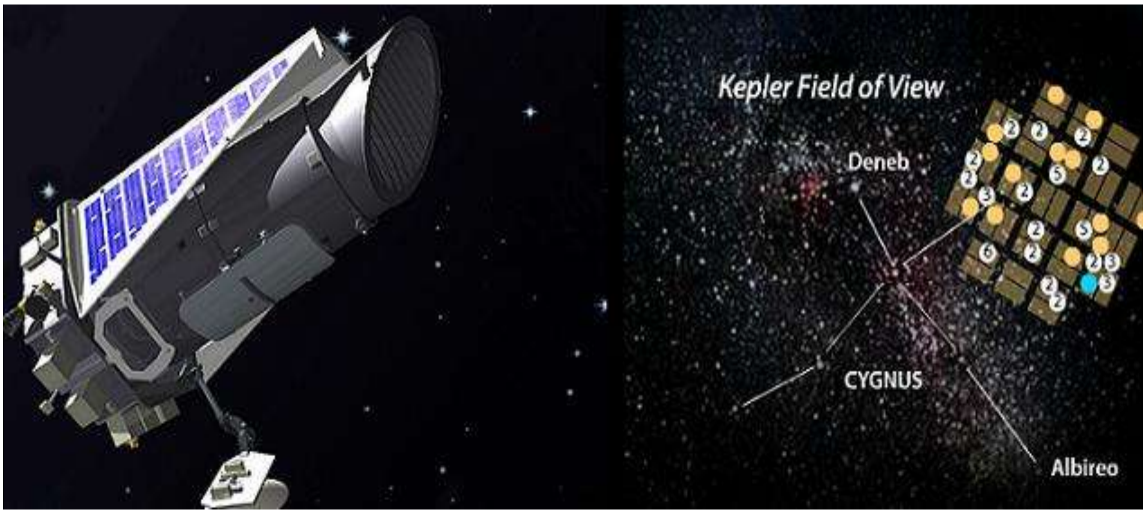
Kepler Mission



Kepler's Mission for detection of Exo-planets

Introduction:

Kepler was a space telescope designed to survey a portion of the Milky Way galaxy in search of exoplanets, which are planets outside our solar system. To find the earth like planets in the space is always the topic of interest. The challenge is to find terrestrial planets (i.e., those one half to twice the size of the Earth), especially those in the habitable zone of their stars where liquid water might exist on the surface of the planet. This was the first mission which capable to find such planets in habitable zones of other stars.

Mission Events:

The Kepler Mission was launched by National Aeronautics and Space Administration (NASA) on March 6, 2009. One of the four reaction wheels used to point the spacecraft failed in 2012, but the other three were able to keep Kepler observing its field of view. Data collection ended in May 2013 when another wheel failed. However, scientists devised a new observing strategy to combine the remaining two reaction wheels with the solar radiation pressure on Kepler's solar panels to keep the spacecraft pointed at the same spot of sky for 83 days at a time. After 83 days, sunlight would enter the telescope, and the satellite would then be turned to another patch of sky. The K2 mission, which used this strategy, began in May 2014 and continued until October 2018, when the spacecraft ran out of fuel and was retired.

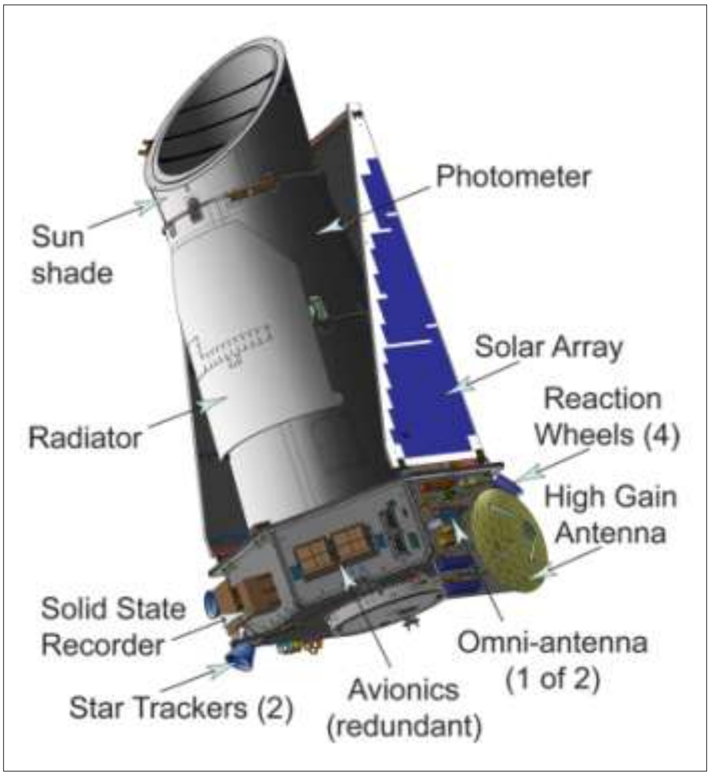
Launch Vehicle: United Launch Alliance Delta II 7925

Launch Location: Cape Canaveral Air Force Station

Launch Pad: Launch Complex 17-B

Launch Date: March 6,2009

Launch Time: 7:49:57 p.m. PST



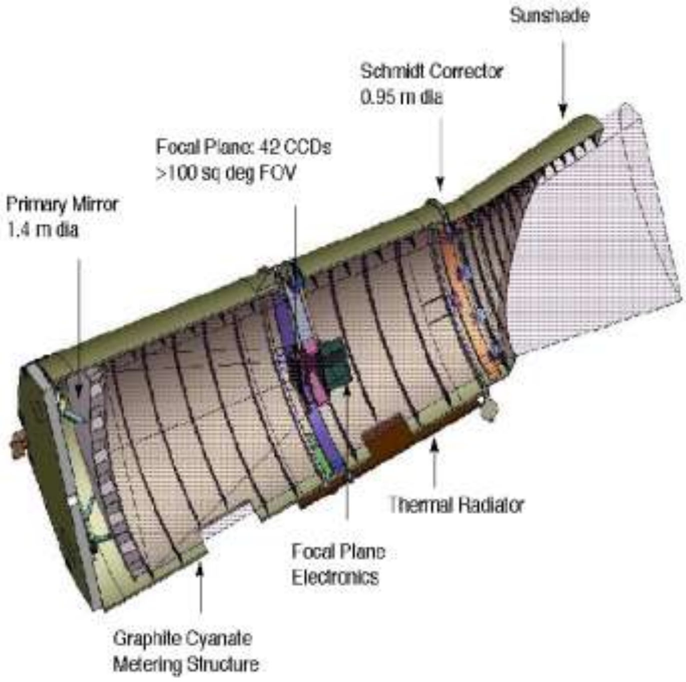
Instruments:

The kepler mission consists of a large field of view photometer and a spacecraft bus.

Spacecraft

The Kepler spacecraft provides the power, pointing and telemetry for the photometer. Pointing at a single group of stars for the entire mission greatly increases the photometric stability and simplifies the spacecraft design. Other than the small reaction wheels used to maintain the pointing and an ejectable cover, there are no other moving or deployable parts.

Photometer



The Kepler photometer is a Schmidt camera design instrument. The instrument consists of a 0.95 m aperture photometer and a 105 square deg (about 12 degree diameter) field-of-view (FOV) to do high-precision photometry of 100,000 solar-like stars to search for patterns of transits. The original selected region was in the constellation Cygnus, which was out of the plane of the solar system to avoid fogging by light scattered by interplanetary dust or reflected by asteroids. The photometer is composed of an array of 42 charge coupled devices (CCDs). Each 50x25 mm CCD has 2200x1024 pixels. The CCDs are read out every three seconds to prevent saturation. Charge-coupled devices (CCDs) operated as light sensors rather than as imagers in order to capture small changes in star brightness during the mission. The CCDs are not used to take pictures. The images are intentionally defocused to 10 arc seconds to improve the photometric precision. Data from the individual pixels that make up each star of the 150,000 main-sequence stars are recorded continuously and simultaneously. The data are stored on the spacecraft and transmitted to the ground about once per month.

Precision differential photometry will be used to detect the periodic signals of transiting planets via small changes in the light of their host stars. Kepler will also support asteroseismology by measuring the pressure-mode (p-mode) oscillations of selected stars.

Kepler Objectives:

The scientific objective of the Kepler Mission is to explore the structure and diversity of planetary systems. This is achieved by surveying a large sample of stars to:

- Determine the percentage of terrestrial and larger planets that are in or near the habitable zone of a wide variety of stars
- Determine the distribution of sizes and shapes of the orbits of these planets
- Estimate how many planets there are in multiple-star systems
- Determine the variety of orbit sizes and planet reflectivities, sizes, masses and densities of short-period giant planets
- Identify additional members of each discovered planetary system using other techniques
- Determine the properties of those stars that harbour planetary systems.

Key Discoveries

Summary Counts

All Exoplanets	**4152**
Confirmed Planets with Kepler Light Curves for Stellar Host	**2358**
Confirmed Planets Discovered by Kepler	**2349**
Kepler Project Candidates Yet To Be Confirmed	**2420**
Confirmed Planets with K2 Light Curves for Stellar Host	**430**
Confirmed Planets Discovered by K2	**397**
K2 Candidates Yet To Be Confirmed	**889**

Measurements from Kepler Mission:

Kepler mission use transit method to detect the terrestrial exoplanets. 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.

To be Remember:

Since transits only last a fraction of a day, all the stars must be monitored continuously, that is, their brightnesses must be measured at least once every few hours. The ability to continuously view the stars being monitored dictates that the field of view (FOV) must never be blocked at any time during the year. Therefore, to avoid the Sun the FOV must be out of the ecliptic plane. The secondary requirement is that the FOV have the largest possible number of stars. This leads to the selection of a region in the Cygnus and Lyra constellations of our Galaxy

Once detected, the planet's orbital size can be calculated from the period (how long it takes the planet to orbit once around the star) and the mass of the star using Kepler's Third Law of planetary motion. The size of the planet is found from the depth of the transit (how much the brightness of the star drops) and the size of the star. From the orbital size and the temperature of the star, the planet's characteristic temperature can be calculated.

Kepler's second mission: K2

Kepler spacecraft in May 2013 brought an end to Kepler's four-year science mission to continuously monitor more than 150,000 stars to search for transiting exoplanets. The K2 mission made use of the Kepler spacecraft and its assets to expand upon Kepler's groundbreaking discoveries in the fields of exoplanets and astrophysics through new and exciting observations. K2 used an innovative way of operating the spacecraft to observe target fields along the ecliptic for the next 2-3 years. The K2 mission represents a new concept for spacecraft operations that enables continued scientific observations with the Kepler space telescope. K2 became fully operational in May 2014 and is expected to continue operating until 2017 or 2018.

Using the transit method to detect brightness changes, the K2 mission entails a series of sequential observing "Campaigns" of fields distributed around the ecliptic plane and offers a photometric precision approaching that of the original Kepler mission. The K2 mission offers long-term, simultaneous optical observation of thousands of objects at a precision far better than is achievable from ground-based telescopes. Astrophysics observations with K2 will include studies of young open clusters, bright stars, galaxies, supernovae, and asteroseismology.