NASAfacts

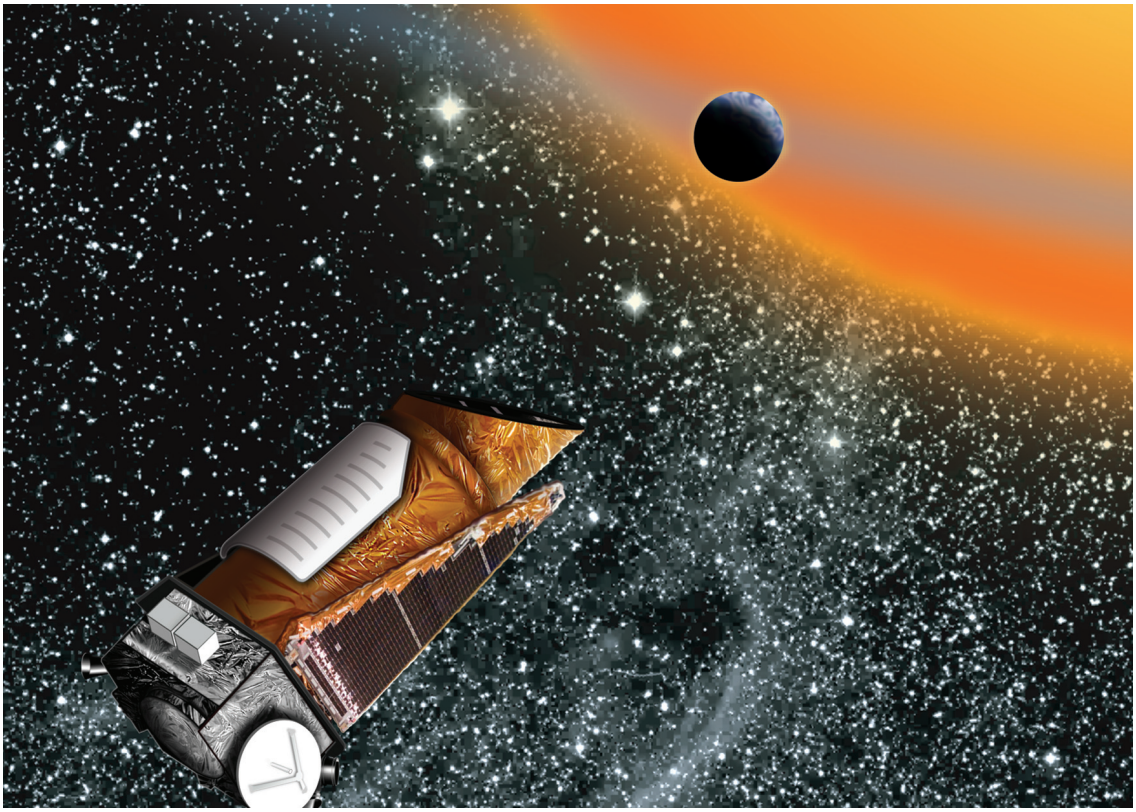
Kepler: NASA's First Mission Capable of Finding Earth-Size and Smaller Planets

Kepler will be the first space mission to search for Earth-size and smaller 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 planetary transits. 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 when a moth flies across a searchlight. Measuring repeated transits, all with a regular period, duration and change in brightness, provides a method for discovering and confirming planets and their orbits—planets the size of Earth and smaller in the habitable zone around other stars similar to our Sun.

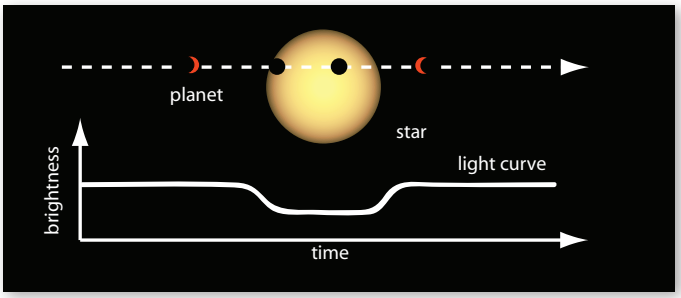
The centuries-old quest for other worlds like our Earth has been rejuvenated by the intense excitement and popular interest surrounding the discovery in the past decade of more than 250 giant planets orbiting stars beyond our solar system. With the exception of the pulsar planets, most of the extrasolar planets detected to date are gas giants. The challenge is to find terrestrial planets, which are 30-600 times less massive than Jupiter. *Kepler* is specifically designed to search for Earth-size and smaller planets in the habitable zone of solar-like stars out to distances of about three thousand light years.

Expected Results

Kepler will continuously monitor over 100,000 stars similar to our Sun for brightness changes produced by planetary transits. At the beginning of the mission, planets of all sizes orbiting very close to their stars will be found. After three years, we will be able to discover planets with orbits of one year, that is those in the habitable zone of stars like the Sun. If Earth-size planets in the habitable zone are common, then life may be ubiquitous in our galaxy. On the other hand, if no terrestrial planets are found, then "Earths" may be rare.



NASA/Ames, Artist's Concept



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

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 will 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 and the period;
- Temperature from the planet's orbit and the temperature of the star.

From the data we 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 common, then hundreds of Earth-size planets in the habitable zone and thousands outside the habitable zone will be detected.

The Spacecraft

The *Kepler* spacecraft consists of a spacecraft bus and 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 a solar-like star that lasts 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 many of the giant planets already discovered. So as not to miss any transits, *Kepler* will stare at the same star field in the Cygnus-Lyra region for the entire mission.

Kepler's aperture is nearly one meter in diameter and *Kepler* will be the largest Schmidt-type telescope ever launched. Schmidt optics have an unusually large field of view. *Kepler's* will be bigger than an open hand held at arm's length. The detectors used are charged coupled devices (CCDs) similar to those found in consumer digital cameras. However, unlike an ordinary digital camera with a few megapixels, *Kepler* has an array of 95 megapixels.

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, California 94035 - 1000

www.nasa.gov

Scientific Community Involvement

There are three ways for the broader scientific community to participate in the mission via NASA Research Opportunities. Scientists will be 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 three and one-half or more years of continuous observations with unprecedented photometric precision of stars. 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* for grades 9-12; KeplerNET, an undergraduate consortium; and *Great Explorations in Math and Science* (GEMS) Space Science Sequence for grades 3-5 and 6-8. GEMS reaches thousands of teachers through over 80 GEMS sites/centers nationwide and worldwide;
- 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; and *StarDate* radio programs.

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 is responsible for managing the development phase. Ball Aerospace and Technologies Corporation is responsible for developing the photometer and spacecraft and supporting mission operations.

As of fall 2007, all of the flight hardware has been built. The Assembly Test and Launch Operations Readiness Review was held in September 2007. The Photometer environmental and performance testing was completed in April 2008. Integration and testing with the spacecraft was begun in May 2008. Launch is planned for March 2009.

Kepler Discovery Mission

Science Principal Investigator	*Project Manager*
William Borucki	James Fanson
NASA Ames Research Center	Jet Propulsion Laboratory

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