



## **Kepler:** NASA's First Mission Capable of Finding Earth-Size Planets

*Kepler* is the first space mission to search for Earth-size planets in the habitable zone of other stars in our neighborhood of the galaxy. *Kepler* is a special-purpose spacecraft that precisely measures the light variations from thousands of distant stars, looking for periodic sequences of minuscule drops in brightness. When a planet passes in front of its parent star, as seen from our solar system, it blocks a small fraction of the light from that star—this is known as a transit. Searching for transits of distant

“Earths” is like looking for the drop in brightness of a car headlight when a gnat flies across it, seen from many miles away. Detecting repeated transits with a regular period, duration and change in brightness, is evidence of a planet orbiting a star. *Kepler* seeks planets the size of Earth in the habitable zone around other stars similar to our Sun.

The centuries-old quest for other worlds like our Earth has been rejuvenated in the past decade by

the intense excitement and popular interest surrounding the discovery of more than 500 planets orbiting stars beyond our solar system. Most of the extrasolar planets discovered are gas giants like Jupiter or Neptune. The challenge is to find small planets like Earth, which are 30-600 times less massive than Jupiter. *Kepler* is searching for these Earth-size planets in the habitable zone of Sun-like stars as far away as 3,000 light years.

### **Expected Results**

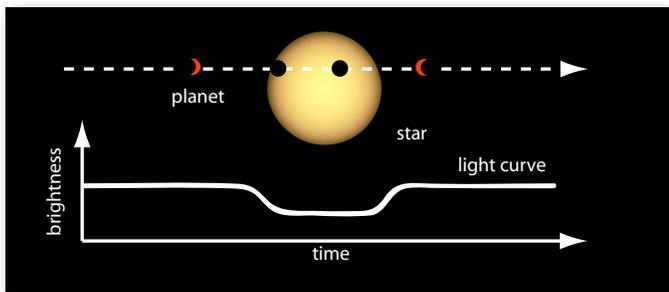
*Kepler* is monitoring over 100,000 stars similar to our Sun for brightness changes produced by planetary transits. Since the beginning of the mission, planets of all sizes orbiting very close to their stars have been found. With three years of data, the *Kepler* scientists will be able to discover and confirm planets with one-year orbits. These will be in the habitable zone of stars like the Sun. If Earth-size planets in the habitable zone are common, then life may



NASA Photo

*NASA's Kepler Mission launches, March 6, 2009.*

# NASAfacts



*Kepler will find planets by looking for tiny dips in the brightness of a star caused by planetary transits.*

be ubiquitous in our galaxy. On the other hand, if no terrestrial planets are found, then “Earths” may be rare.

Three or more transits of a given star—all with a consistent period, brightness change and duration—provide a rigorous method of detection and confirmation. The data reveal the planet’s:

- Size from the brightness change and size of the star;
- Orbital period from the time between transits;
- Orbital size from the mass of the star, the period, and using Kepler’s Third Law;
- Temperature from the planet’s orbit and the temperature of the star.

From these data, scientists can calculate the fraction of stars that have planets, and the distributions of planetary sizes and orbits for many different types of stars.

The results will tell us how often planets occur in the habitable zone of other stars. If Earth-size planets are common, then *Kepler* is capable of detecting hundreds of Earth-size planets in the habitable zone, and thousands more outside of the habitable zone.

### The Spacecraft

The *Kepler* spacecraft contains a single instrument called a photometer, that is, a light meter, which can simultaneously measure the brightness variations of over 100,000 stars with a precision of about 20 parts per million (ppm). This precision allows detection of Earth-like transits, which cause a change in brightness of 84 ppm of solar-like stars. The transits last for a few hours to about half of a day. The photometer is so sensitive that planets as small as Mars can be detected when they occur in short-period orbits, like those of many of the giant planets already discovered. So as not to miss any transits, *Kepler* is staring at the same star field in the Cygnus-Lyra region for the entire mission.

With an aperture of nearly one meter in diameter, *Kepler* is the largest Schmidt-type telescope ever launched. Schmidt optics have an unusually large field of view. The amount of sky viewed is equivalent to an open hand held at arm’s length. The detectors are charged coupled devices (CCDs) similar to those found in consumer digital cameras. However, unlike an ordinary digital

camera with a few megapixels, *Kepler*’s detector array has 95 megapixels.

### Scientific Community Involvement

There are three ways for the broader scientific community to participate in the mission via NASA Research Opportunities. Scientists have been invited to propose to:

- Conduct complementary investigations that support the planetary detection science of *Kepler*;
- Use *Kepler* to observe other types of astrophysically interesting objects in its field of view, such as variable stars, quasars and galaxies; and
- Analyze the unique *Kepler* data archive for phenomena relating to stellar activity.

The archive will contain many years of continuous observations of stars with unprecedented photometric precision. For example, such data are useful for estimating how often stars like our Sun could cause a climate change like that which brought on the mini-ice age in the 17th century.

### Education and Public Outreach Program

The EPO program leverages pre-existing collaborations, networks, and team experience to maximize the development and impact of EPO products and activities. It includes:

- Formal Programs—*Hands On Universe* (HOU) for grades 9-12, *Great Explorations in Math and Science* (GEMS) for grades 3-5, and *Full Option Science System* (FOSS) for 6-8 reach thousands of teachers nationwide and worldwide; over 80 GEMS sites/centers nationwide and worldwide; *Kepler* Teacher Development Workshops and Courses;
- Informal Programs—Exhibits and programs for science and technology museums and planetaria; and
- Public Outreach Programs—Kits for amateur astronomers via the *Night Sky Network*; nationally broadcast science documentaries, *StarDate* radio programs, and the *Kepler Mission* website.

### Mission Organization and Status

The *Kepler Mission* was competitively selected in December 2001 as NASA’s tenth Discovery mission. NASA Ames Research Center is responsible for the data analysis and scientific interpretation of the data, the development of the ground system and management of the operations phase. NASA’s Jet Propulsion Laboratory managed the development phase. Ball Aerospace and Technologies Corporation developed the photometer and spacecraft and supports mission operations at Laboratory for Atmospheric and Space Physics, University of Colorado Boulder.

### Kepler Discovery Mission

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Learn more at the *Kepler* web site: <http://kepler.nasa.gov>

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