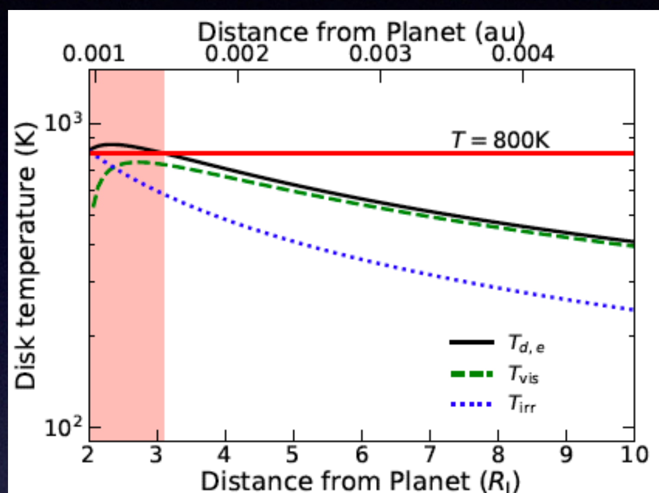
Magnetic Fields and Accreting Giant Planets around PDS 70

Yasuhiro Hasegawa (Jet Propulsion Laboratory, California Institute of Technology)

1. Energy budget

The inner edge region can be MRI active due to thermal ionization



2a. Weak magnetic fields

Magnetospheric accretion becomes possible when planetary magnetic fields are

$$20 \text{ G} \lesssim B_{ps} \lesssim 40 \text{ G},$$

This field strength is predicted for rapid rotators

Disk locking leads to the spin rate of ~ 84 % of the break-up limit

2b. Strong magnetic fields

Thermodynamically available internal energy generates planetary magnetic fields:

$$1.3 \times 10^2 \text{ G} \lesssim B_{ps} \lesssim 5.0 \times 10^2 \text{ G},$$

The same scaling law can reproduce indirect measurements of B-fields for hot Jupiters

Disk locking leads to the spin rate of ~ 14 % of the break-up limit, which is consistent with the recent observations

3. The inner edge properties of circumplanetary disks

Planetary magnetic fields & non-ideal MHD effects play an important role

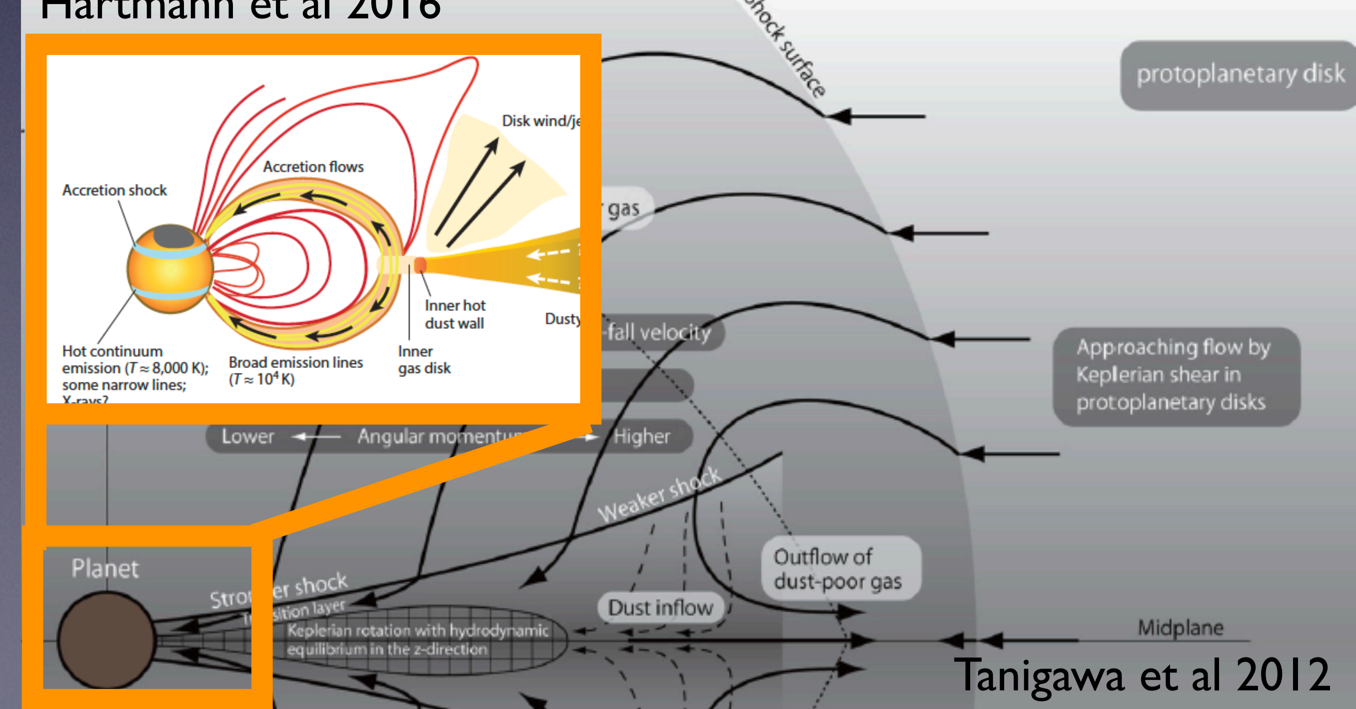
Giant planets very likely undergo magnetospheric accretion, following mass growth and radius evolution

$$\Sigma \simeq 4.0 \times 10^4 \text{ g cm}^{-2} \left(\frac{M_p}{10 M_J}\right) \left(\frac{\dot{M}_p}{10^{-7} M_J \text{ yr}^{-1}}\right)^{2.9} \times \left(\frac{R_p}{2 R_J}\right)^{-12} \left(\frac{T_{p,e}}{1200 \text{ K}}\right)^{-0.5} \left(\frac{B_{ps}}{130 \text{ G}}\right)^{-3.9} \left(\frac{r}{6 R_J}\right)^{4.8}, \quad (22)$$

The resulting surface density lies between two empirically derived models: the minimum mass *sub*nebular model and the gas-starved one

The positive radial gradient invokes traps for both satellite migration and radial dust drift

Hartmann et al 2016



Tanigawa et al 2012