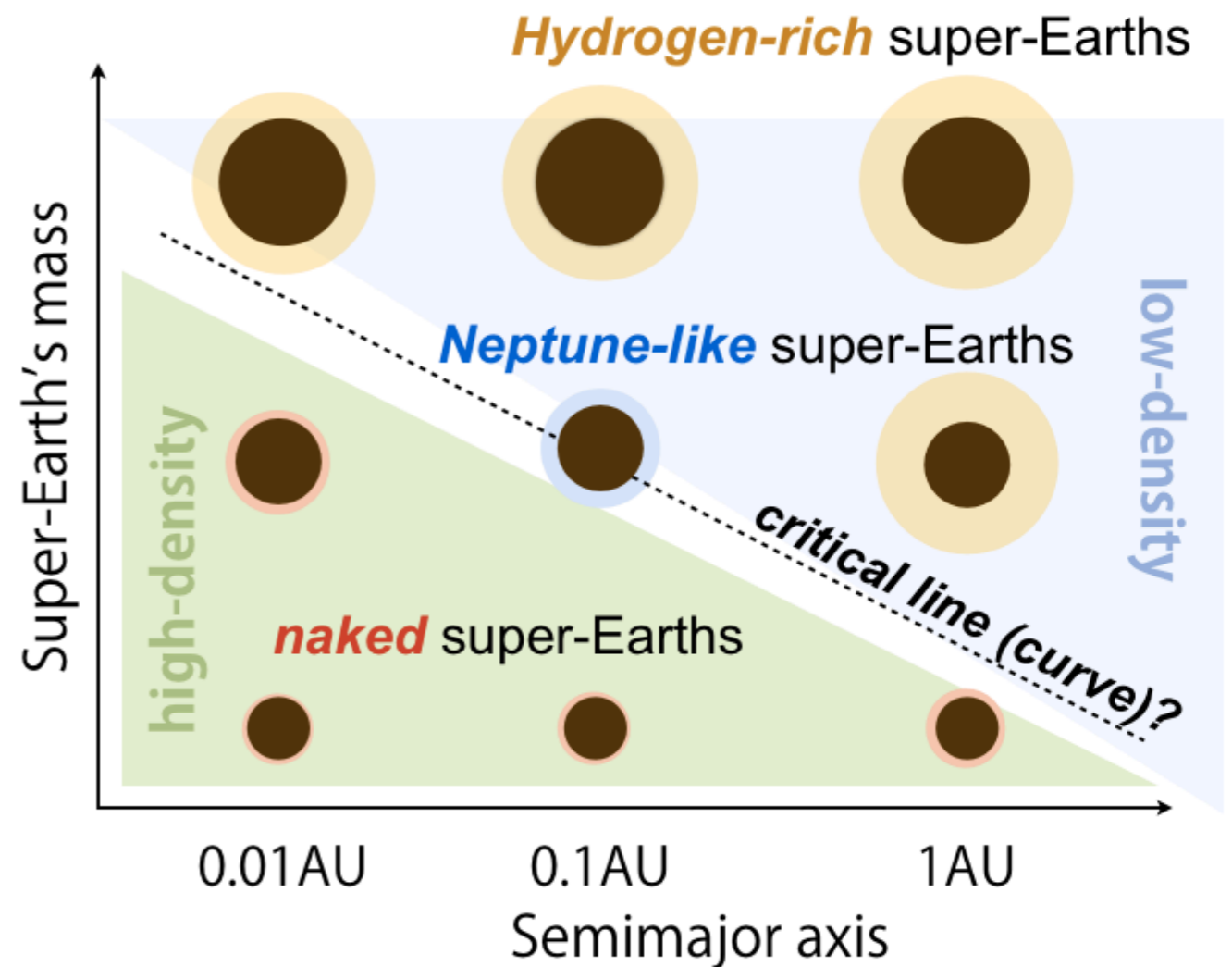


On the Accretion of Atmospheres Onto the Super-Earths

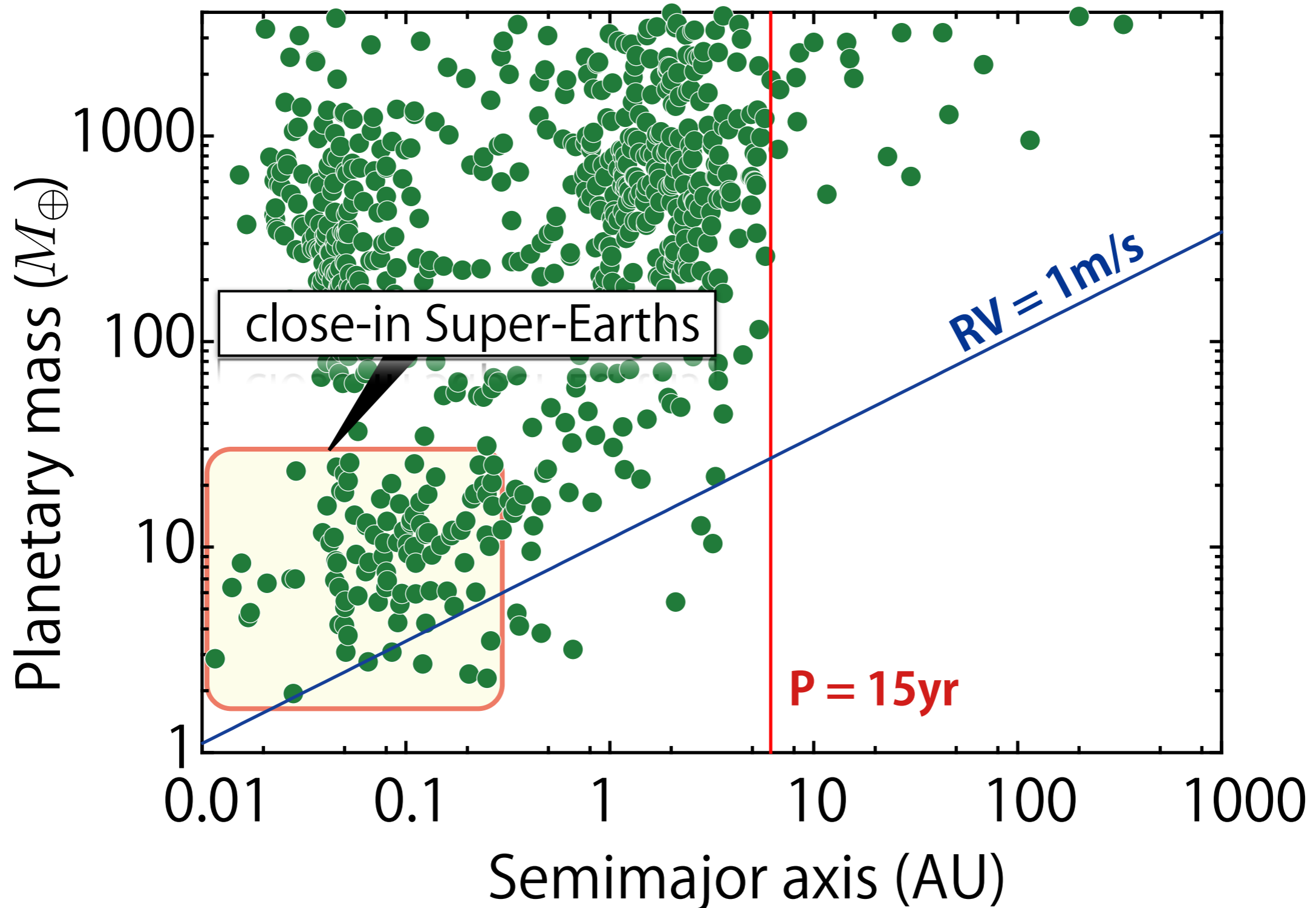
Yasunori HORI

National Astronomical Observatory of Japan
(yasunori.hori@nao.ac.jp)



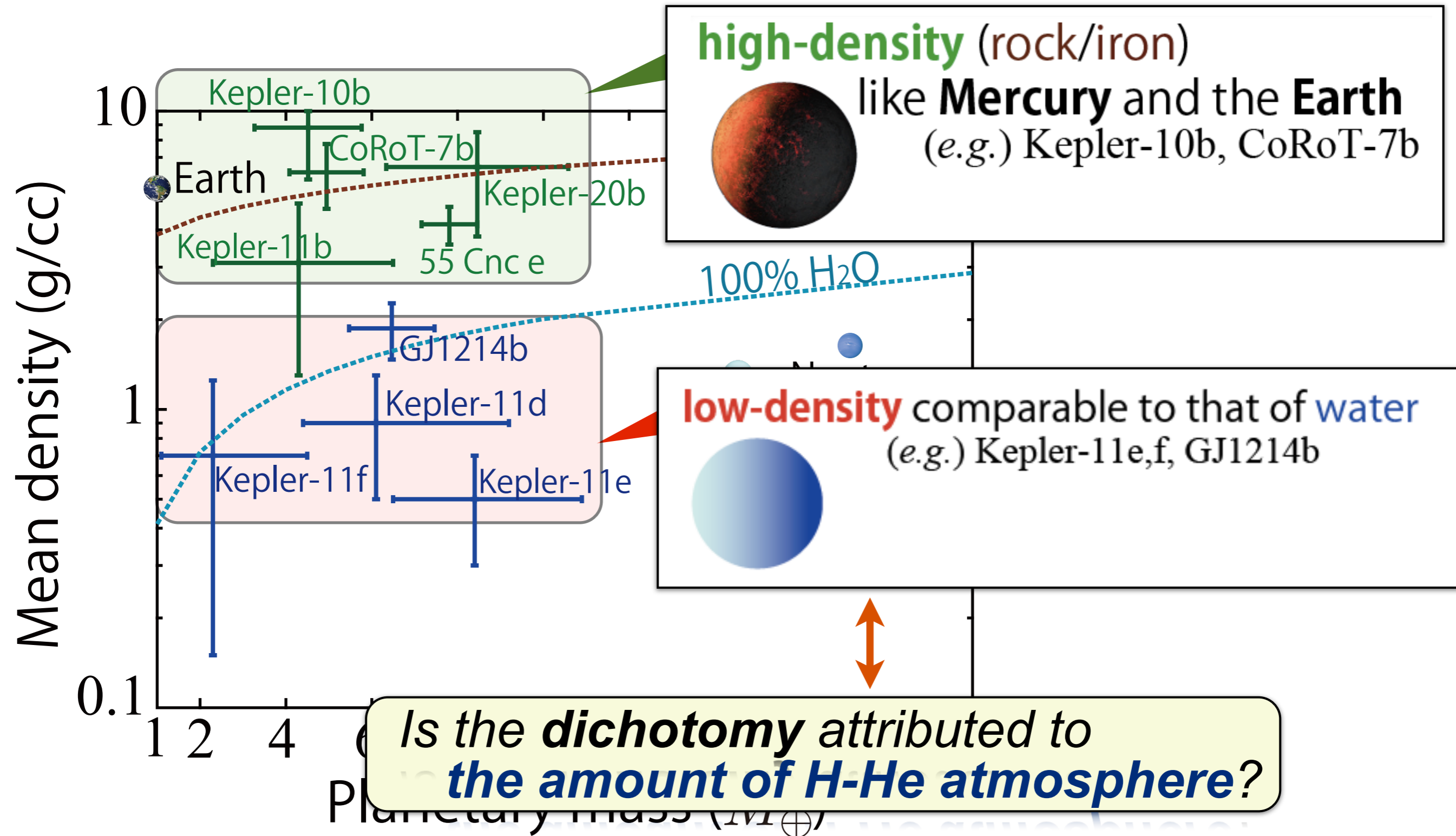
Exoplanet Census

Over **3,100** exoplanets found, including Kepler candidates

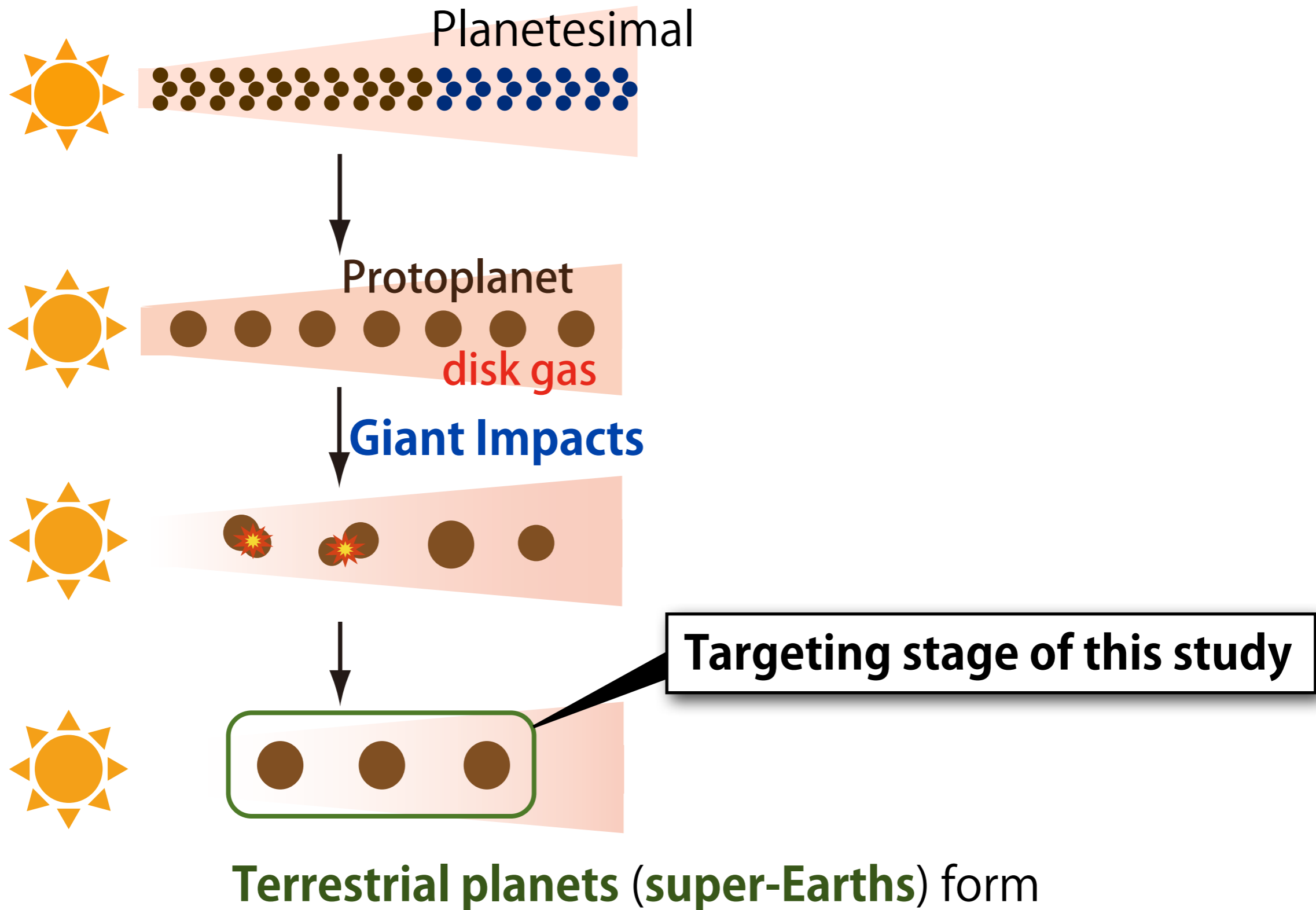


Dichotomy of Close-in Super-Earths

Close-in super-Earths with $< 20M_{\oplus}$ inside 0.35AU



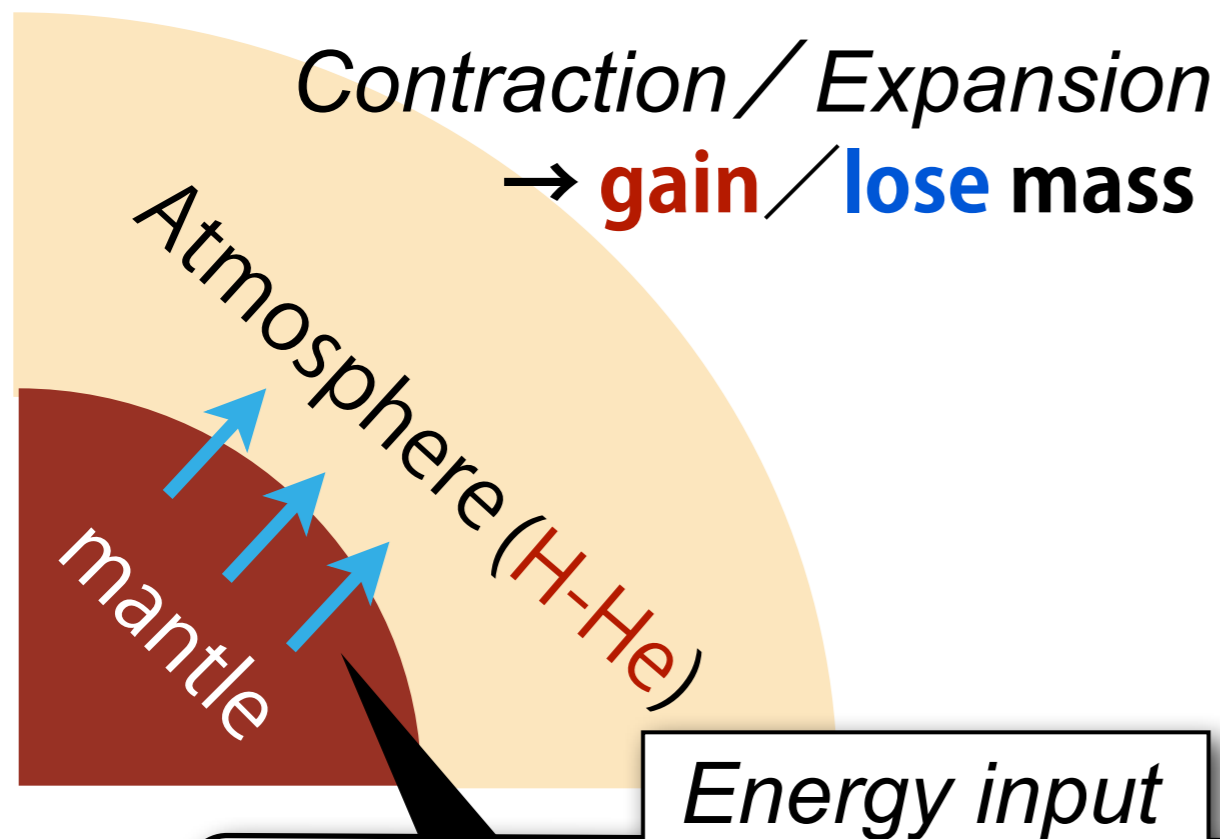
In Situ Formation of Close-in Super-Earths



Gas Accretion onto Super-Earths in a Dissipating disk

Super-Earths embedded in a **dissipating disk after G.I.**

- planetesimals **no longer** accrete
- **H-He atmosphere** accreted **before G.I. dissipated**



mantle cooling + **radioactive decay**
→ **heat up** the atmosphere

■ Atmosphere

H, He : SCVH EOS (Saumon *et al.*1995)

opacity

gas : Freedman *et al.*(2008)

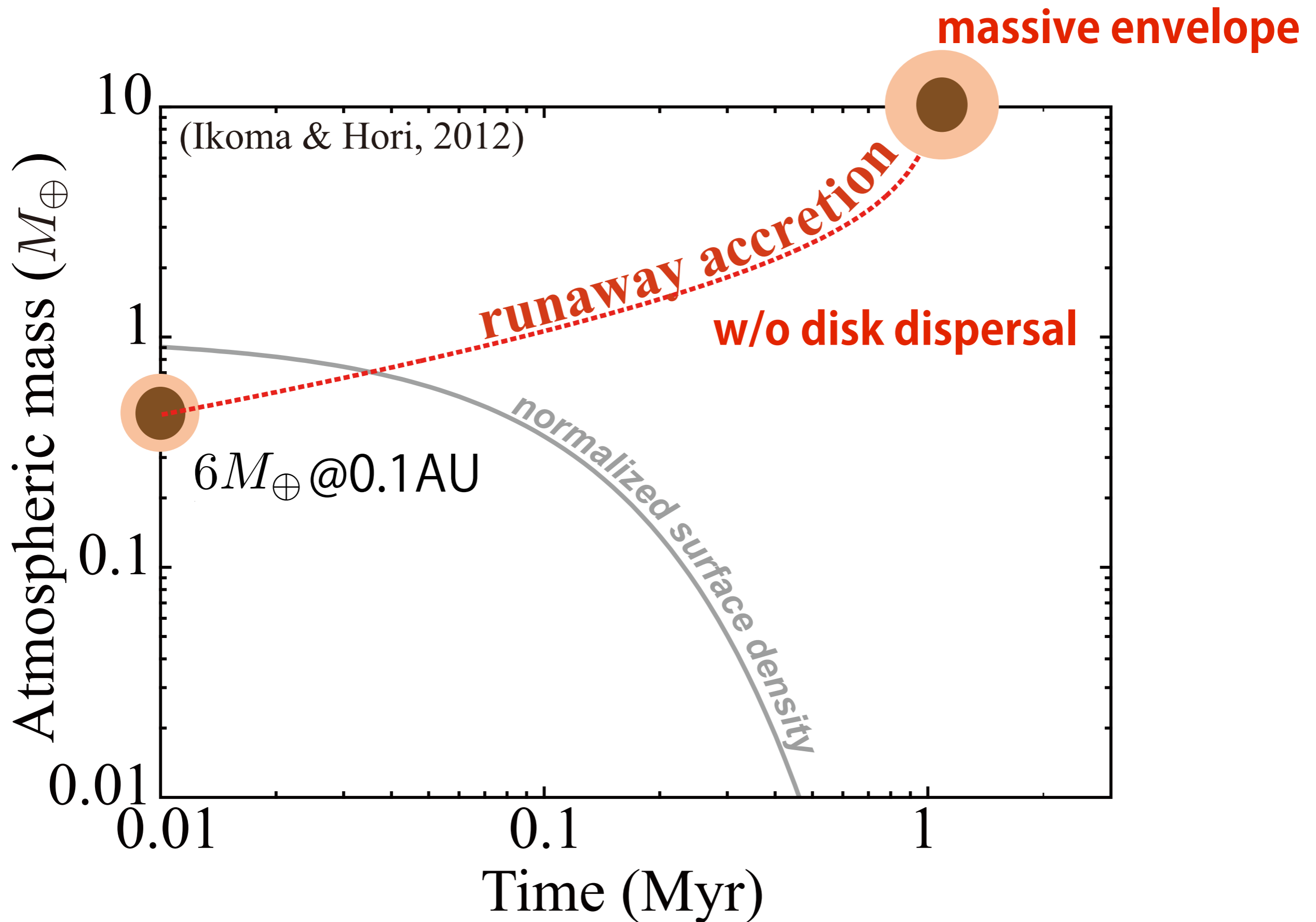
grain : Semenov *et al.*(2003)

■ Disk dispersal

$$\exp(-t/\tau_{\text{disk}})$$

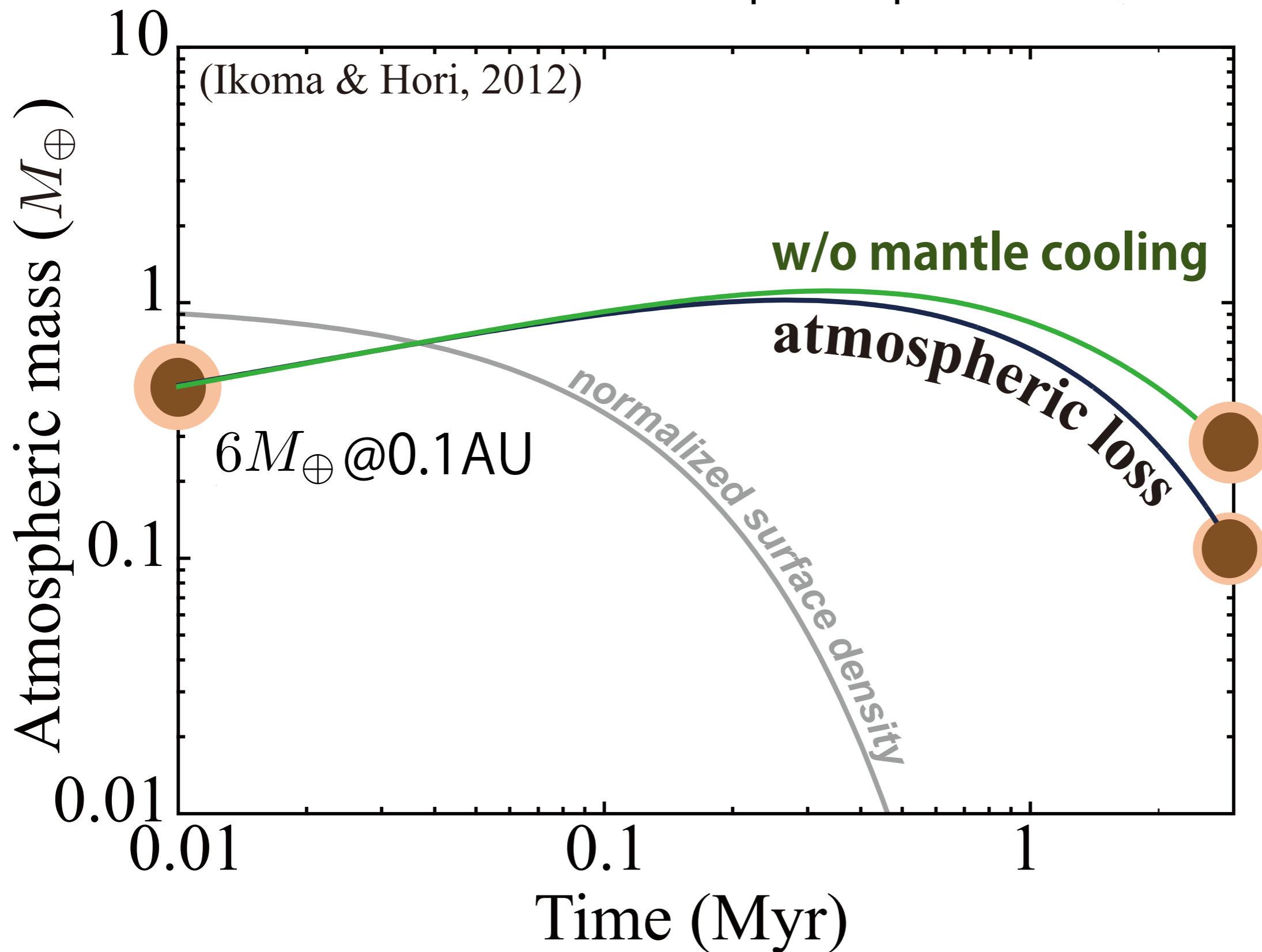
$$, \tau_{\text{disk}} = 0.01 - 1\text{Myr}$$

A Schematic Picture of Atmospheric Growth



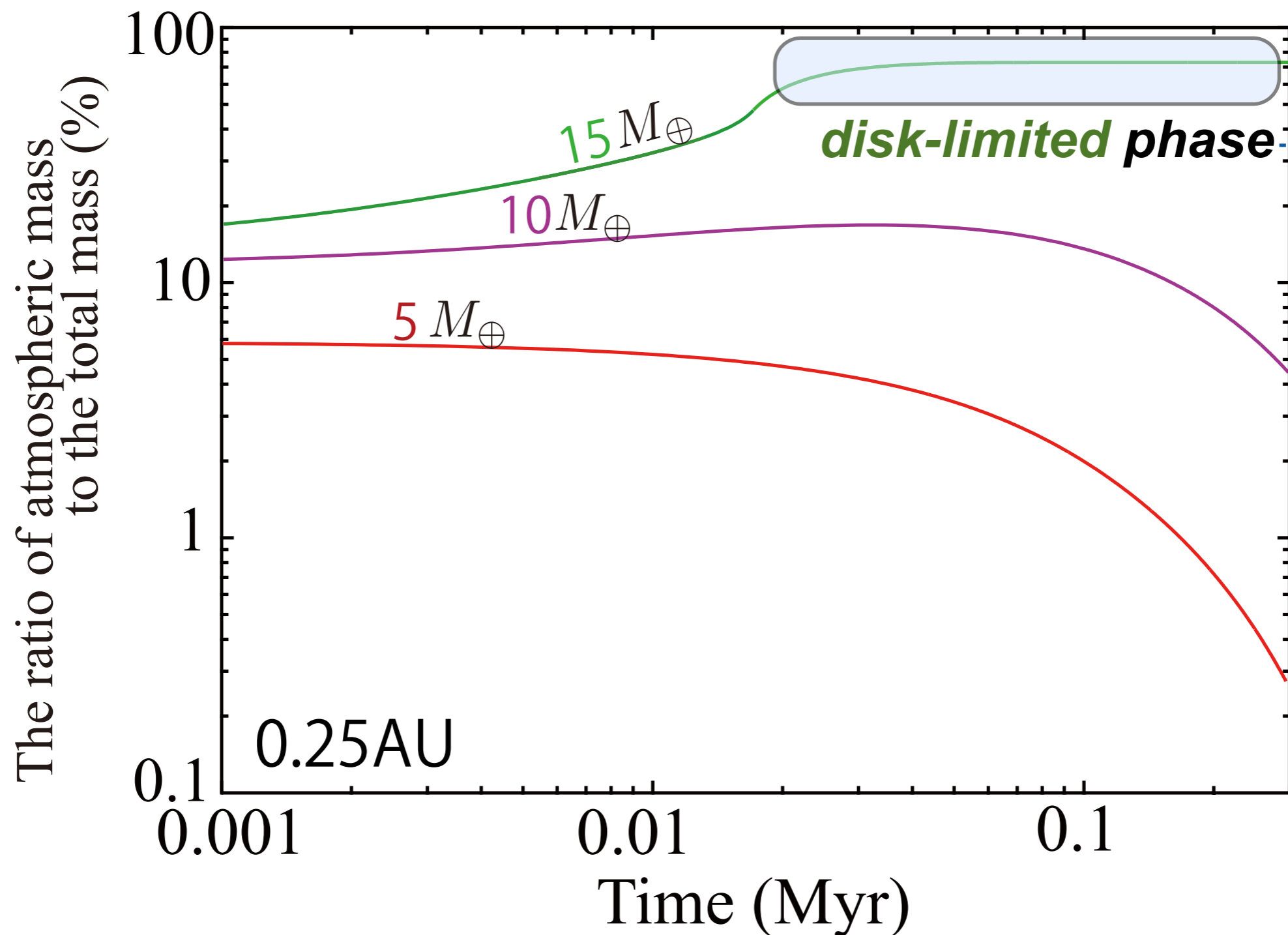
A Schematic Picture of Atmospheric Growth

Disk dispersal proceeds ($\tau_{\text{disk}} = 0.1\text{Myr}$)

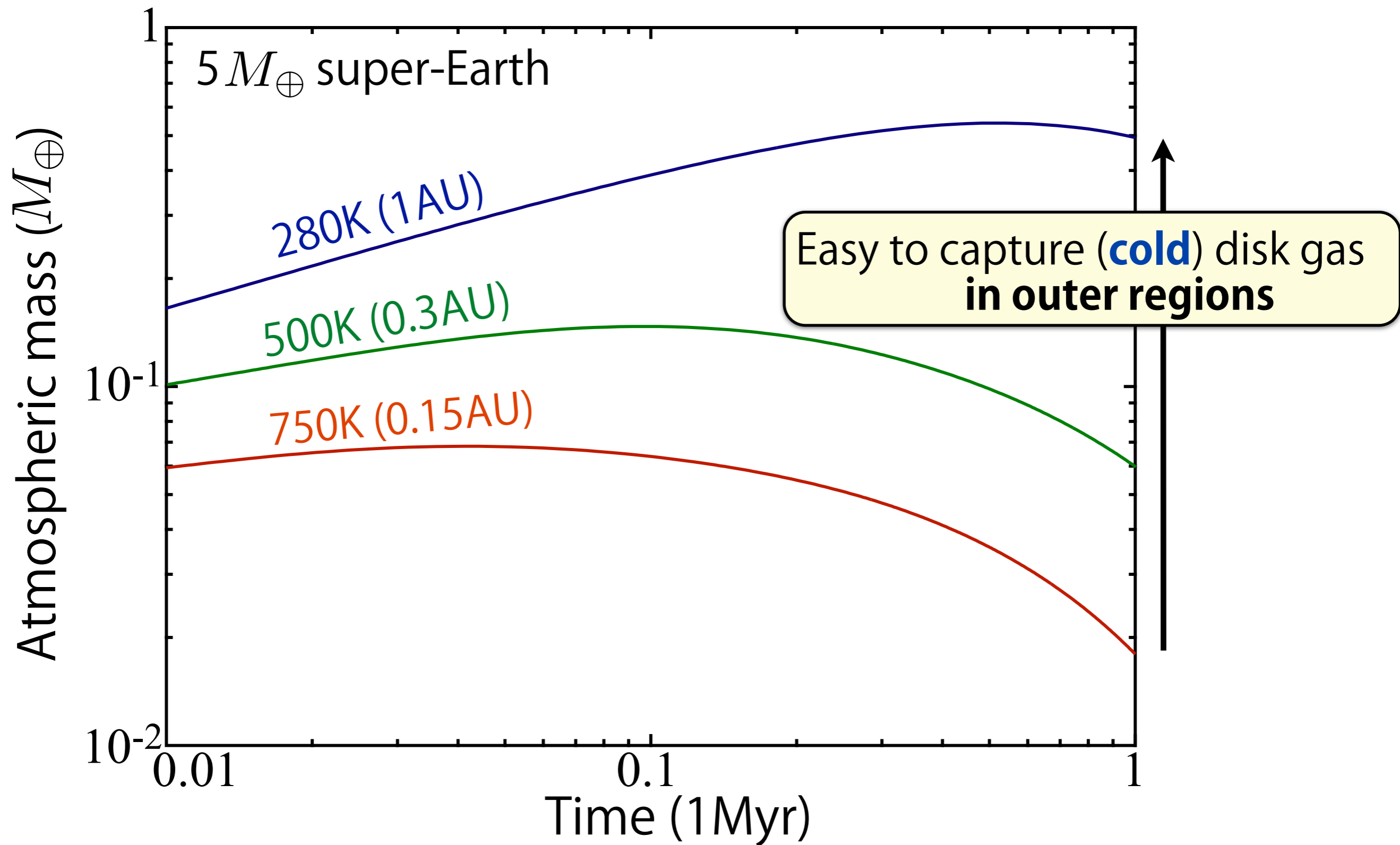


Mass Dependence of Atmospheric Growth

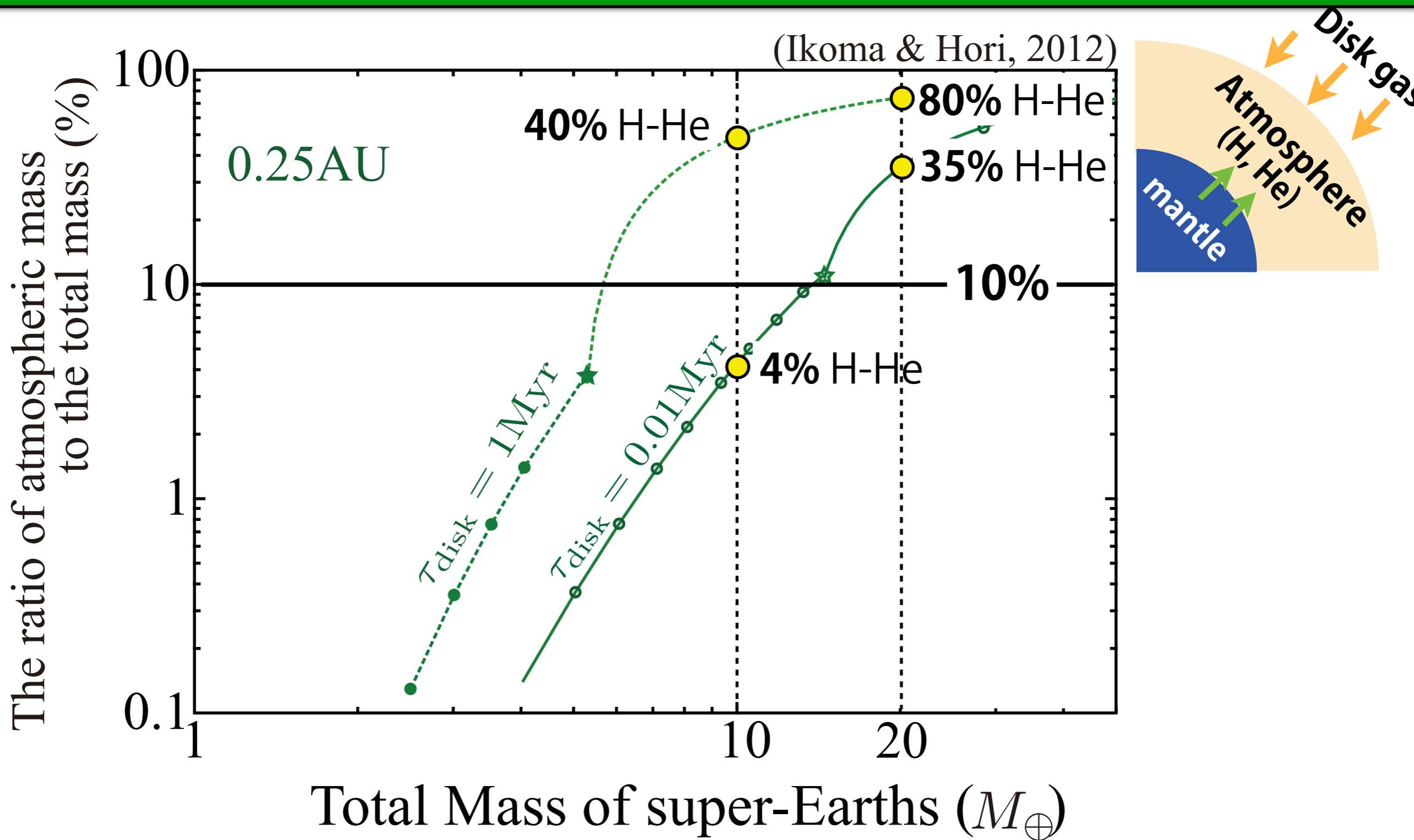
If **super-Earths** obtain **relatively-thick** envelopes before disk gas is severely depleted
→ they can **avoid atmospheric loss**



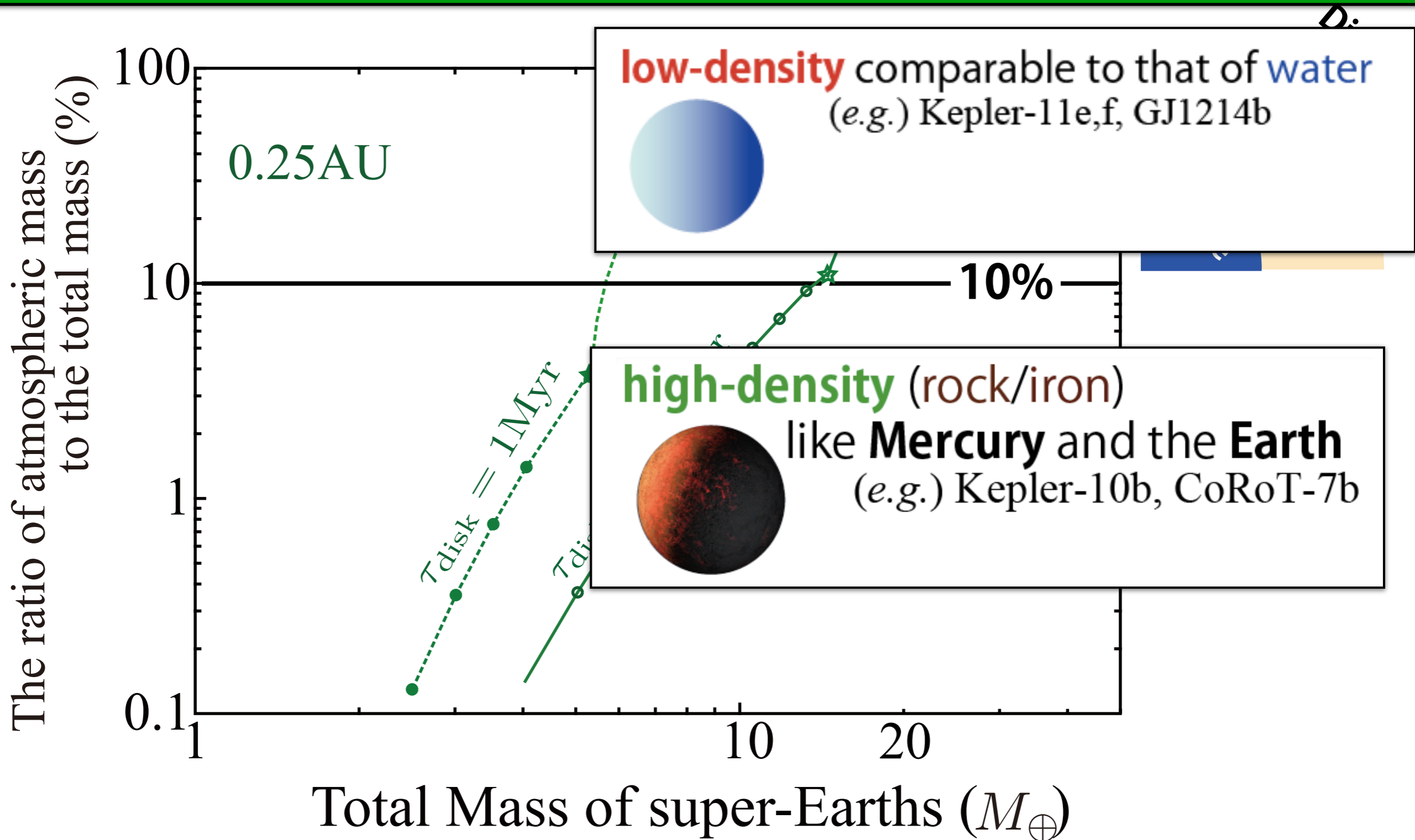
The Sensitivity to Locations of SEs



Final Atmospheric Mass of SEs

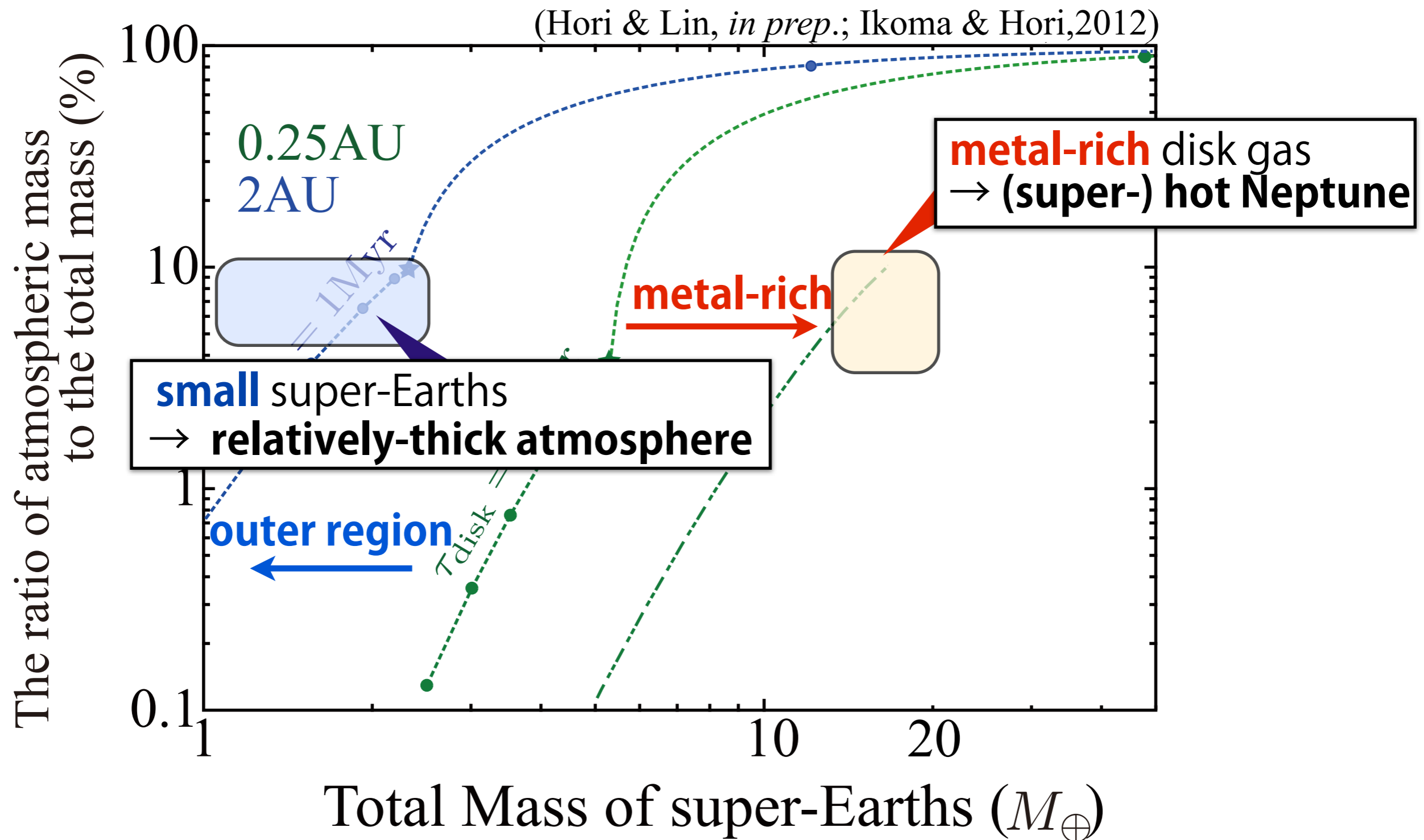


Final Atmospheric Mass of SEs



Bimodal pattern : (a) **less than 10%** H-He atmosphere
(b) **(more than) 40-50%** H-He atmosphere

Implications for Variety of Super-Earths



Summary for H-He Atmospheres of SEs

