



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

The *Kepler* space mission searches for Earth-size planets in our neighborhood of the galaxy (within about 3,000 light years), in stars' habitable zones, the regions in which a planet's temperature would make liquid water possible. *Kepler* is a special-purpose spacecraft that precisely measures light variations in thousands of distant stars, looking for periodic sequences of minuscule drops in brightness. When a planet passes in front of its star, it blocks a small fraction of the light from that star—this event 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 the star. *Kepler* seeks Earth-size planets in the habitable zones of stars similar to our Sun.

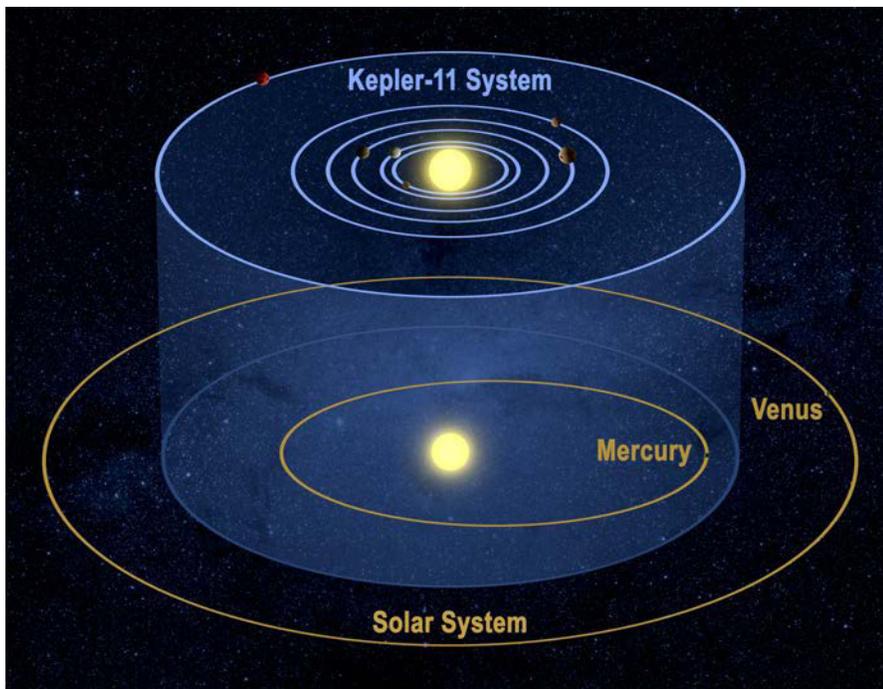
Expected Results

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. At least three years of data are needed to analyze and search for planets with one-year orbits. These will be in the habitable zones 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.

Three or more transits of a given star—all with a consistent period, brightness change and duration—are the minimum required for detection and

confirmation. The data reveal several important planet characteristics:

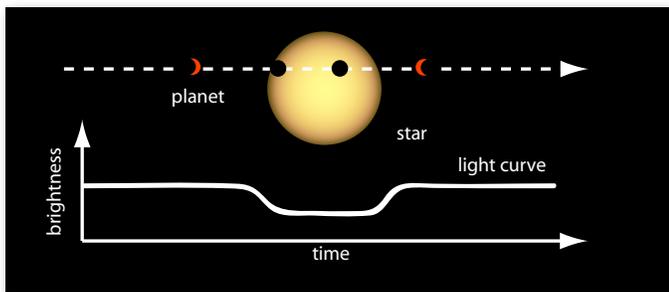
- Size—from the brightness change and size of the star;
- Orbital period—from the time between transits;
- Orbital size—from the mass of the star, the period, and using Kepler's Third Law;
- Temperature—from the planet's orbital size and the temperature of the star.



Credit: NASA/JPL (Caltech)

In its search for Earth-size planets, NASA's Kepler Mission has observed more than 2,000 planet candidates and has established many firsts. Many candidates are in multiple-planet systems, like Kepler-11, which has the most exoplanets so far discovered in a single system.

NASAfacts



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

From these data, scientists can ascertain the fraction of stars that have planets, the distribution of planetary sizes and orbits for many different types of stars, and how often Earth-size planets occur in the habitable zone of a star. Latest results can always be found on the *Kepler* website: kepler.nasa.gov

The Spacecraft

The *Kepler* spacecraft contains a single instrument called a photometer—an exquisitely sensitive 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 transits of Earth-size planets, which cause a change in brightness of 84 ppm of solar-like stars. This is a dip in the starlight of 0.01%. 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. So as not to miss any transits, *Kepler* is staring at the same star field in the Cygnus-Lyra region of our Milky Way galaxy 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 several megapixels, *Kepler's* detector array has 95 megapixels.

Scientific Community Involvement

The *Kepler* mission data archive contains years of continuous observations of stars with unprecedented photometric precision. All *Kepler* data are public; there is no exclusive use period or restrictions on the type of research possible. The data supports research from exoplanets to variable stars to galaxies. Research opportunities include (but are not limited to)

- Large and small exoplanets
- Radial velocity follow-up for masses
- Transit timings
- Planetary system architecture
- Asteroseismology

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- Stellar activity
- Interacting variable stars
- Eclipsing Binaries
- Active galaxies.

The broader scientific community can get involved with the *Kepler Mission* via data use and with funding through NASA Research Opportunities, the *Kepler* Guest Observer Program, the *Kepler* Participating Scientist Program, the NASA Origins of Solar Systems Program, the NASA Archival Data Analysis Program, the special NASA call for Keck proposals, and *Kepler* community working groups. More information at *Kepler Science Center*: <http://keplerscience.arc.nasa.gov/>

Education and Public Outreach (EPO) Program

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

- Formal Programs—*Great Explorations in Math and Science* (GEMS) for grades 3-8, and *Full Option Science System* (FOSS) for grades 6-8, and *Hands On Universe* (HOU) for grades 9-12, reach thousands of teachers and hundreds of thousands of students nationwide and worldwide. There are also *Kepler* Teacher Development Workshops and Courses;
- Informal Programs—Exhibits and programs for science and technology museums and planetaria, public art and writing projects
- Public Outreach Programs—Kits for amateur astronomers via the *Night Sky Network*; nationally broadcast science documentary, and the *Kepler Mission* website, <http://kepler.nasa.gov>.

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>