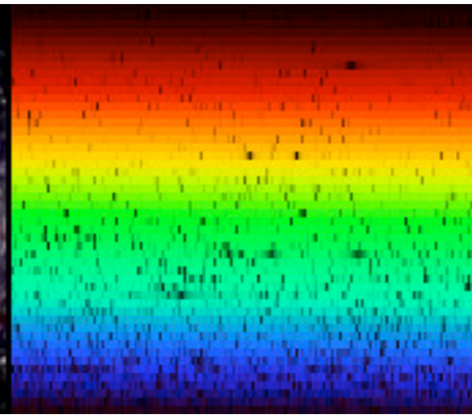
ASTR/PHYS 3070: Foundations Astronomy



Week 9 Tuesday

Today's Agenda

- Exoplanet populations
- Star masses from binaries
- Magnitude system
- Practice with magnitudes

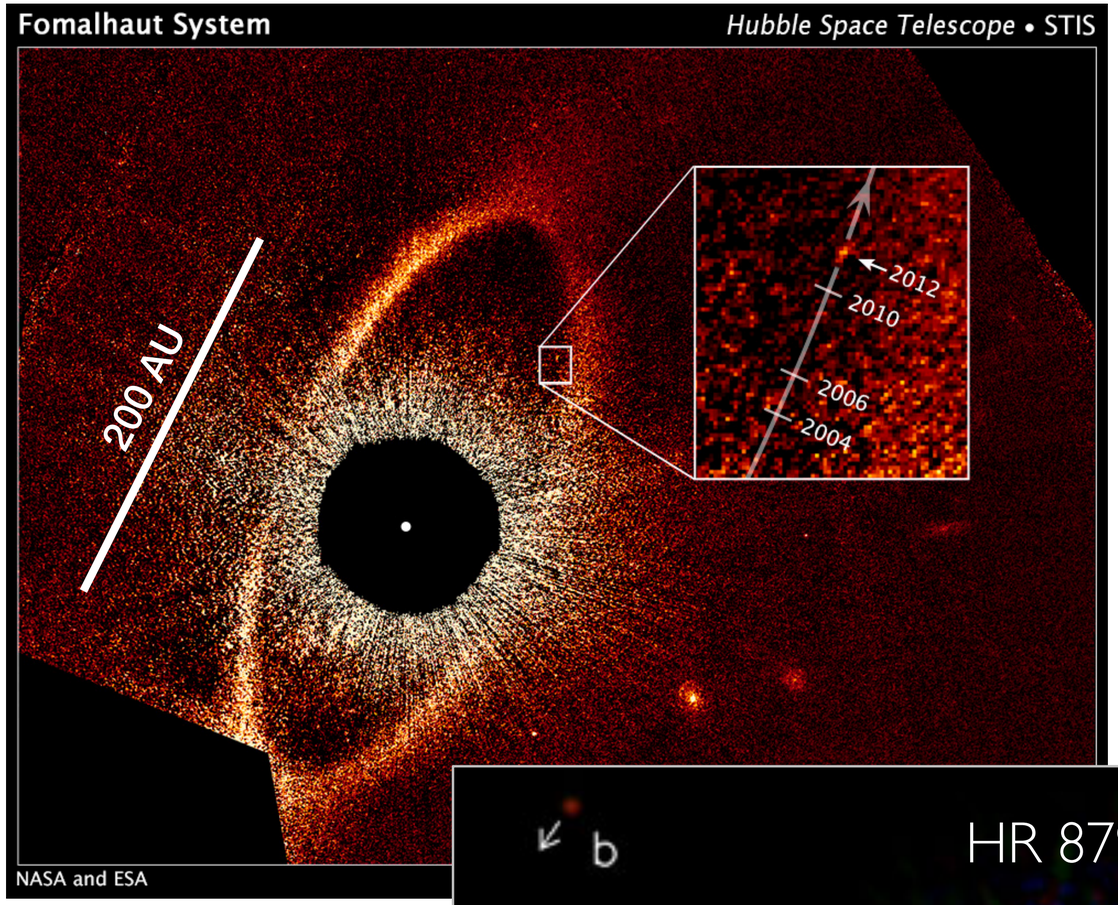
Announcements / Reminders

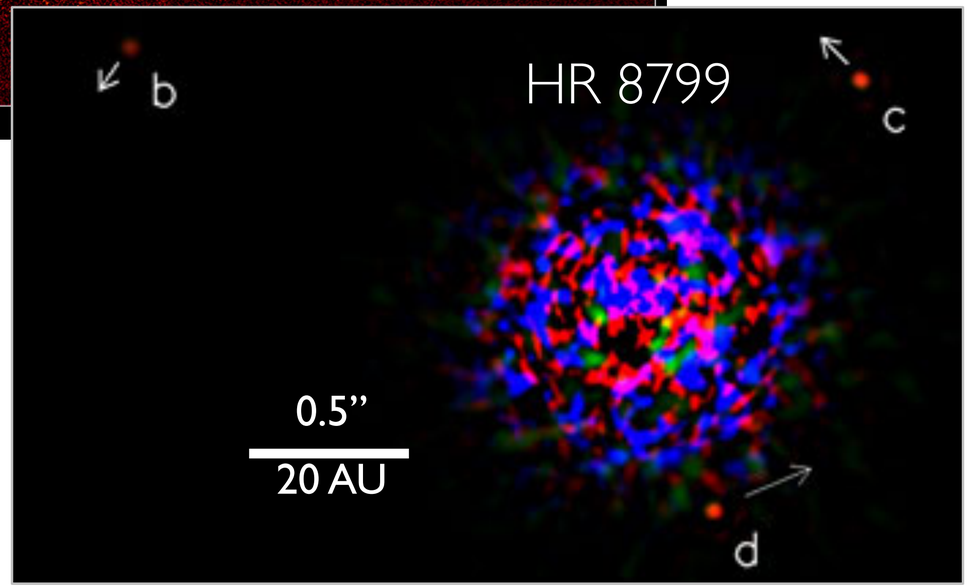
- HW 6 due Friday 1min before midnight
- Read Chapter 13

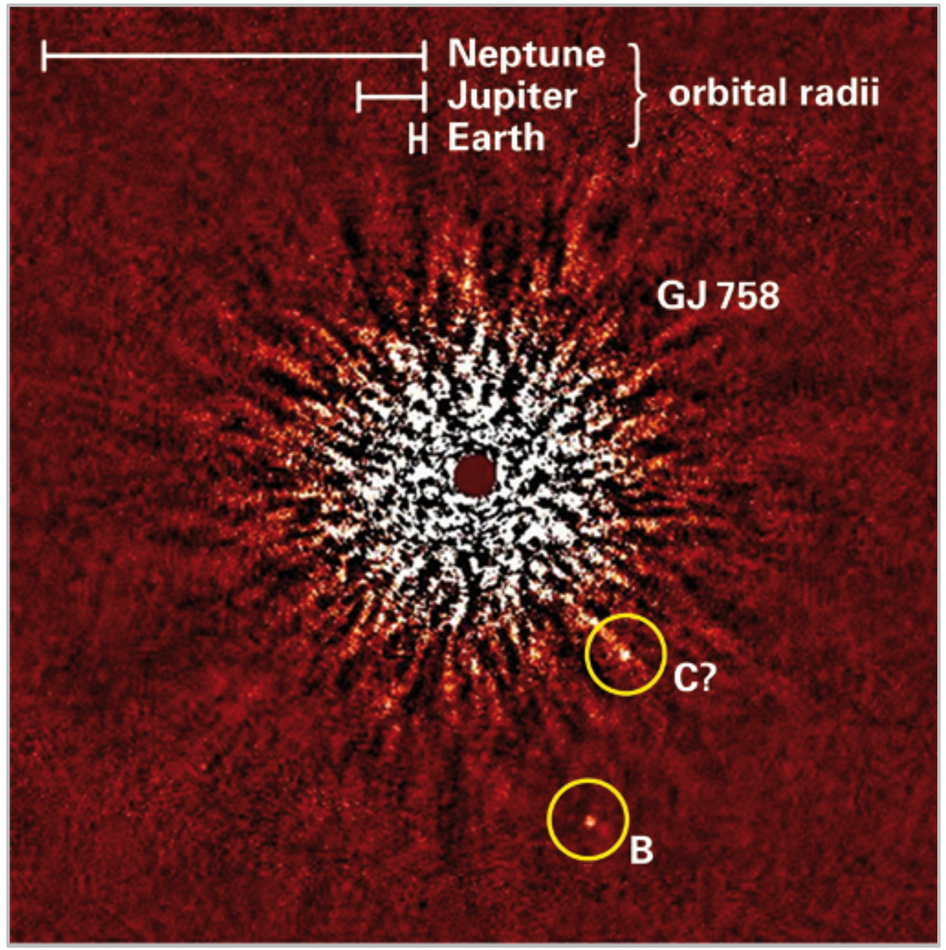
- HEAP talk at 4pm on Thursday
  - Spica: its stars and nebula
- Colloquium at 2pm on Friday
  - Breaking the Myth of the "Non-Traditional" Physicist: The Real Story About Employment for Physics Graduates

Direct Imaging

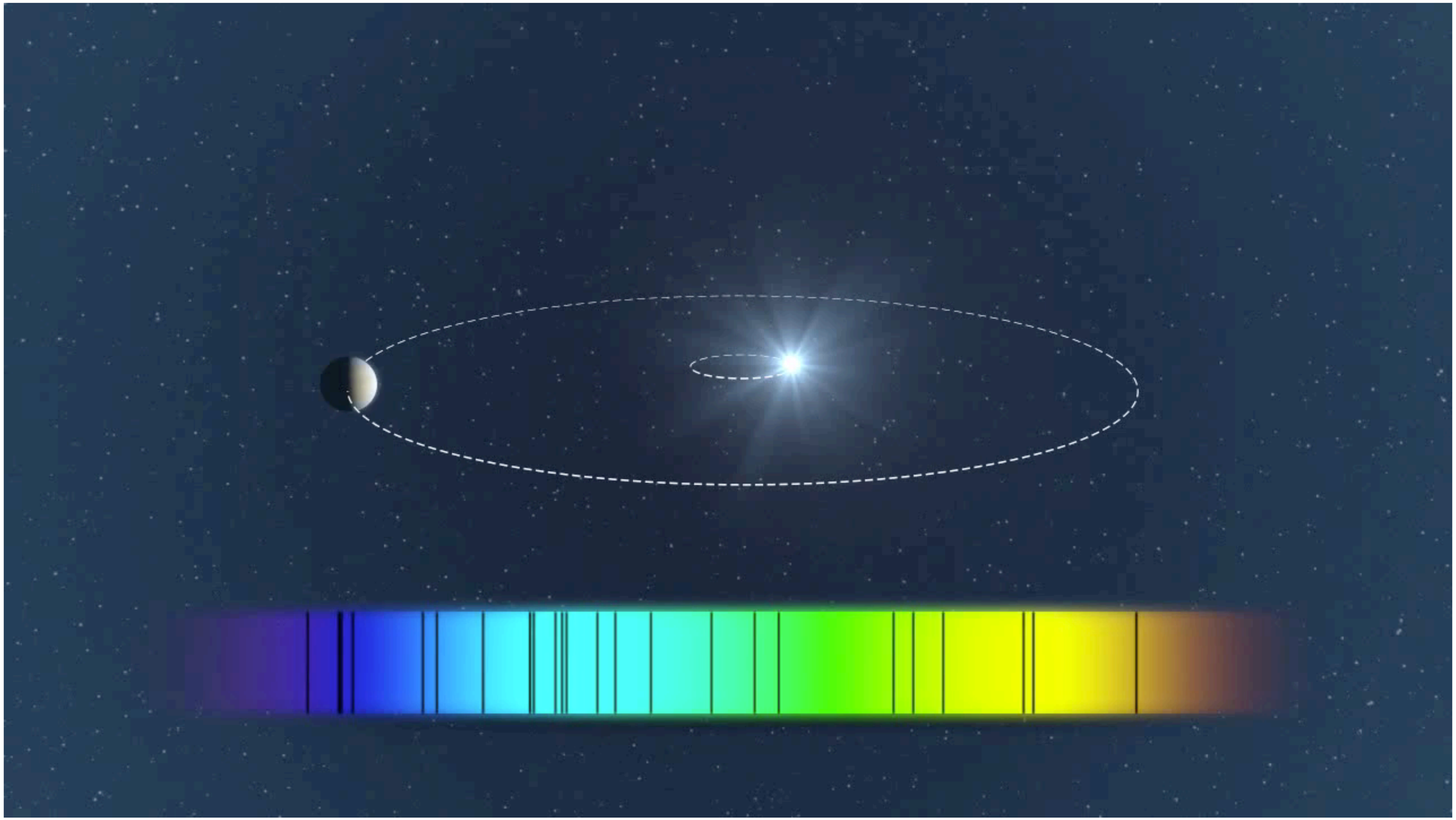
Planet millions of times fainter
Need to mask the starlight





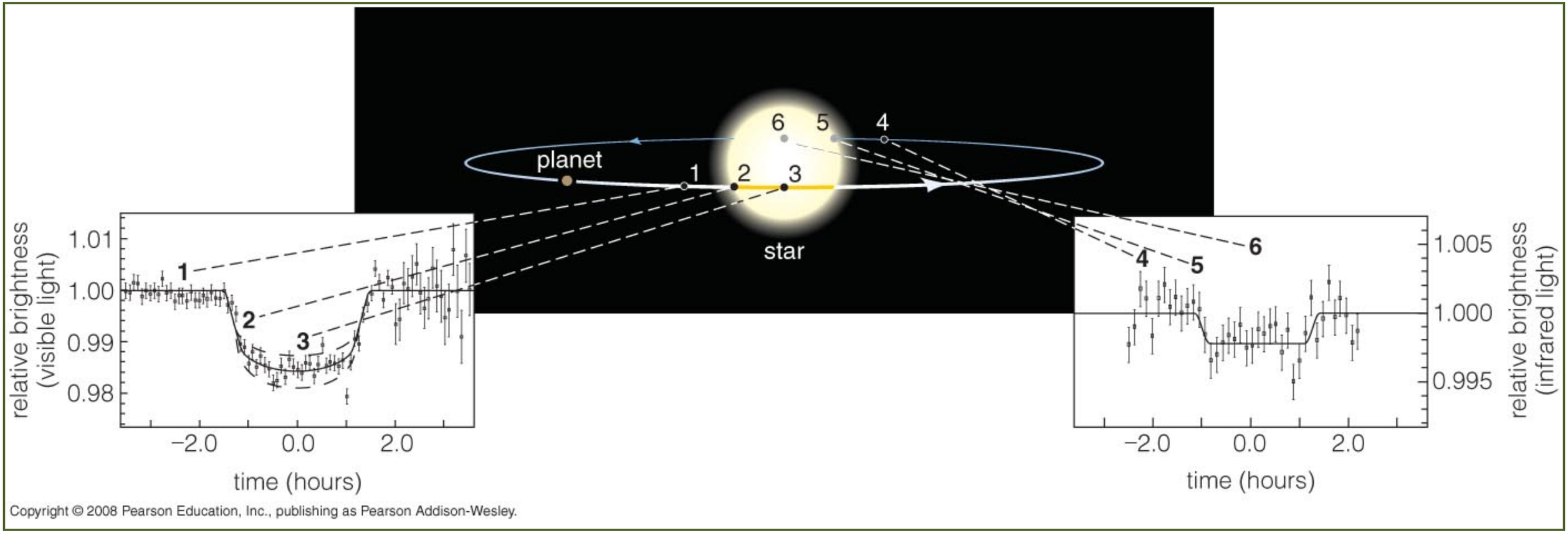


Can’t see the planet, but can see the star

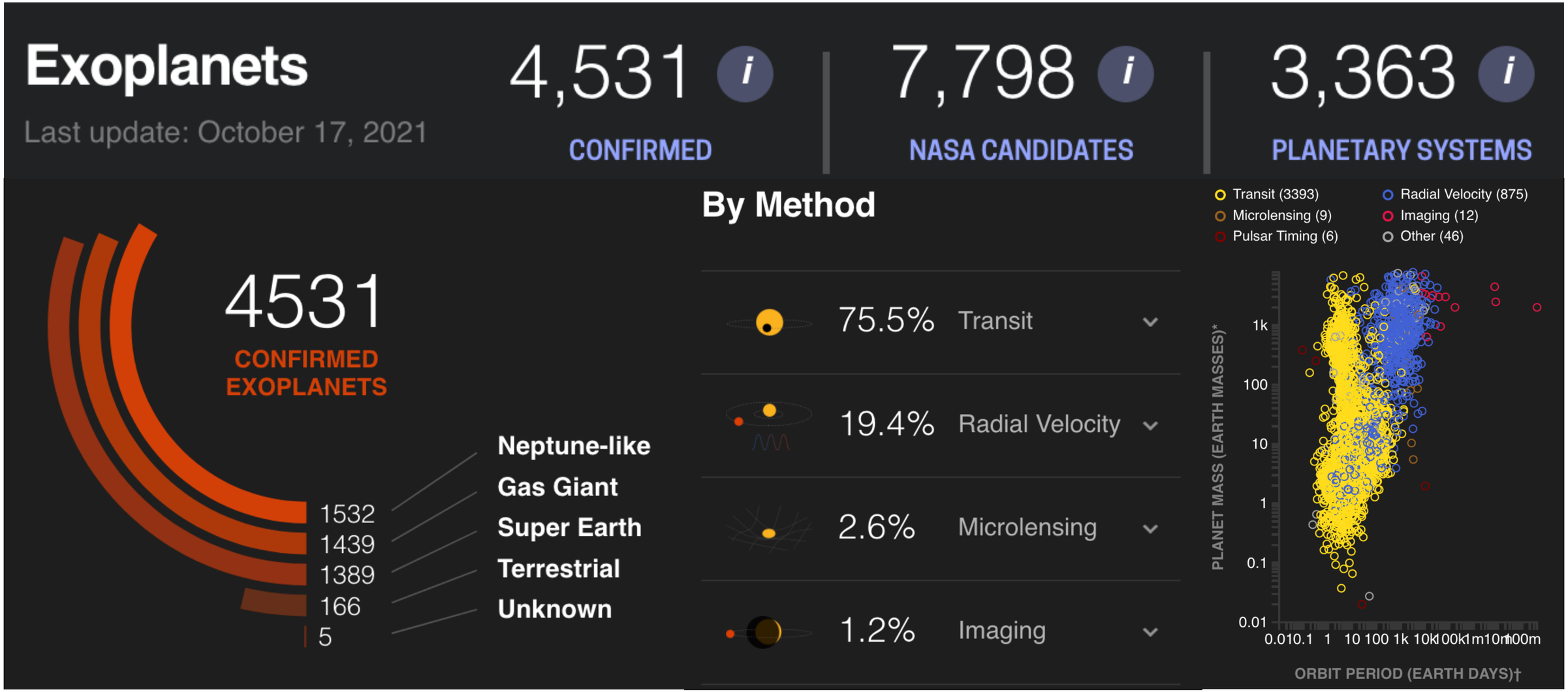


Transit Method

Starlight is blocked by the planet, reducing the amount of light detected from the star

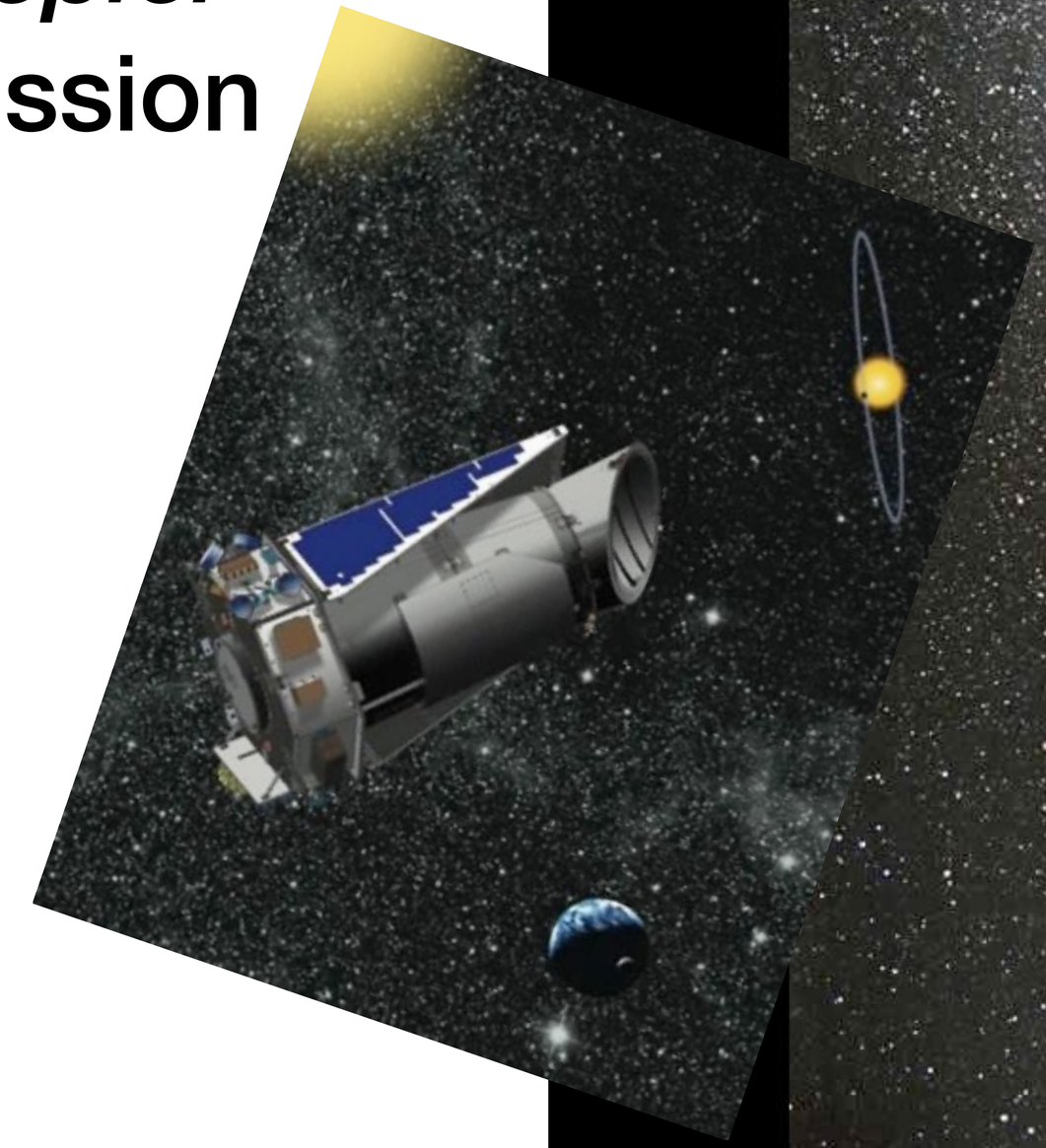


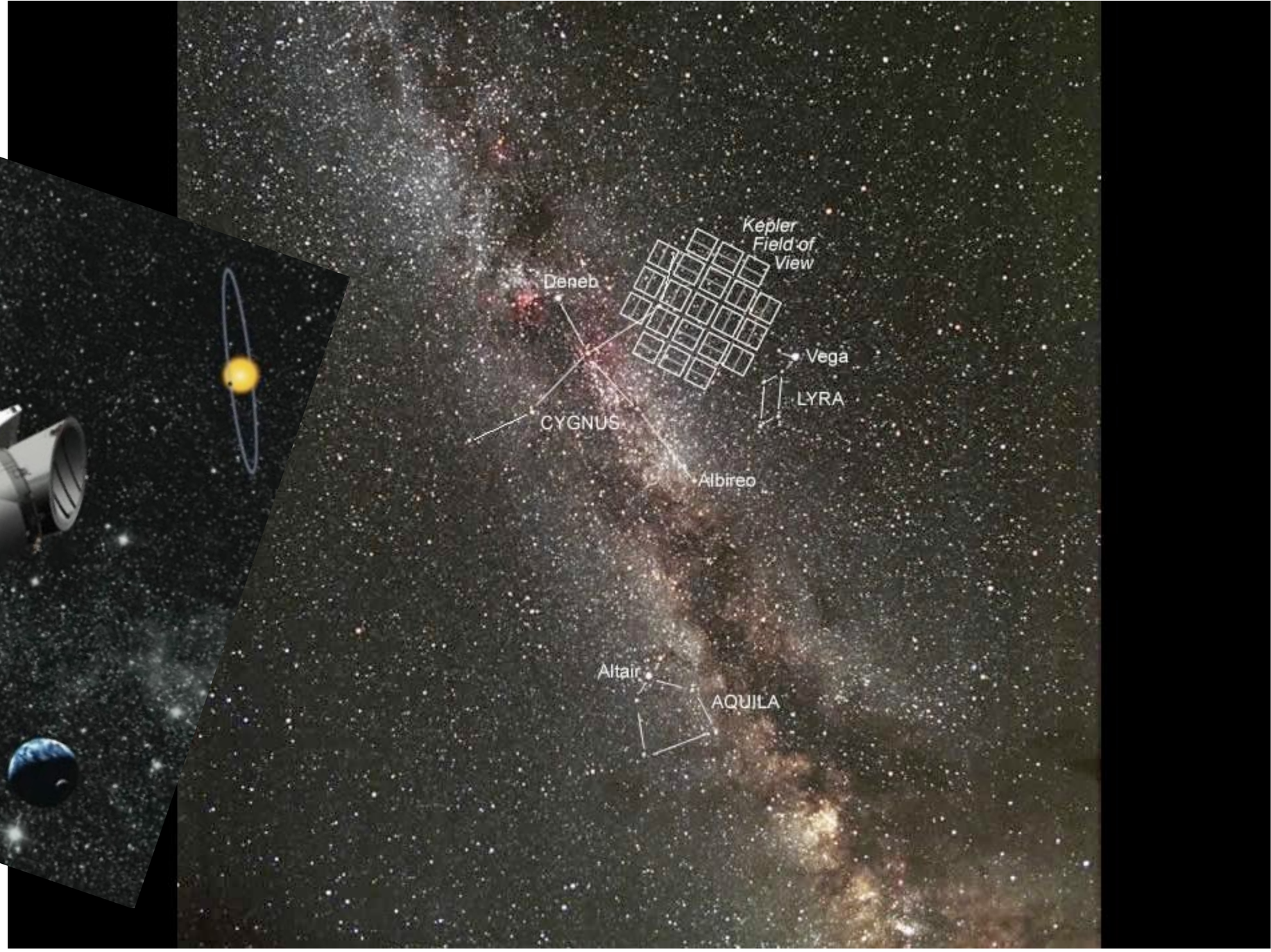
Exoplanet Detections



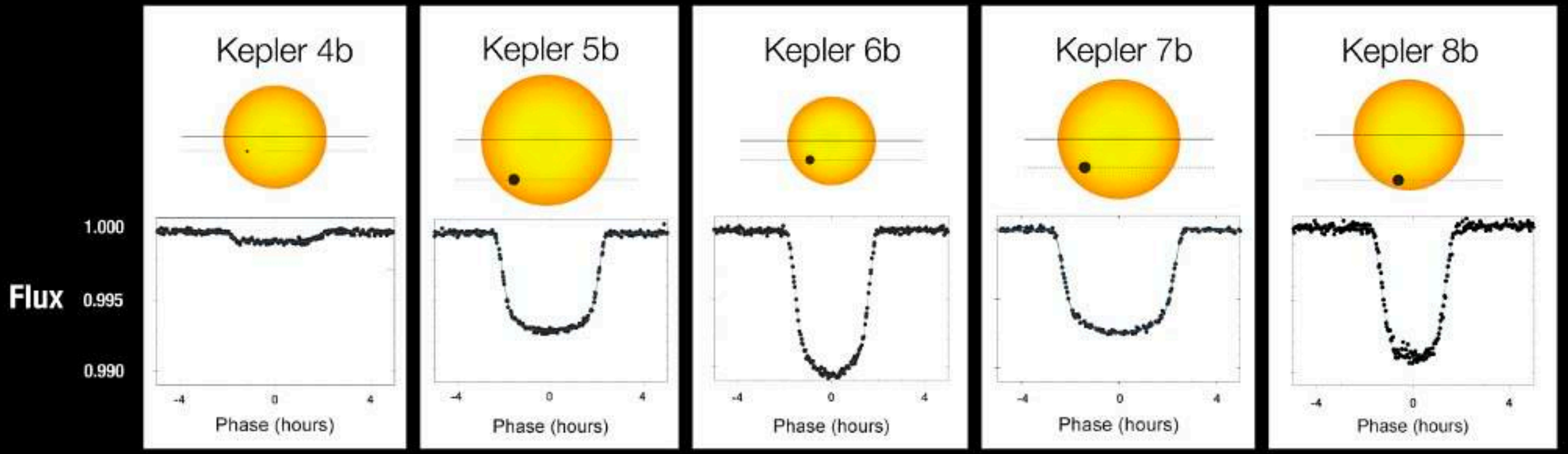
exoplanets.nasa.gov

Kepler Mission



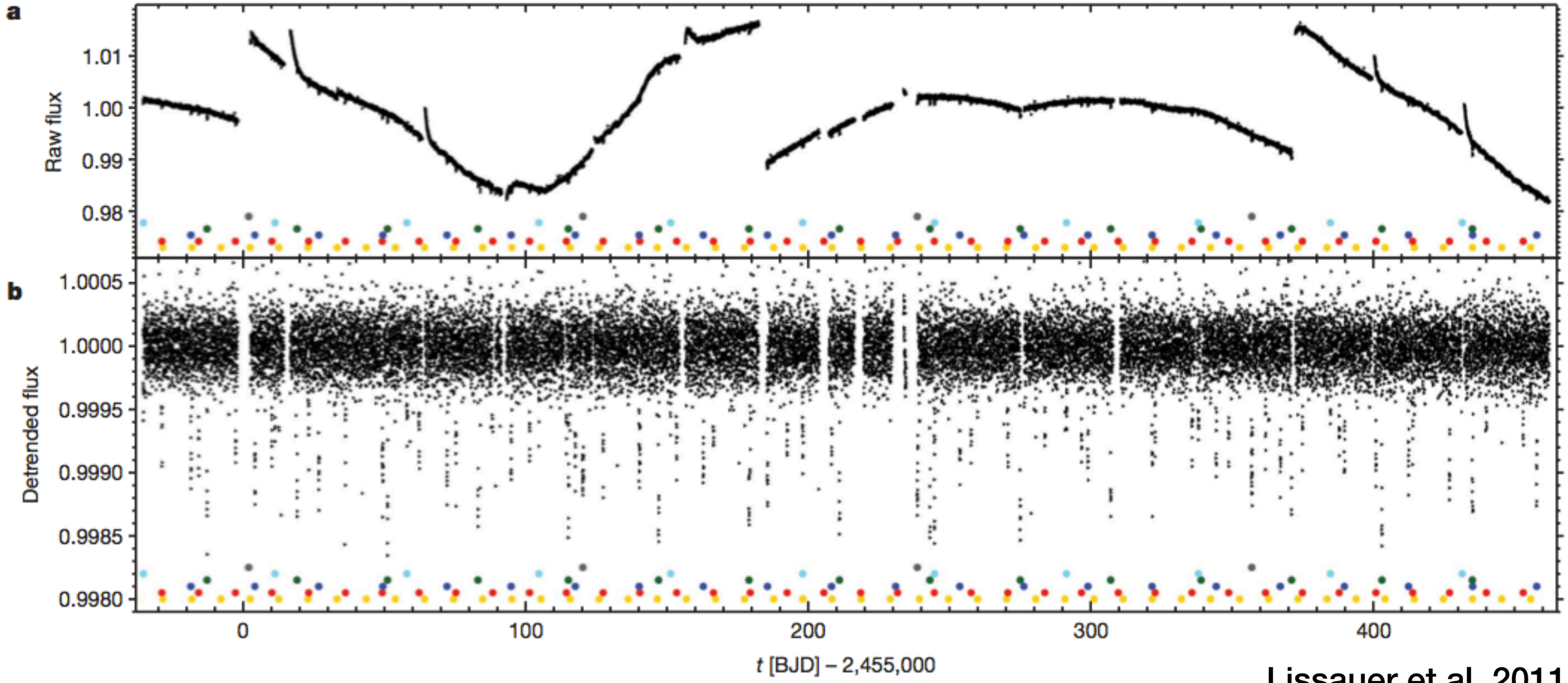


Transit Light Curves



Orbital Period (days)	3.2 days	3.5 days	3.2 days	4.9 days	3.5 days

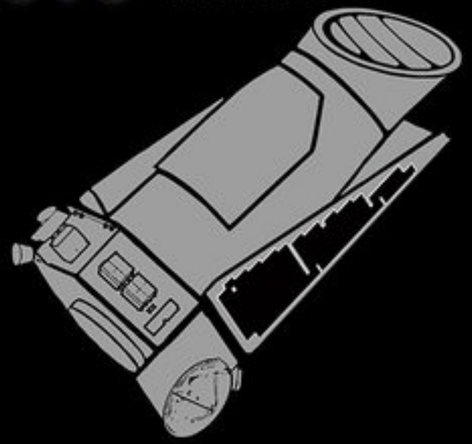
Kepler-11 System (6 planets)



Lissauer et al. 2011

Kepler
BY THE NUMBERS

9.6 YEARS IN SPACE

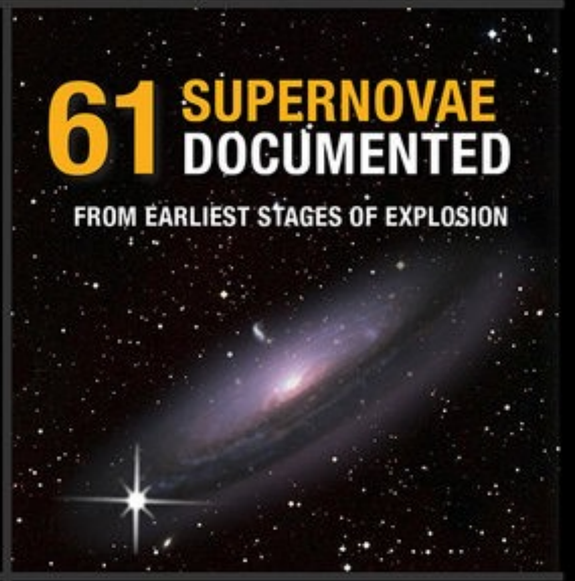


530,506 STARS OBSERVED

2,662 PLANETS CONFIRMED

61 SUPERNOVAE DOCUMENTED

FROM EARLIEST STAGES OF EXPLOSION

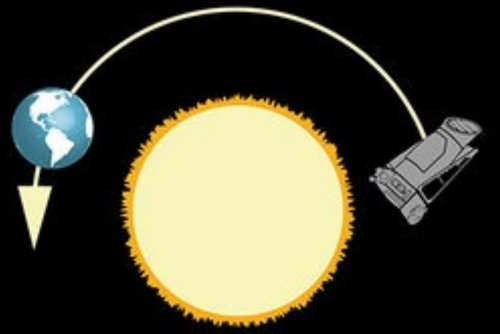


2 MISSIONS COMPLETED

678 GB SCIENCE DATA COLLECTED

2,946 SCIENTIFIC PAPERS PUBLISHED

94 MILLION MILES AWAY



3.12 GALLONS FUEL USED

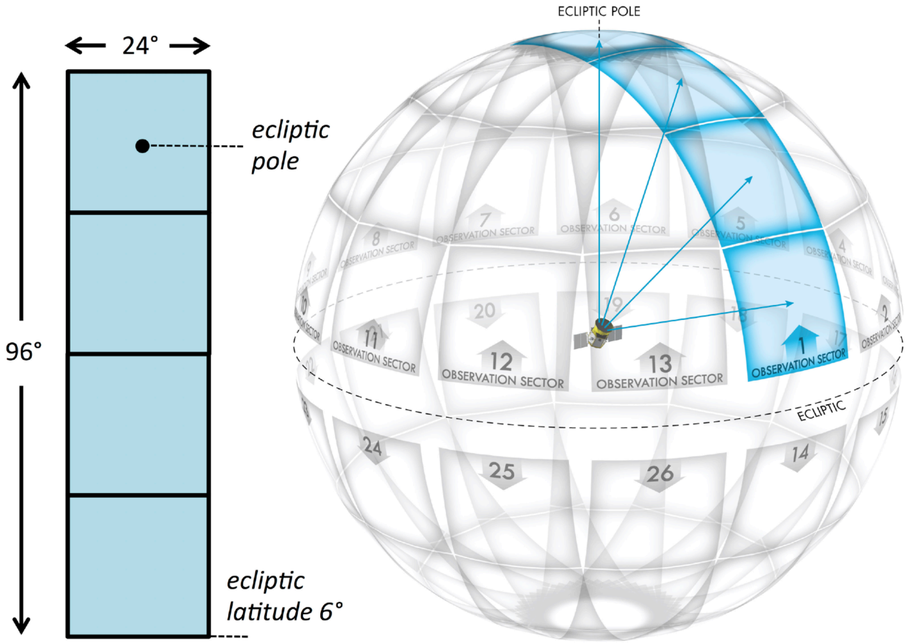
732,128 COMMANDS EXECUTED

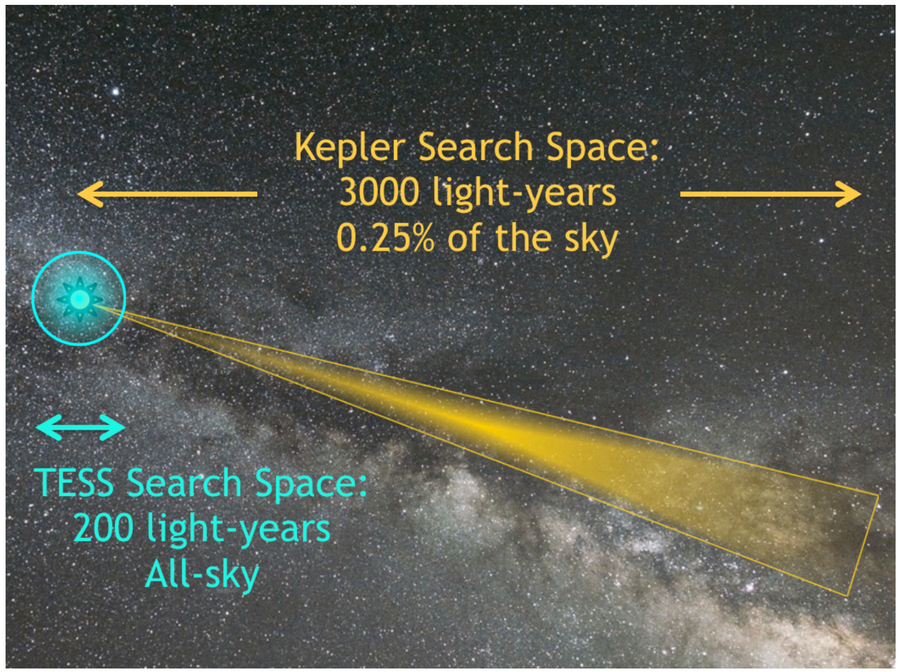
www.nasa.gov/kepler

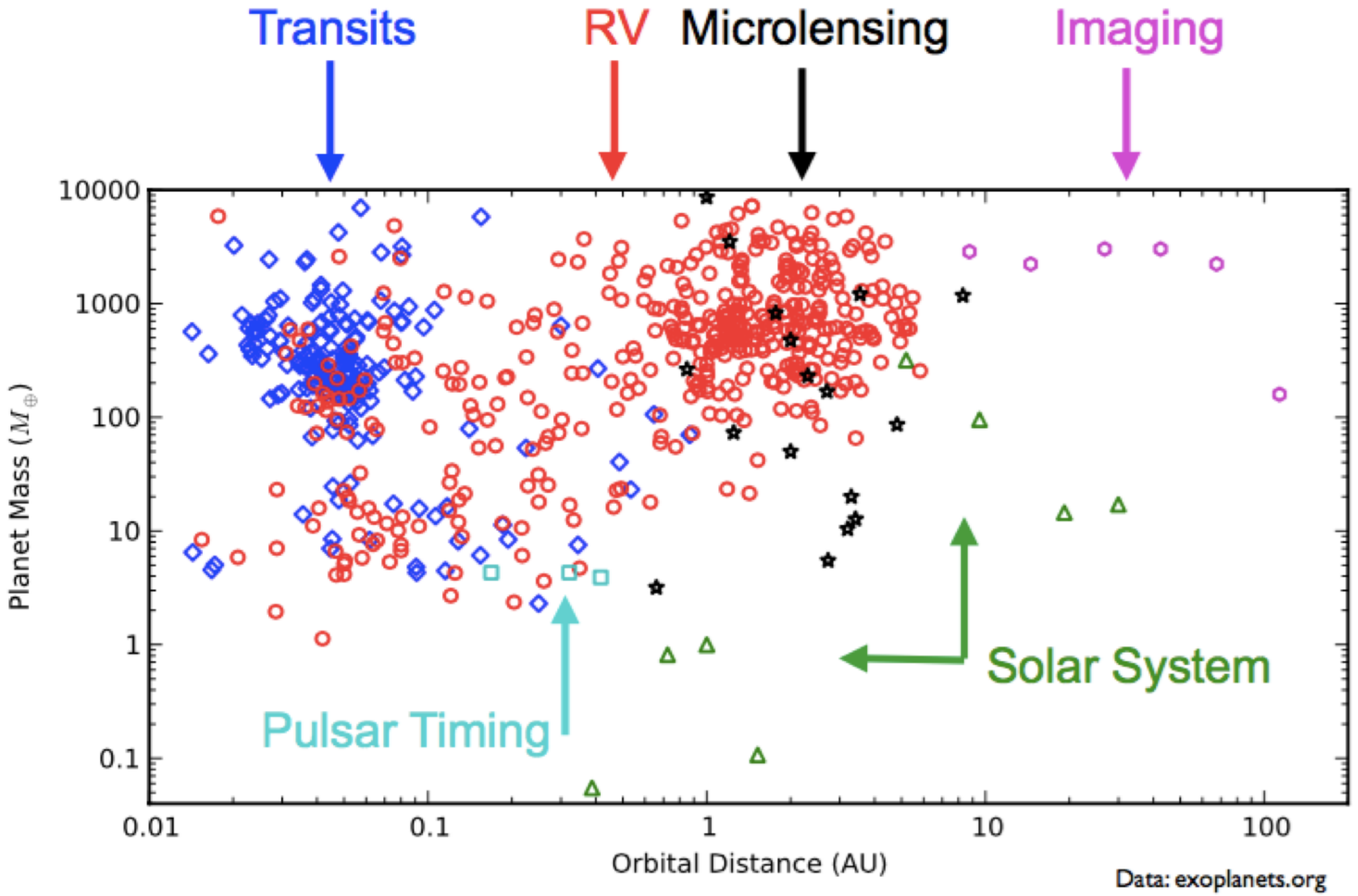
As of October 24, 2018

@NASAKepler

TESS: Transiting Exoplanet Survey Satellite

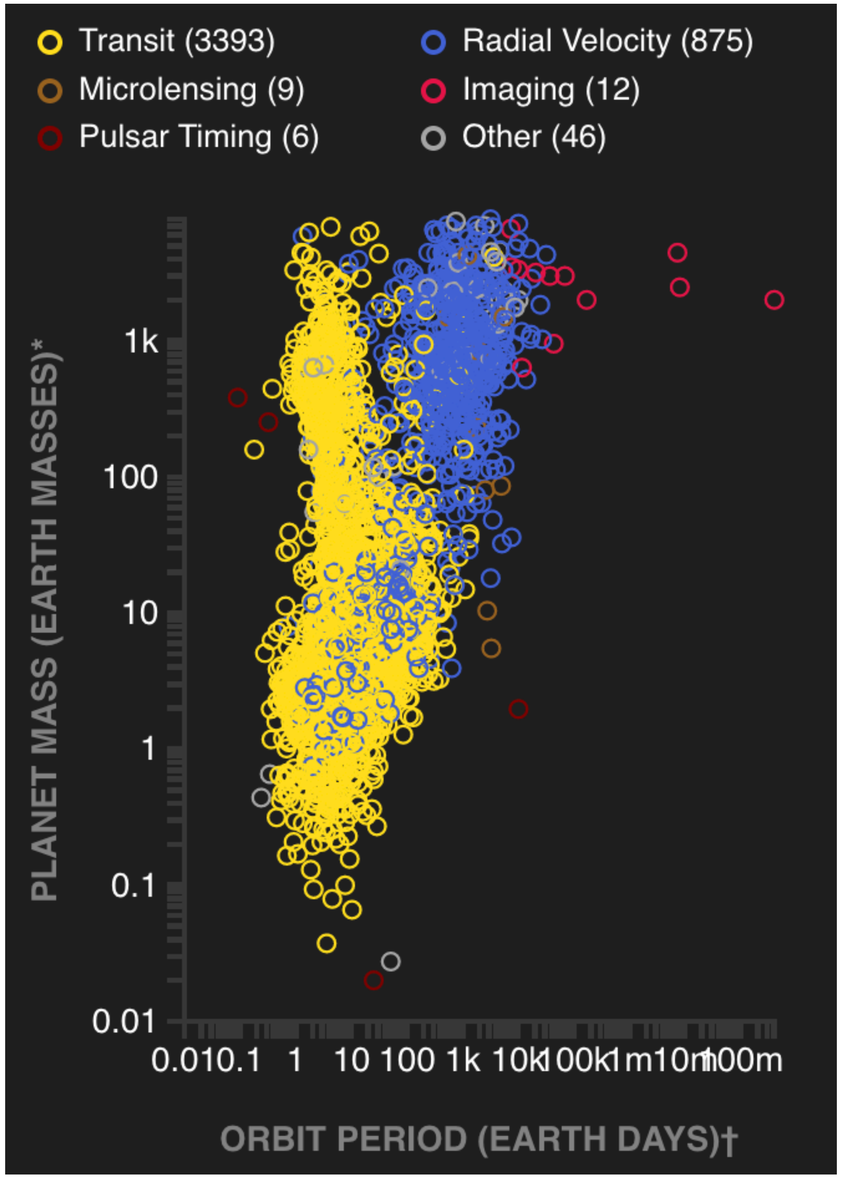





Transits
RV
Microlensing
Imaging
10000
1000
100
10
1
0.1
Planet Mass ($M_\oplus$)
0.01
0.1
1
10
100
Orbital Distance (AU)
Pulsar Timing
Solar System
Data: exoplanets.org

What do we know about planets in general?

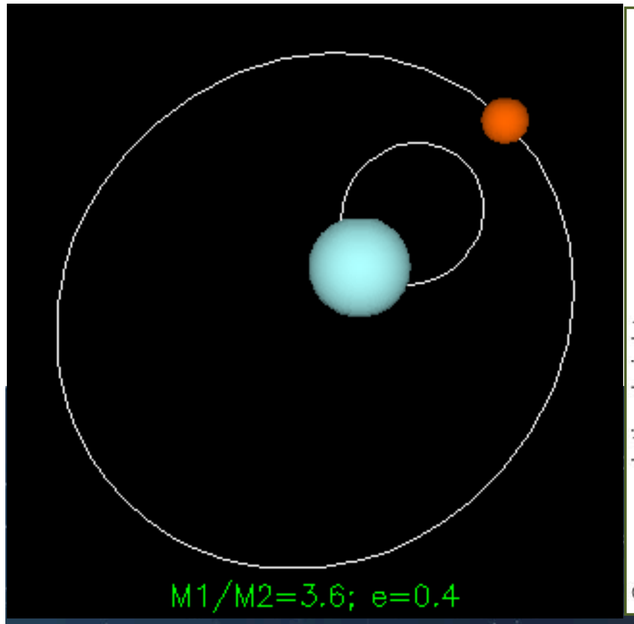
- Planets are more numerous in the Galaxy than stars!
- Smaller, rocky planets are common (20-50% of stars should have at least 1)
- Solar system is a little weird
  - Most common planet is b/t Earth and Neptune in mass
  - Many systems are more compact than the solar system

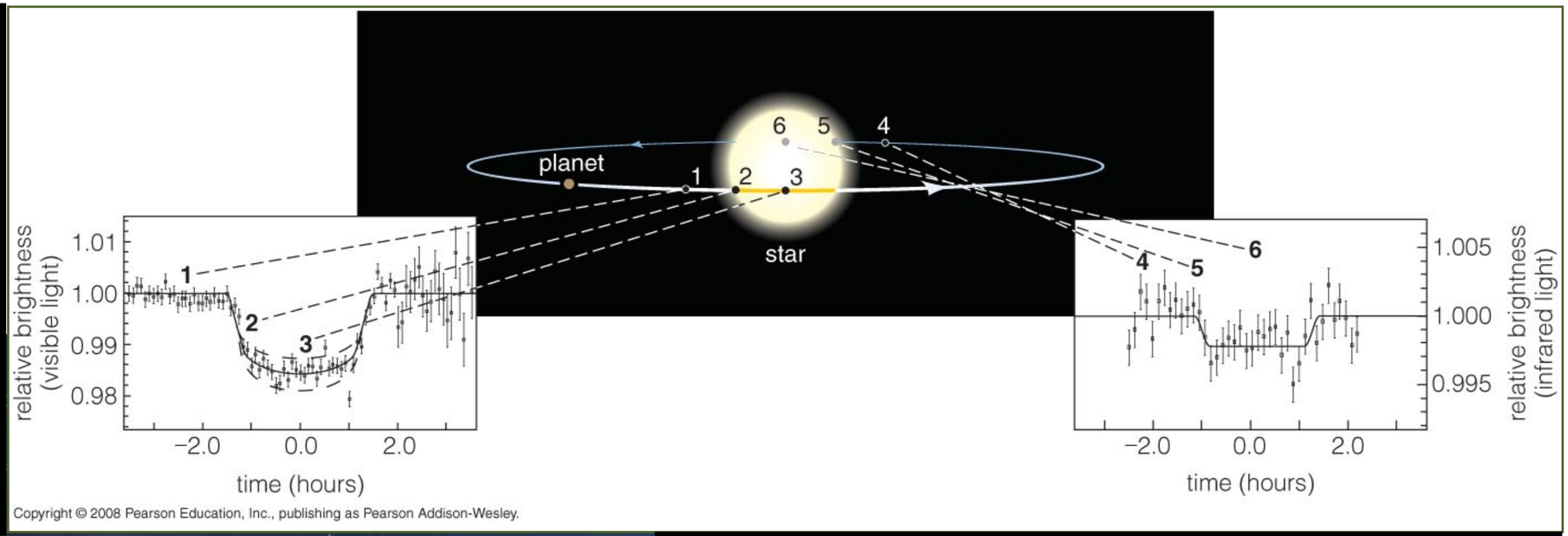


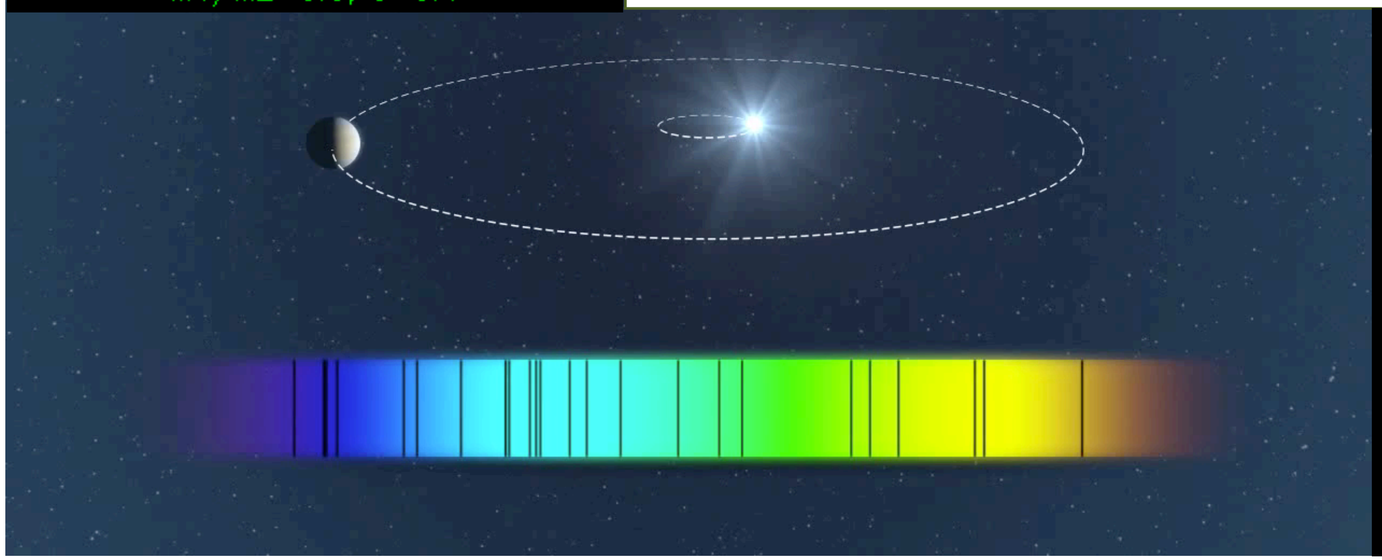
exoplanets.nasa.gov

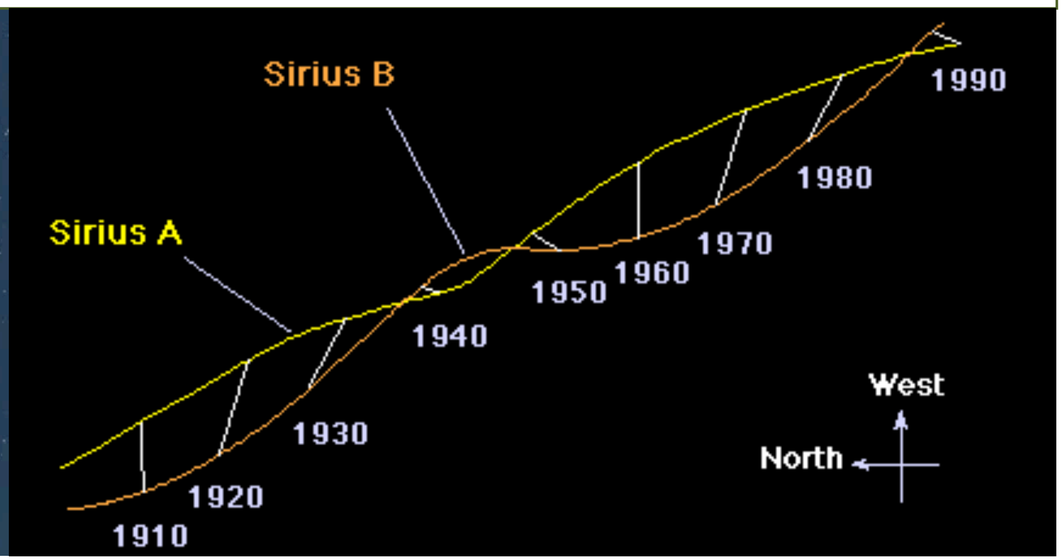
Measuring Stars

Binaries: use same methods as with planets

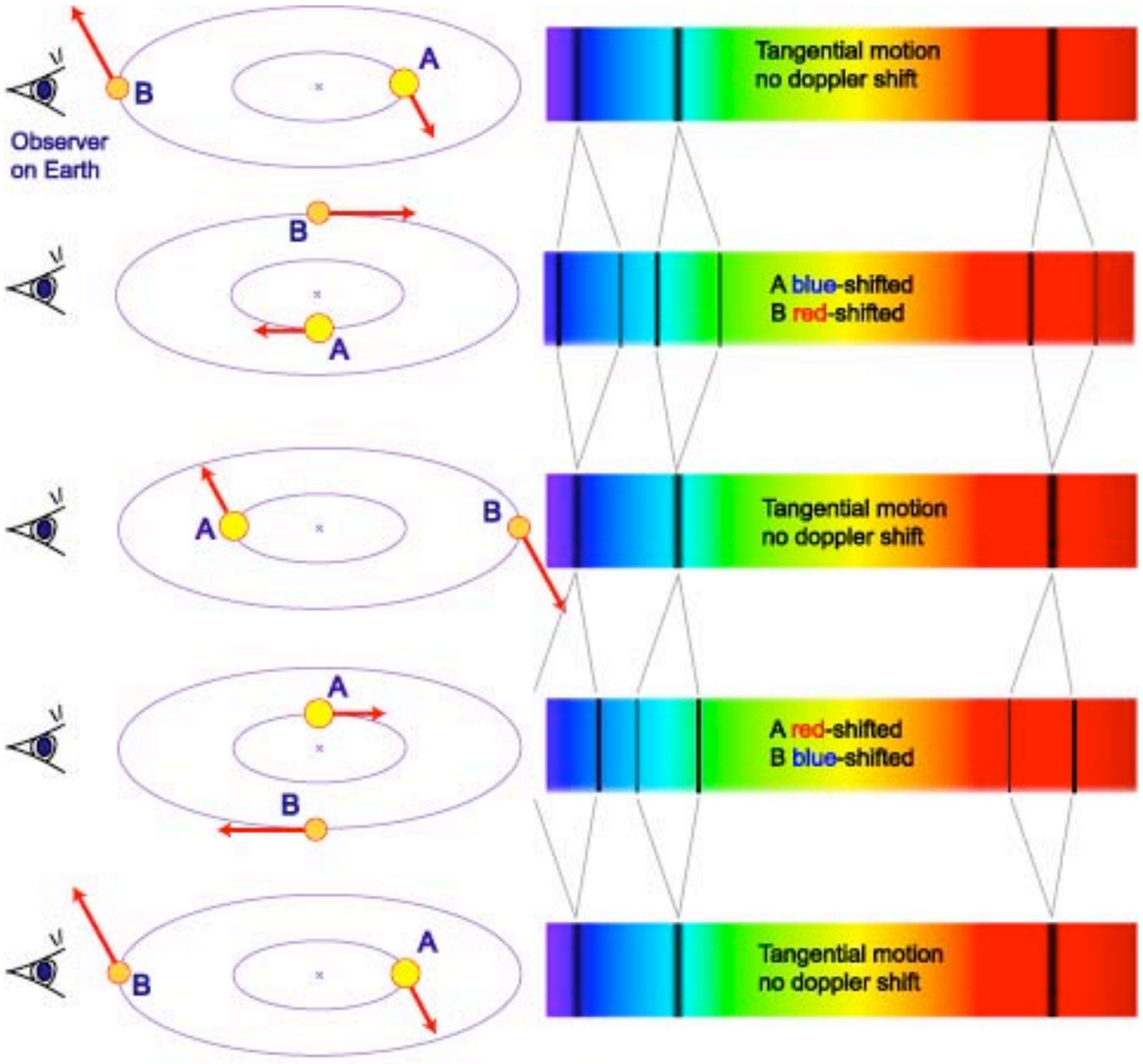








Spectroscopic Binary



Measuring Stars

Parallax

$$d = \frac{1 \text{ pc}}{\pi''}$$

Inverse Square Law

$$F = \frac{L}{4\pi d^2}$$

Effective Temperature

$$T_{\text{eff}} = \left(\frac{L}{4\pi R^2 \sigma_{\text{SB}}} \right)^{1/4}$$

$$m_2 - m_1 = 2.5 \log(F_1/F_2)$$

Apparent Magnitude

$$m = C - 2.5 \log(F)$$

Absolute Magnitude

$$M_{\text{bol}} = 4.74 - \log\left(L/L_\odot\right)$$

Distance Modulus

$$m - M = 5 \log \left(\frac{d}{10 \text{ pc}} \right)$$

Practice with Magnitudes

Consider 2 stars in a binary system, A & B.
A is brighter, and the difference in their magnitudes is 2.5.
If $m_B = 10$, what is m_A?

If the parallax angle to the system is 0.025”,
what is the absolute magnitude of star B?
What is the difference in absolute magnitudes
between the 2 stars?

Another star elsewhere in the sky is found to have a very similar spectrum to star B.
Assuming their intrinsic properties are similar and this star has a magnitude of 15,
how far away is it?