

Astrobiology & Astrophysics II

Overview & Welcome

*We will never know how to study by any means the
chemical composition of stars* *Auguste Comte (1835)*

Lisa Kaltenegger, MPIA/Harvard



Planets symphony...

Astrobiology & Astrophysics II

Questions on the forefront of science

- Life as a planetary phenomenon
- A tour of our Solar System – places for life ?
- How do we search for exoplanets – problems ?
- What really is the Habitable Zone ?
- What is a biosignature and how do you find one?
- Can planets around cool stars be habitats ?
- Problems with two Suns – can Tatooin work?
- Do the movies get it right ?

Organization

When: Each Wednesday, 17:00-19:00 -> Dec 18.

Where: KIP, Ground Floor, Hörsaal 2

Web: https://www.cfa.harvard.edu/~lkaltenegger/WS_2013__Astrobiology_%26_Astrophysics_II.html

Material KIP homepage:

www.kip.uni-heidelberg.de/user/hausmann

(User name: planets, pwd=„exoplanets“)

- Material to read before class
- Lecture material will be posted by end of the week on web-page. (for copyright reasons).

Practicalities

Your Grade:

Final exam 100%

No laptops in class – sorry ☺

Seminar: Astrobiology & Astrophysics II

blocked – vacation seminar (doodle)

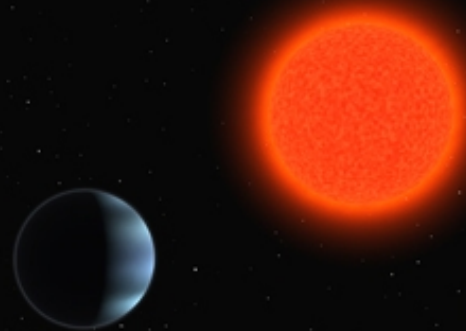
WHEN is a good time

(send me an email & I'll add you to doodle to vote)



S

Signs of Life?

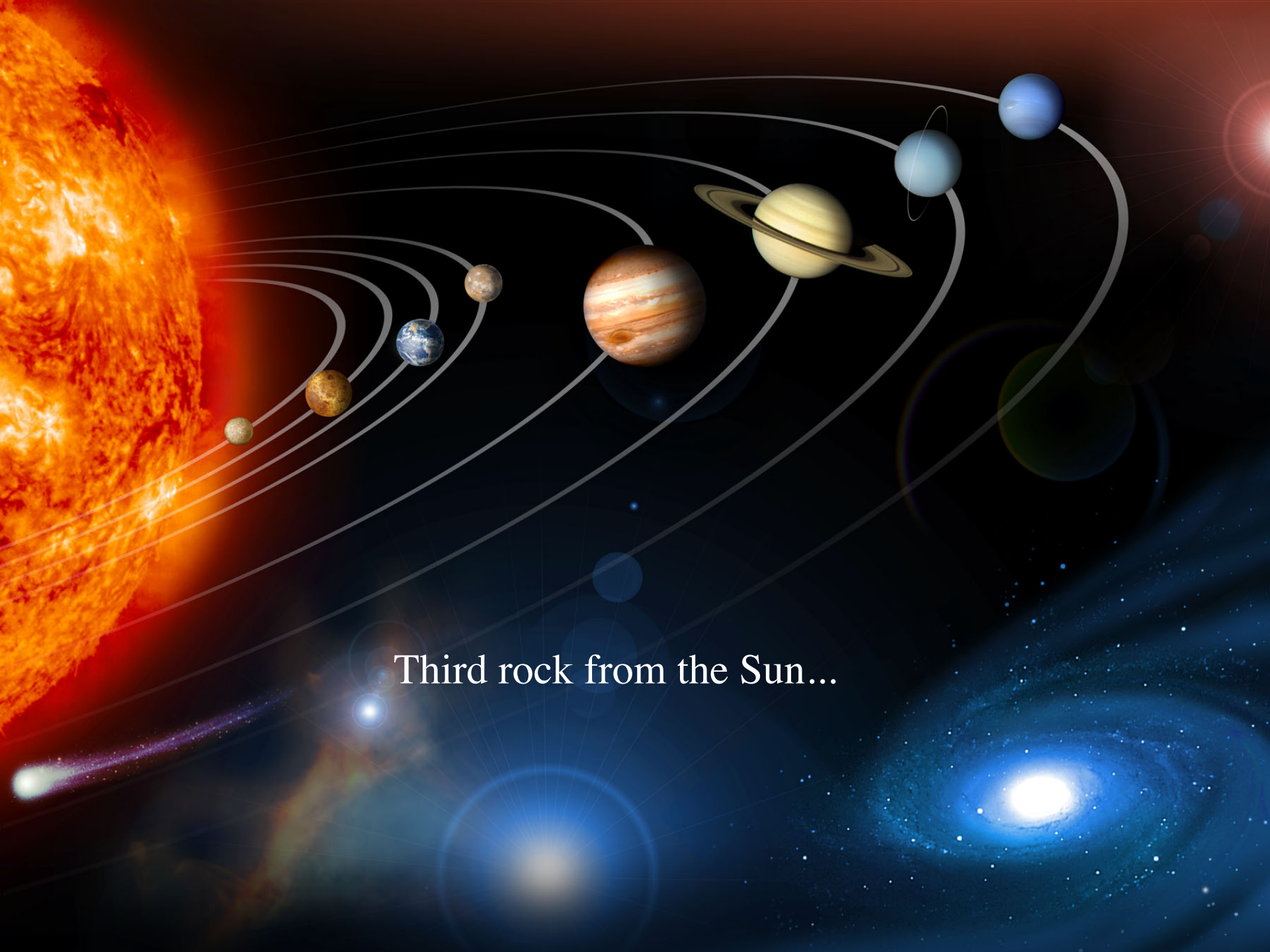


First question: Why are you here?

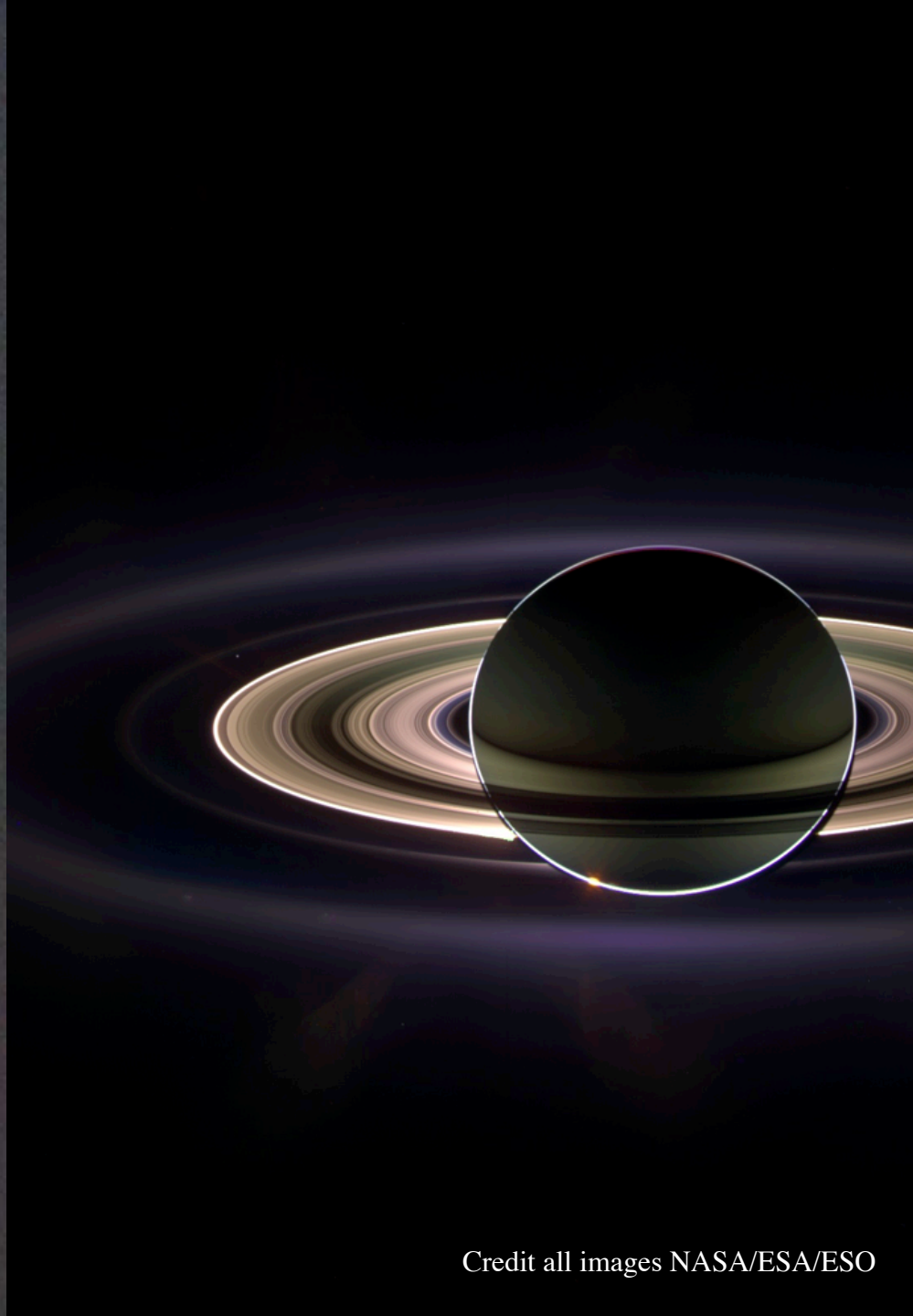
YOU ARE HERE







Third rock from the Sun...



Credit all images NASA/ESA/ESO

Earth and Moon



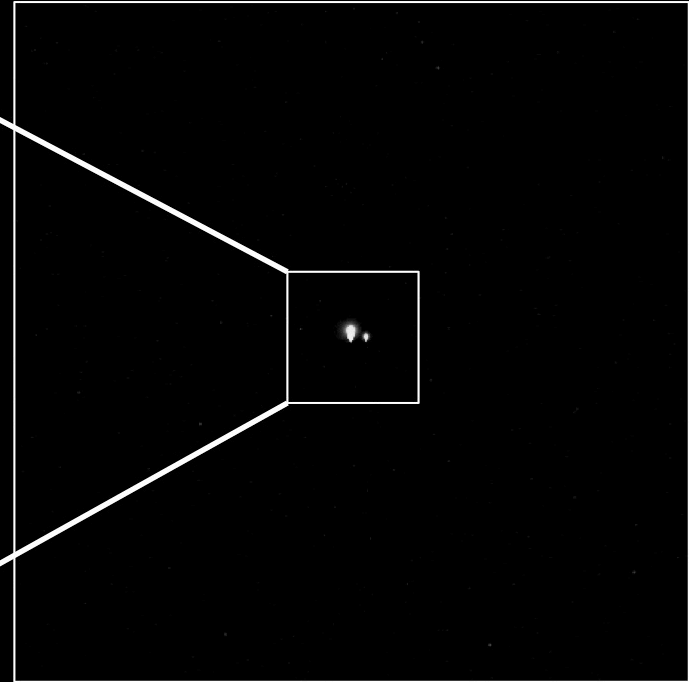
Image credit NASA

The Day the Earth Smiled — Earth from Mercury

July 19, 2013

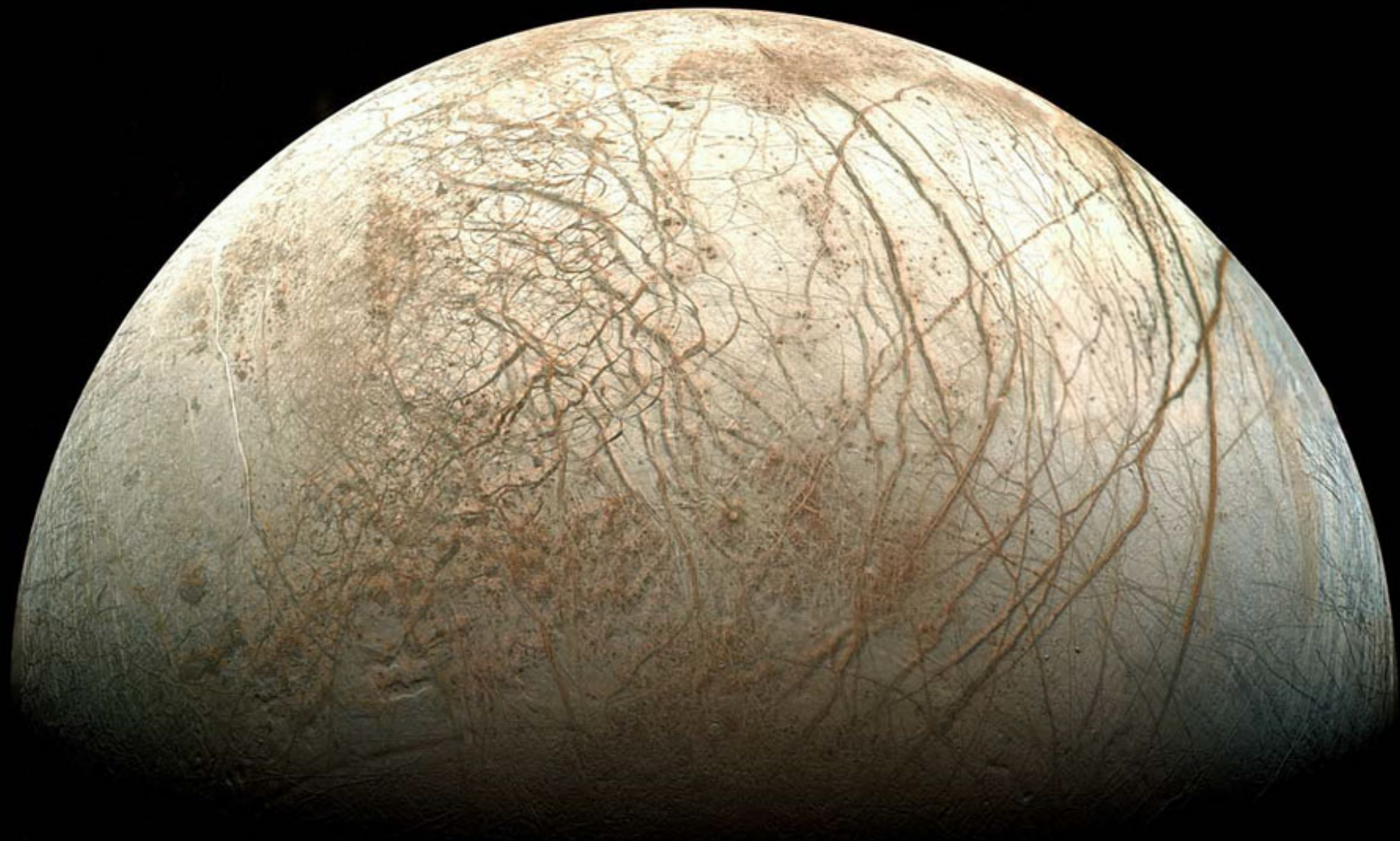


A Bright Blue Marble from Earth Orbit
22 thousand miles away

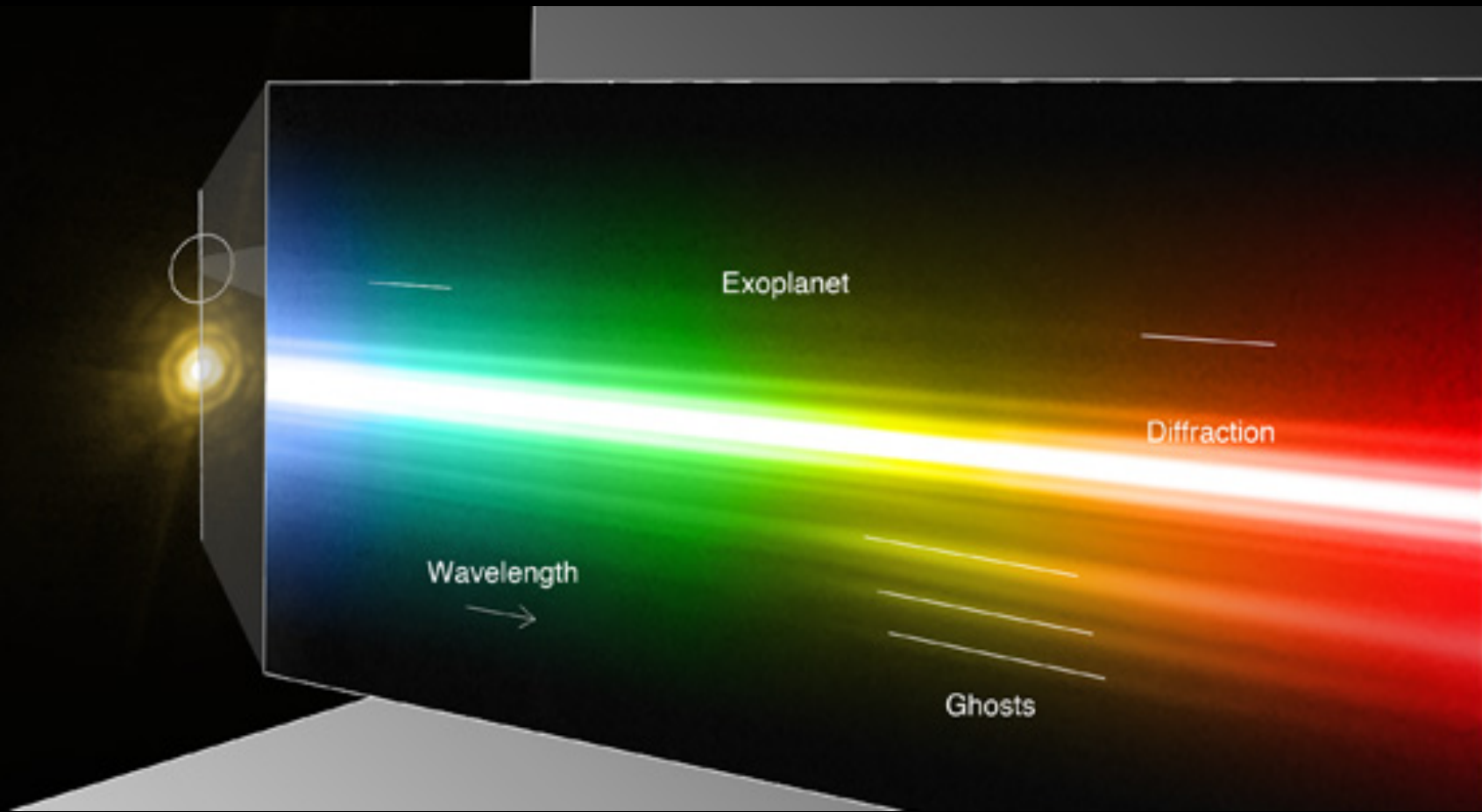


A Pale Blue Dot from Mercury
61 million miles away

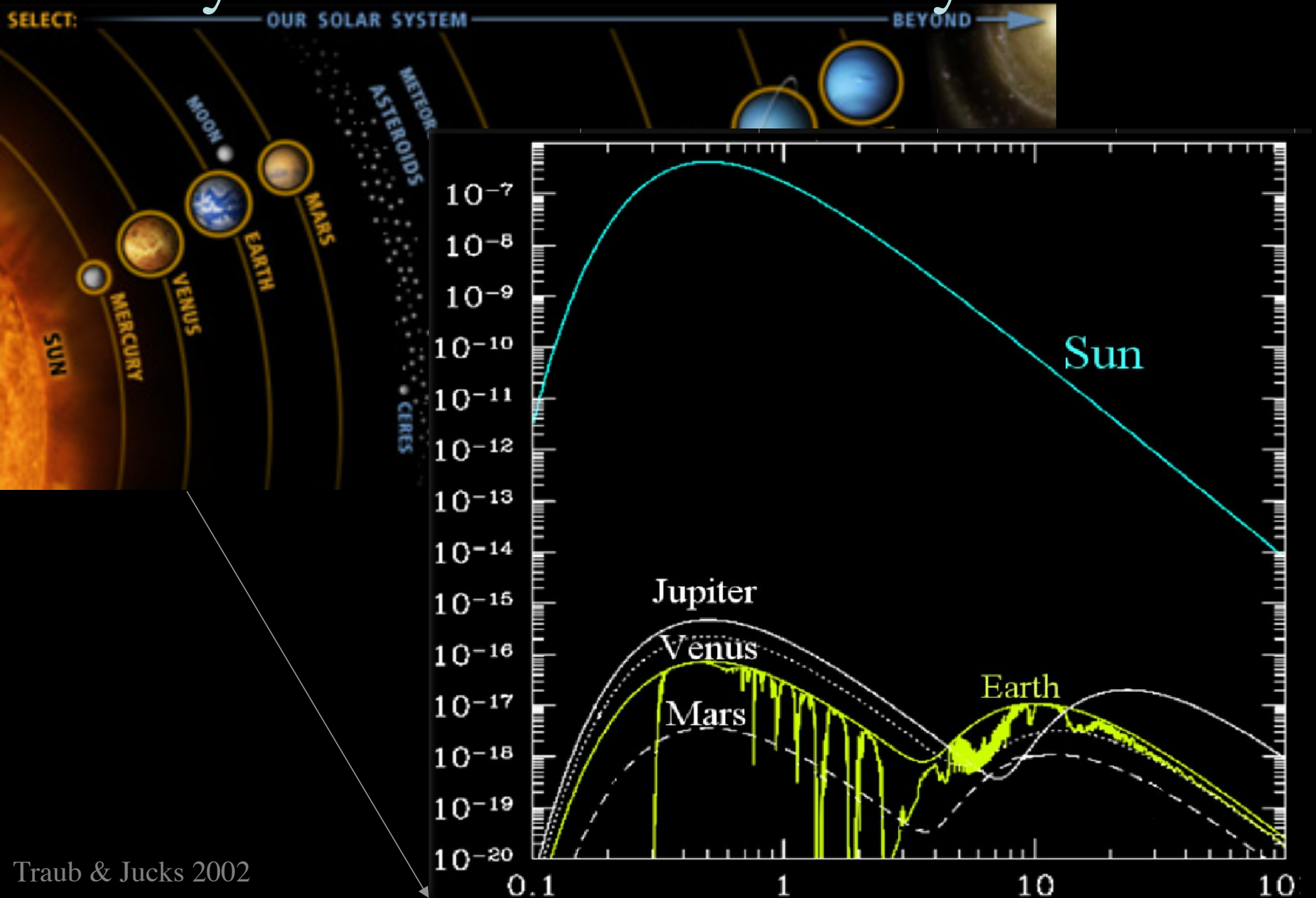
Credit: PHL @ UPR Arecibo, NASA/ Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington, NERC Satellite Station, Dundee University, Scotland

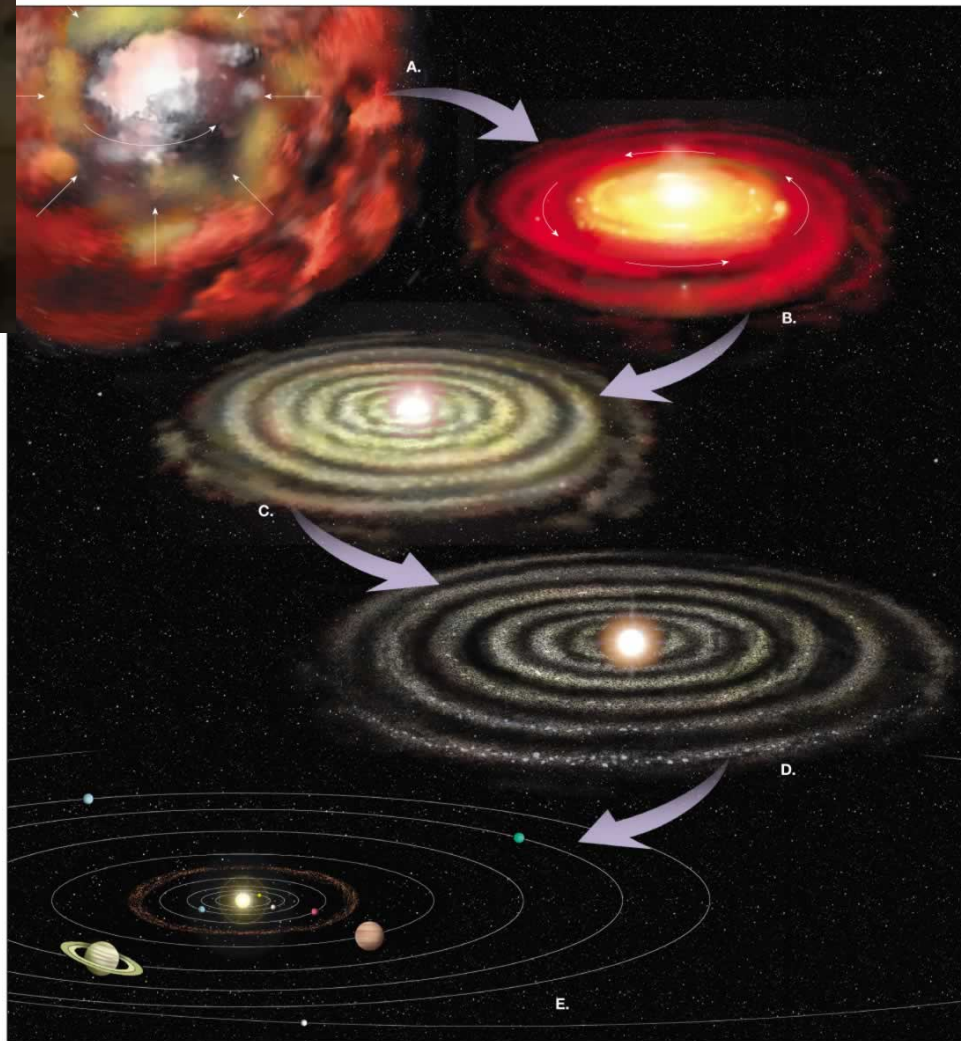


Direct Imaging – the concept



Verify Model & Data: Solar System





Open questions in
planet formation...



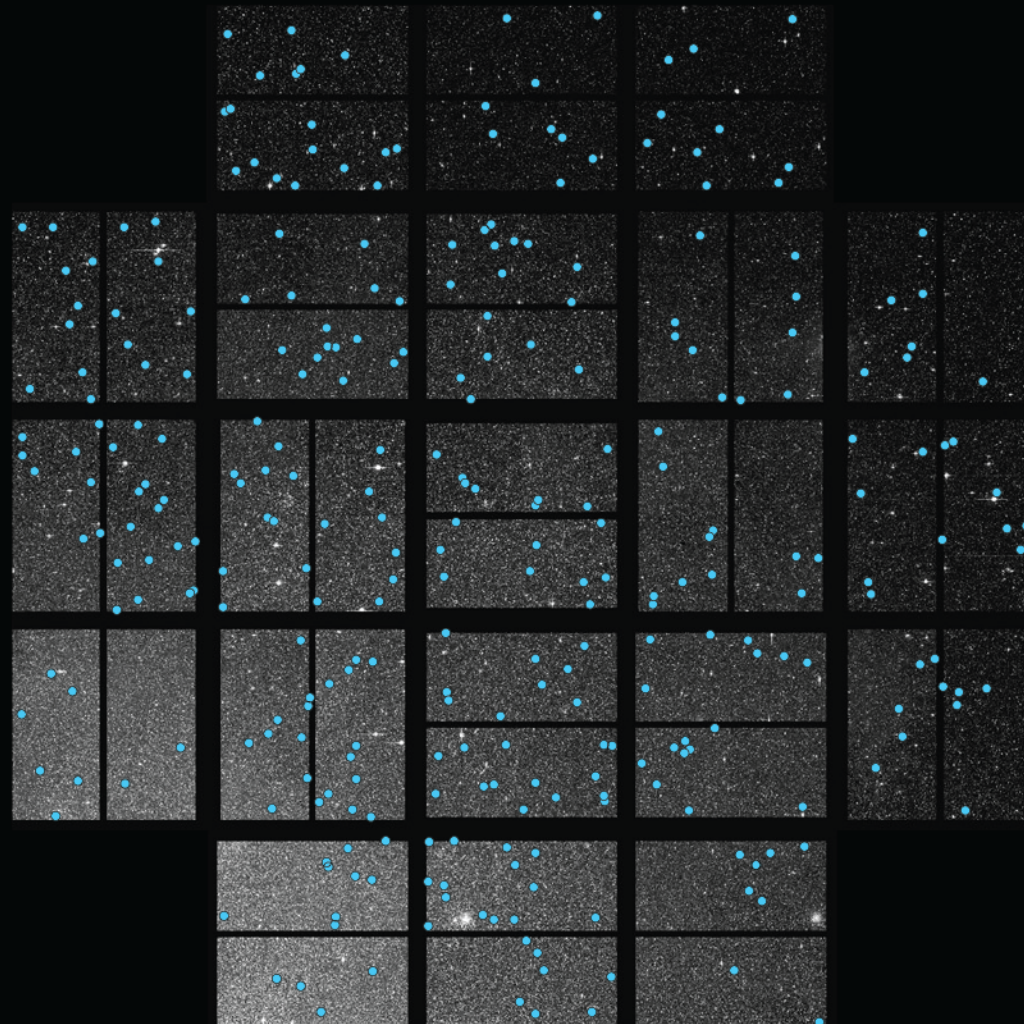
Where to look for 150.000 stars



Locations of Kepler Planet Candidates

By Catalog Release Date

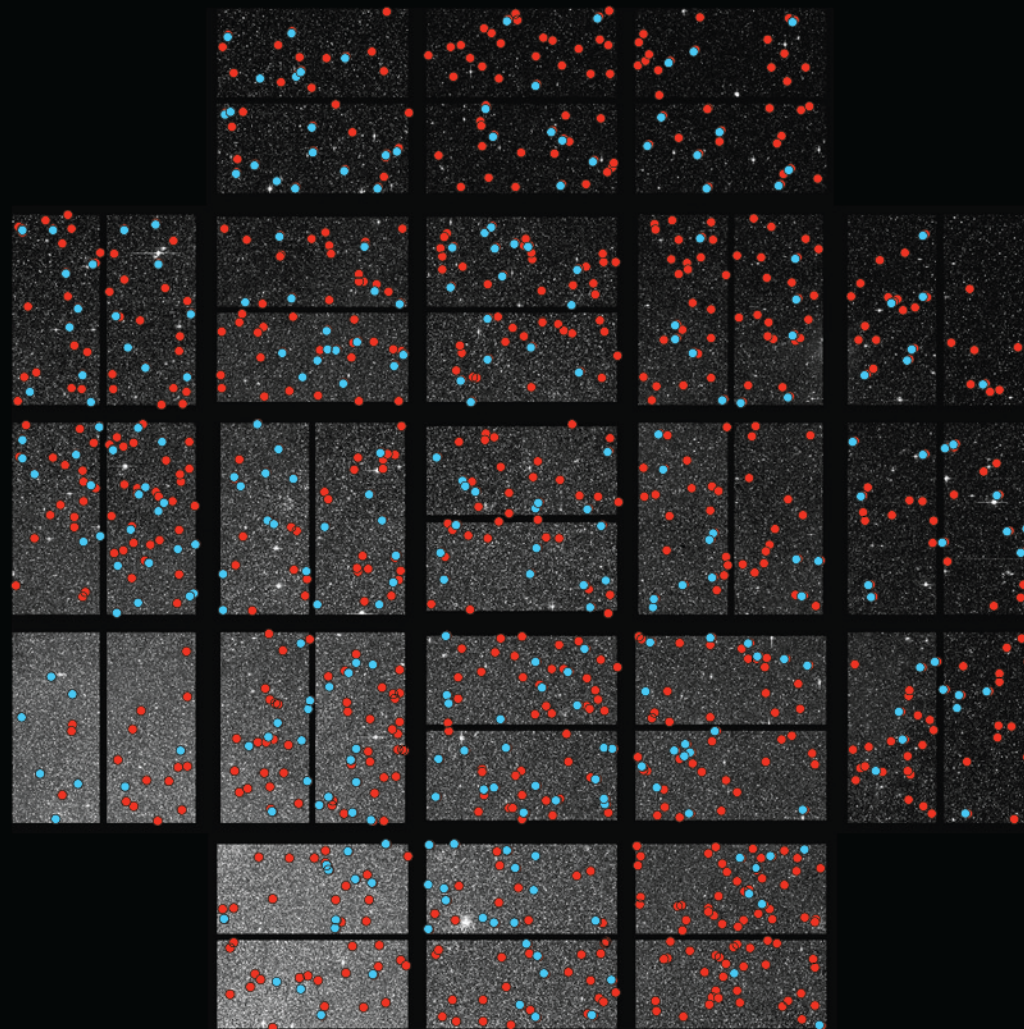
● June 2010
Catalog Release



Locations of Kepler Planet Candidates

By Catalog Release Date

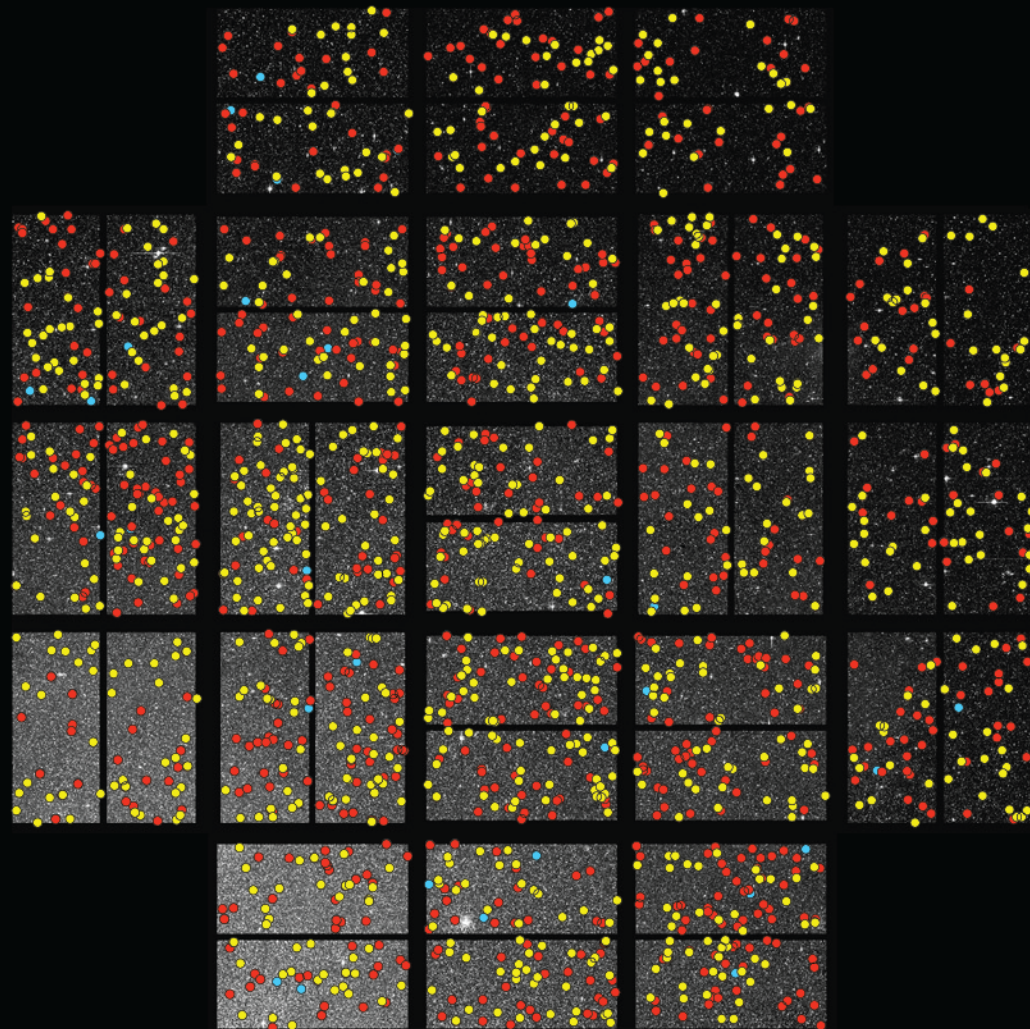
- June 2010
Catalog Release
- February 2011
Catalog Release



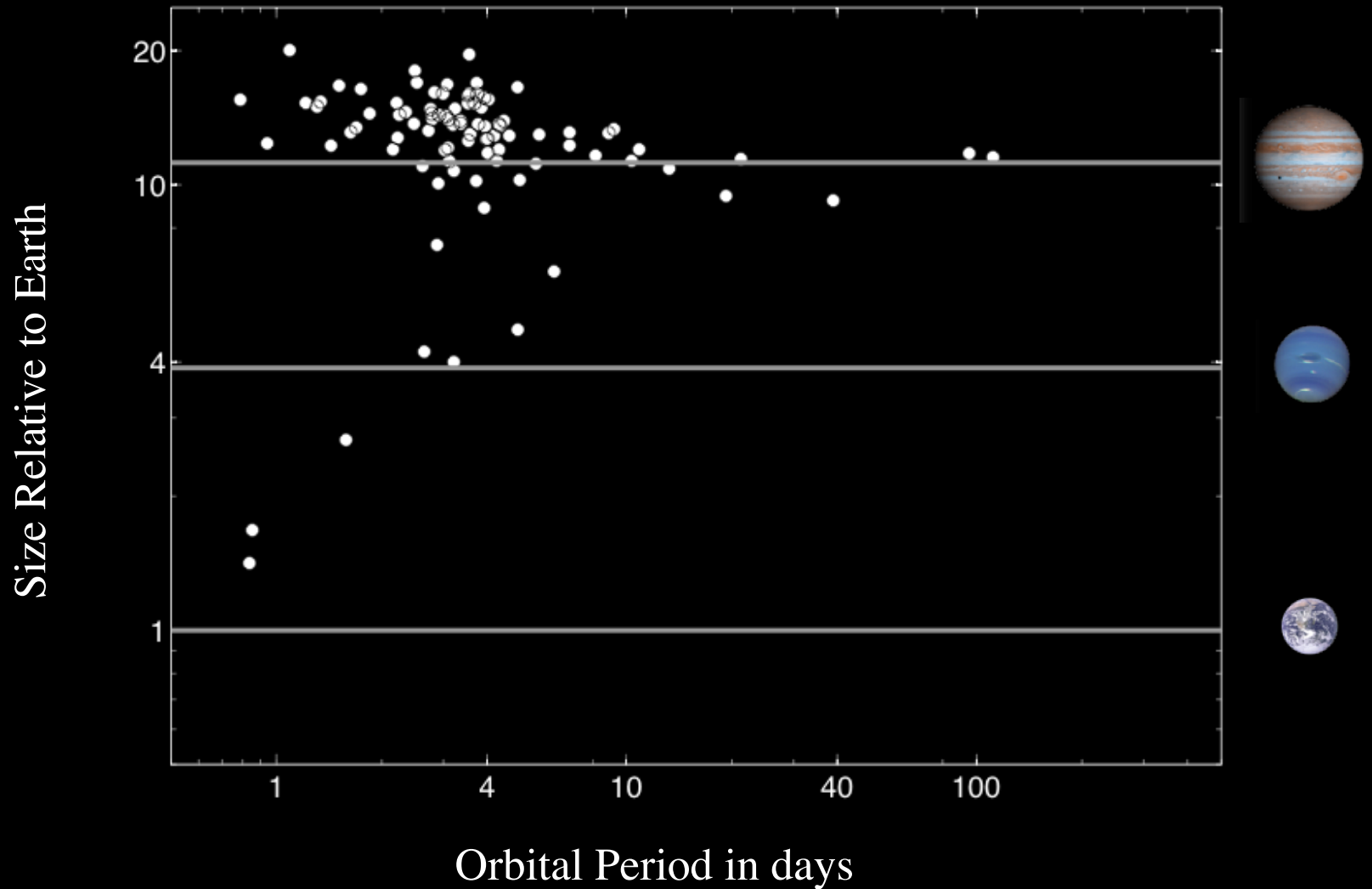
Locations of Kepler Planet Candidates

By Catalog Release Date

- June 2010
Catalog Release
- February 2011
Catalog Release
- February 2012
Catalog Release

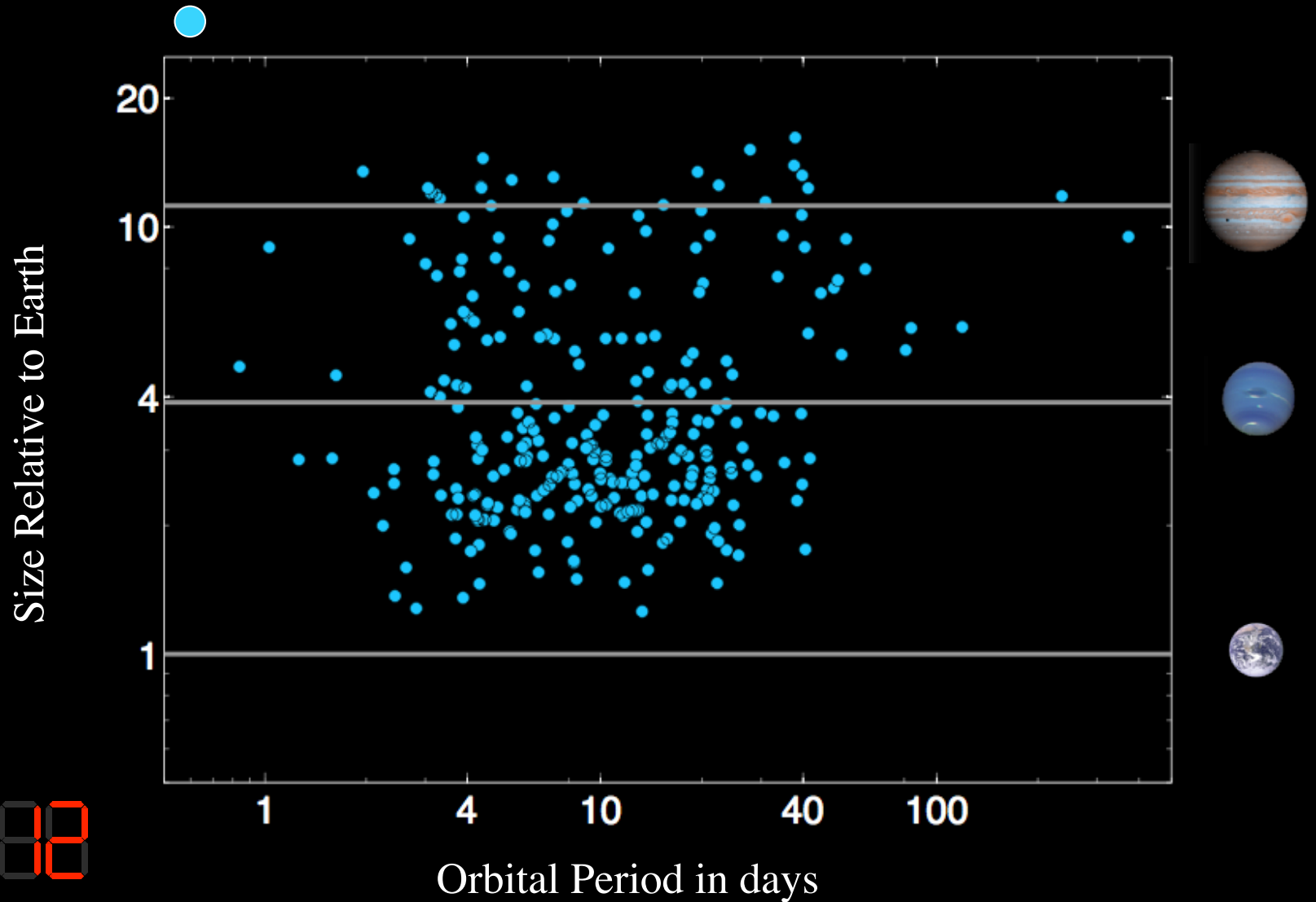


Transiting Planets pre-Kepler



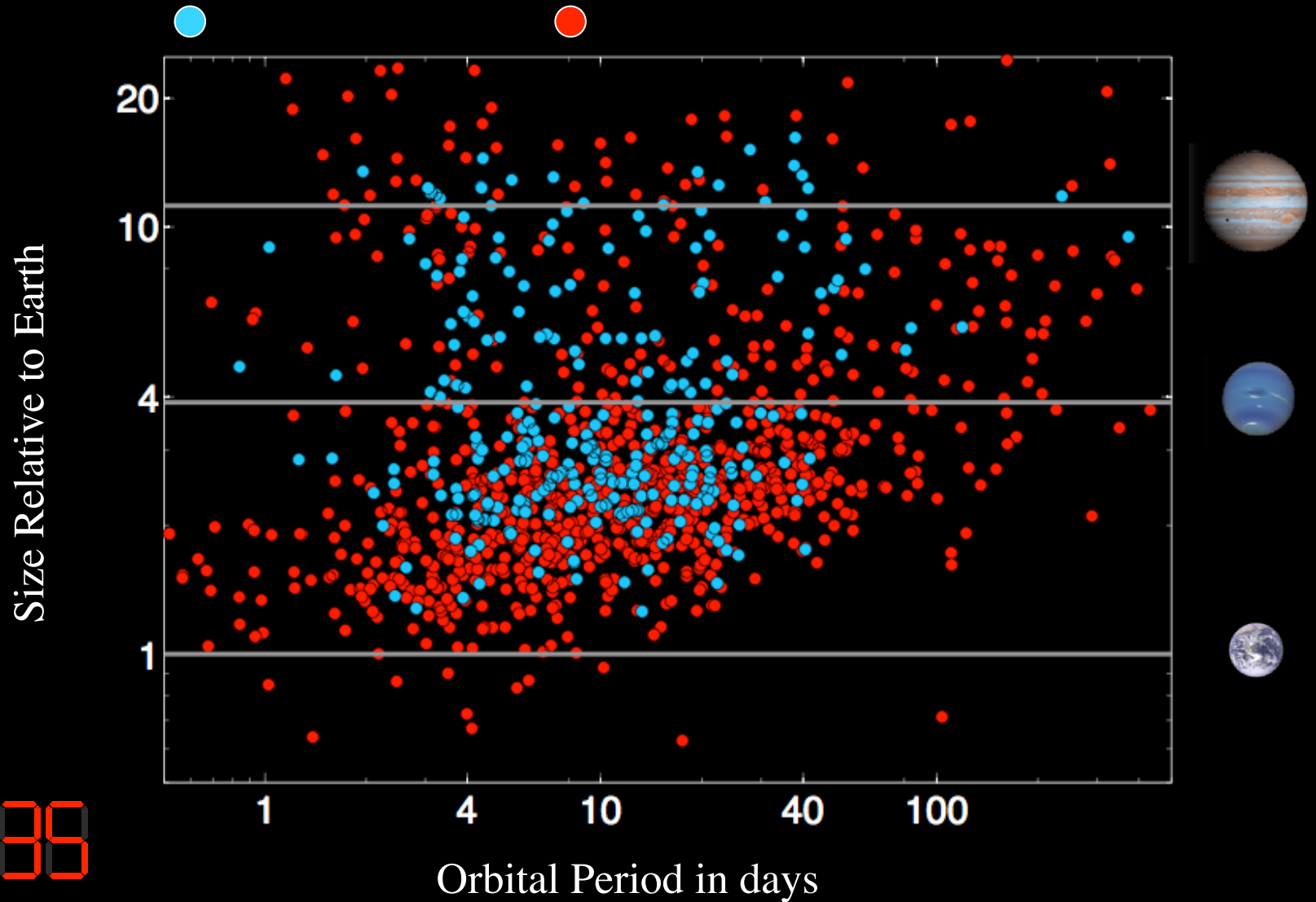
Candidates as of June 2010

Q0-Q1: May-June 2009

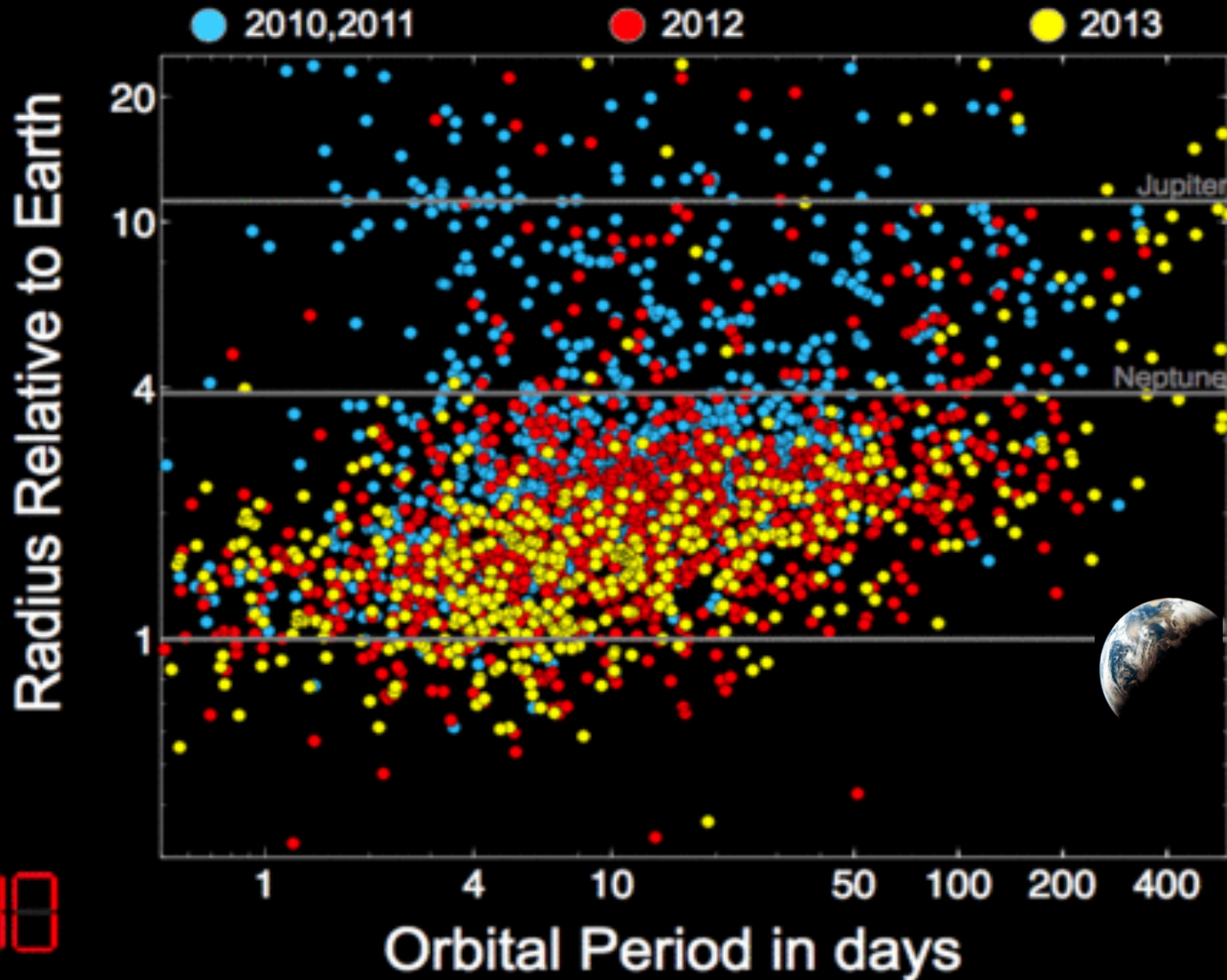


Candidates as of Feb 2011

Q0-Q5: May 2009 - Jun 2010



Kepler's Planet Candidates



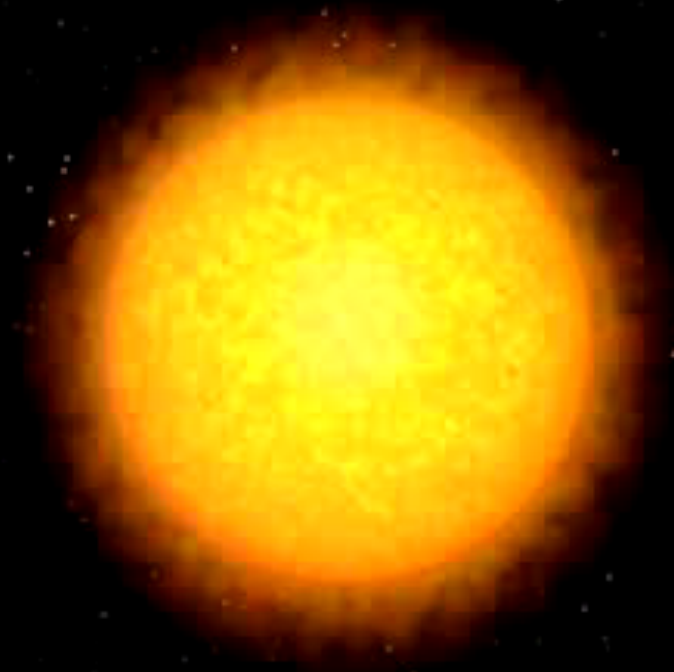
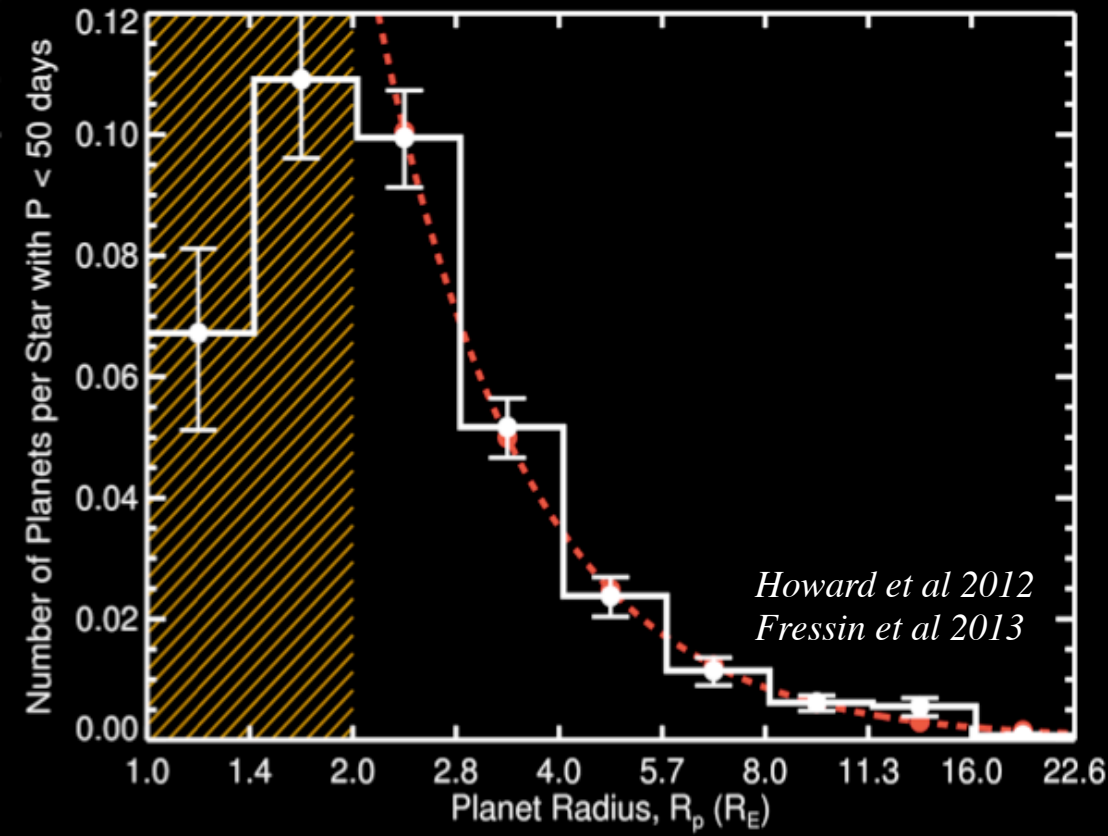
2040

Spectra of Earth-like planets – next challenge

RV

JWST, E-ELT

Small planet *statistic* sample
Distribution: planet size &
mass 900+ (3500+ candidates)



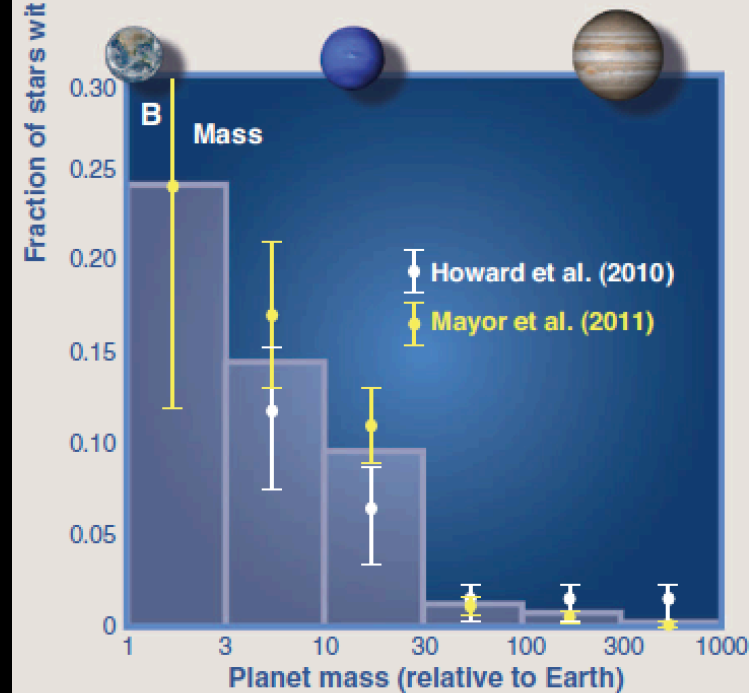
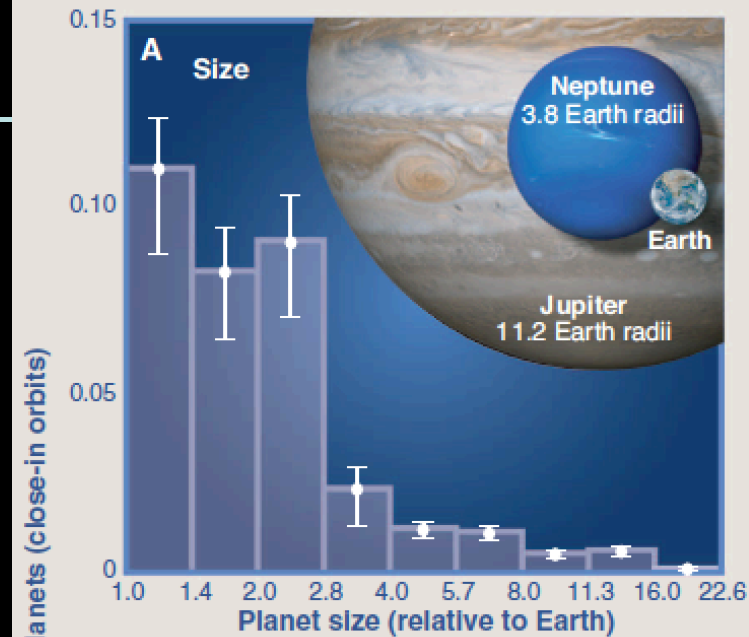
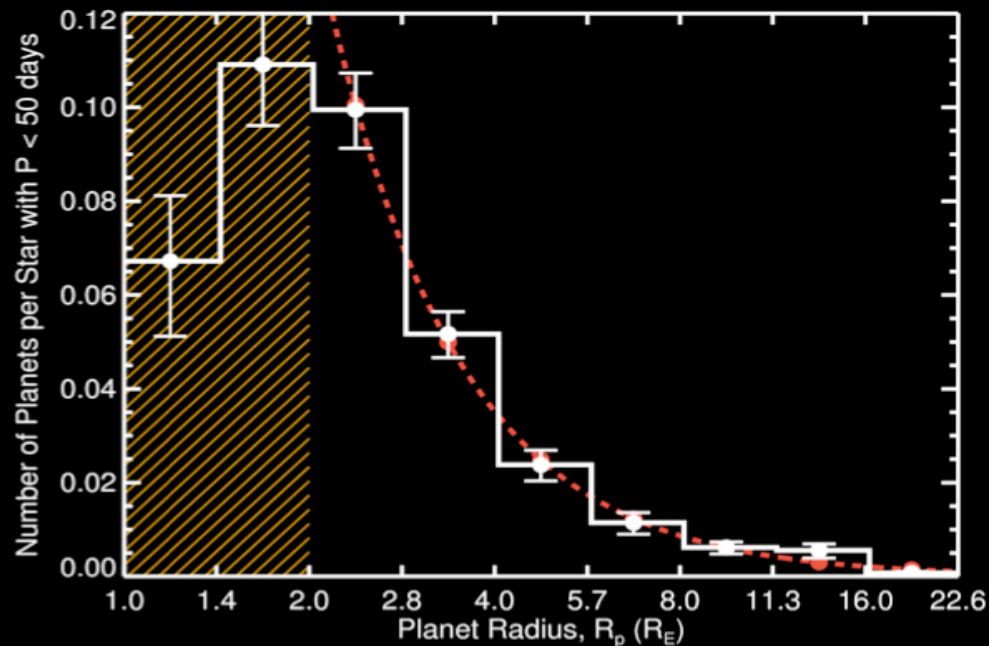
TRANSIT

Spectra of Earth-like planets –

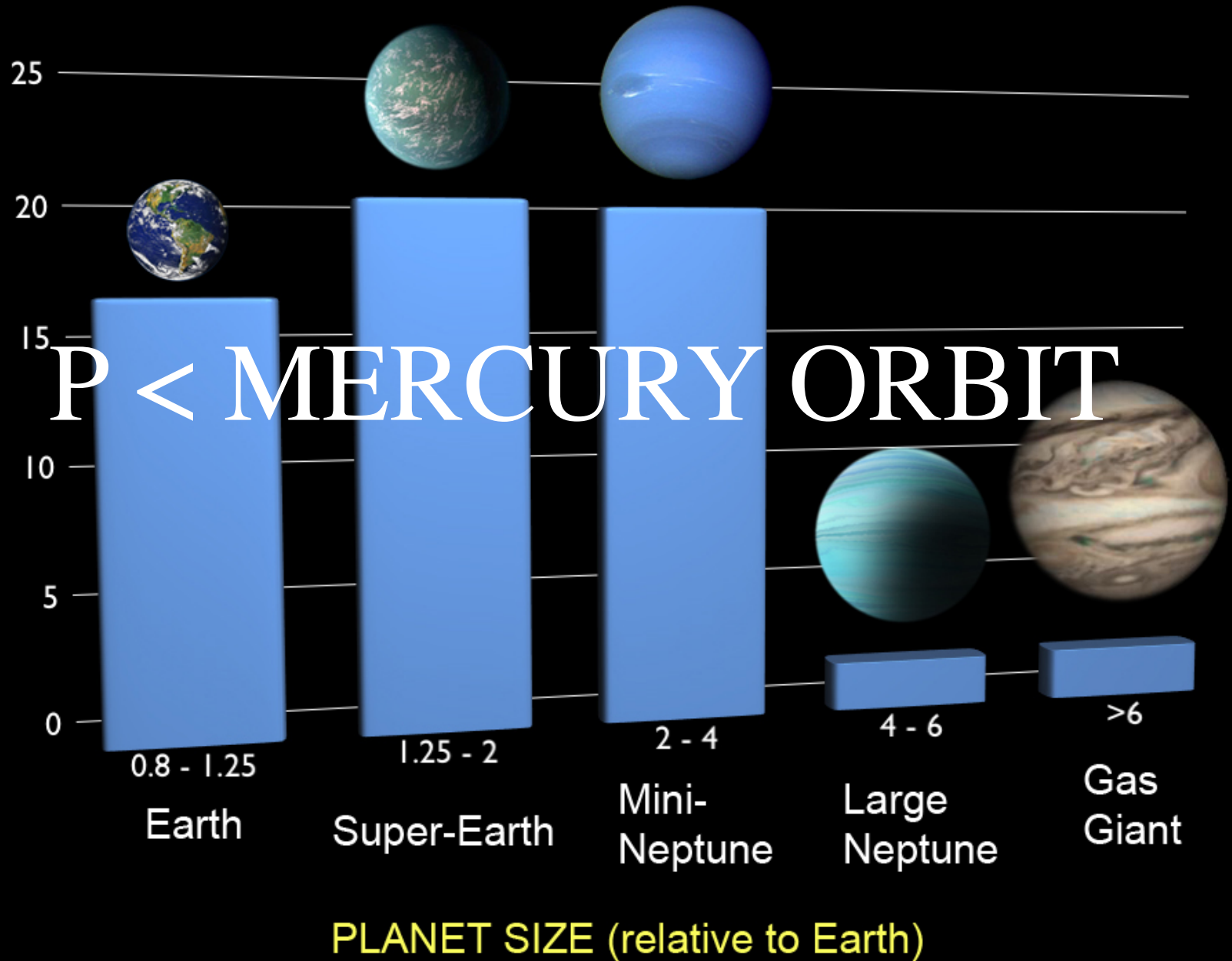
Small planet = *statistic* sample

Distribution from 1) planet size (transits)
& planet min. mass (Radial Velocity)

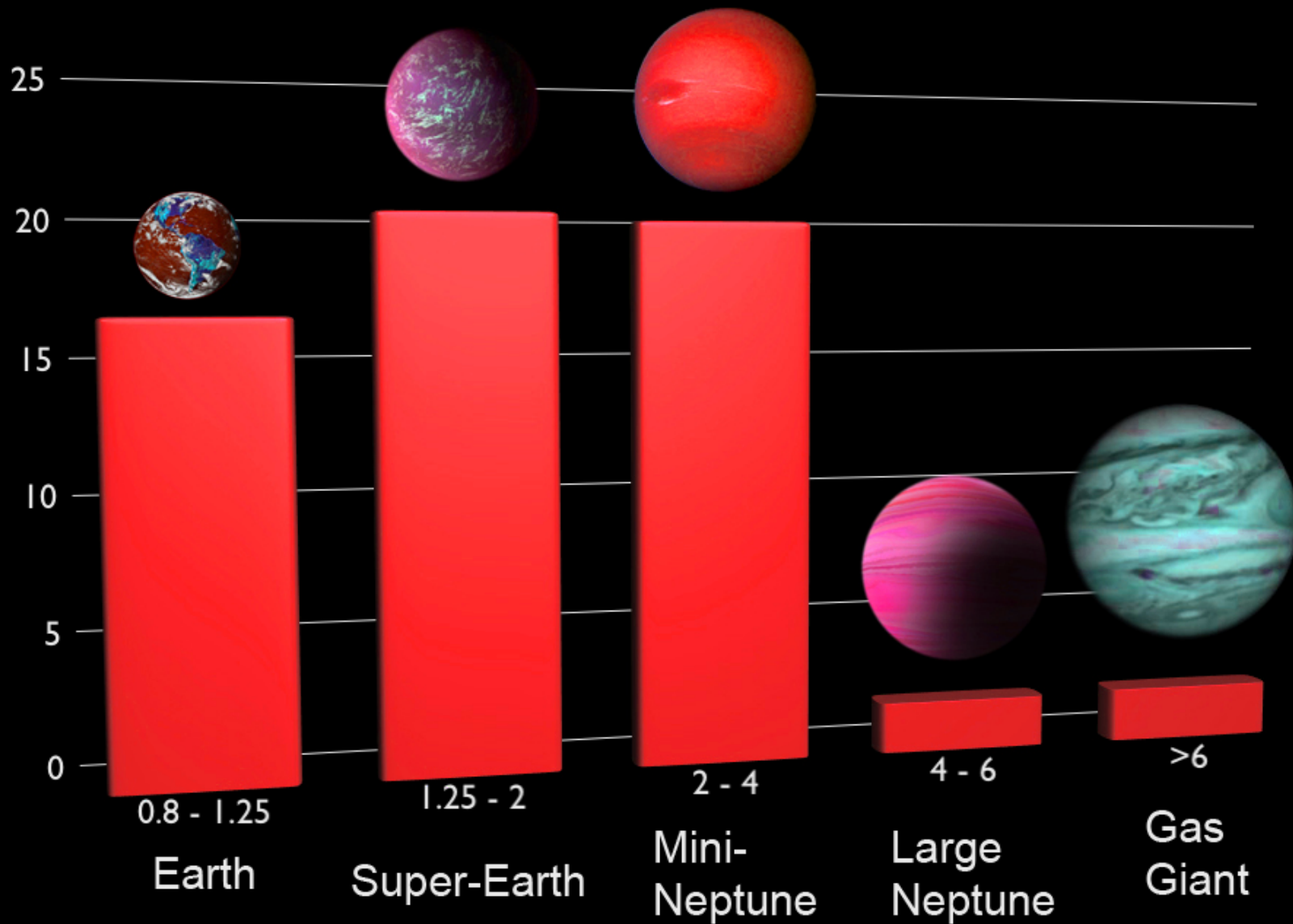
Planets confirmed: 900+ (3500+ candidates)



FRACTION OF STARS
WITH AT LEAST ONE PLANET



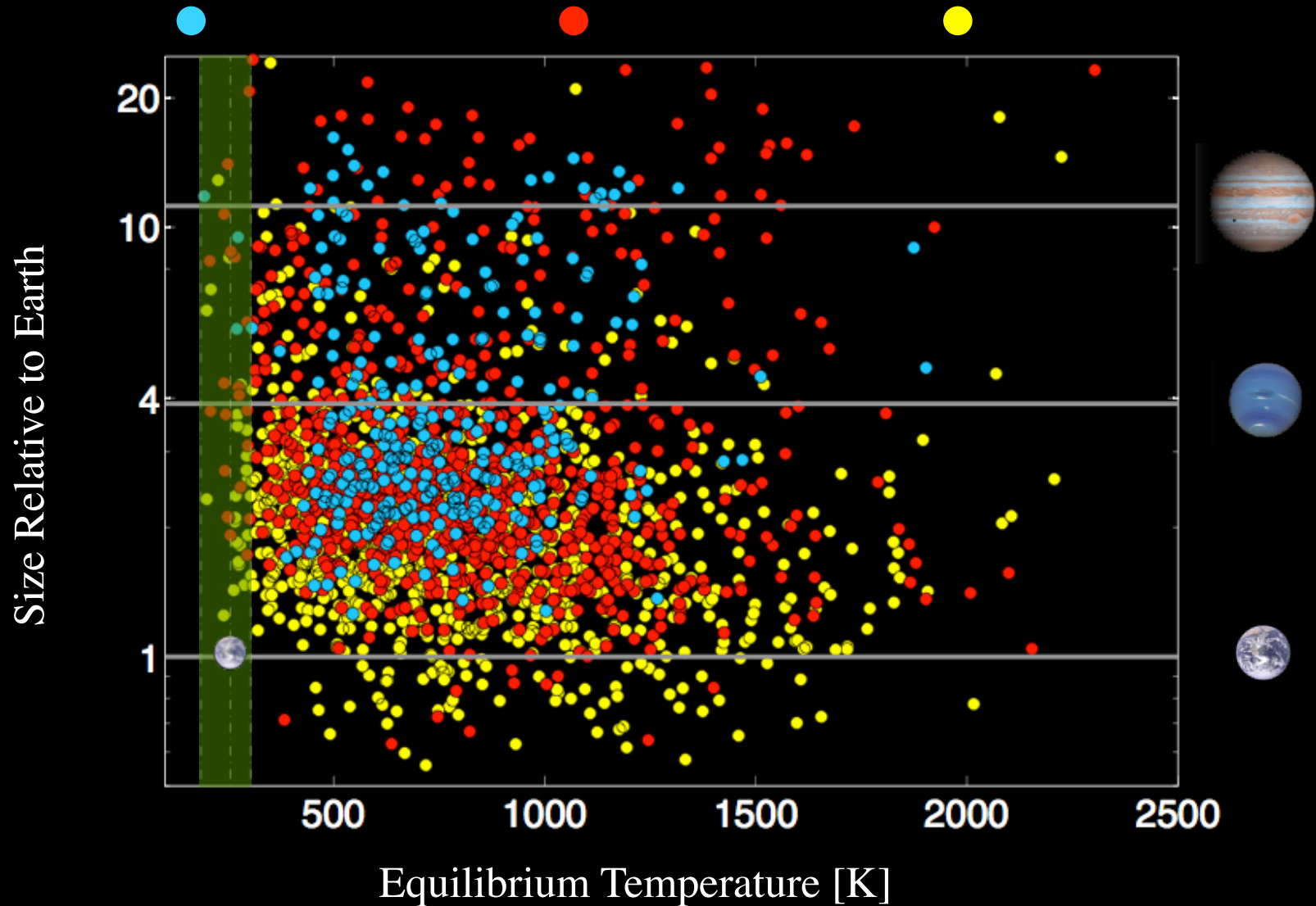
FRACTION OF STARS
WITH AT LEAST ONE PLANET



PLANET SIZE (relative to Earth)

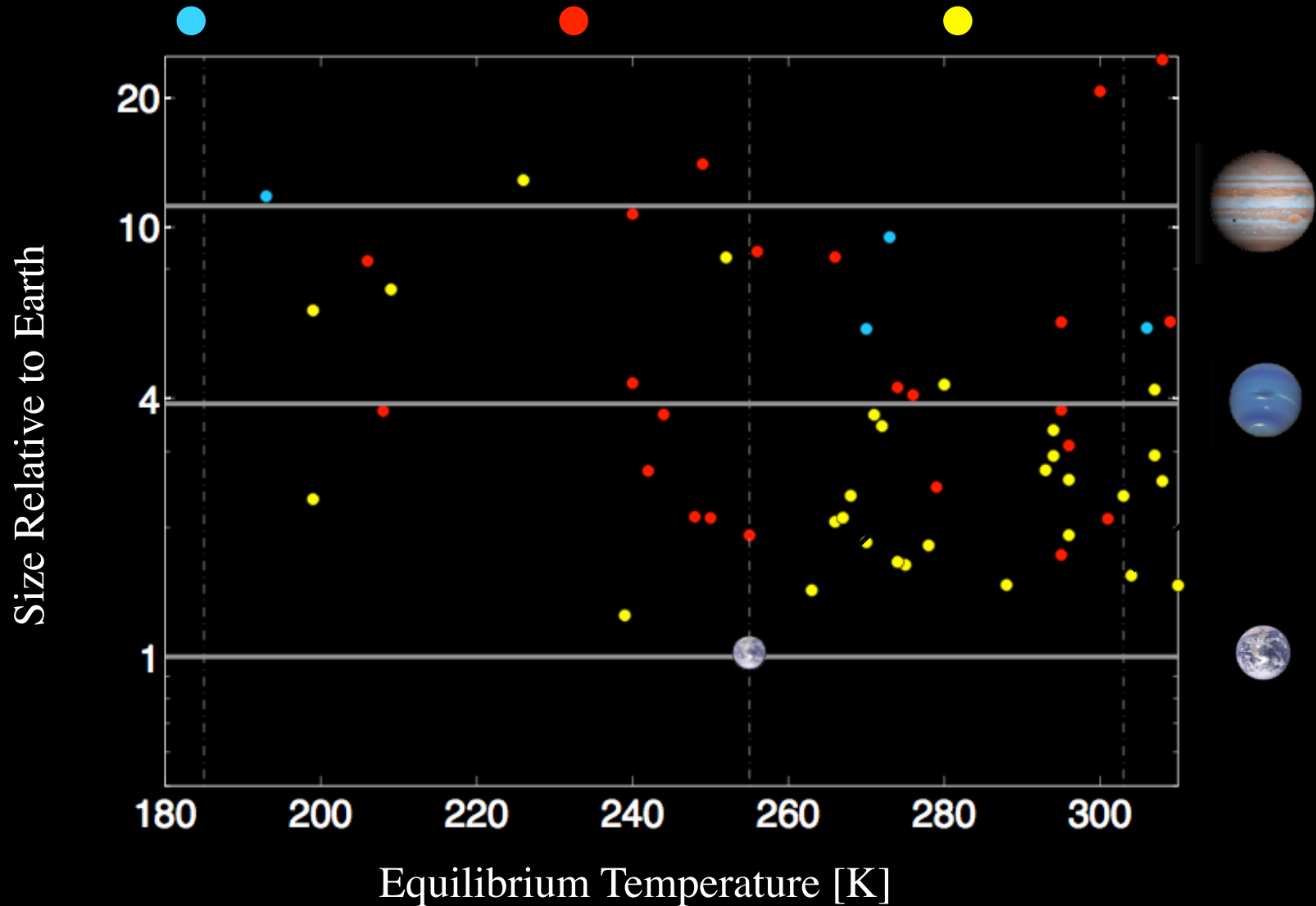
HZ Candidates

48 with T_{eq} between 185 and 303 K

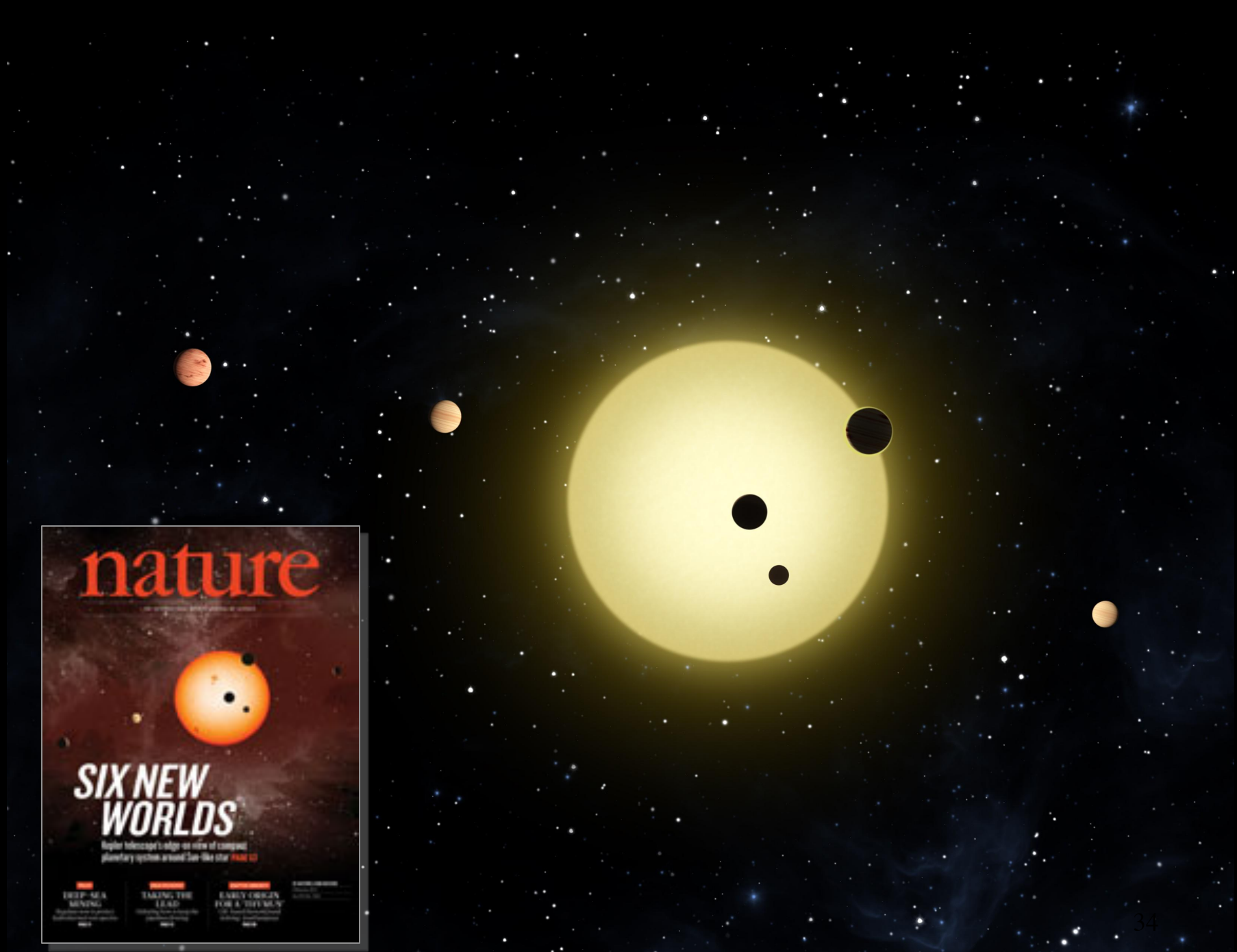


Candidates

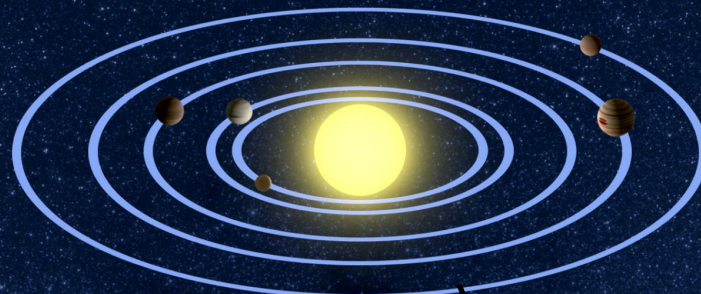
Ten with $R_p < 2 R_e$ ($185 \text{ K} < T_{eq} < 303 \text{ K}$)







Kepler-11 System



Venus

Mercury

Solar System

