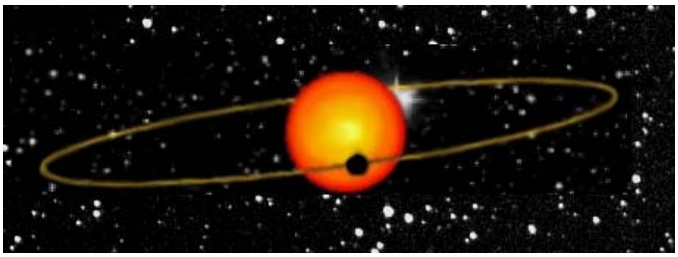
Kepler
A Search For Terrestrial Planets

WHAT IS *KEPLER*?

What are the chances that in the entire universe our planet is unique in supporting life? If it is not unique, how many Earth-size planets are there? These are key questions that the NASA's *Kepler* team seeks to answer. From Earth, more than 100 planets have been found, but they are all very large planets—none as small as Earth. To enhance our knowledge of planetary systems, including planets that might support life, we need to find the small planets as well. To do that, we need to go to space.

HOW DOES *KEPLER* FIND PLANETS?

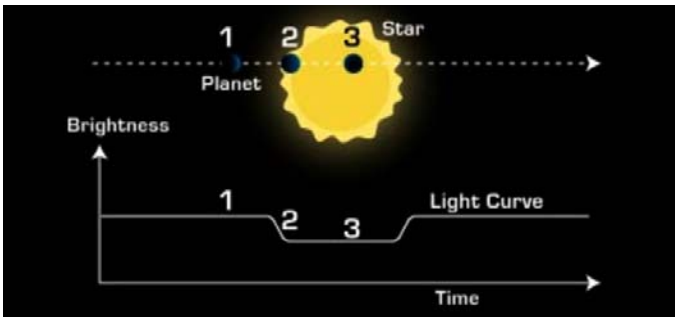
On June 8, 2004, observers on Earth will see a small black dot creep across the Sun. It is the planet Venus blocking sunlight as it moves in its orbit between us and the Sun. The event is called the "transit of Venus" and the term "transit" applies anytime one object moves in front of another object. *Kepler* finds planets by looking for tiny dips in the brightness of a star when a planet crosses in front of it—we say the planet transits the star. This is called the "transit method" of finding planets. Suppose an extraterrestrial lived on a planet near a distant star that was nearly lined up with the plane of Earth's orbit. If that extraterrestrial had a spacecraft like *Kepler,* it could regularly detect a slight dip in brightness of the Sun as the Earth, or other planets in our solar system, pass between the extraterrestrial observer and the Sun. These periodic dips would signal to the extraterrestrial that a planet was present, even though the planets themselves would be invisible to the extraterrestrial. However, the dip in brightness caused by an Earth-size planet is minuscule. Detecting the dip in brightness is like detecting a gnat crossing a car's headlight. The *Kepler* photometer (a very sophisticated light meter) is capable of detecting a change in a star's brightness equal to 20 parts per million!



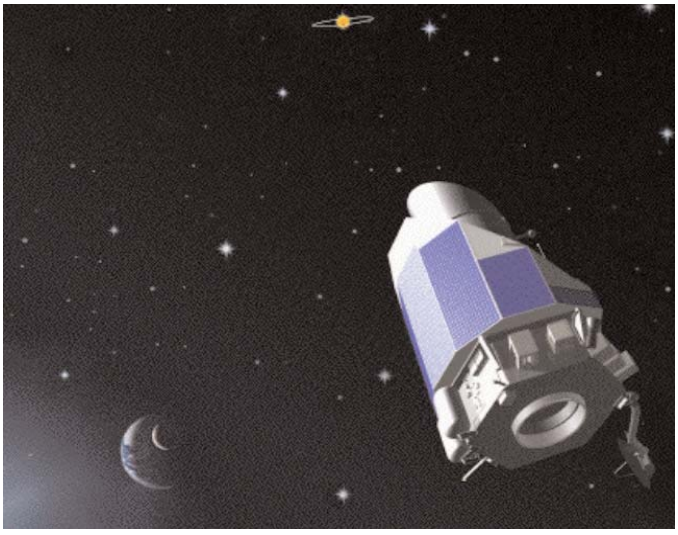
The *Kepler* spacecraft will stare at one large area of the sky, about equal in size to two human hands held at arm's length, in the constellation Cygnus. It will stare continuously for 4 years—virtually never blinking—making brightness measurements of 100,000 stars every 15 minutes. This vigilance assures that *Kepler* can find planets the size of Earth orbiting stars in the habitable zone—the distance from a star where liquid water can exist on the surface of a planet.

HOW DO WE CONFIRM A DETECTION?

Some stars vary in brightness intrinsically; they are called variable stars and have the potential to confuse the *Kepler* results. Variations in brightness due to transits can be distinguished from the behavior of variable stars. Transits are short—between 2 and 16 hours—and the changes in brightness are relatively abrupt. Transits are also perfectly periodic and for each planet they are exactly the same duration and dip in brightness.



William Borucki, *Kepler's* Principal Investigator, describes the way that *Kepler* will verify that it has found a planet: One detection is nearly useless, and two detections provide only the first estimate of a planetary orbital period. At least three significant transits of a star, all with a consistent period, brightness change and duration, provide a rigorous method of detection and confirmation. If this pattern is observed, it is certain that the change in brightness is caused by a transiting planet. That is why the 4-year mission can be assured of finding planets at least as far from their stars as Earth is from the Sun.



http://www.kepler.arc.nasa.gov

WHY ARE WE DOING THIS?

The *Kepler Mission* seeks to explore the nature and diversity of planetary systems. It seeks to find out how many Earth-size planets there might be. More than that, it seeks planets in "habitable zones" of stars. The habitable zone is the range of distances from a star where temperatures permit liquid water to exist on the surface of a planet.

It is remarkable that simply measuring changes in star brightness, with some follow-up Earth-based observations, will allow the *Kepler* team to determine an amazing number of things about a planetary system:

- length of planetary years (orbital periods)
- distances planets are from their host star
- sizes of planets
- what types of stars have planets

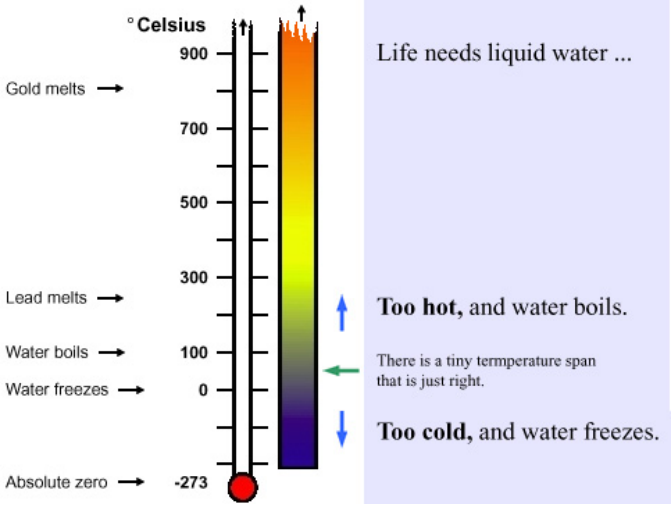
…and for giant planets like Jupiter

- the shapes of the planets' orbits
- masses and densities of planets

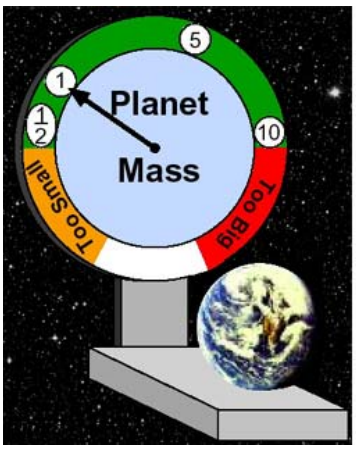
Kepler will help us understand how planetary systems form and the variety of planetary systems in our galaxy.

WHAT MAKES A PLANET HABITABLE?

Planets must have the right temperature...



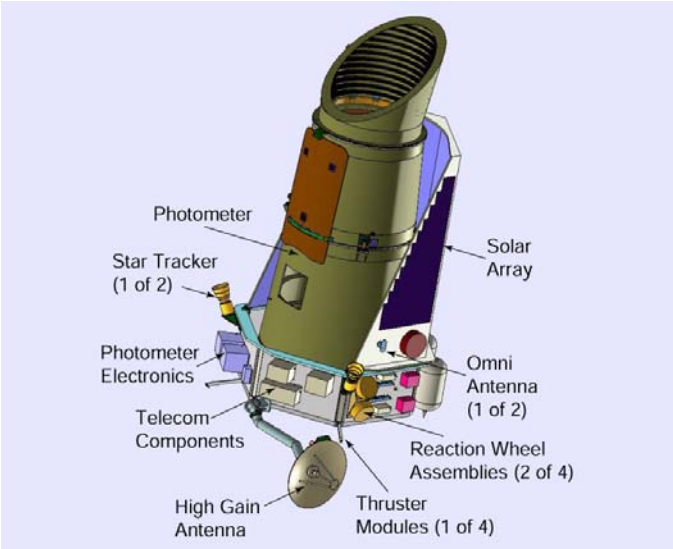
... and planets must have the right masses.



If a planet's mass is too large, a huge atmosphere like Jupiter's will form.

If a planet's mass is too small, the life-supporting atmosphere will escape to space.

The *Kepler* Spacecraft



With *Kepler*, for the first time in human history, we will know if there are Earth-size planets capable of supporting life beyond our solar system.

WHO COMPRISES THE *KEPLER* TEAM?

NASA's Kepler Mission involves many people—

- Science and Mission Lead: NASA Ames Research Center
- Ground-based Observations: Smithsonian Astrophysical Observatory, University of Texas-Austin, University of California Berkeley, SETI Institute
- Data Management: Space Telescope Science Institute
- Data Capture: Deep Space Mission System
- Engineering & Mission Operations Center: Ball Aerospace
- Program Management: Jet Propulsion Laboratory
- Education and Public Outreach: Lawrence Hall of Science University of California Berkeley, SETI Institute

WHEN DOES *KEPLER* LAUNCH?

Kepler launches in 2007, beginning a mission that will last at least four years. The *Kepler* spacecraft will orbit the Sun, trailing the Earth.

WHAT NEXT?

The *Kepler Mission* is vital to future NASA missions, in particular the Space Interferometry Mission and Terrestrial Planet Finder (TPF). TPF will make detailed studies of planets orbiting other stars.

For more information, a transit animation, and a do-it-yourself paper model of the *Kepler* spacecraft, visit the *Kepler* website.

http://www.kepler.arc.nasa.gov