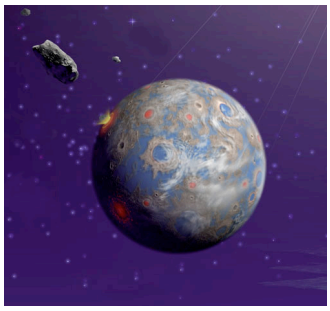
Earthlike Extrasolar Planet



(Artist conception, Courtesy: NASA/JPL-Caltech Planetquest).

In this Exploration, find out:

- What planets have been found around other stars?
- How does our own solar system compare to the newly found planetary systems?
- What are the limitations of current and planned planet hunting efforts?

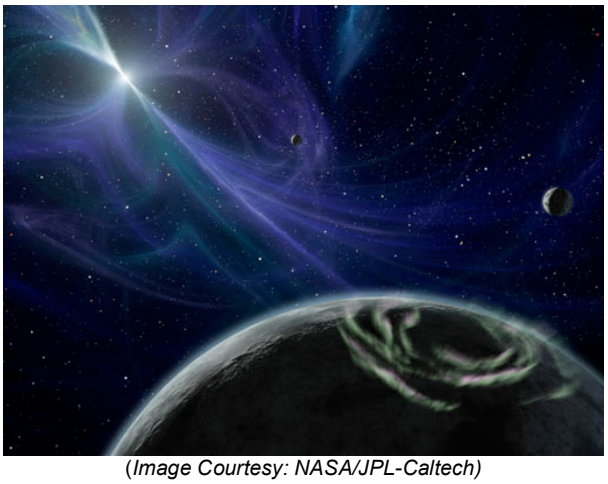
Planet Hunting – New Discoveries

Extrasolar Planet Discoveries

The very first planet found outside of our solar system was discovered in 1992 orbiting the core of a "dead" high-mass star - a type of neutron star called a **pulsar**. Pulsars send beams of radio waves into space regular basis, and like a lighthouse, the rotation of the pulsar causes the beams to sweep across space. A pulsar seems to switch on and off as the beams of light it produces sweep by. Orbiting planets will cause small changes in the timing of these pulses of light that can be measured by radio telescopes on the Earth.

Planets around pulsars are easier to find than planets around normal stars. Even planets the size of Earth's moon have enough gravity to pull on a pulsar enough to make a noticeable change in the timing of pulsar pulses. The three planets orbiting pulsar PSR B1257+12 are small

Pulsar Planets



(Image Courtesy: NASA/JPL-Caltech)

This image is an artist's conception of the pulsar planet system discovered by Aleksander Wolszczan in 1992. Pulsar planets may form much the way other planets do – from disks of gas and dust circling a star. In the case of pulsar planets, however, the gas and dust are debris left over from the supernova of a massive star. And the star these planets orbit is the collapsed core of the star that exploded.

and may be similar to the Earth in terms of their mass. But the planetary system is very different from our solar system. Before PSR 1257+12 became a neutron star, it was a very massive star that went *supernova*! Any planets that orbited the star before the violent end of its life as a normal star are unlikely to have survived. The planets orbiting the pulsar probably formed from debris left behind after the original star went supernova.

First Planet around a Sun-Like Star

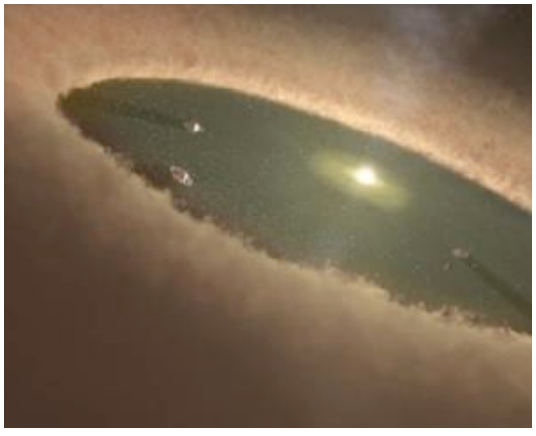
In 1995, astronomers M. Mayor and D. Queloz announced the discovery of the first extrasolar planet orbiting a Sun-like star called 51 Pegasi or just 51 Peg. *The planet was nothing like what was expected!* Most planetary scientists had assumed astronomers would find extrasolar planets that were very similar to planets in our own solar system. The planet orbiting 51 Peg, however, is very strange. It is a Jupiter-like planet, but is only 0.05 AU away from its star. *(How far away is Jupiter from our own star, the Sun?)*

Even More Planets Found

Using clever techniques and careful observations astronomers had found more than 250 planets orbiting other stars by September 2007. Many more have probably been found by the time you read this. Most of the 250+ planets have been discovered with the method called a Radial Velocity Search, and at least one planet has also been "seen" by the Transit Method. Table 3 contains a sampling of some of the planetary systems that have been discovered around normal main sequence stars. Some planetary systems are known to have multiple planets. By 2007, most of the objects found orbiting nearby main sequence stars are Jupiter-like planets and some failed stars called **brown dwarfs.** As telescopes and observing techniques improve, astronomers are finding smaller planets.

Planet Formation

Planets are believed to grow from the solid material in a disk around a young star.



(Image courtesy: *NASA/JPL-Caltech)*

Artist's conception: Planets sweep away a clearing in mass of dust surrounding a fledgling star.

In 2005, the Earth-like first planet orbiting another main sequence star was found. The planet, Gliese 876 d, is more than five times more massive than the Earth. The rocky planet orbits its small M class star at a distance equal to only about 1/50th of the Earth-Sun distance. In 2007, two planets about the same size were found around another small M class

star, Gliese 581. Both of these planets are closer to their star than Mercury is to our hotter and brighter sun. At the time of this writing, scientists are debating the probability that one or both of these two planets might have the right surface temperature for liquid water!

- Look at Table 3. How do the distances of extrasolar planets from their star compare with the distances between the Sun and the Earth and the Sun and Jupiter? (*Part 1, Table 1 may help you answer this question.)*

Comparing Other Planetary Systems with the Solar System

There is only one solar system, but astronomers now know that the solar system is only one of many planetary systems in our part of the galaxy. The first extrasolar solar planets discovered around other normal stars are closer to their stars than Jupiter is to the Sun, and many are closer than the Earth is to the Sun. These planets are often referred to as “hot Jupiters”. Some of these planets are so close to their star, and only take three days to complete an orbit! Mercury, which takes 88 days to complete an orbit, has the shortest year of any planet in our own solar system. Astronomers are now finding Jupiter-like planets in orbits that resemble Jupiter’s orbit around the Sun, but most planetary systems found so far are very different from our own.

Astronomers don't know yet how typical the recently discovered planetary systems are, or whether or not our own solar system is typical. Large, massive, Jupiter-like planets are much easier to find than Earth-like planets. Techniques that depend on the effect the gravity of a planet has on its star are also more likely to find planets that orbit close to their stars. The more mass a planet has, and the closer it is to its star, the stronger pull of the planet's gravity on the star will be.

Many extrasolar planets have been found around Sun-like G-class stars. Astronomers aren't able to search for planets around every star in the solar neighborhood. Instead, they must choose what stars to observe.

- Why do you think that astronomers may have chosen more Sun-like stars than other classes of stars?

Scale Models of Other Planetary Systems Activity

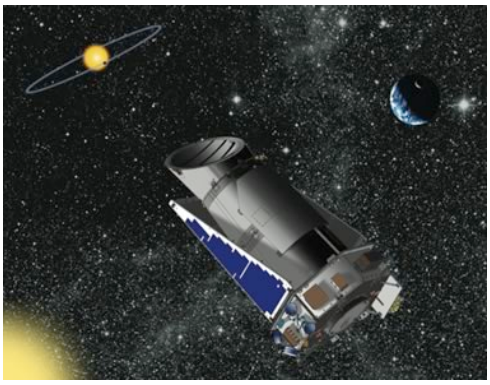
We can make scale models of other planetary systems and compare them directly with our own solar system.

- First, complete the last column of Table 3 with distances using the 1:10 billion scale factor also used to make the Scale Model Solar System.

- Using our scale model objects from previous activities construct scale models of the planetary systems in the table.

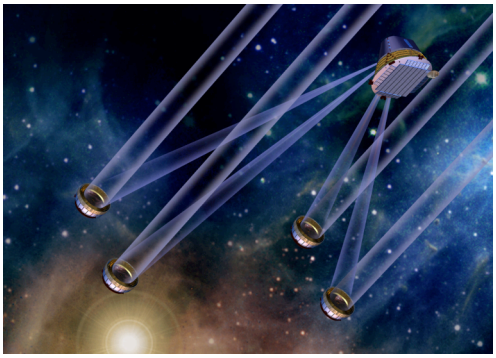
Searching for Earth-like Planets:

Dozens of planned and current efforts are involved in the search for extrasolar planets. Astronomers use telescopes here on Earth now and in the future plan to continue those "ground-based" efforts and also use new telescopes in space. Some of the most exciting planned missions will have the goal of finding Earth-like planets around other stars.



Kepler Mission

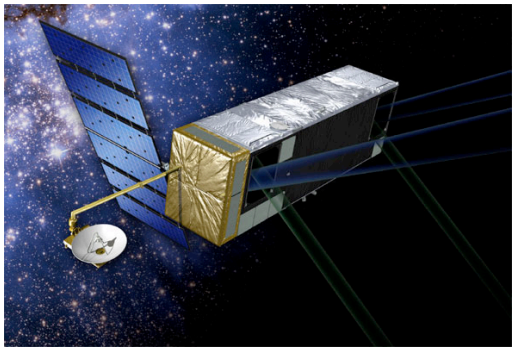
The **Kepler mission** was selected by NASA for a 2005 launch, and will look for small rocky planets from Earth orbit using the Transit method. One of Kepler's goals is to find out if Earth-like planets are common in the solar neighborhood. Check out the Kepler Web site (*http://www.kepler.arc.nasa.gov/*) for more information on this exciting mission.



Terrestrial Planet Finder

Another NASA mission to find Earth-like planets, the **Terrestrial Planet Finder** *(http://tpf.jpl.nasa.gov),* is currently in the planning phase. Terrestrial Planet finder will actually have the capability to image Earth-like planets around other stars and find out information about the atmospheres of those planets that could tell scientists if other Earth-like planets are capable of supporting life. To accomplish its task, the Terrestrial Planet Finder will use four extremely light-sensitive telescopes orbiting the Earth together and a technique called **interferometry** to reduce the glare of parent stars a factor of more than one hundred-thousand to see planetary systems as far away as 50 light years. The mission will also study disks around forming stars to help astronomers better understand how planets form.

SIM PlanetQuest



SIM PlanetQuest (formerly called Space Interferometry Mission), currently under development by NASA and Jet Propulsion Laboratory, will determine the positions and distances of stars several hundred times more accurately than any previous program. This accuracy will allow SIM to determine the distances to stars throughout the galaxy and to probe nearby stars for Earth-sized planets. SIM will open a window to a new world of discoveries. Check out the SIM Planet Quest website *(http://planetquest.jpl.nasa.gov/SIM/sim_index.cfm)* for more information on this planned mission.

A list of the projects involved in the search for extrasolar planets is available on the Extrasolar Planet Encyclopedia Web site at http://exoplanet.eu/searches.php.

Things to Think About:

- If a planetary system is listed as having one planet does that mean that we know for certain that only one planet is orbiting the star?

- Many of the planetary systems that have been found so far, with giant planets very close to their stars, look nothing like our own. Does that mean that solar systems like our own are rare?

- How might the discoveries of planets around other stars affect the way scientists view the possibility of finding evidence of life on another planet?