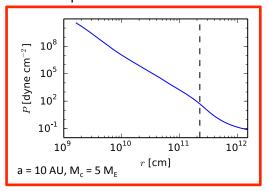
Minimum Core Masses for Giant Planet Formation

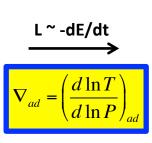
Piso, Youdin, & Murray-Clay (ApJ, 2015, 800, 82) Piso & Youdin (ApJ, 2014, 786, 21)

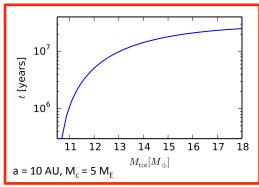
We determine the minimum core mass, M_crit, to form a giant planet before the gas in the protoplanetary disk dissipates, assuming the limiting case in which the solid cores no longer accrete planetesimals and the cores' atmospheres are dominated by Kelvin-Helmholtz contraction. We explore the effects of a non-ideal equation of state (EOS) and grain growth opacities on atmospheric evolution.

ATMOSPHERIC MODEL SUMMARY

- Quasi-static evolution of spherically symmetric atmospheres in hydrostatic balance and embedded in a gas disk
- Negligible planetesimal accretion => solid core of fixed mass
- Inner convective & outer radiative regions
- Constant luminosity throughout the radiative region



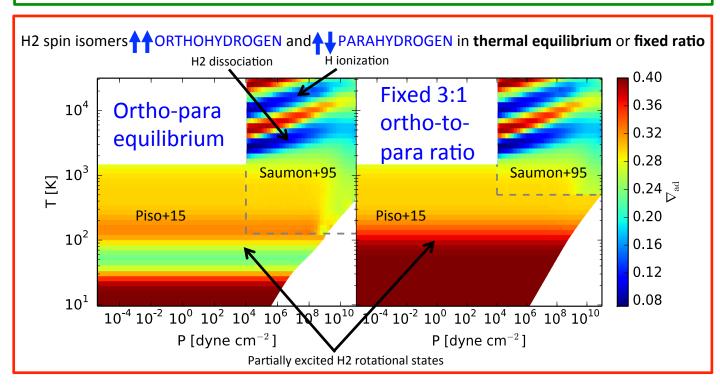




Vad

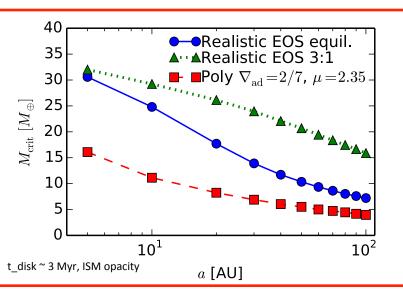
ad relates P, T, rho => determines atmospheric profile and parametrizes EOS

Atmospheric evolution and M_crit are highly dependent on EOS and DUST OPACITY



Minimum Core Masses for Giant Planet Formation

Variations in the adiabatic gradient due to H2 dissociation and variable occupation of H2 rotational states INCREASE the atmospheric evolutionary time when compared to an ideal gas polytrope => M_crit INCREASES

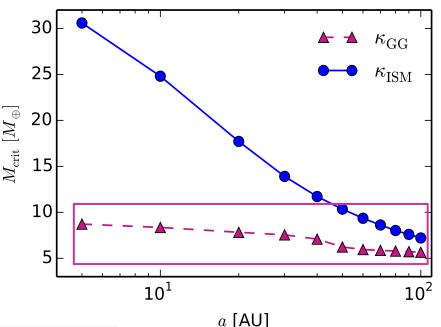


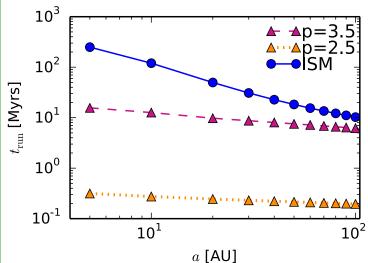
Grain growth opacityDECREASES **M_crit**

For size distribution $dN/ds \sim s^{(-p)}$, p = 3.5 max. particle size = 1 cm:

M_crit is

~8 M_E @ 5 AU ~5 M E @100 AU





If coagulation is taken into account, p = 2.5, the time to runaway accretion decreases by more than one order of magnitude -> Critical Core Mass could be up to one order of magnitude lower!