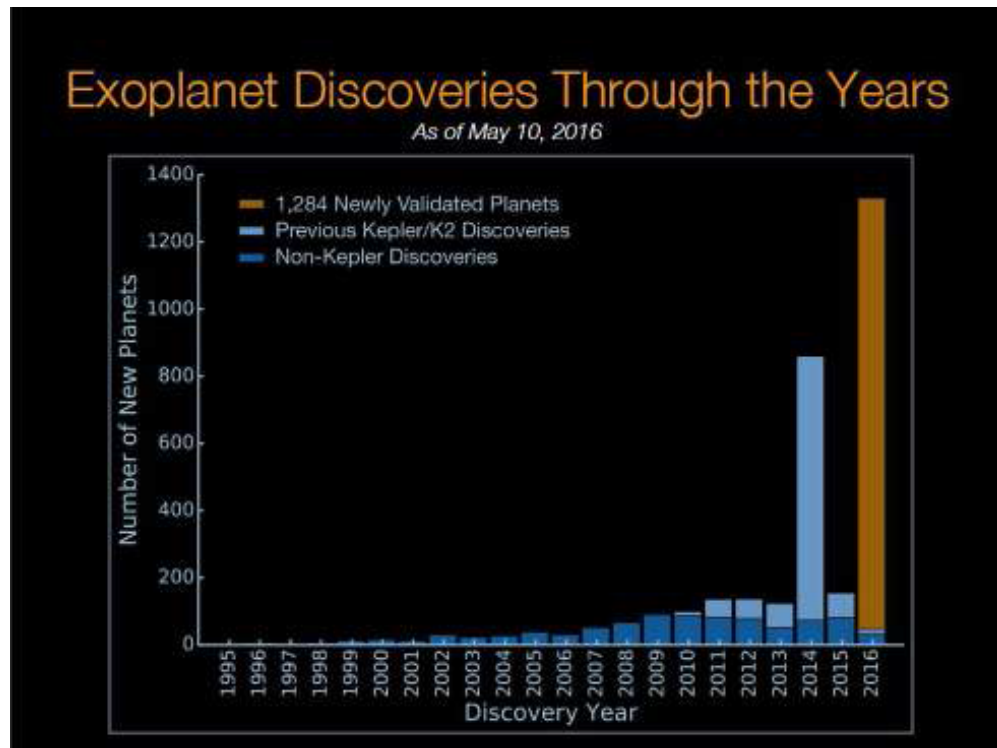


Tuesday 4th April 2017: "Burning Questions: understanding exoplanets by studying the hottest worlds" - Dr. Eric Lopez

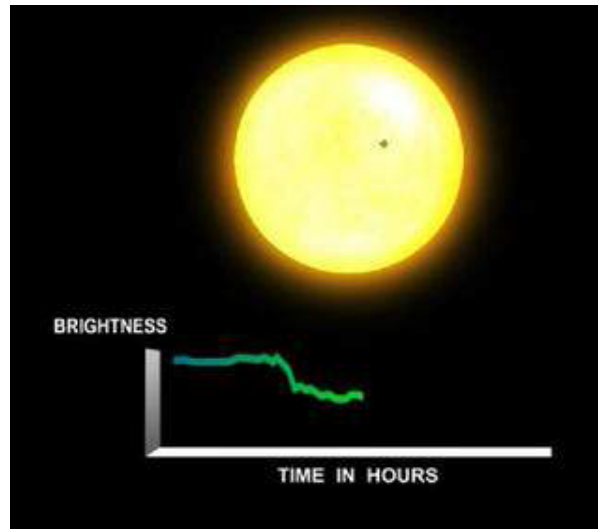
The first extrasolar planet to be discovered was 51 Pegasi-b in 1995; since then we have found thousands (1) most of which have been discovered by the Kepler mission which was launched in 2009. Kepler is a space telescope with a mirror just less than 1m across which studies 100 sq degrees of the sky off the galactic plane in the summer triangle between Cygnus and Lyra. Its mission is to discover hundreds of Earth-size and smaller planets in or near the habitable zone and determine the fraction of the hundreds of billions of stars in our galaxy that might have such planets.

(1)



The extrasolar planets are found by the transit method (2) which involves looking for a tiny reduction of light as a planet passes in front of its star. Kepler spent three and a half years of its primary mission staring at about 150,000 stars monitoring them continuously.

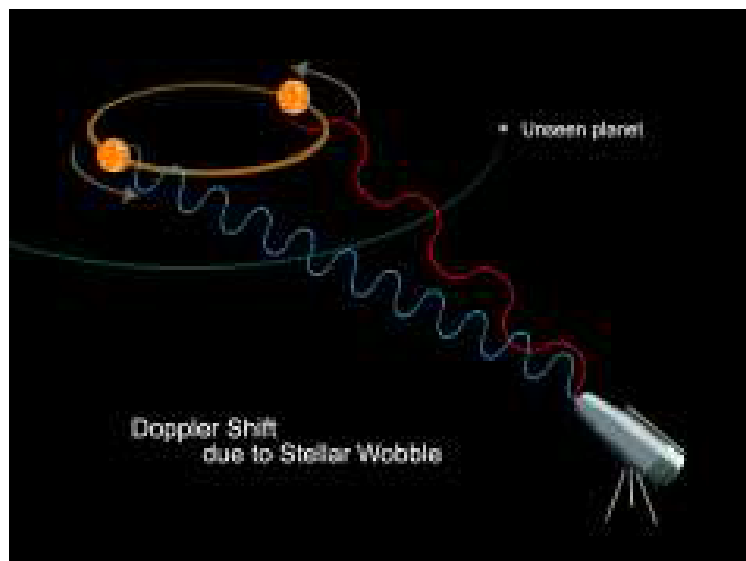
(2)



There appear to be a lot of planets small enough to be rocky, however, most are Neptune sized and there are relatively few 'hot Jupiters' close to their star. It is thought that about one and a half times the size of the Earth is the point where a planet would transition from rocky to non-rocky, and the non-rocky maybe water worlds or perhaps more like Neptune - an ice giant with a gaseous atmosphere.

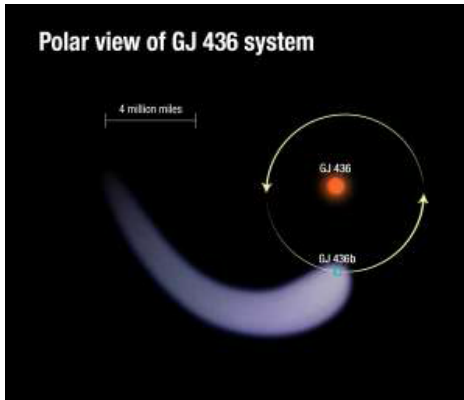
The transit method can give the size of a planet whereas the radial method, also called Doppler shift (3), can give the mass of a planet. The radial method is how the first extrasolar planets were found. It is particularly useful to combine these two methods because when the size and the mass are known it is possible to get an idea of the composition. The instrument used to determine the precise measurement of planet mass when using the radial velocity method, is called HARPS-N. Many of the rocky planets we are finding seem to have abundances of rock and iron similar to Earth, i.e. 30% iron.

(3)

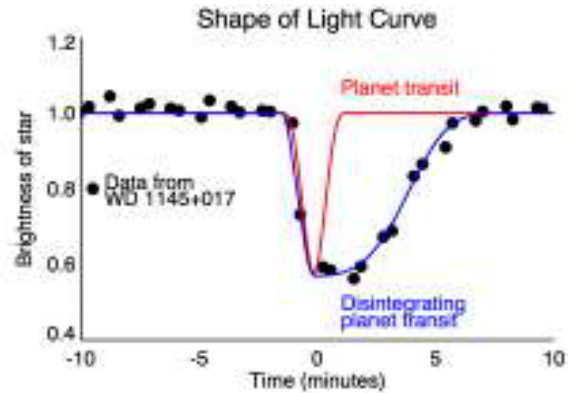


Most extrasolar planets are found close to their star, and planets close to their star orbit very quickly. A planet with an orbit of one day would be so close that the star's radiation would be incredibly fierce, and any atmosphere around the planet would be stripped off. This is called photo-evaporation and is perhaps what happened to Venus early in its history.

(4)



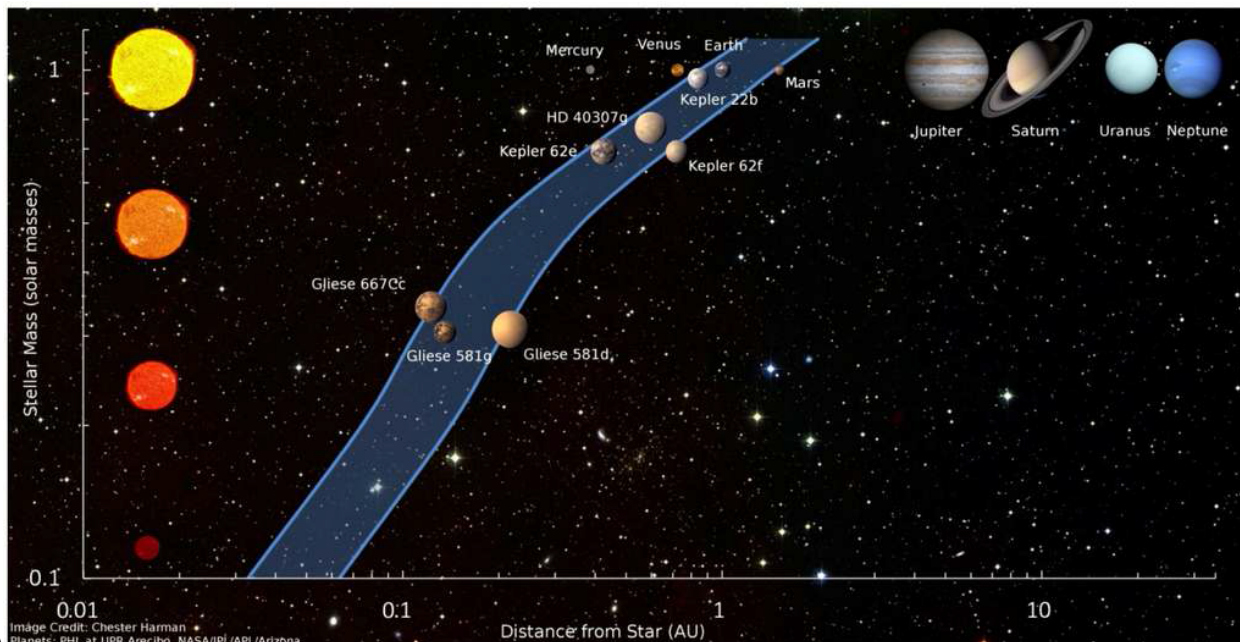
(5)



If an extrasolar planet blocks a lot of starlight this can be due to escaping gas; GJ 436b (4) has been found to have an extended tail of atmosphere. Kepler 1520b is on an eight-hour orbit and can be likened to a disintegrating Mercury gradually spiralling into its star. The light curve (5) shows the difference between a normal transit (red line) and the transit of a planet that is disintegrating and material is escaping.

Studying these hot planets will help us to understand how planets form and evolve in general and eventually we should be able to work out how the planets in our solar system formed. (6)

(6)



Earth-like planets need to be in a habitable zone so that liquid water can exist on their surface. It is difficult to detect Earth-size planets around Sun-like stars as they orbit so far out. Some of the most exciting discoveries last year occurred when using the radial velocity method. The first concerned a planet orbiting Proxima Centauri in 11 days, with a similar mass to Earth and it was in the middle of the habitable zone. Proxima Centauri is a red dwarf star only 4.2 light years away, a star not much bigger than Jupiter with just 12% the mass of our Sun.

Another extraordinary discovery is the Trappist system that has seven planets around a low mass red dwarf star as close to their star as the Galilean moons are to Jupiter. Three of these planets are within the habitable zone and may even be rocky. The new James-Webb Telescope should help us to understand these planets. It has such sensitivity and spectral resolution that it should be possible to decide, not only if an extrasolar planet has an atmosphere, but also the composition of this atmosphere, and this is what makes this mission exciting. It's still on course for launch in 2018.