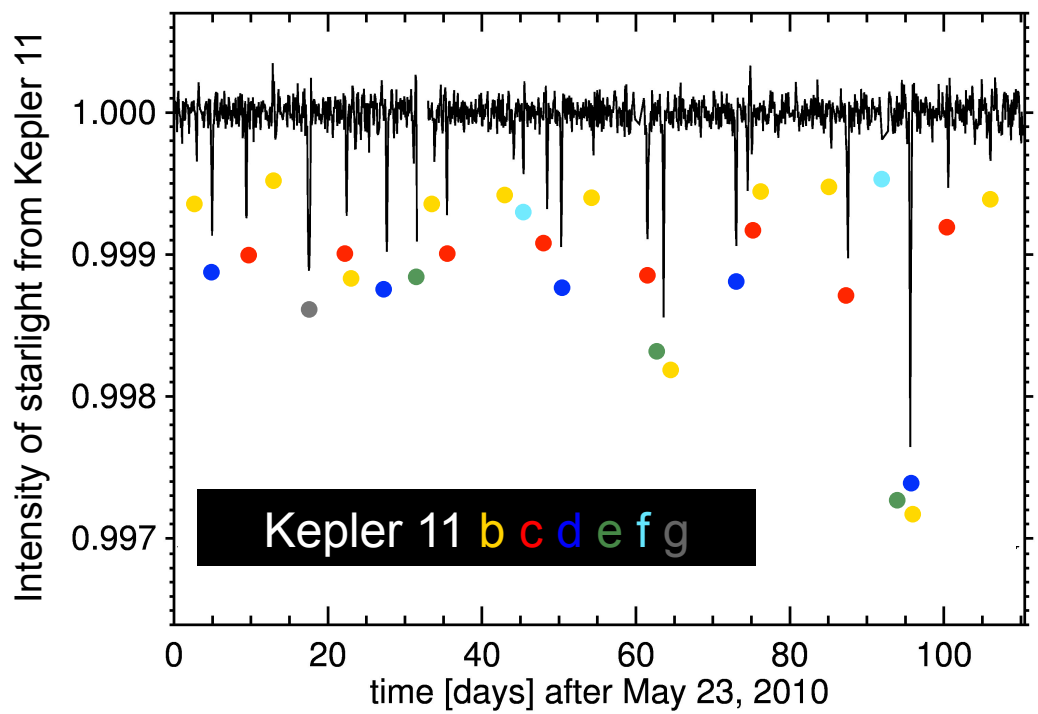
Discovery of A Six-Planet System

- NASA's Kepler spacecraft searches a small portion of the sky for periodic dimming of more than 150,000 stars in our Milky Way galaxy, indicating planets may be passing in front of (*transiting*) them
- A system of 6 planets was recently reported orbiting a single star named Kepler 11
- The planets are among the smallest discovered around other stars. Their properties challenge theories for planetary formation.

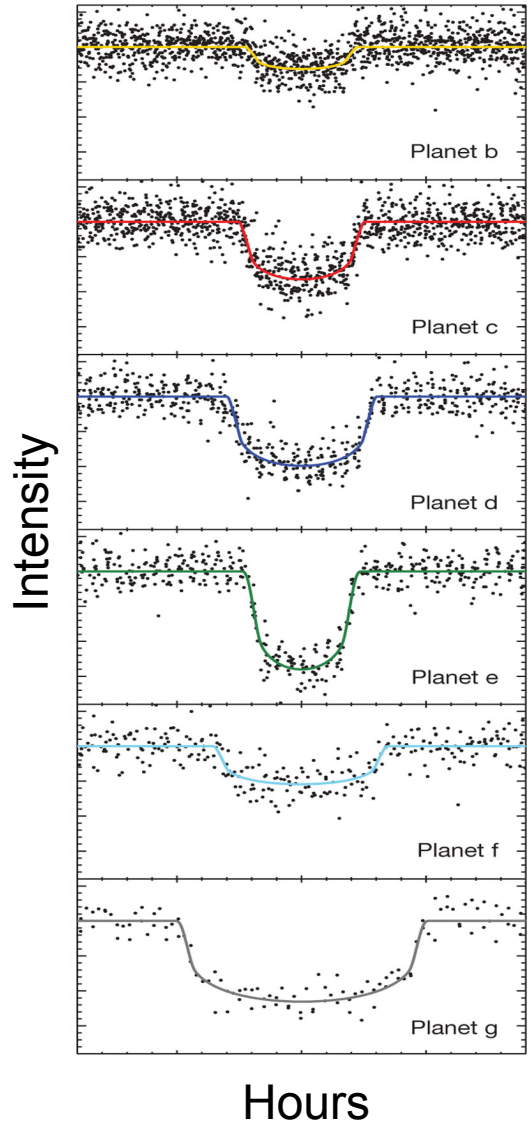


The amount of light from the star Kepler-11 decreases when each of six planets (denoted by the six circle colors) passes in front of it. Note that each planet's transit occurs at regular intervals.

Finding Planet Sizes and Masses

- The starlight dimming tells us:
  - Size: 2-5 times Earth's size (from amount of dimming)
  - Orbital period: 10-120 days (from frequency of dimming)
  - Orbital distance: 0.1-0.5 Earth's (from period and Kepler's 3rd Law)
  - Mass: 2-15 Earth masses* and Orbit shape: nearly circular * (from simulations of transits being early or late by minutes, caused by the planets nudging each other gravitationally)
  - Density: 0.1-0.6 times Earth density * (mass / volume)

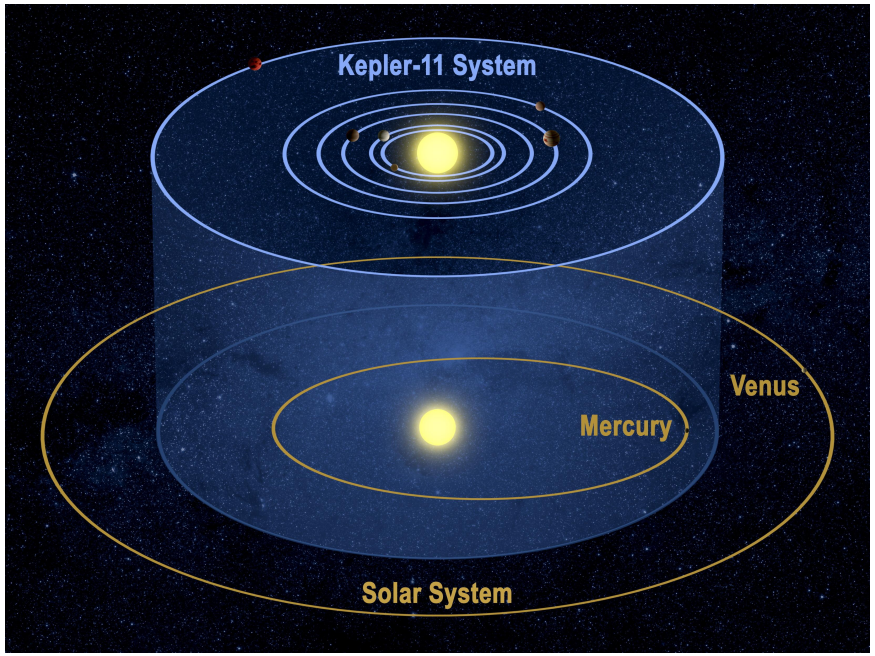
* Can only be determined for the 5 inner planets



The amount of light measured from Kepler 11 for each transit allows scientists to infer many properties of the six planets

The Big Picture

- Knowledge of the planets' orbits and characteristics allows scientists to constrain their composition and evaluate scenarios for their formation
- The planets are less dense than Earth, implying they have substantial amounts of gas, or possibly ice
- But they are also close to their star where temperatures are high, making it harder for them to keep gas or ice
- Recent discoveries are highlighting diverse population of exoplanets - forcing scientists to rethink theories for planetary formation



Schematic view of the Kepler-11 planetary system (blue), with the orbits of Venus and Mercury shown for reference. How did such a compact, circular, flat system of low-density planets form?

For More Information…

Press

- Space.com - 02/02/10 - “Astronomers Find 6-Pack of Planets in Alien Solar System”
  http://www.space.com/10744-alien-planets-solar-system-kepler-mission.html
- Sky & Telescope - 02/02/11 - “Kepler's Outrageous Six-planet System”
  http://www.skyandtelescope.com/news/115102594.html
- NASA Kepler - 02/02/11 - “NASA's Kepler Spacecraft Discovers Extraordinary …”
  http://www.nasa.gov/mission_pages/kepler/news/new_planetary_system.html
- NASA Kepler Mission Site - 02/01/11 - “NASA Announces 1,235 Planet Candidates, …”
  http://kepler.nasa.gov/news/index.cfm?FuseAction=ShowNews&NewsID=98

Images

- Slide 1 image courtesy Daniel Fabrycky and the Kepler team, based on:
  http://www.nature.com/nature/journal/v470/n7332/full/nature09760.html
- Slide 2 image from Lissauer et al., Nature article
  http://www.nature.com/nature/journal/v470/n7332/full/nature09760.html
- Slide 3 image courtesy NASA / Tim Pyle
  http://www.nasa.gov/mission_pages/kepler/news/new_planetary_system.html

Source Articles (on-campus login may be required to access journals)

- Lissauer et al., ‘A closely packed system of low-mass, low-density planets transiting Kepler-11’, *Nature*, 470, doi:10.1038/nature09760, 2011.
  http://www.nature.com/nature/journal/v470/n7332/full/nature09760.html

Prepared for the Division for Planetary Sciences of the American Astronomical Society by David Brain and Nick Schneider
dpsdisc@aas.org - http://dps.aas.org/education/dpsdisc/ - Released 15 April, 2011