

Exoplanets

Lecture 5

06 November 2020

Outline

- Data archives of space missions
- Tools to detect exoplanets
- Exoplanet family

Ondrejov OES spectrograph

- Tour of Perek telescope facilities

MAST archive

- <https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html>
- <https://exo.mast.stsci.edu>
- <http://archive.stsci.edu/searches.html#missions>

Eleanor tool

- Downloading of the LC
- Performing photometry on the TESS LC
- Checking the cut-offs
- Creating own photoemtric masks
- <https://github.com/afeinstein20/eleanor>
- <https://arxiv.org/abs/1903.09152>

Exoplanets families

- Which types of exoplanets do we know?
- Statistics of exoplanets
- Evolution of exoplanetary systems and Solar system

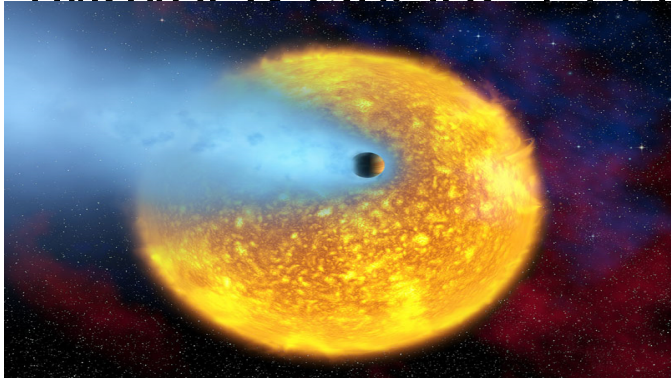
State of the art in 2006

- Hot Jupiters – gas planets
- Super Earths – small terrestrial planets

Types of planets (2006)

Giant planets (hot Jupiters)

- close-in orbits
- short orbital periods (a few days)
- Jupiter-sized
- In transit with intensity decrease of a few %
- 1995 first detection 51 Peg (Mayor & Queloz 1995)



Vidal-Madjar et al. (2004)

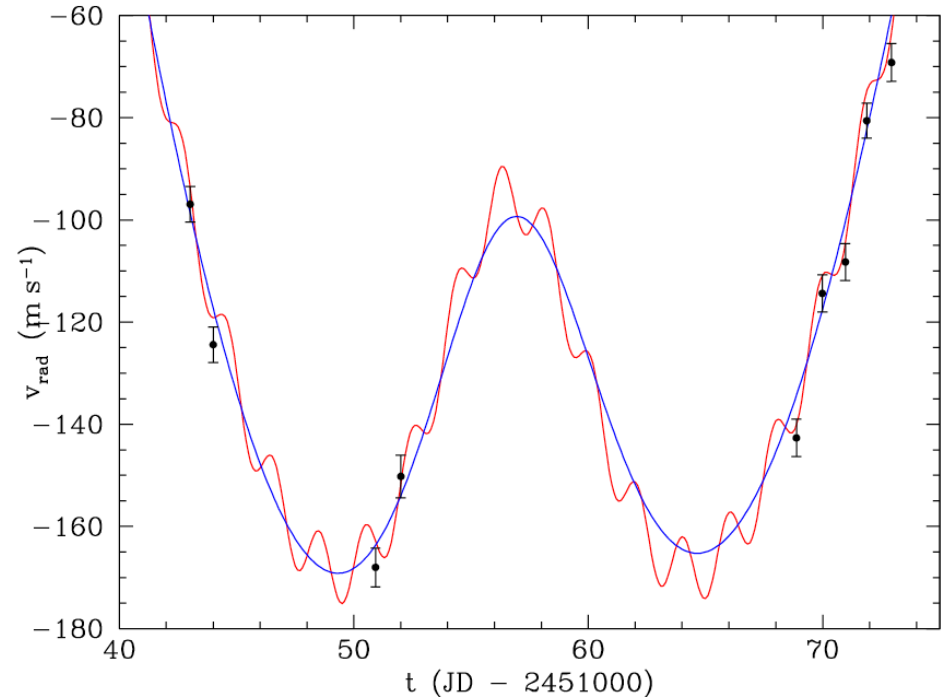
Super Earths

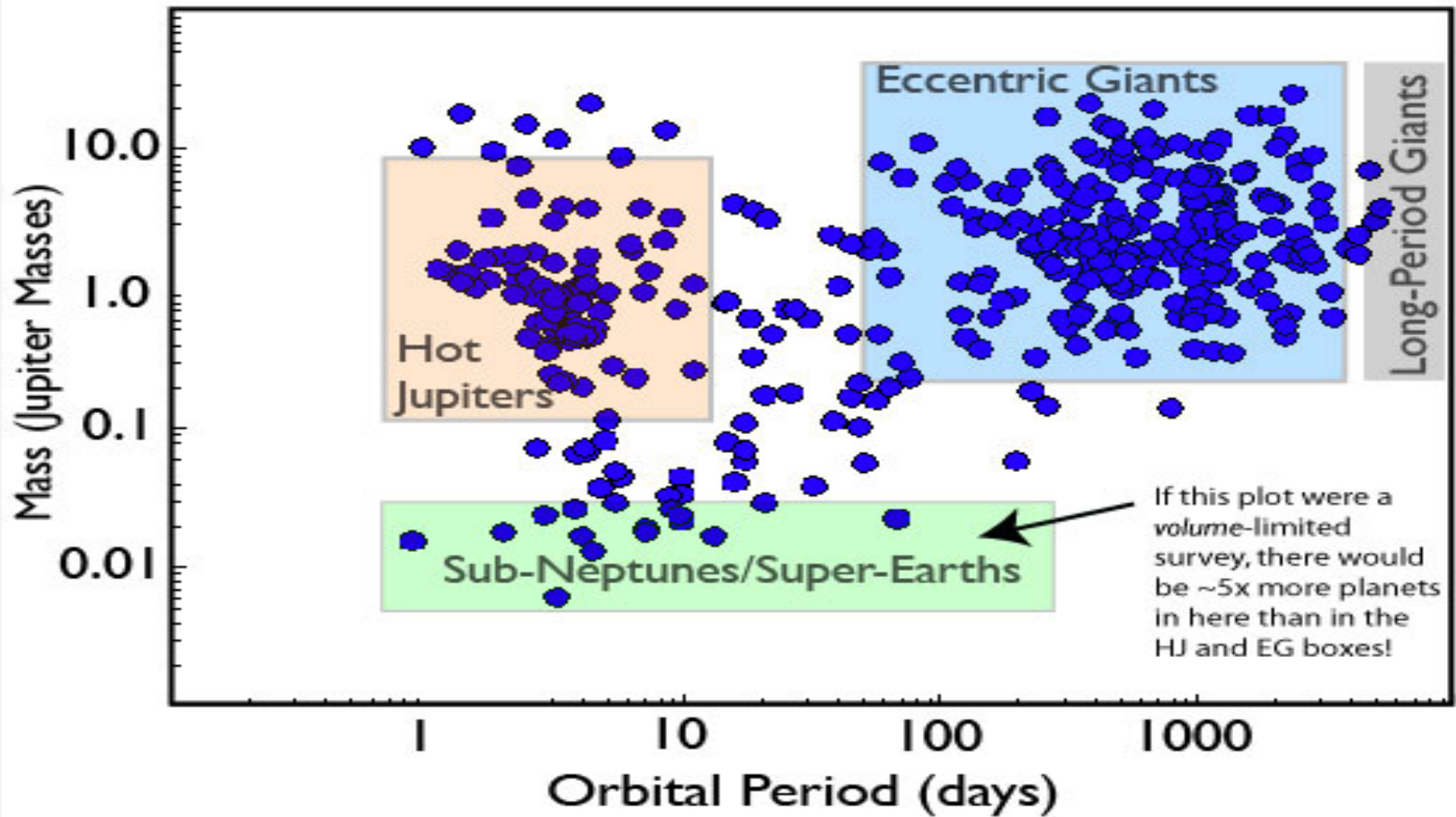
- masses up to $10 M_{\text{Earth}}$ (Valencia 2007)
- constraint on radius: $10 M_{\text{Earth}} - \text{max } 1.9 R_{\text{Earth}}$ (Valencia 2007)
- consist of rocks and iron & planetary ice (Fortney 2007)
- Gliese 581 system (Mayor, Udry 2009)



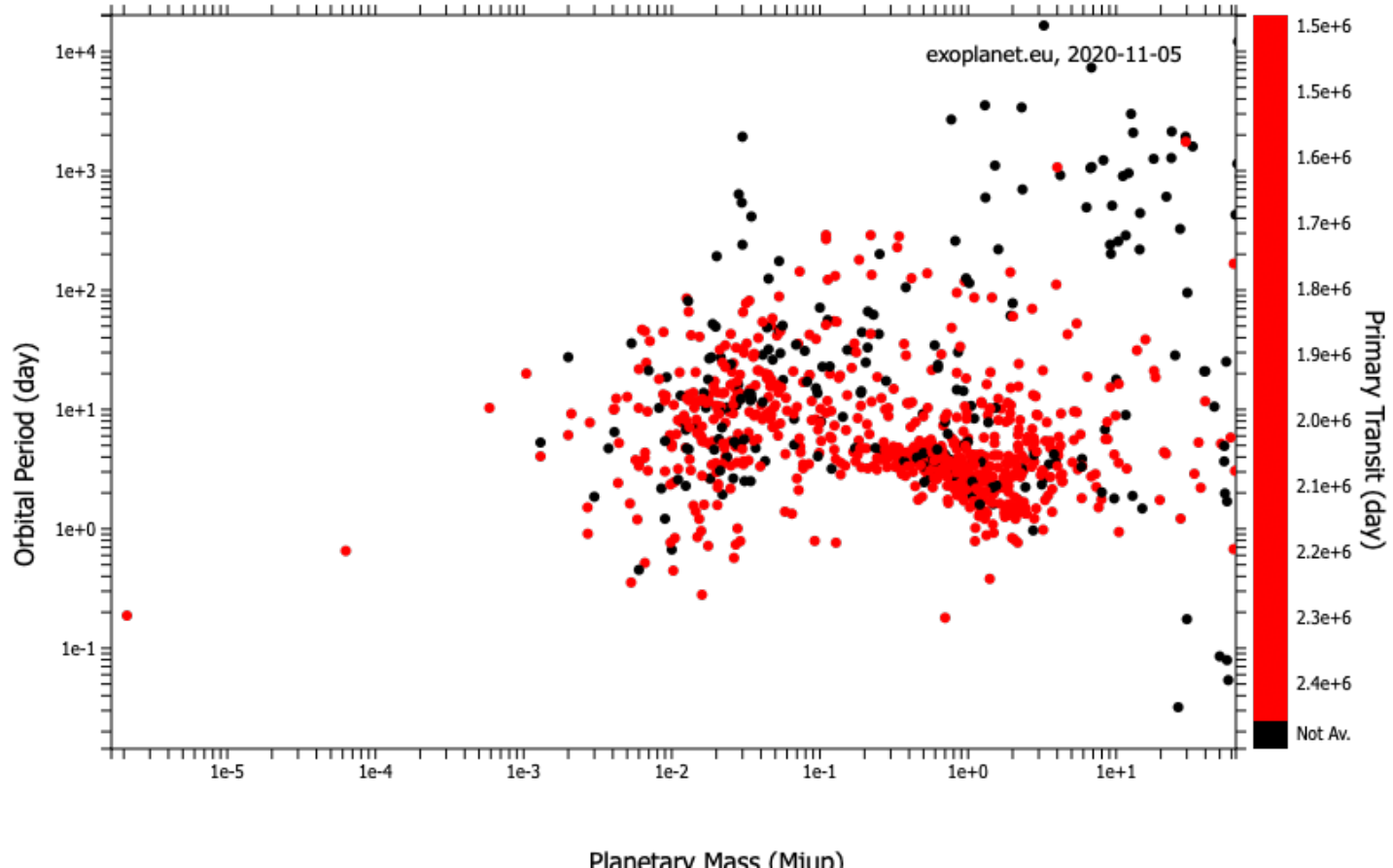
The first Super Earth

- GJ 876d Rivera et al. 2005 (Figure with RVs)
<https://arxiv.org/pdf/astro-ph/0510508.pdf>
- $M=7.5M_{\text{earth}}$
- The first model
- - Valencia et al. 2006
[https://iopscience.iop.org/
article/10.1086/509800/pdf](https://iopscience.iop.org/article/10.1086/509800/pdf)

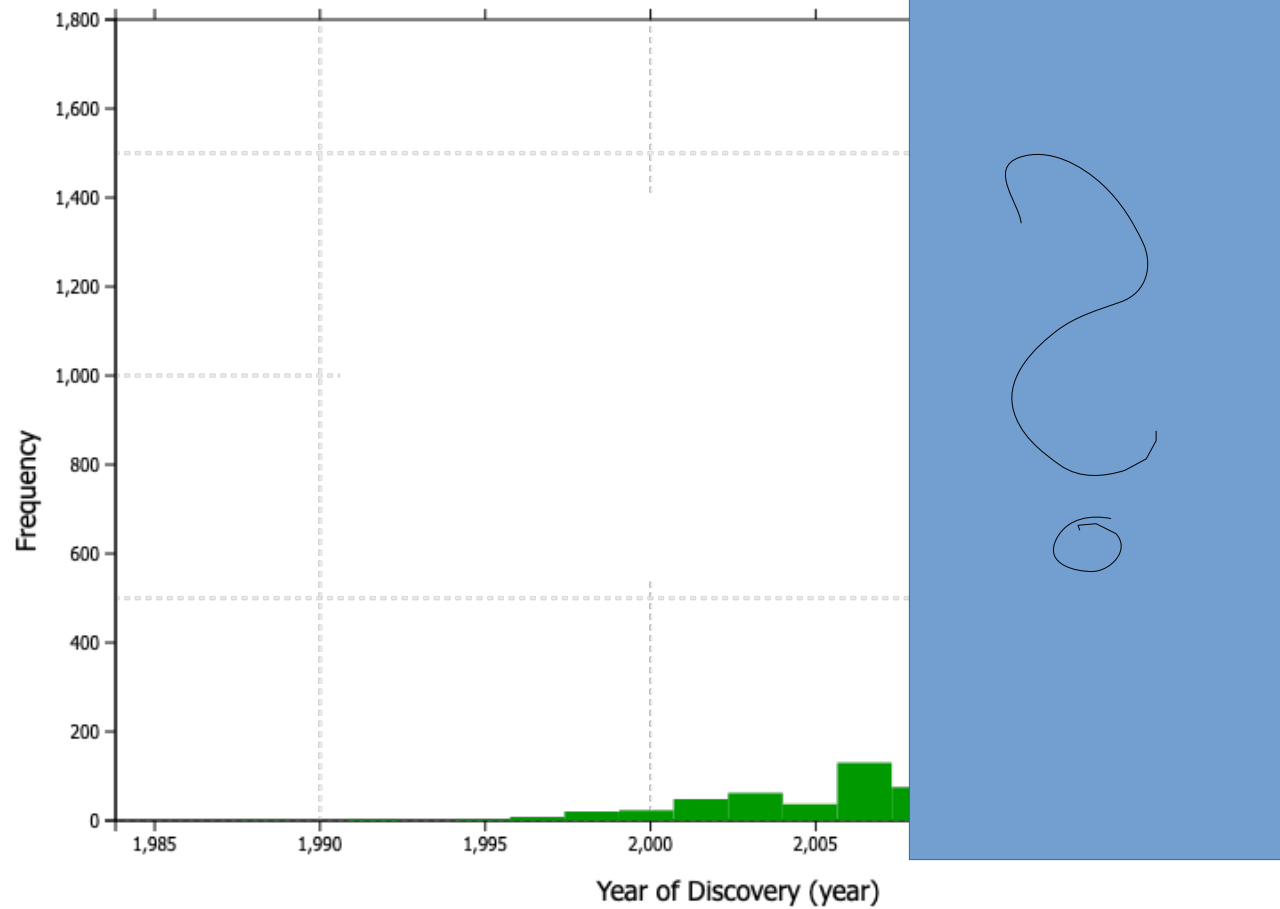




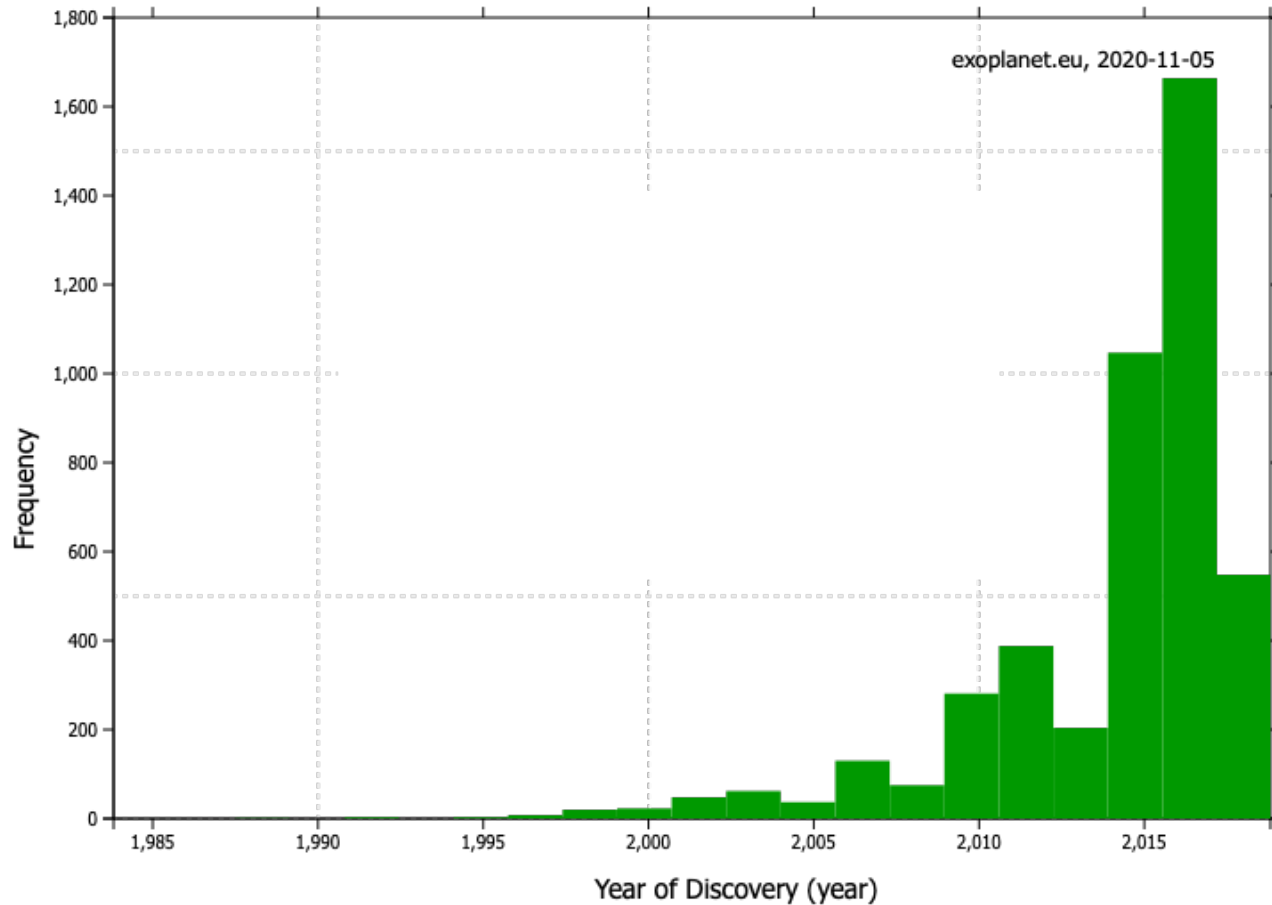
Mass vs. Period



Status 2006



How is the status today?



Then came mini-Neptunes

GJ1214b

- Super-Earth-sized planet detected in 2010
Charbonneau et al. 2010, Nature

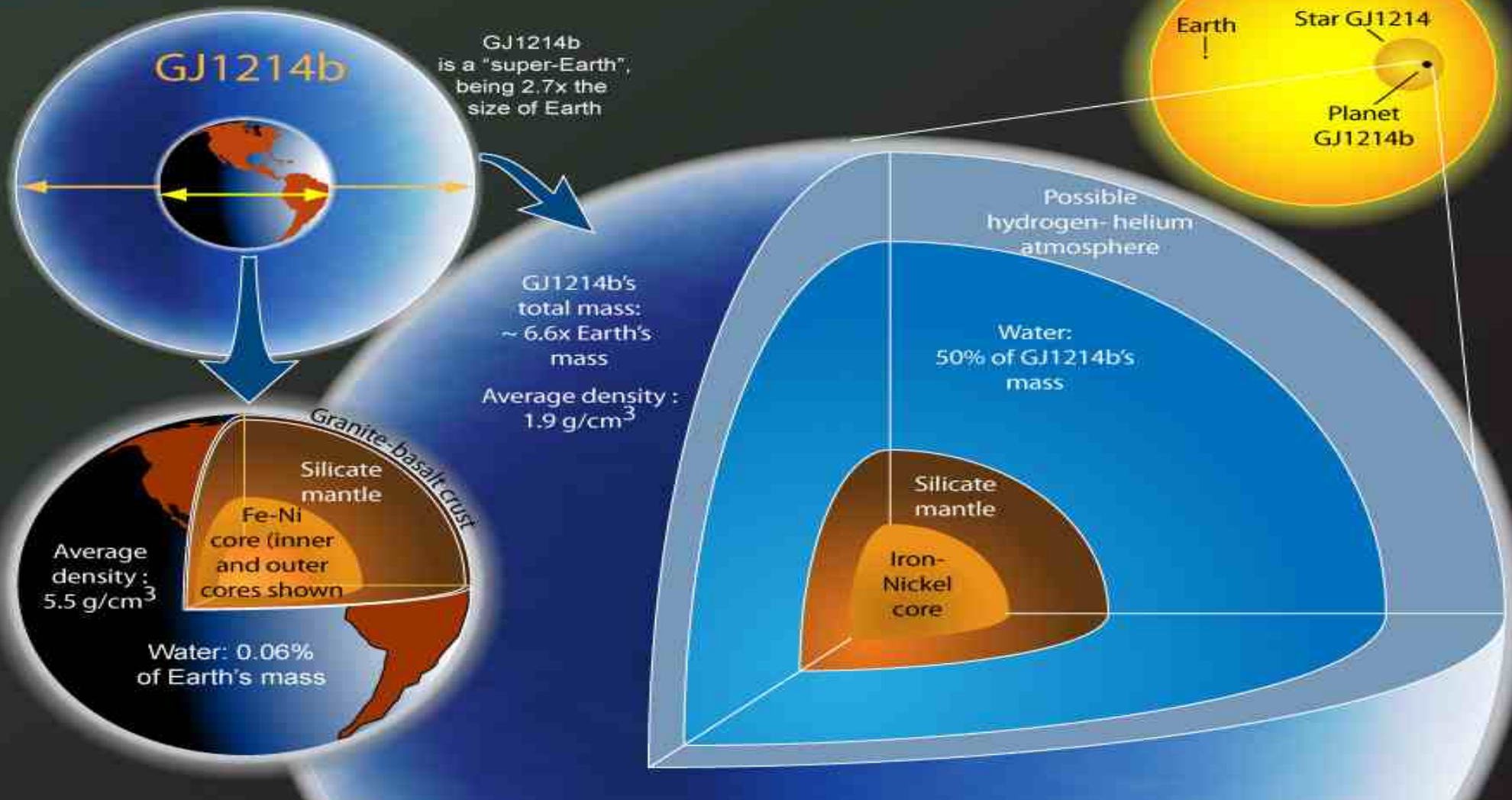
PARAMETERS

- Orbiting M dwarf star ($V=14.71$ mag) in 1.58 days
- Only 14pc distance
- $M=0.02M_j$

Water World: Exoplanet GJ 1214b

From Nature 17 Dec. 2009; Review by Marcy; Letter by Charbonneau et al.

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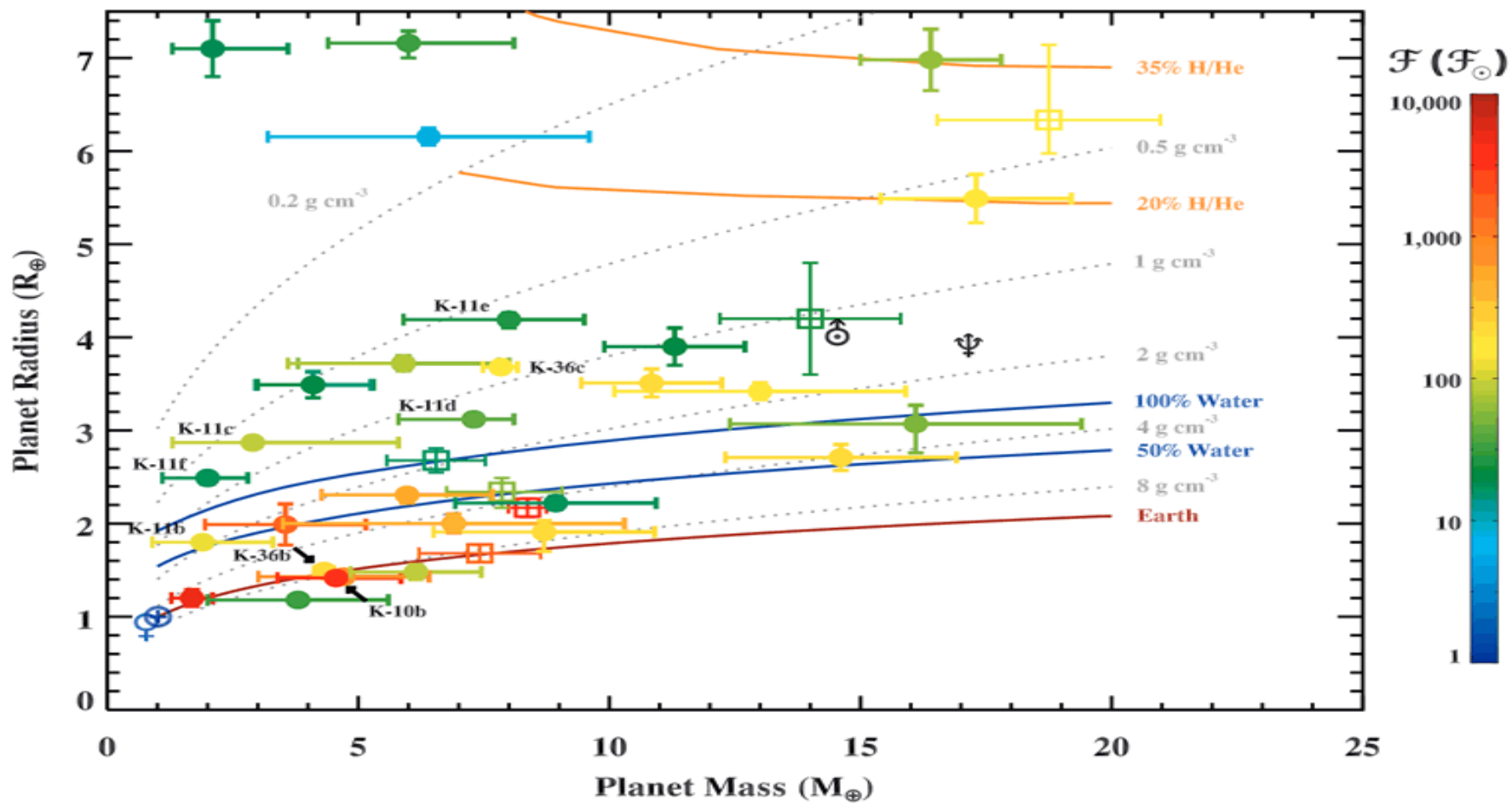
Super Earths and Rocky planets

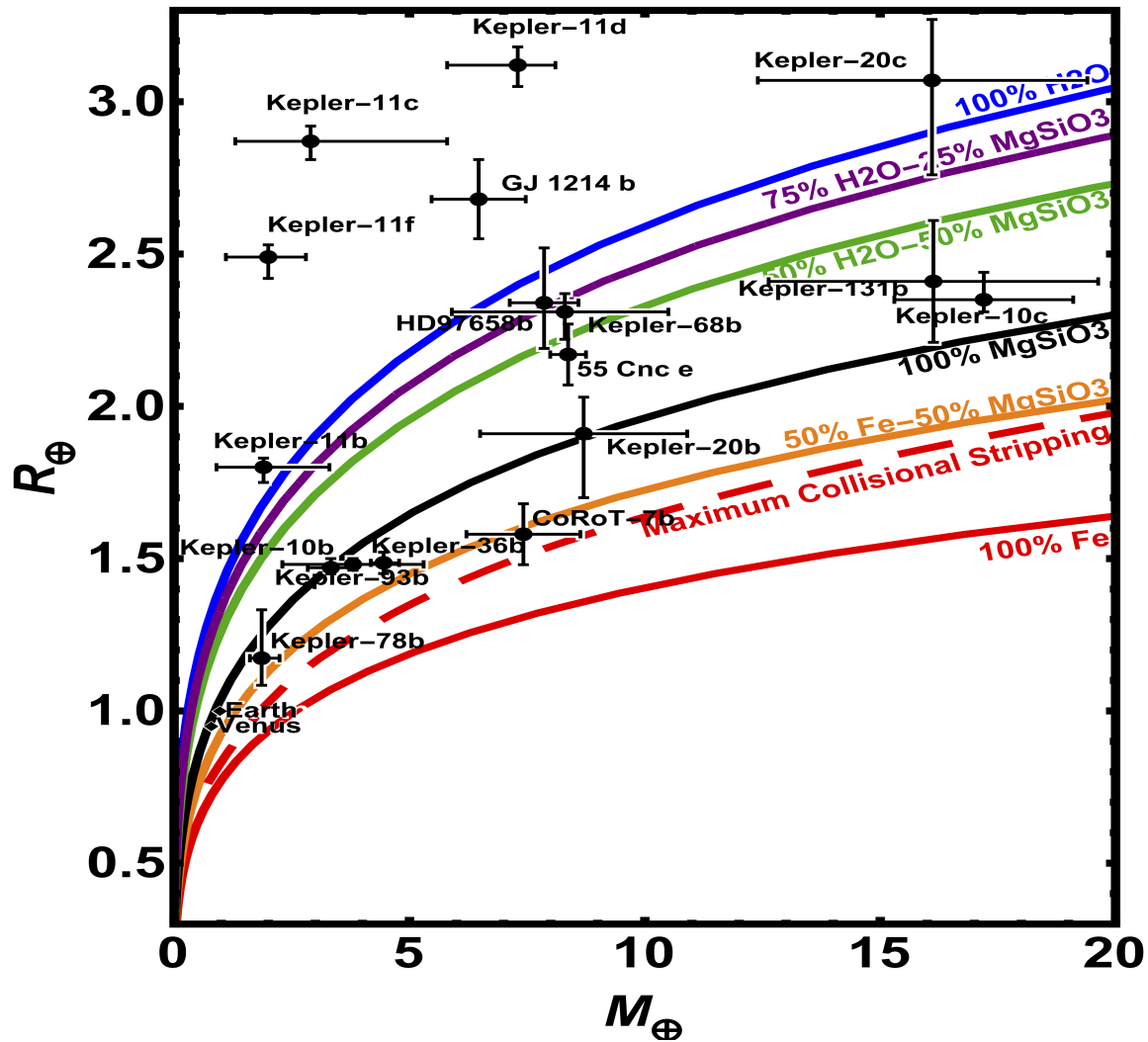
- Super Earths < 10 M Earth (Valencia et al. 2006)
- Planets with a solid surface
- Sub-group of SuperEarths
- They can have an atmosphere or not
- Kepler discovered the most of them

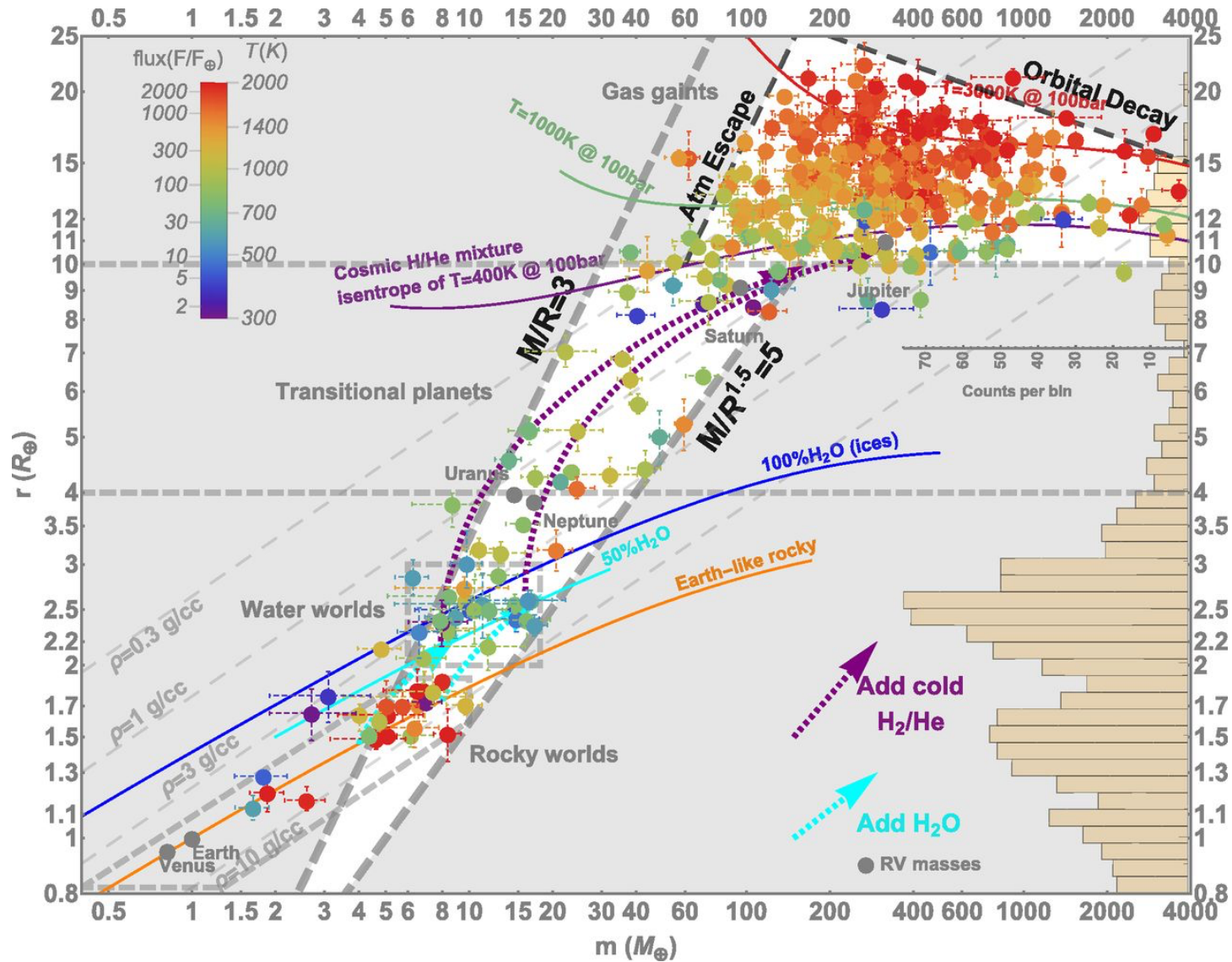
Super Earths mass limits

- 1-10 Mearth
- Ida et al. 2004, ApJ,
<https://iopscience.iop.org/article/10.1086/381724/fulltext/58801.txt.html>
 - 10MEarth is the limit where H. He gas can be retained
 - lower bound is for historical reasons
- In this group belong planets with oceans, rocky and massive Earths planets

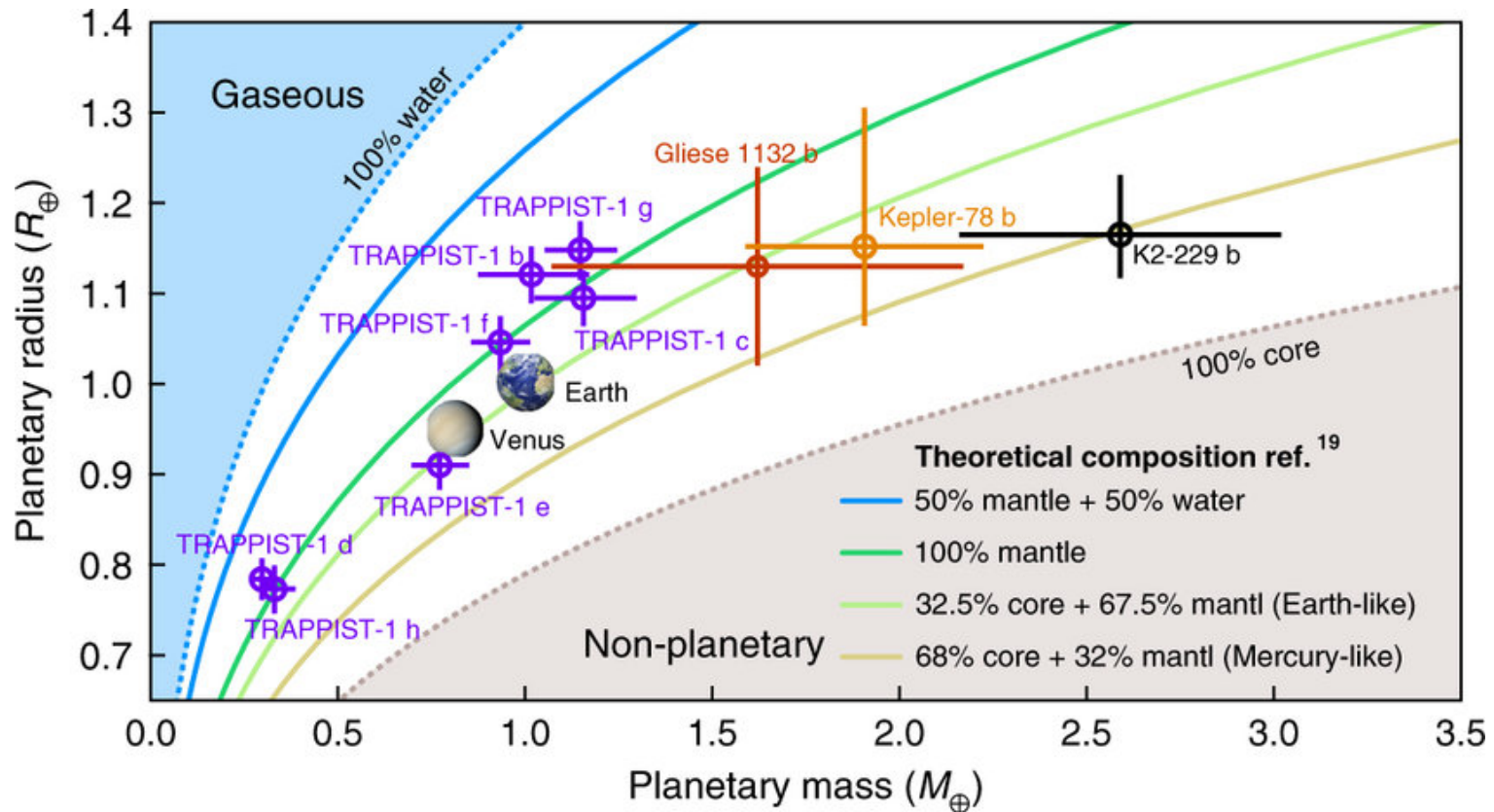
Mass radius diagrams







Getting closer to the Earth-like



Next week

- Evolution of our Solar System
- Evolution of exoplanetary systems
- The place of our Solar system in the Universe