

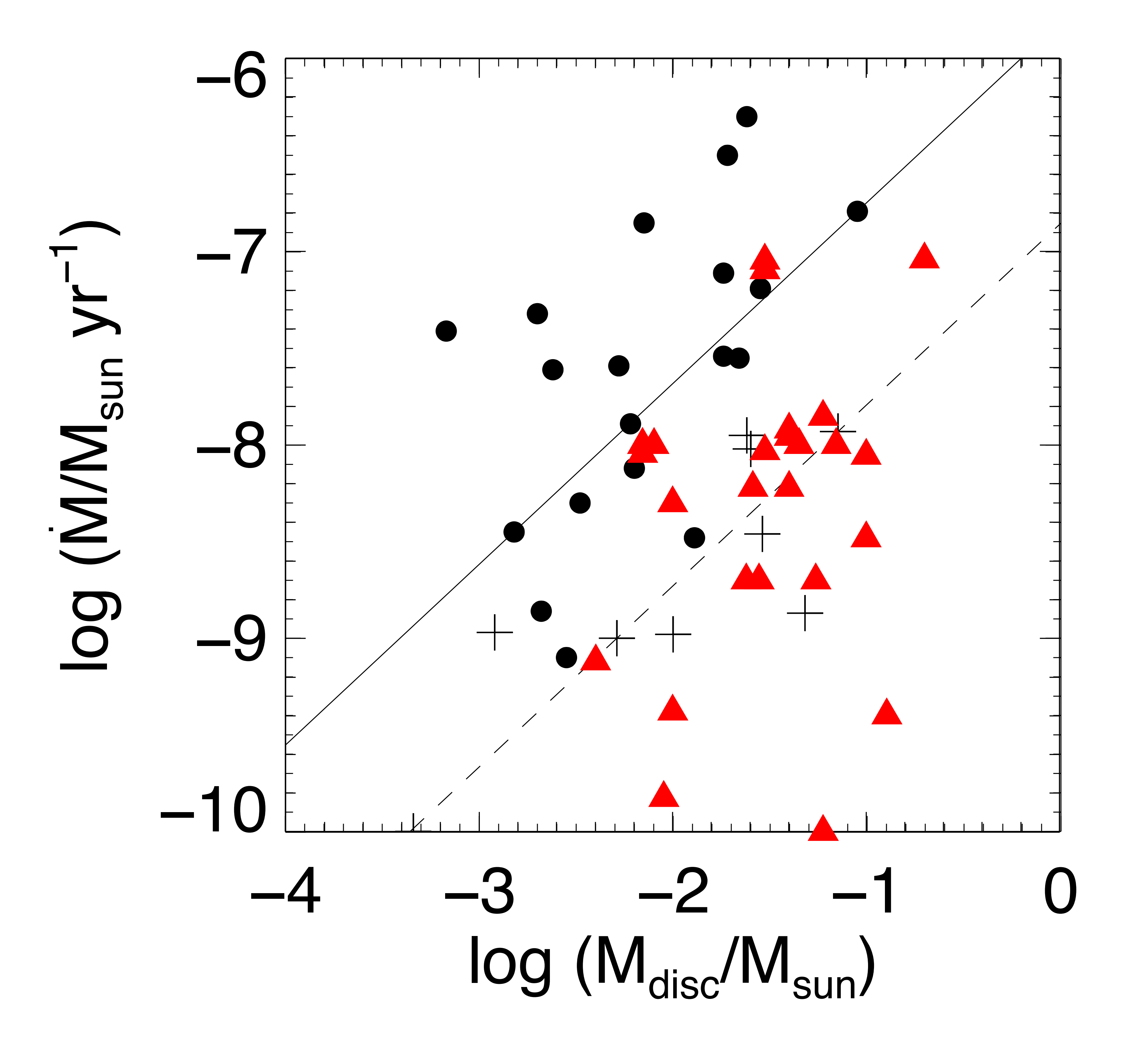
Accretion rate signatures



Najita, Strom , Muzerolle (2007)

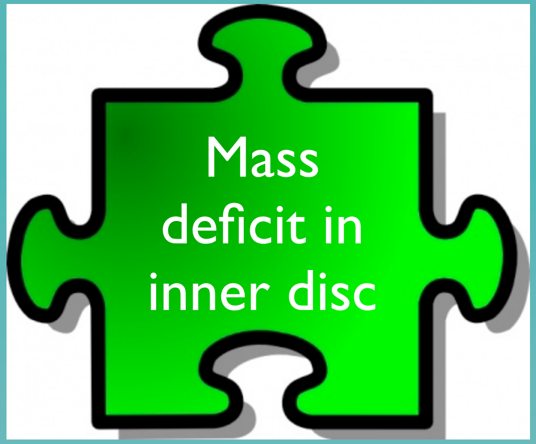
(also, Alexander & Armitage 2009)

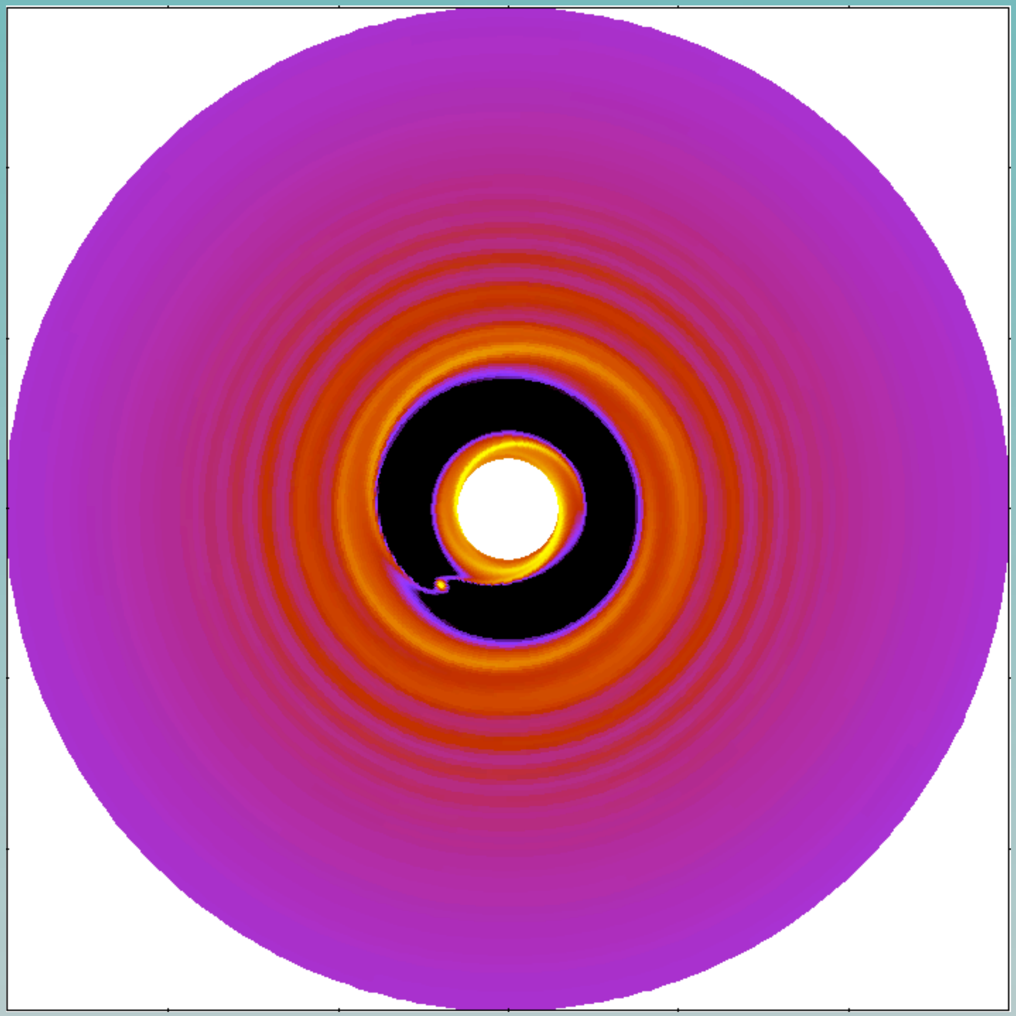
Accretion rate signatures



Najita, Strom , Muzerolle (2007)
Espaillat et al 2007, 2010, 2011, 2012
Kim et al 2009
Andrews et al 2011
Cieza et al 2011
Öberg et al 2011

Does the presence of a planet starve the inner disc?



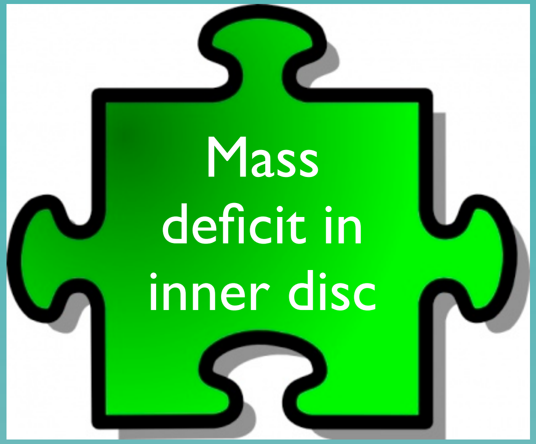


F. Meru

- Inner disc not starved (boundary conditions may play a part)
  Lubow et al (1999)

- Inner disc starved
  Varnière et al (2006)

How do we reconcile these results?

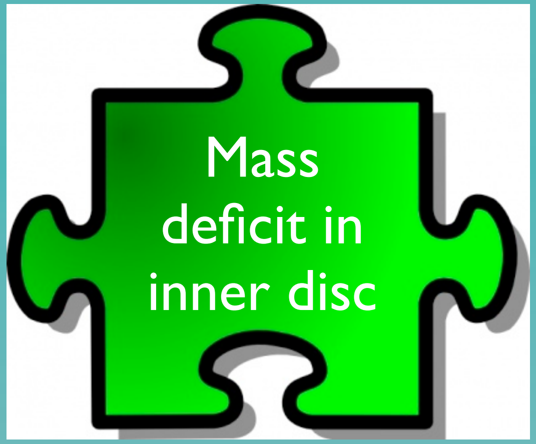


Crida & Morbidelli (2007):

- Deficit increases with planet mass
- Deficit decreases with planet semi-major axis and disc mass

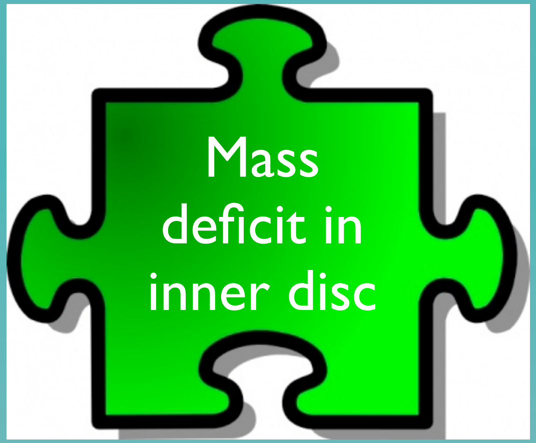
$$\frac{q}{4\mu} = \frac{M_p}{4\pi R_p^2 \Sigma} >> 1$$

Planet mass and location effects on the pre-transition duration



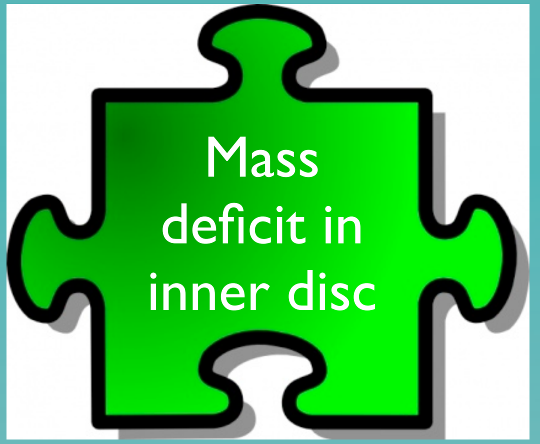
- Planet mass: 3, 5, 7 M_{Jup} planets at 3AU
- Initial planet location: 3M_{Jup} planet at 2, 3, 4 AU
- Comparison with disc without planet
- $\frac{q}{4\mu} = \frac{M_p}{4\pi R_p^2 \Sigma}$ is of the order of a few

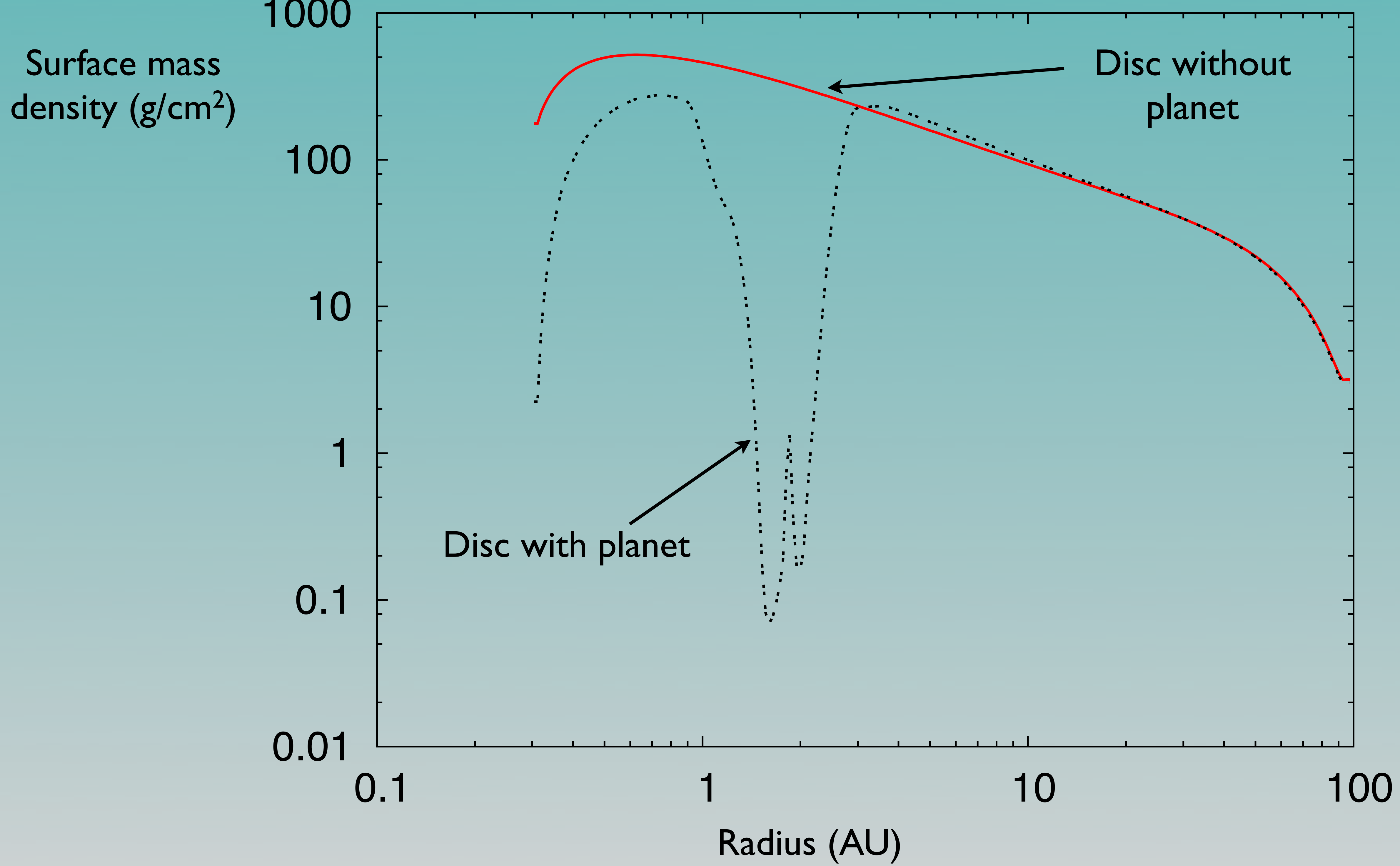
Numerical simulations



- $1M_\odot$ star
- $0.1M_\odot$ disc
- 0.3 < R < 100AU
- $\Sigma \propto R^{-0.5}$
- $T \propto R^{-0.5}$
- SS alpha viscosity: $\alpha = 0.01$
- Isothermal equation of state
- FARGO2D1D hydrodynamics code (Crida et al 2007)
- Evolve for $t = t_\nu$ at 3AU

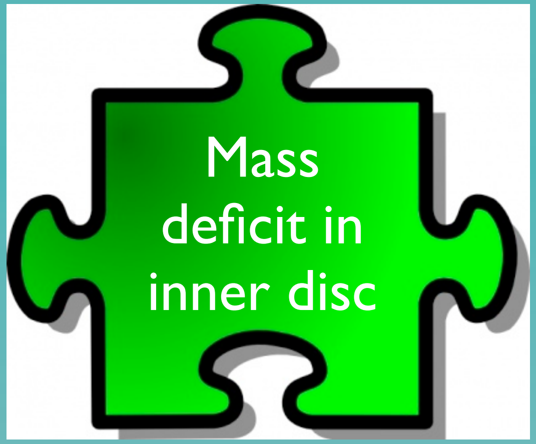
Inner disc surface mass density

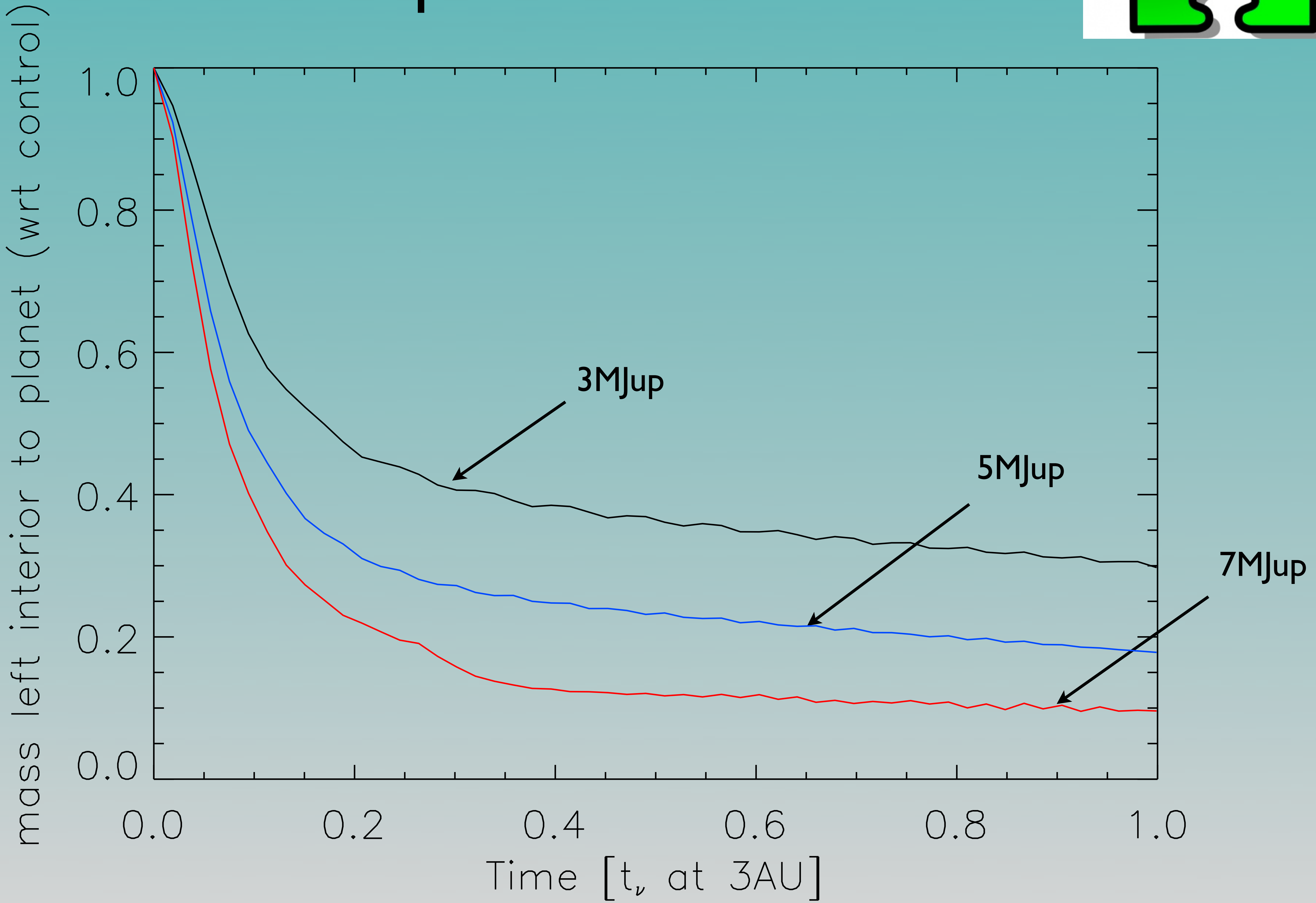




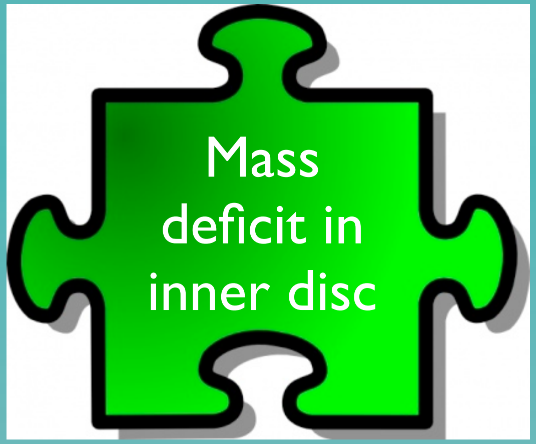
$5M_{Jup}$ planet initially at 3AU; $t = t_\nu$ at 3AU

Deficit increases with planet mass



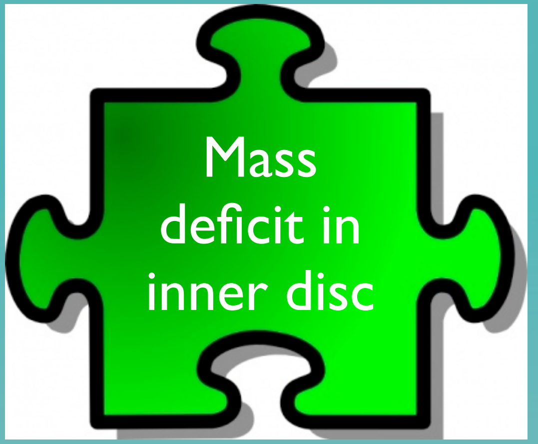


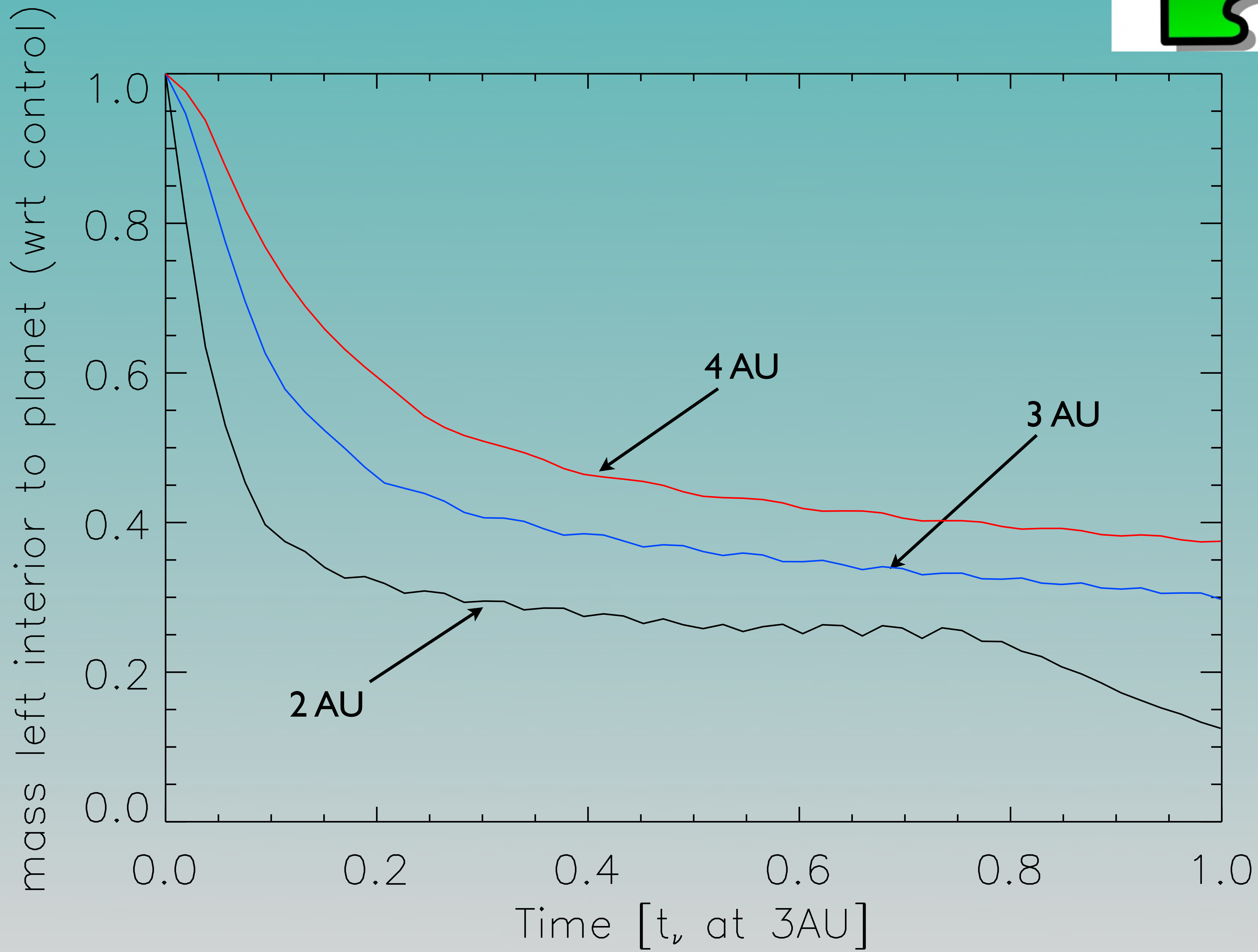
Observational implications for planet hunters



- Observers more sensitive to high mass planets
- Higher mass planets deplete inner disc more rapidly
- Expect that pre-transition phase is shorter for high mass planets
- Preferentially point telescopes to TD rather than PTD

Deficit with planet location





Summary

- 2D hydrodynamical simulations to investigate the inner disc deficit due to the presence of a planet
- Higher planet mass increases the deficit
    - Observers might preferentially consider looking in TD rather than PTD
- Deficit increases as planets are placed closer in to the star
- Put together with mass deficit for different disc masses, mass accretion rates and mass build up around the planet, this can give us details on the lifetime of the PTD phase