

Planet formation: effect of multiplicity

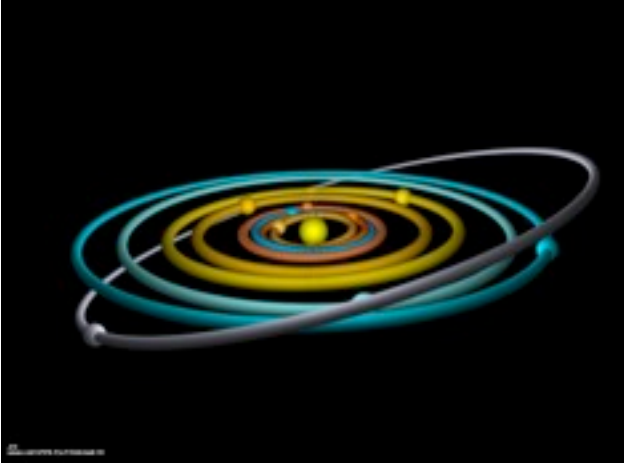
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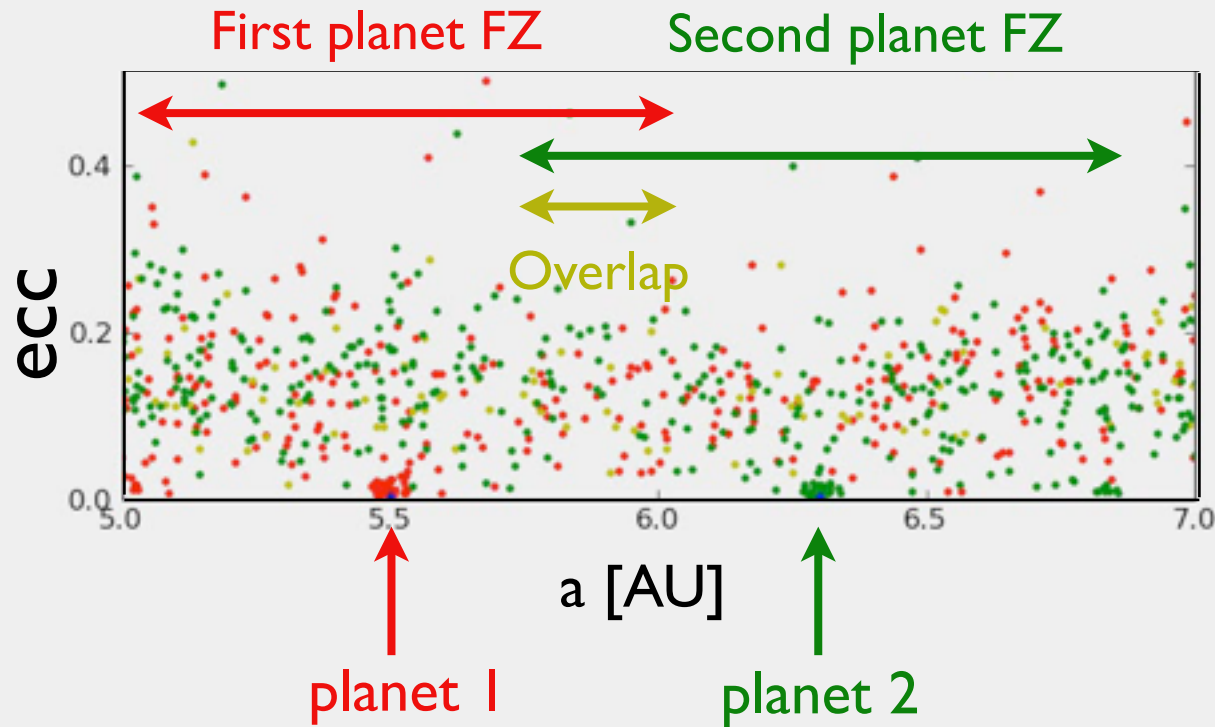
formation of planetary systems

* gravitational interactions → **N-body calculation**
(orbital elements of planets, collisions, ejections, resonances)

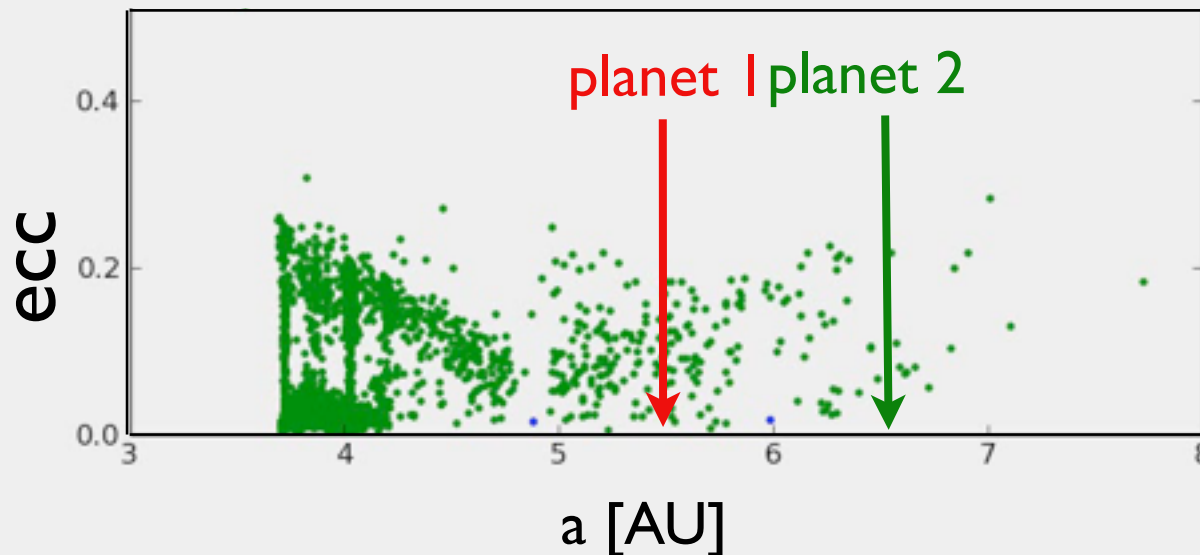
* stirring of planetesimals by planetary neighbors

* competition for accretion (solids and gas)

Competition for solid accretion

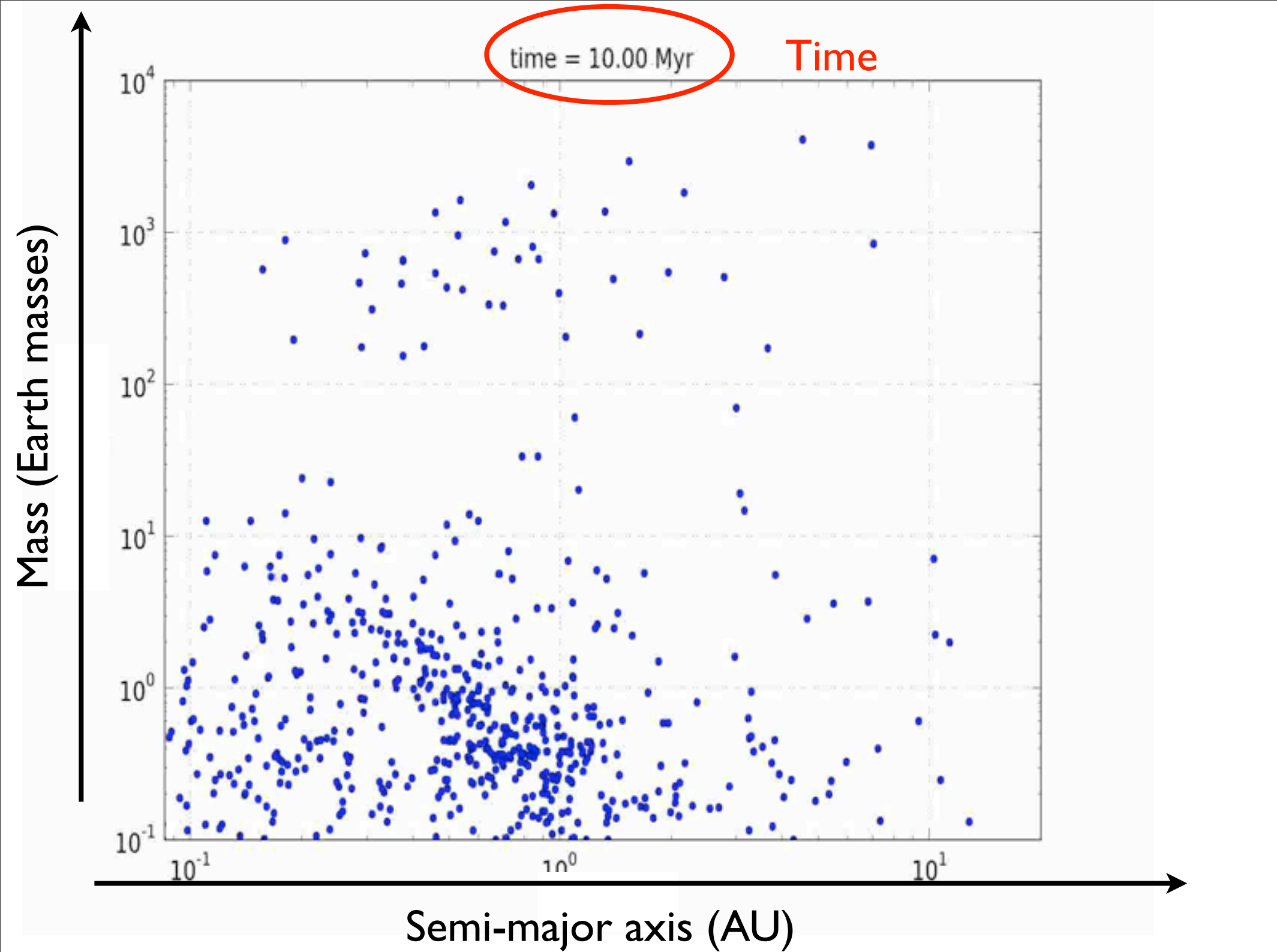


Uniform surface density
and excitation in the
common FZ



Planetesimal transport
to the outermost planet

The internal structures of the two planets are no more independent



time = 10.00 Myr

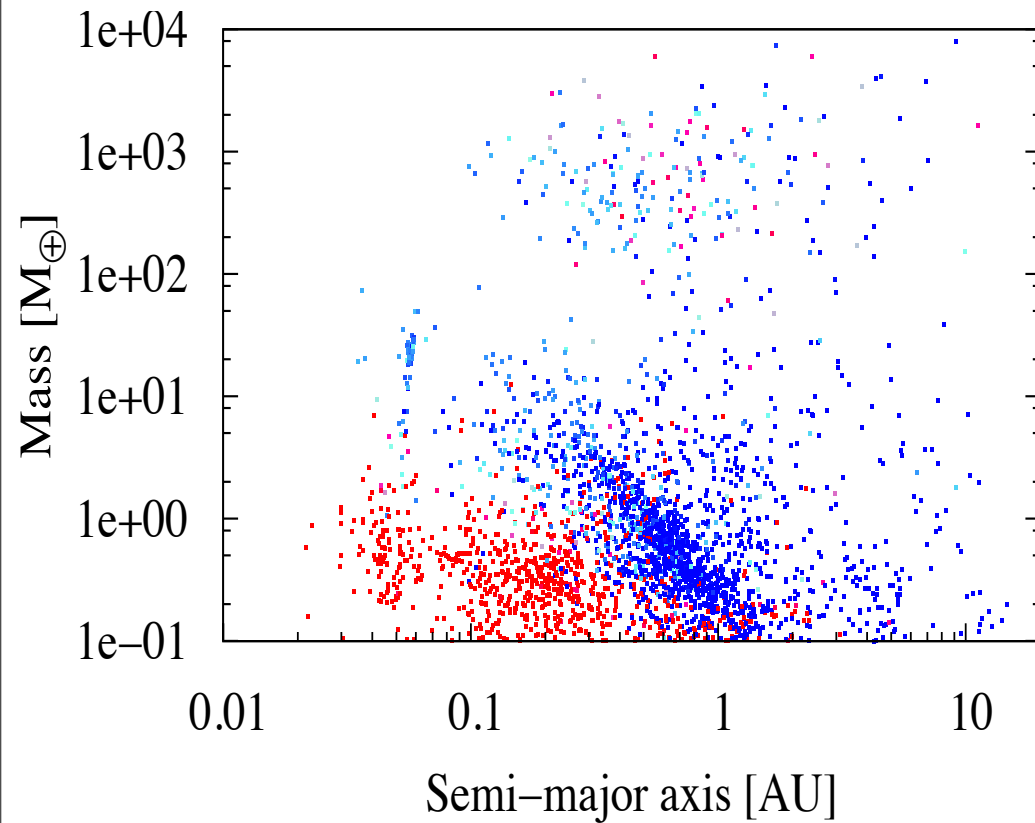
Time

Mass (Earth masses)

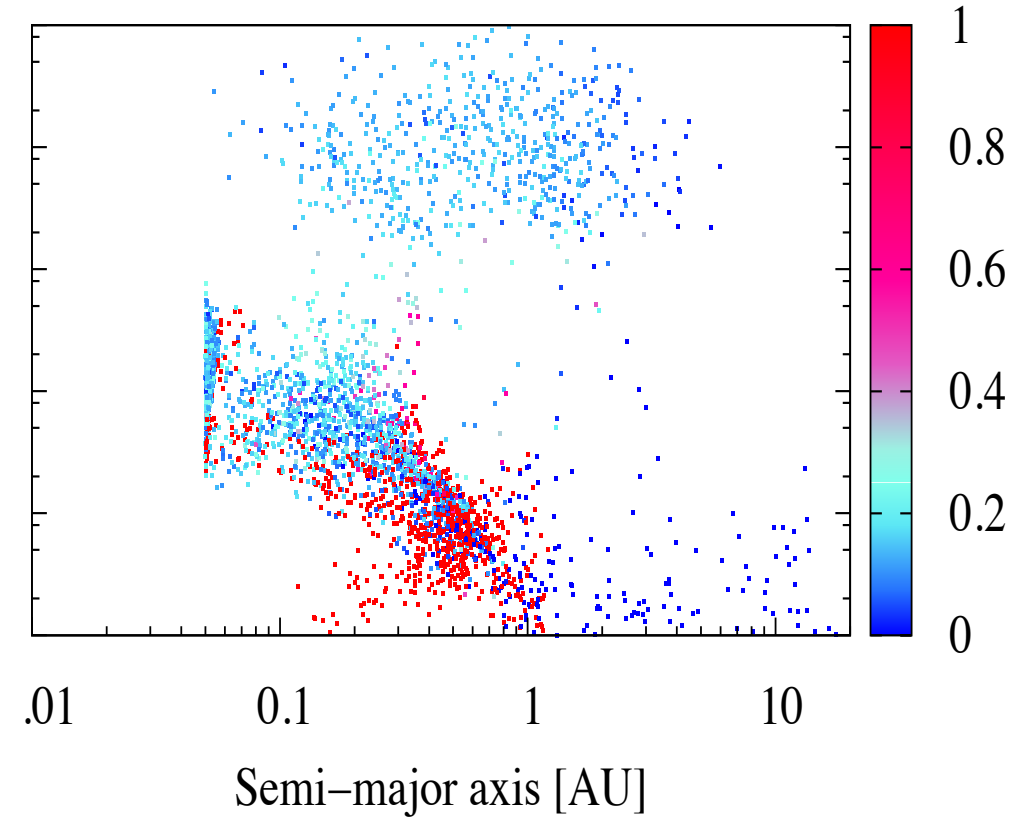
Semi-major axis (AU)

Masses and semi-major axis of planets at the end of formation

470 systems - 10 planetary seeds/system



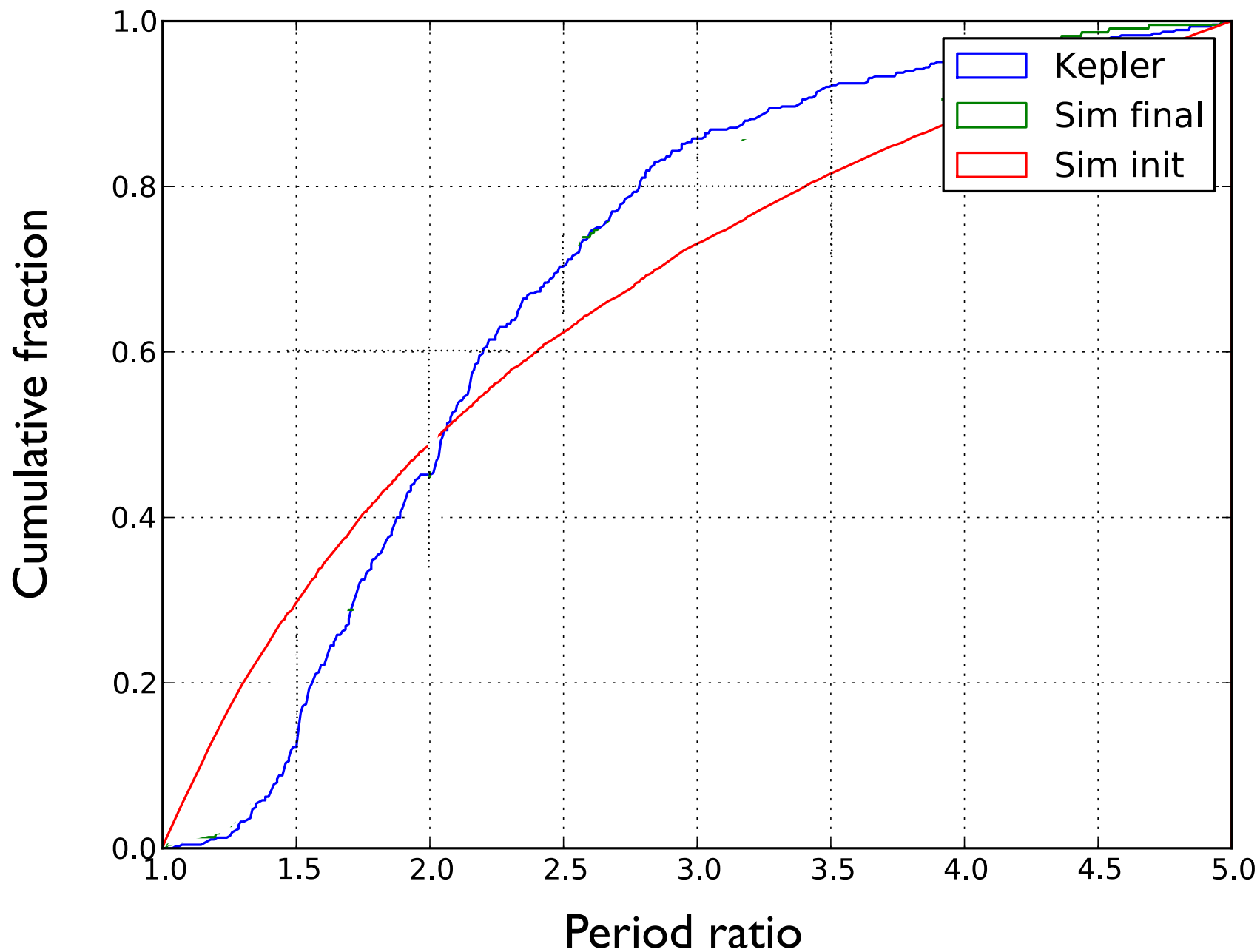
4700 systems - 1 planetary seed/system



- giant planets less massive (competition)
- population of close super-Earth
- difference in composition

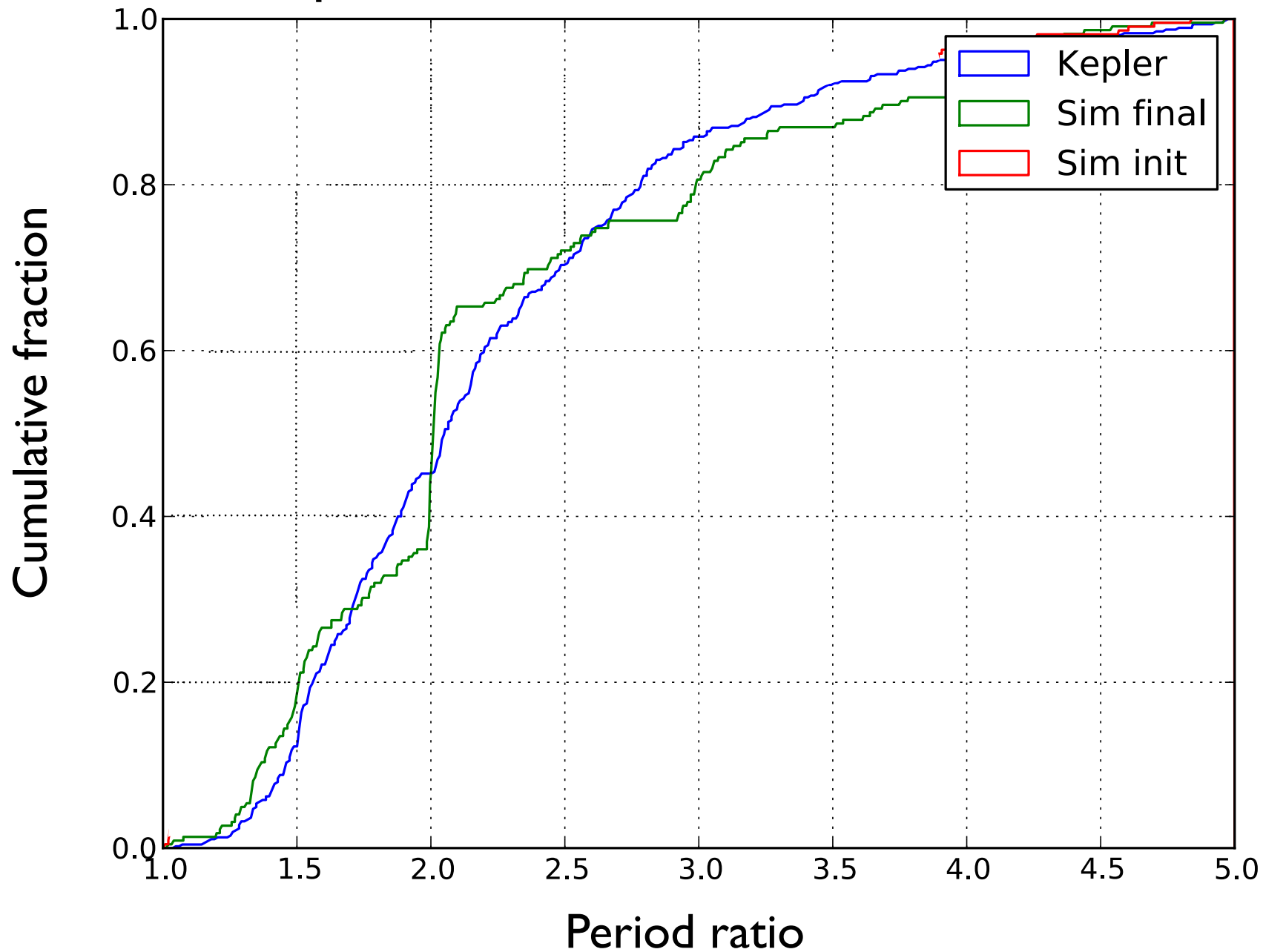
Comparison with Kepler period ratios

Initial conditions



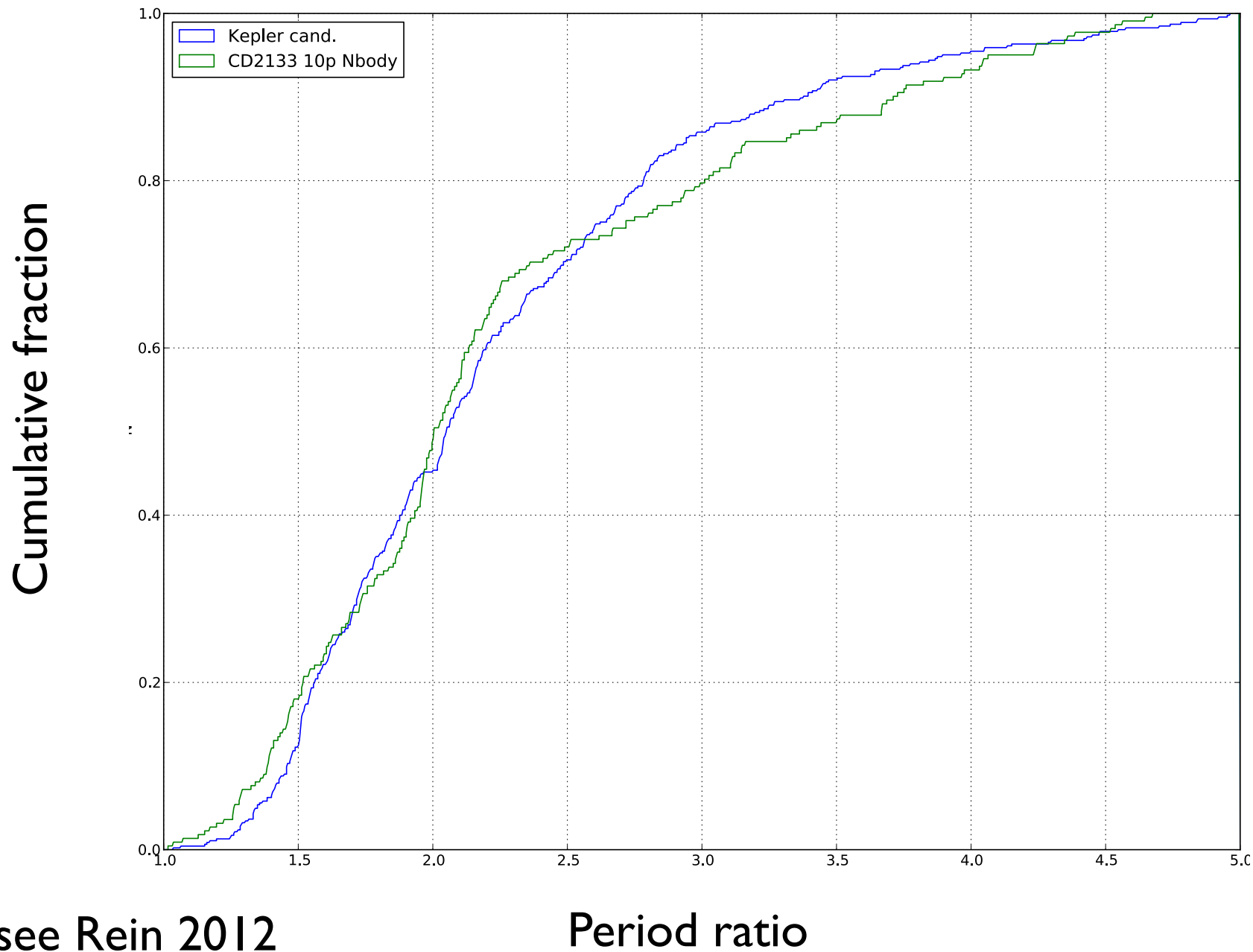
Comparison with Kepler period ratios

All planets below 1 AU and $> 2 M_{\text{earth}}$



Comparison with Kepler period ratios

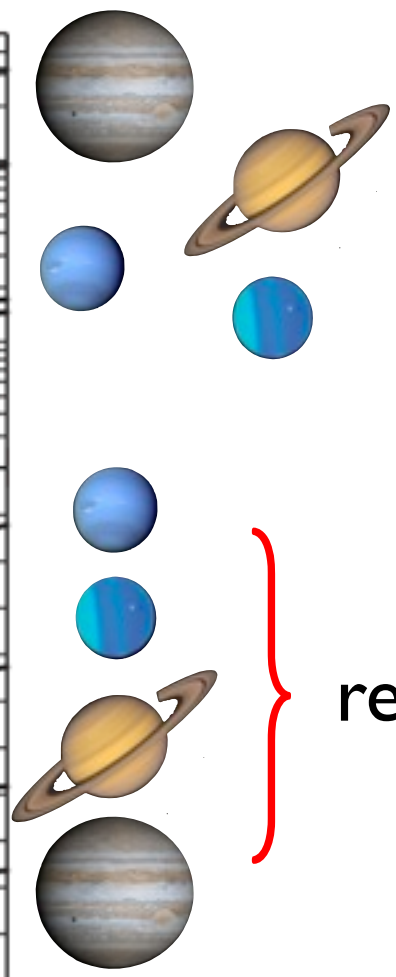
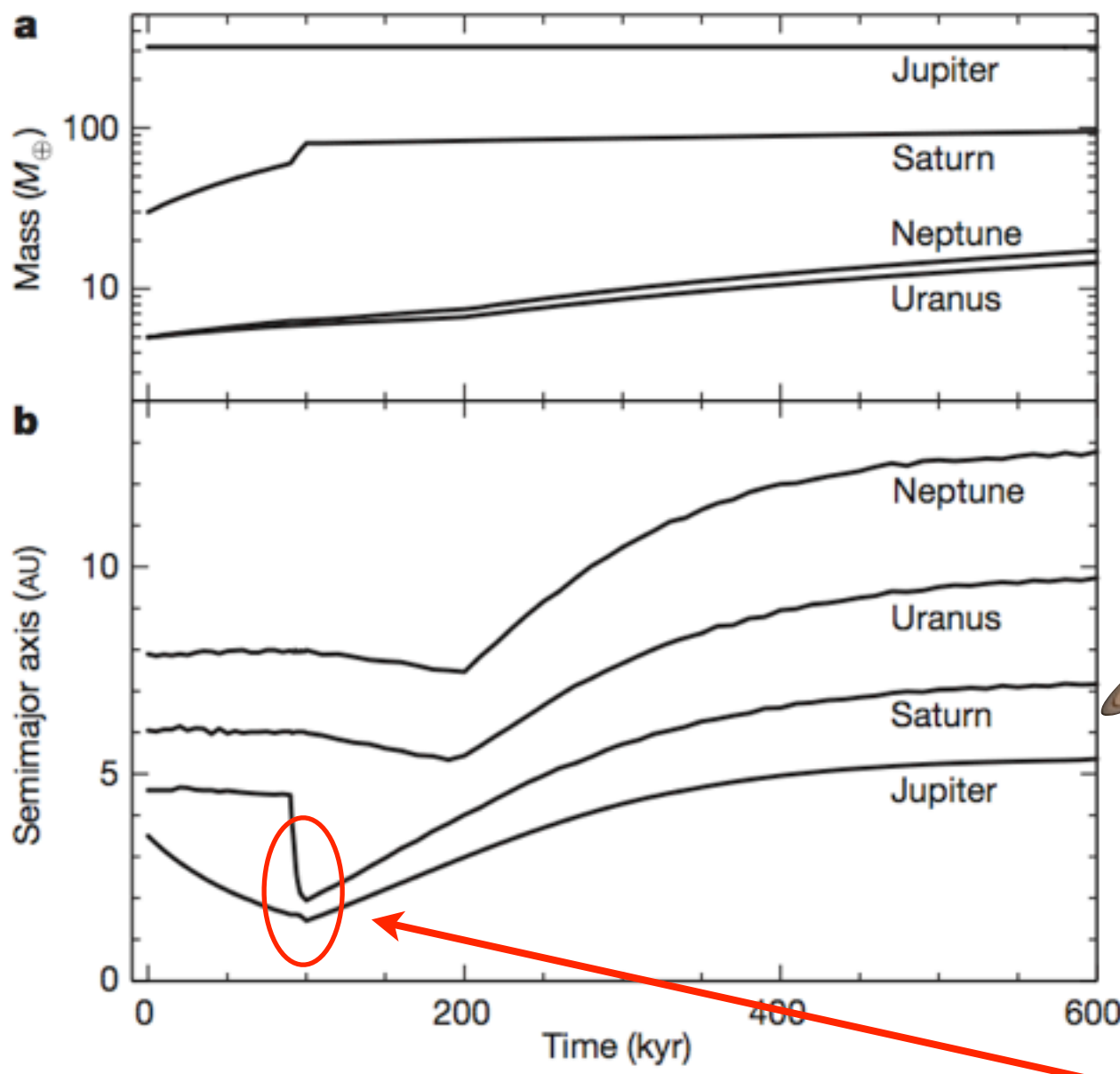
Type I migration + random walk



see Rein 2012

Period ratio

The Nice Models (I-3)

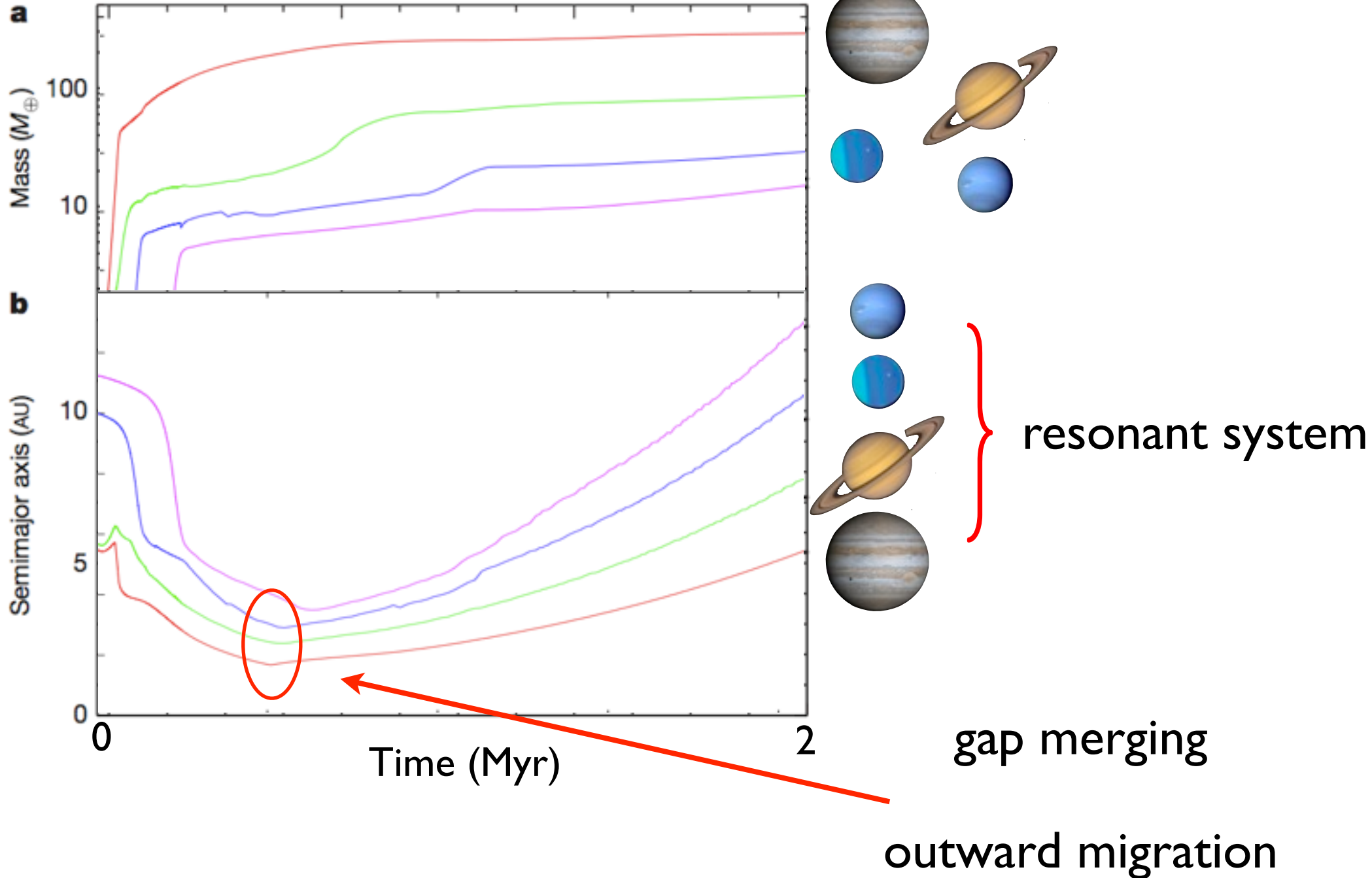


gap merging

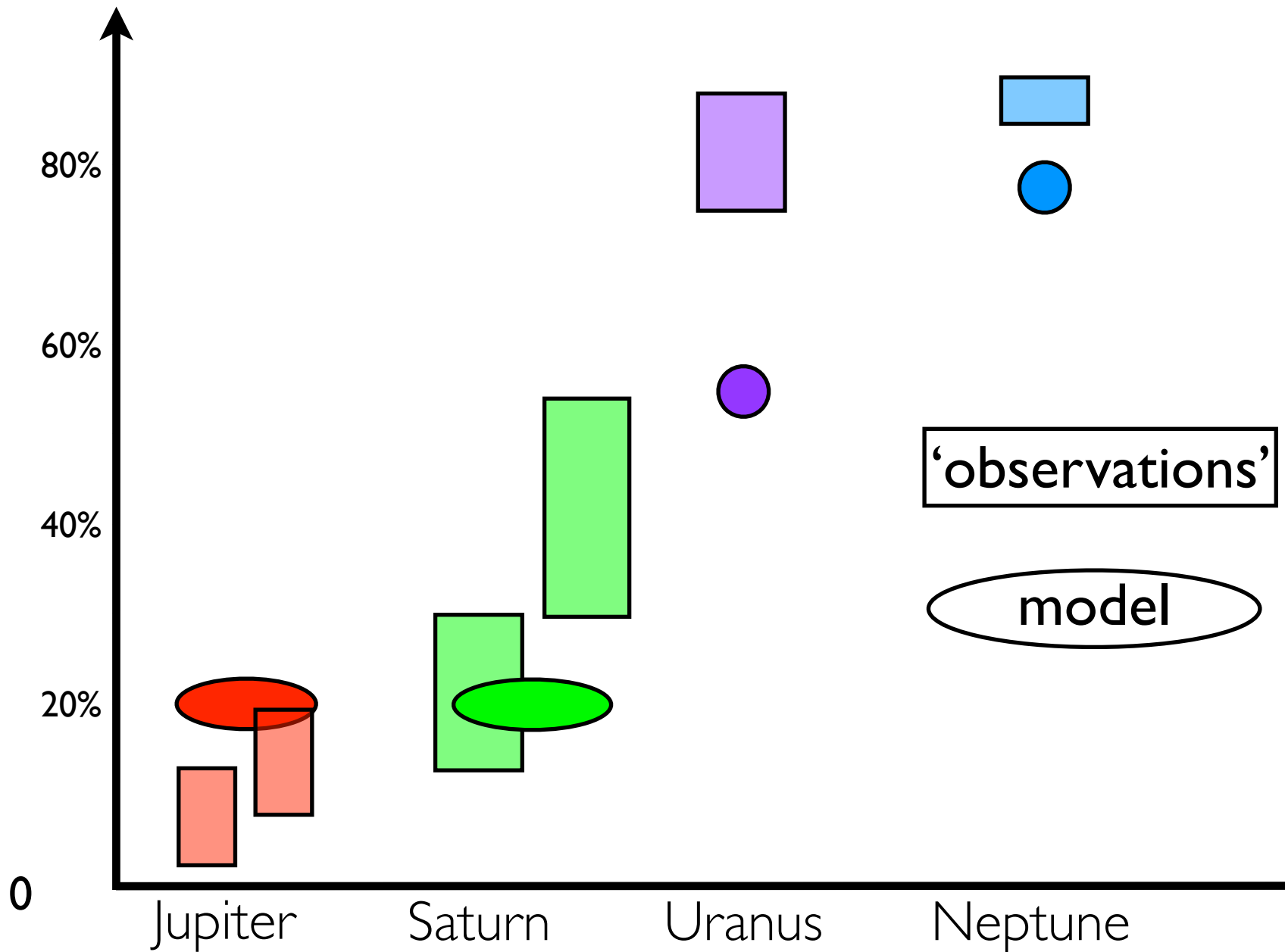
outward migration

Walsh et al. 2011

Solar System formation



Heavy elements



Saumon & Guillot, 2004; Helled et al. 2011; Leconte & Chabrier 2012

Planet-planet interactions

smaller planets in the gas giant domain (competition)

population of small close in planets (grav interactions)

modify planet's composition

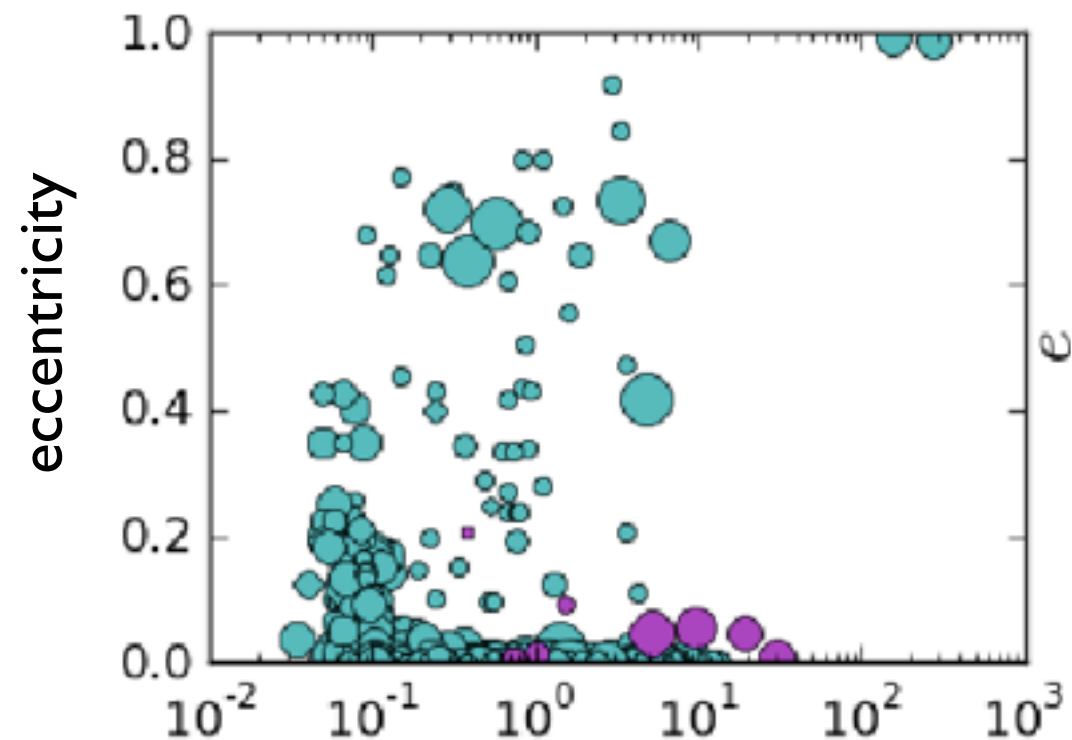
Stochastic migration required from Kepler data

Solar system formation in the 'Grand Tack' scenario

See posters P8 by N. Cabral and P48 by H. Meheut

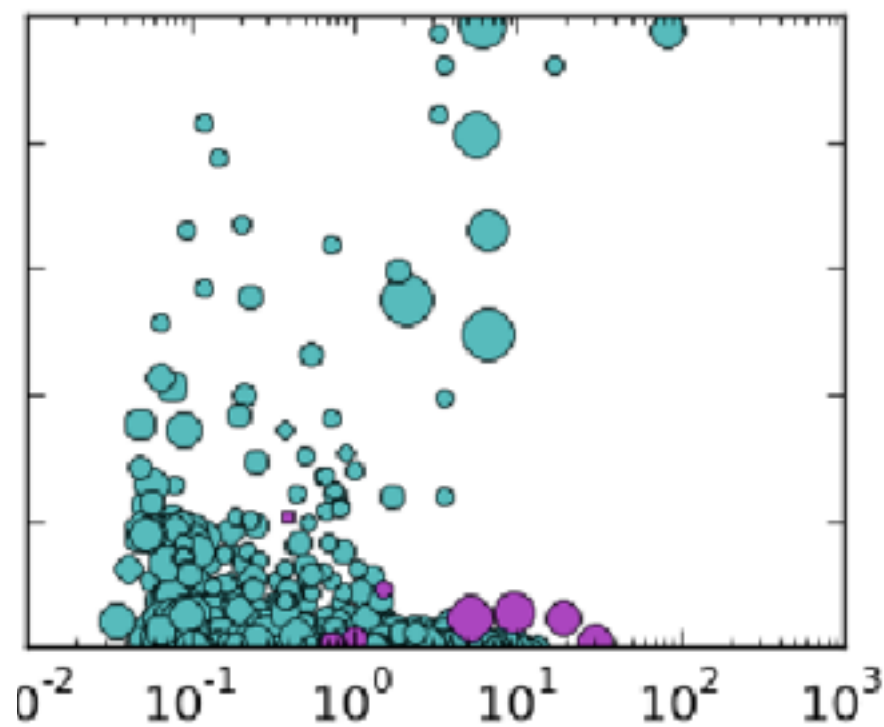
Eccentricities

end of formation



distance to star [AU]

after 100 Myr



distance to star [AU]