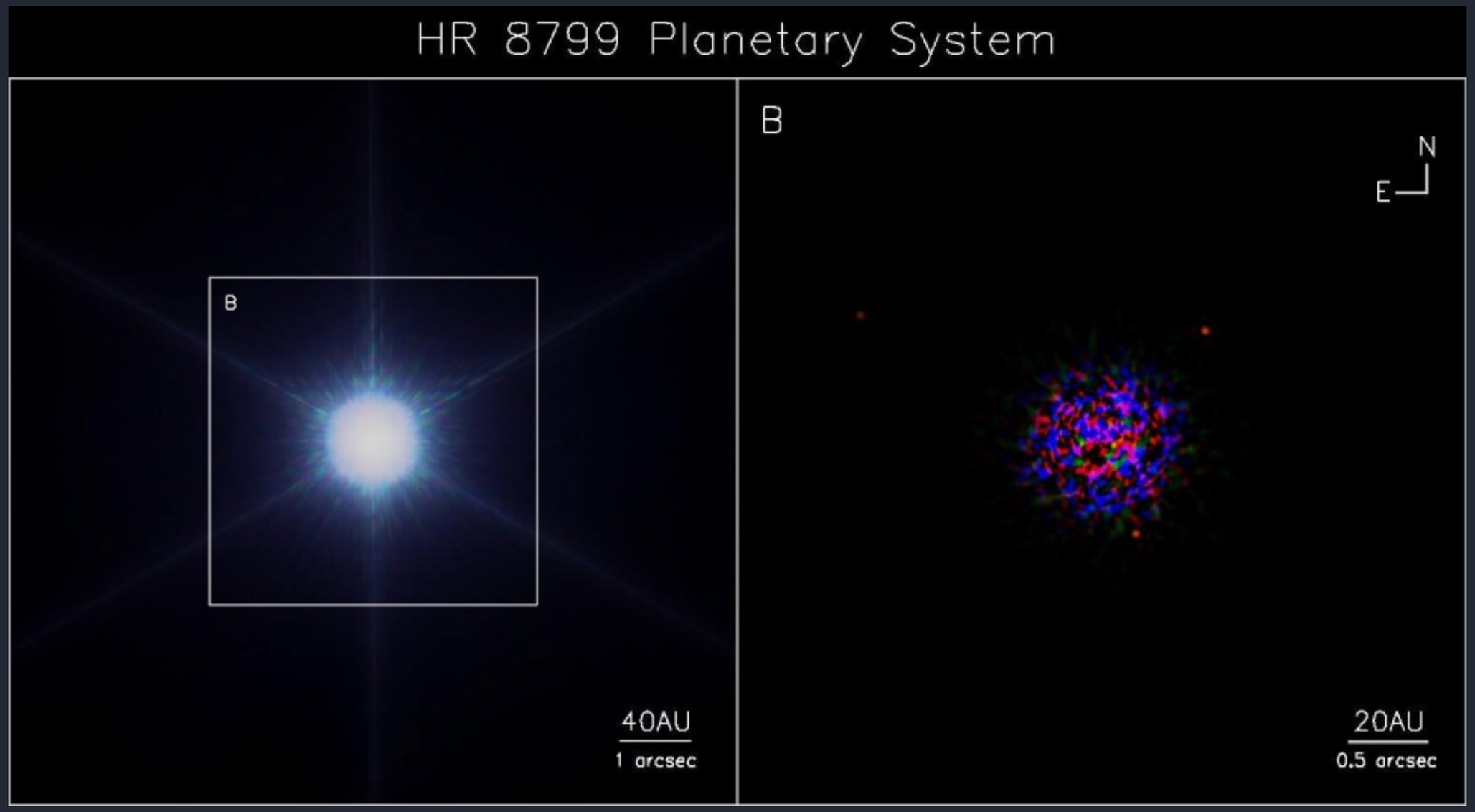
Astro 1: Introductory Astronomy

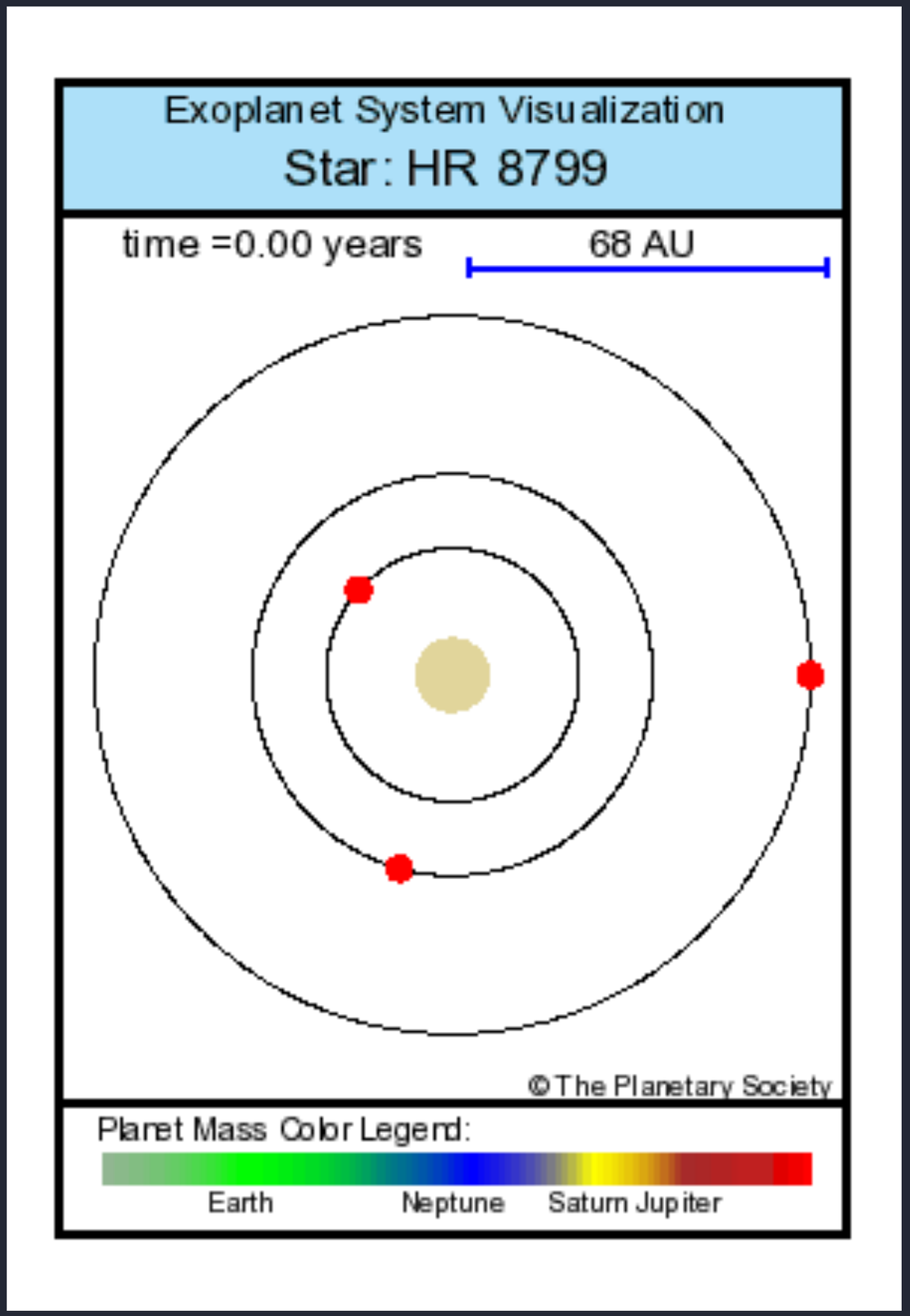


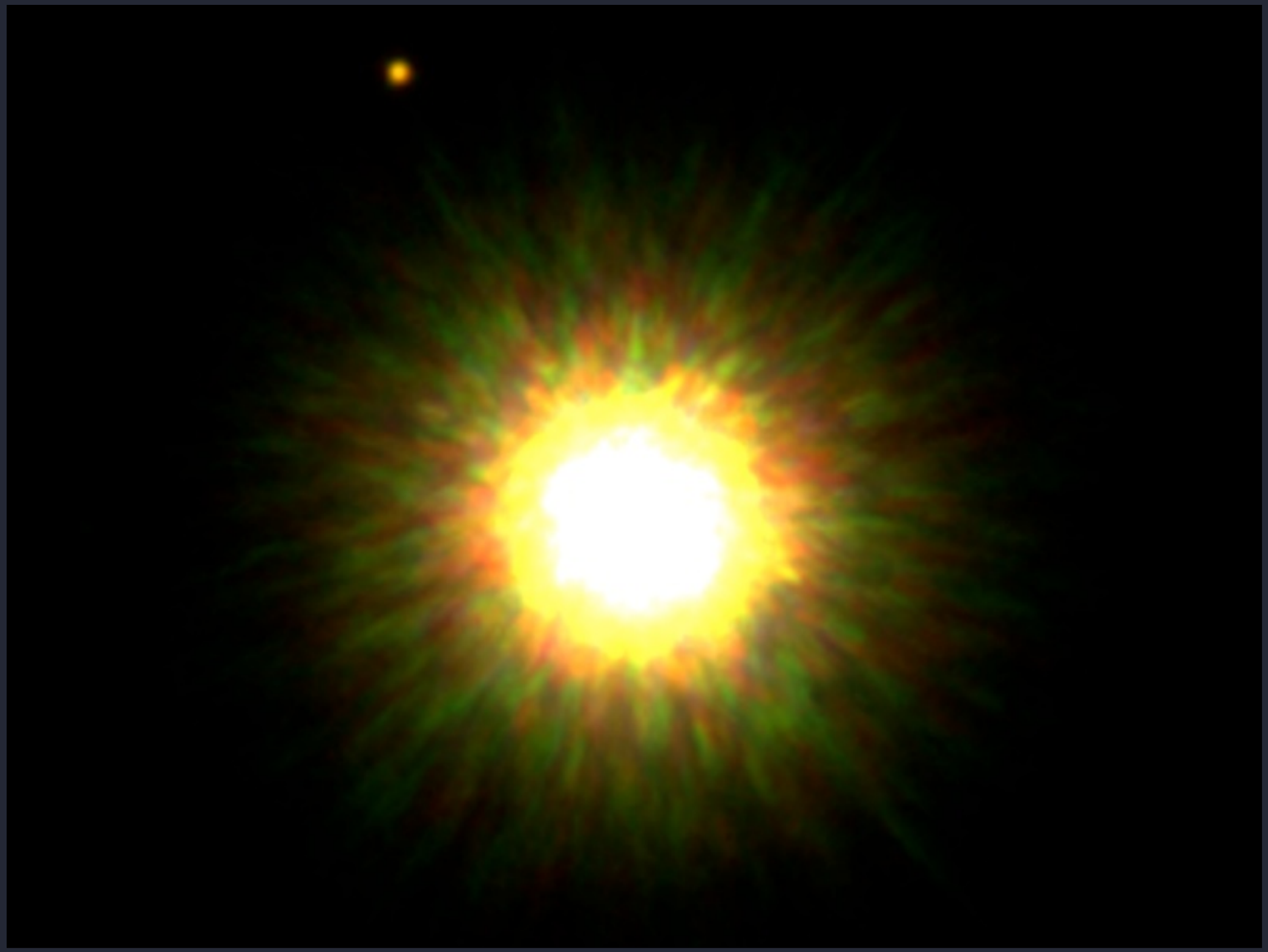
David Cohen

Class 17: Tuesday, March 25

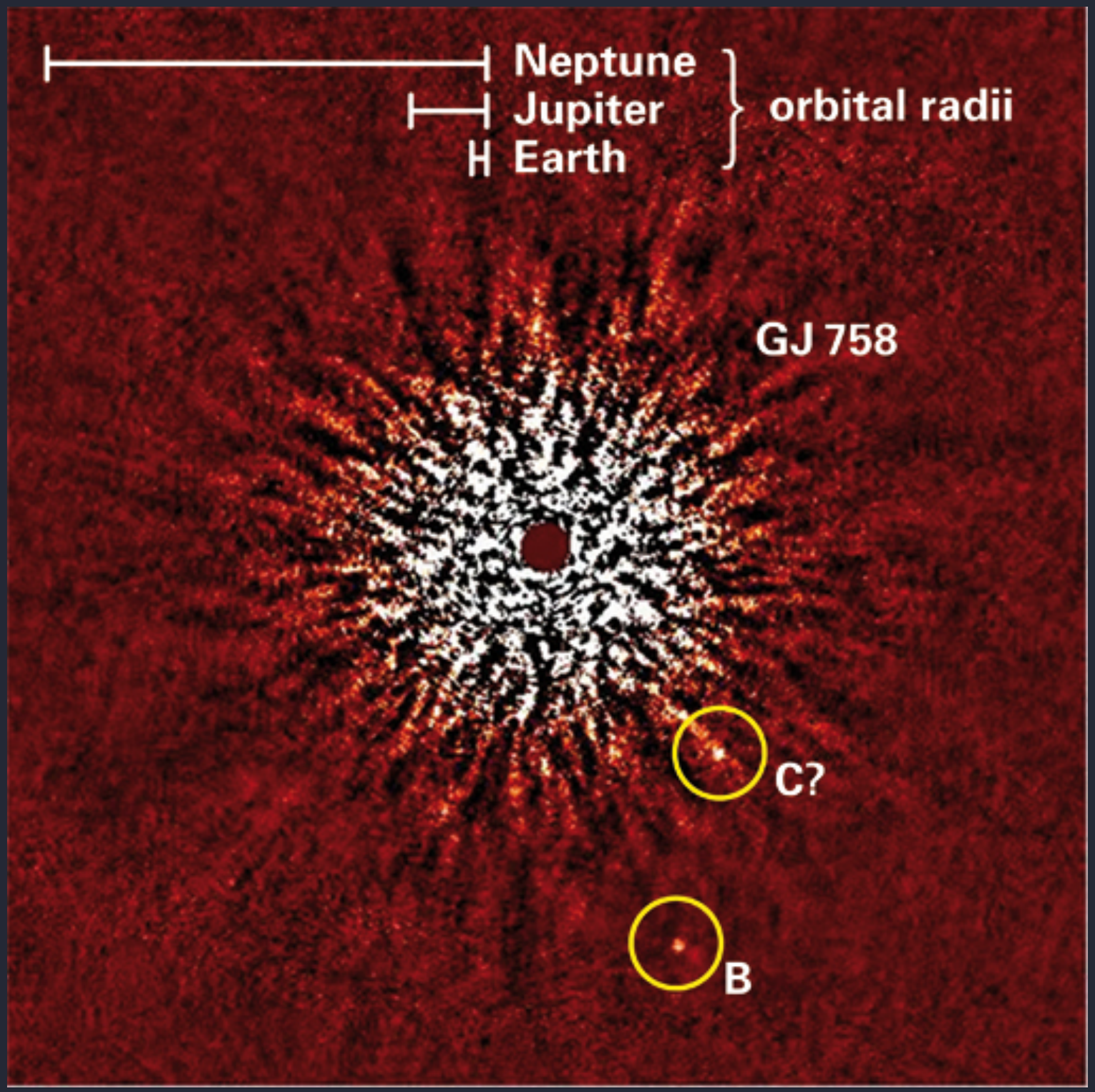
Spring 2014

Quite a bit bigger than our Solar System - that makes it easier to detect by direct imaging



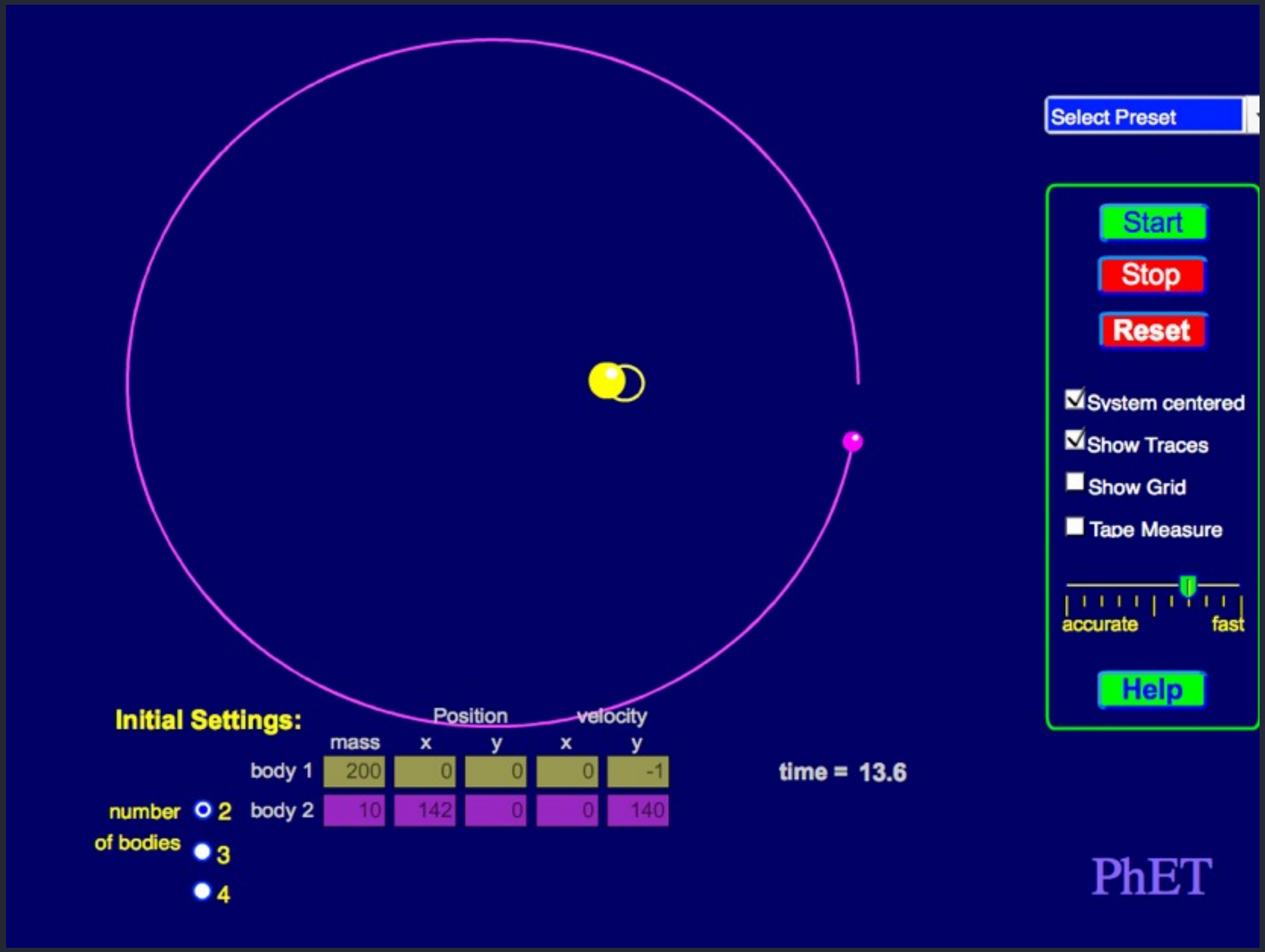


Only a few exoplanets so far from direct imaging (but undoubtedly more to come)

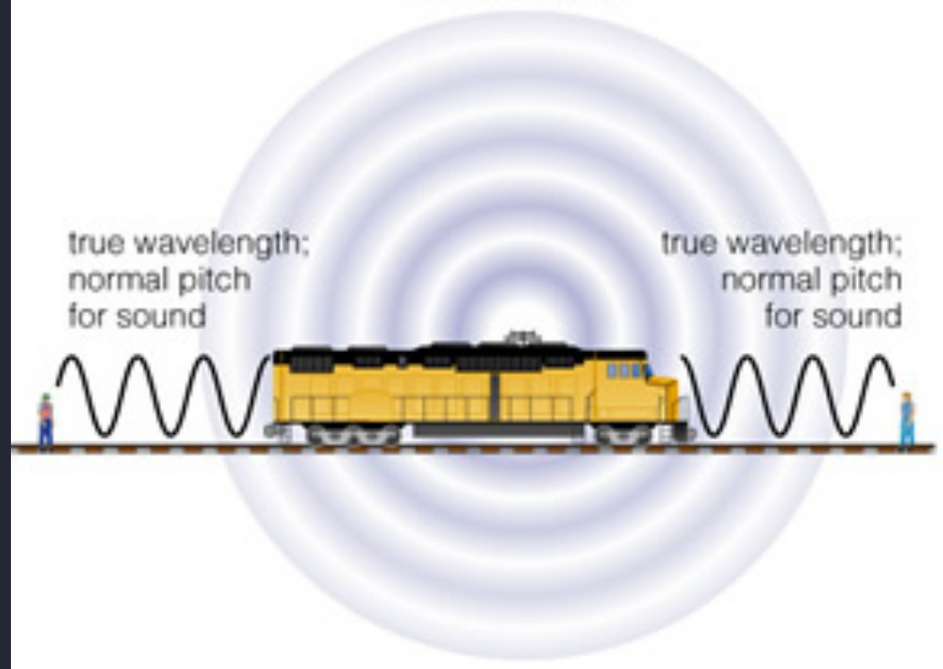


Indirect methods rely on measuring something about the host star

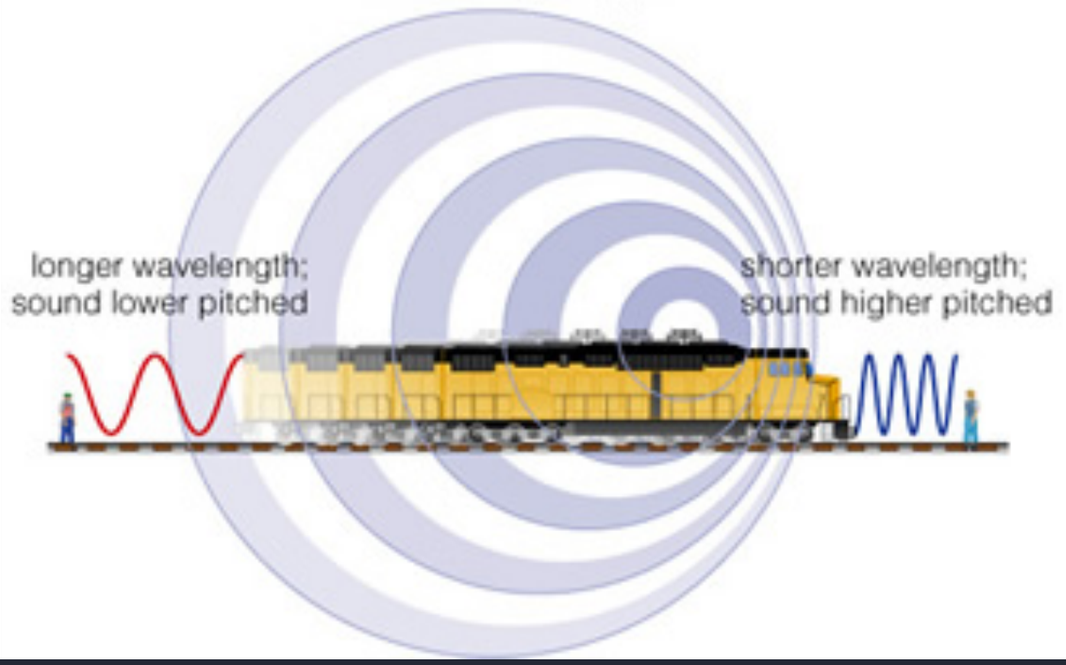
see the orbit simulator: https://phet.colorado.edu/sims/my-solar-system/my-solar-system_en.html



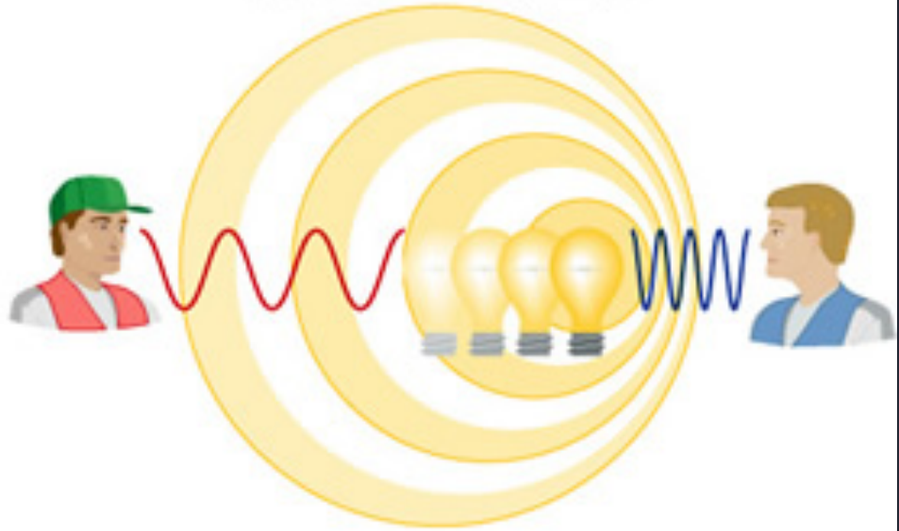
train stationary

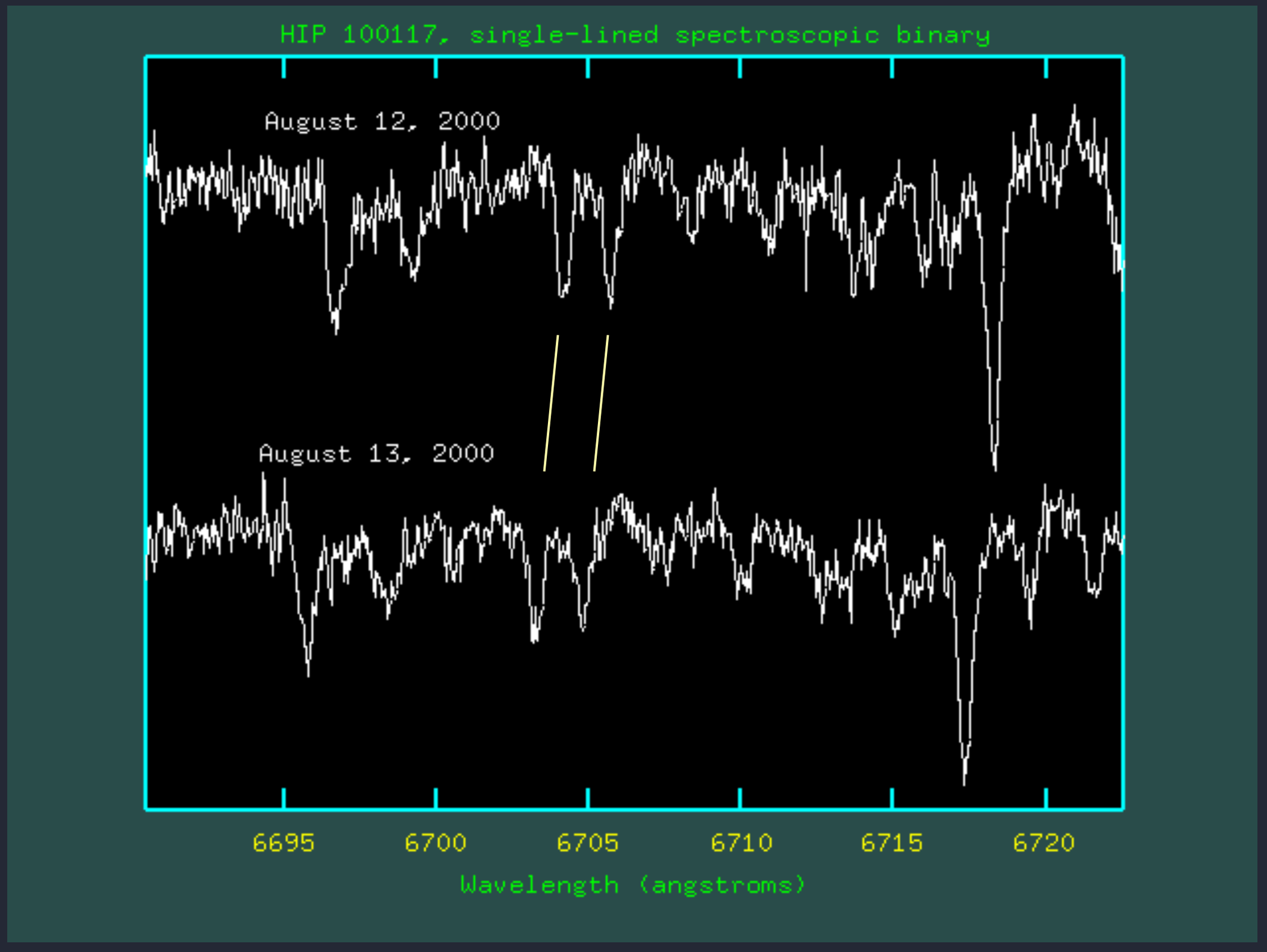


train moving to right



light source moving to right




HIP 100117, single-lined spectroscopic binary
August 12, 2000
August 13, 2000
6695
6700
6705
6710
6715
6720
Wavelength (angstroms)

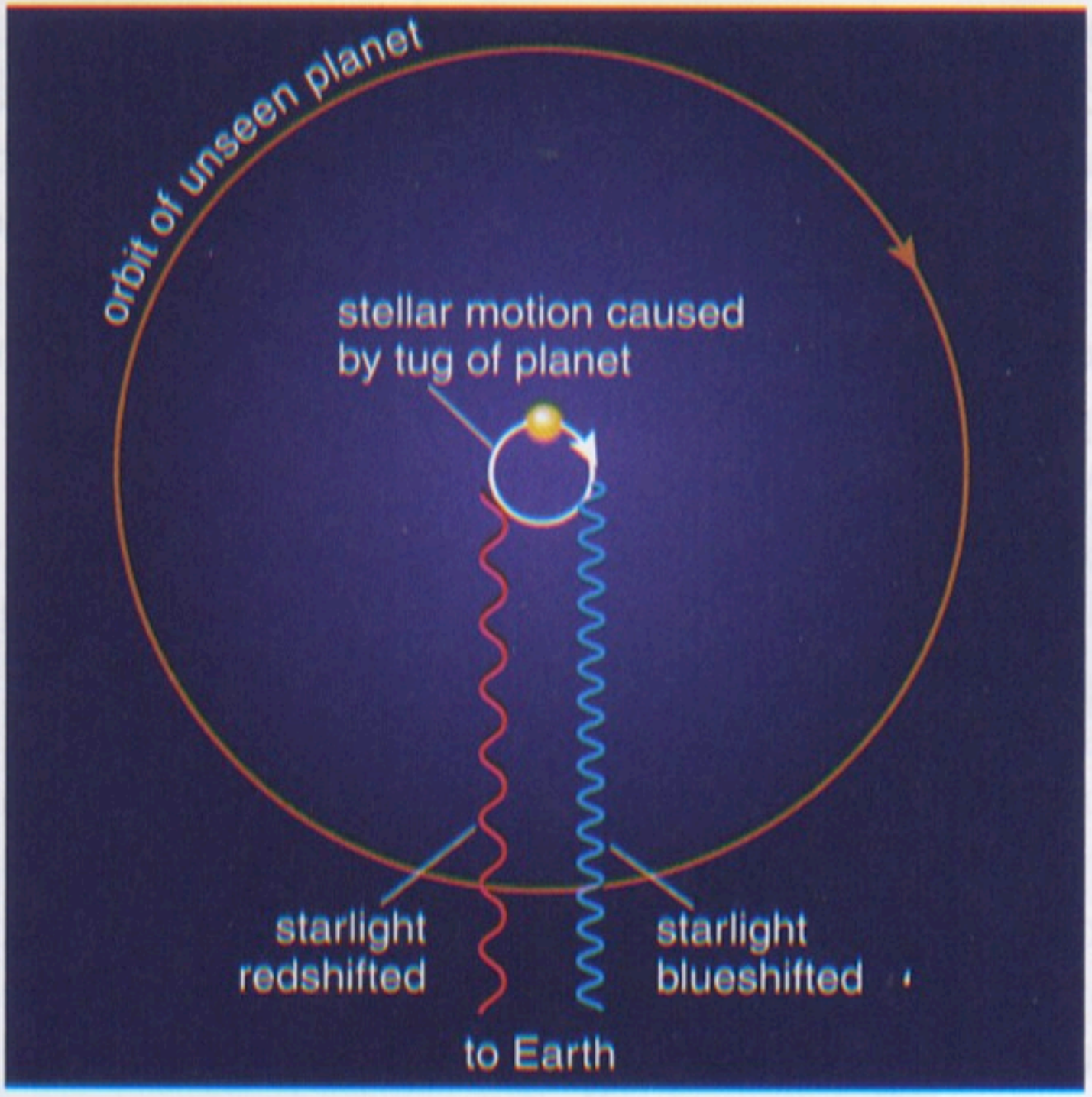
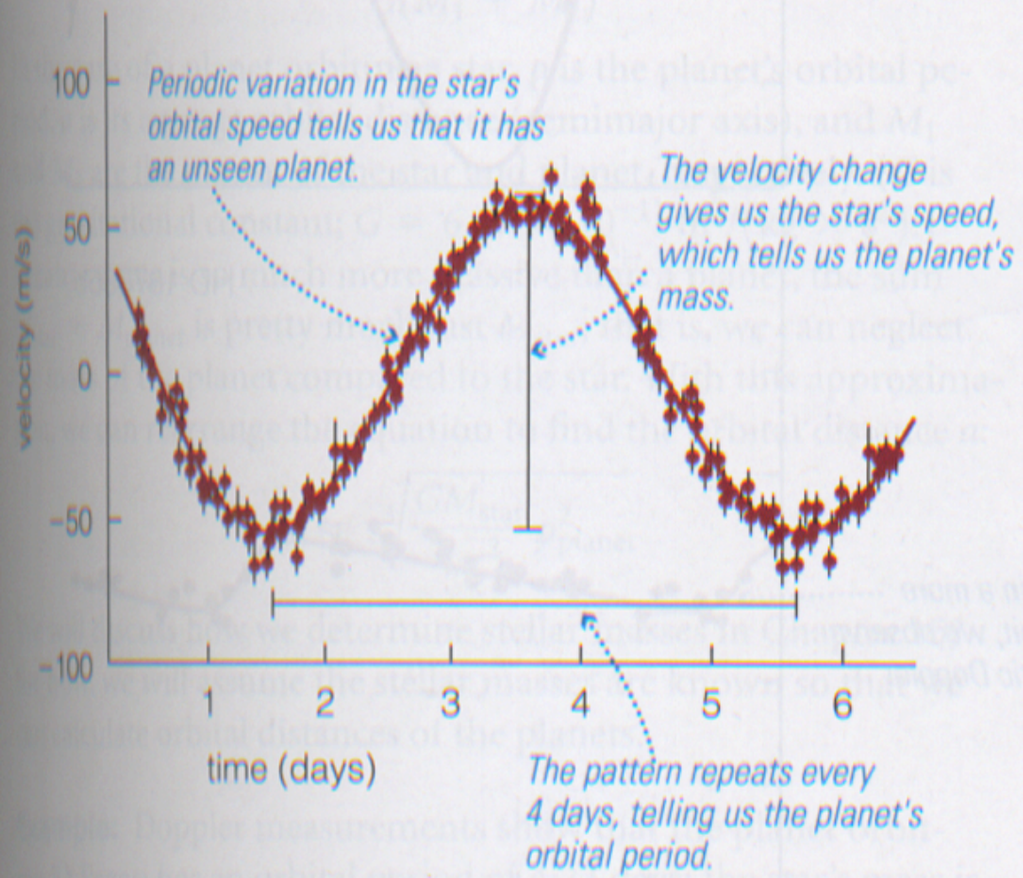
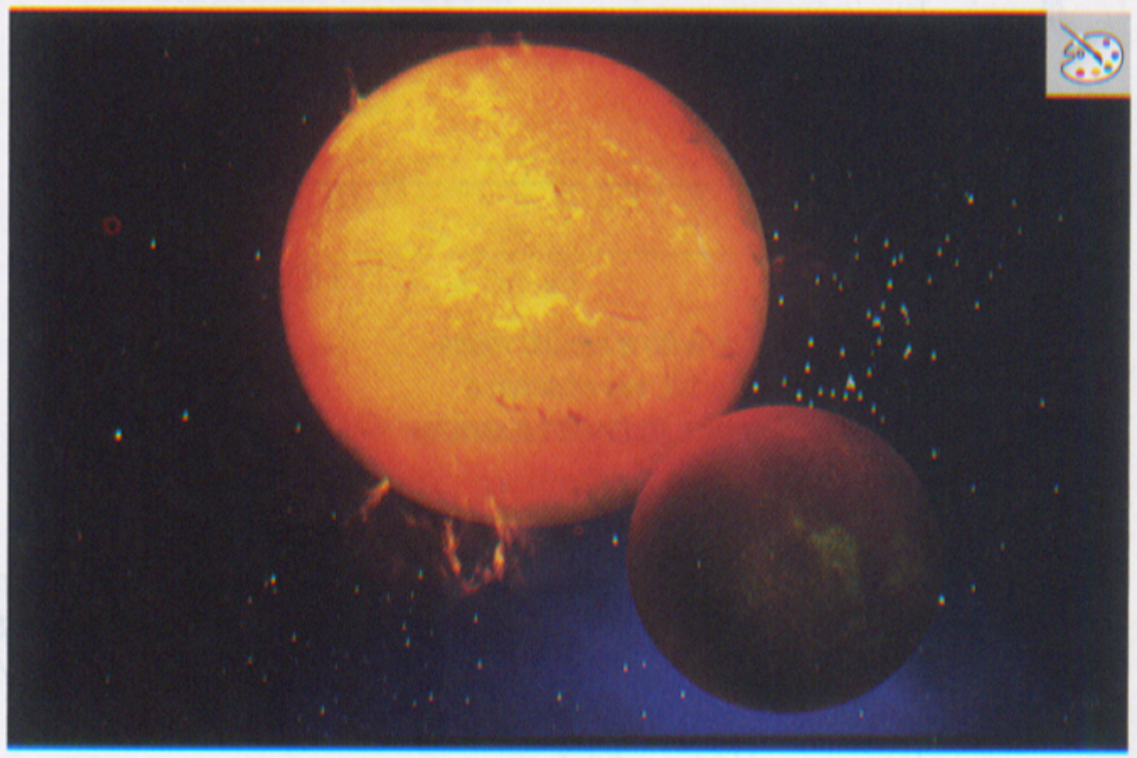


Figure 13.3 The Doppler technique for discovering extrasolar planets: The star's Doppler shift alternates toward the blue and toward the red, allowing us to detect its slight motion around the center of mass caused by an orbiting planet.



a A periodic Doppler shift in the spectrum of the star 51 Pegasi shows the presence of a large planet with an orbital period of about 4 days. Dots are actual data points; bars through dots represent measurement uncertainty.



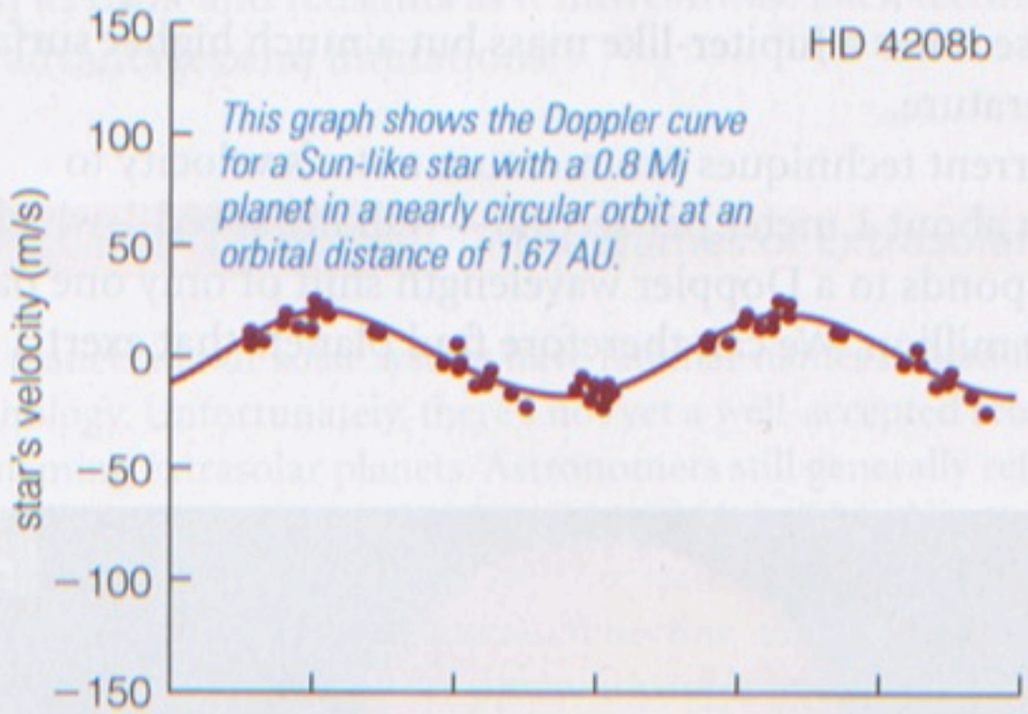
b Artist's conception of the planet orbiting 51 Pegasi, which probably has a mass similar to that of Jupiter but orbits its star at only about one-eighth of Mercury's orbital distance from the Sun. It probably has a surface temperature above 1,000 K, making it an example of what we call a "hot Jupiter."

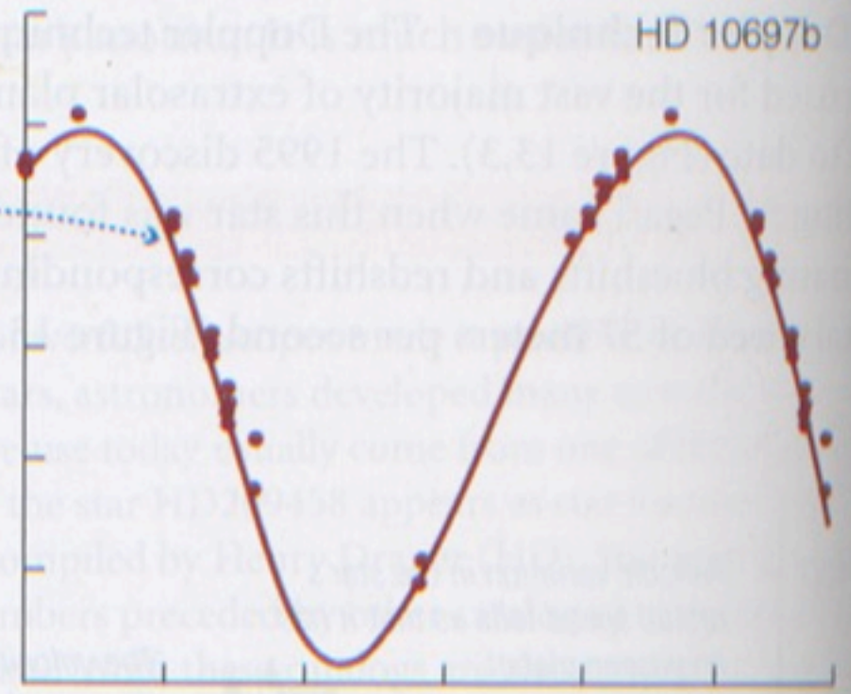
HD 4208b

This graph shows the Doppler curve for a Sun-like star with a 0.8 Mj planet in a nearly circular orbit at an orbital distance of 1.67 AU.

HD 10697b

For a more massive planet in a similar orbit, we observe a larger Doppler shift with the same planet.



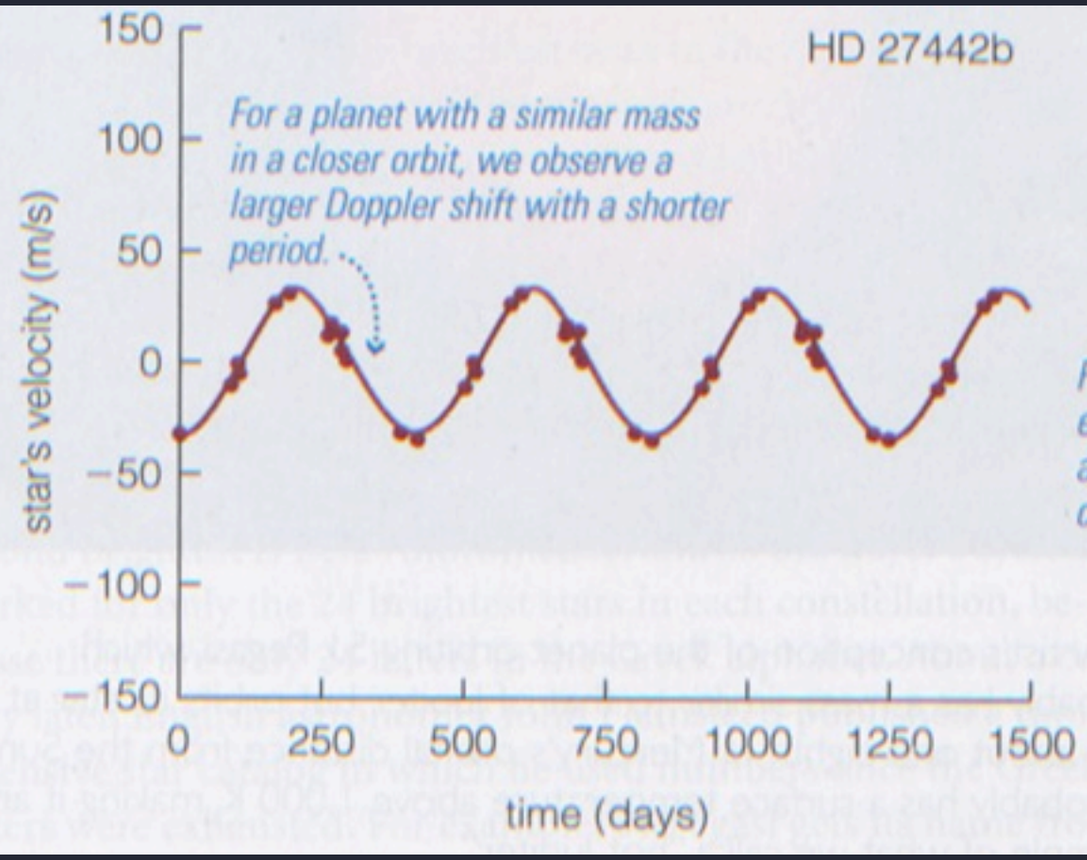


HD 27442b

For a planet with a similar mass in a closer orbit, we observe a larger Doppler shift with a shorter period.

HD 187085b

For a planet in a more eccentric orbit, we observe an asymmetric Doppler curve.



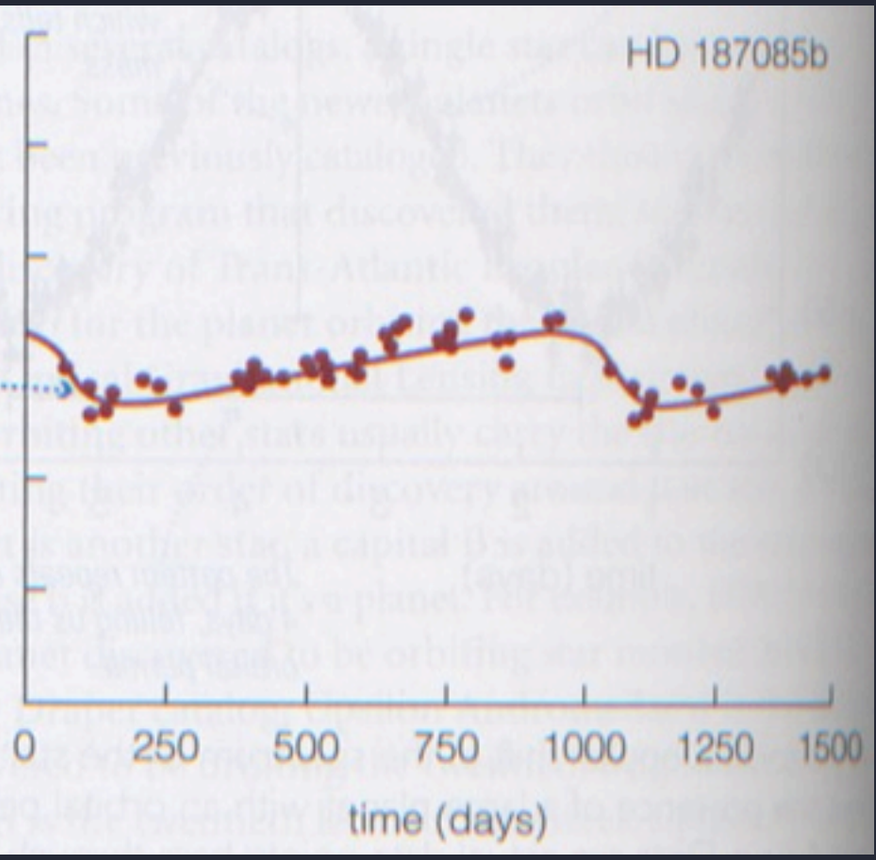
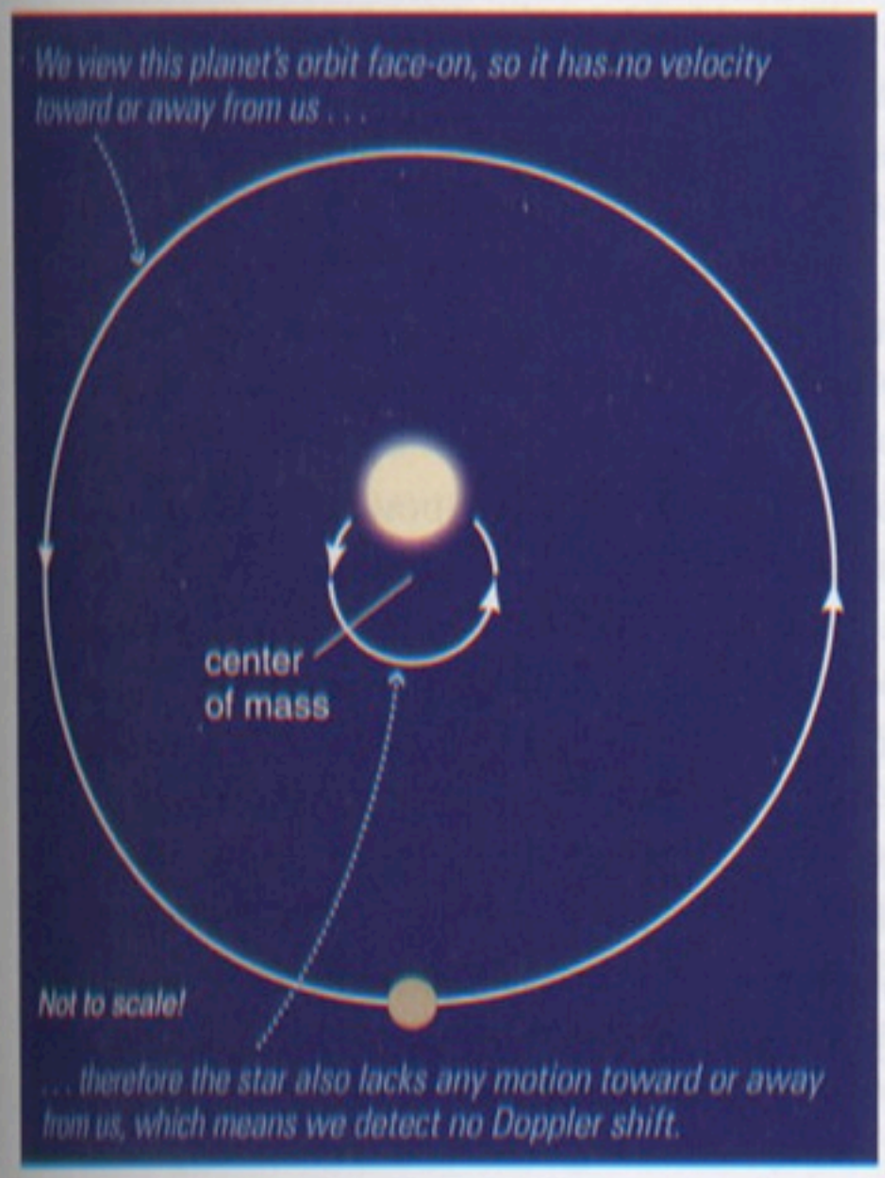
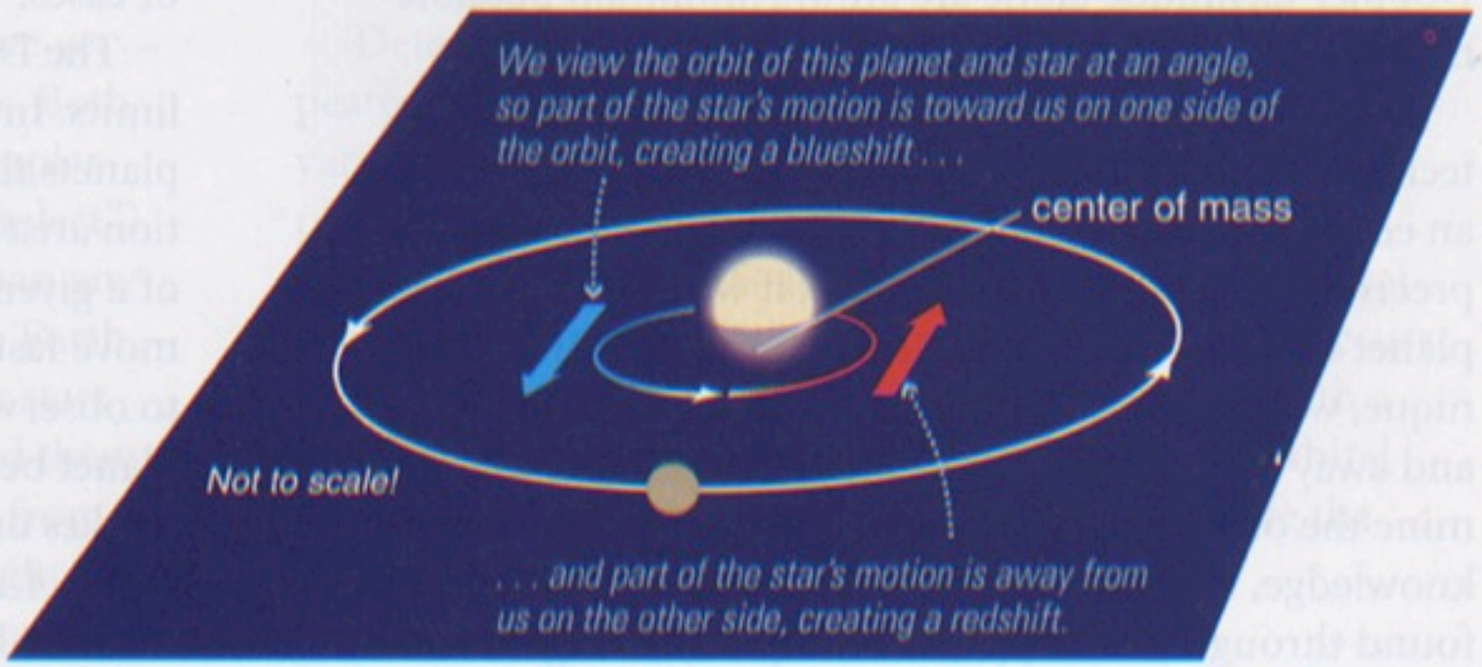


Figure 13.6 The amount of Doppler shift we observe in a star's spectrum depends on the orientation of the planetary orbit that causes the shift.



a If we view a planetary orbit face-on, we will not detect any Doppler shift at all.



b We can detect a Doppler shift only if some part of the orbital velocity is directed toward or away from us. The more an orbit is tilted toward edge-on, the greater the shift we observe.

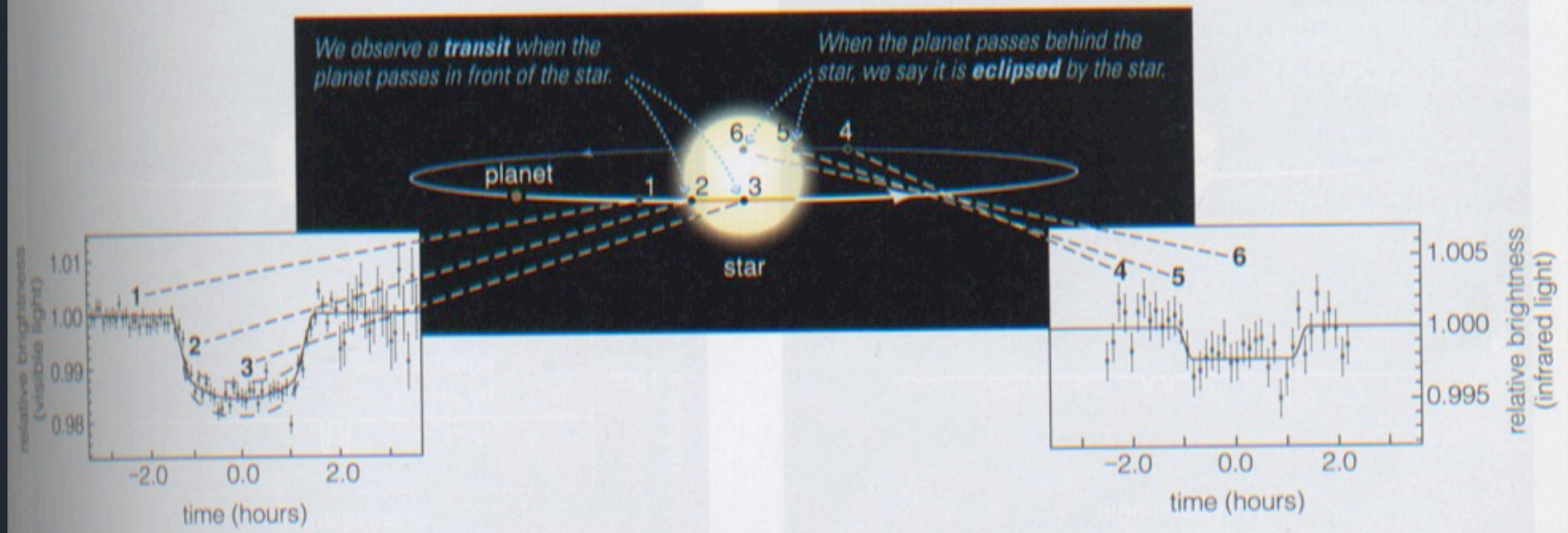


Figure 13.7 Interactive Figure The artist's conception (center) shows the planet orbiting the star HD209458. The graphs show how the star's brightness changes during transits and eclipses, which each occur once with every $3\frac{1}{2}$-day orbit. During a transit, the star's brightness drops for about 2 hours by 1.7%, which tells us how the planet's radius compares to the radius of its star. During an eclipse, the infrared signal drops by 0.25%, which tells us about the planet's thermal emission.