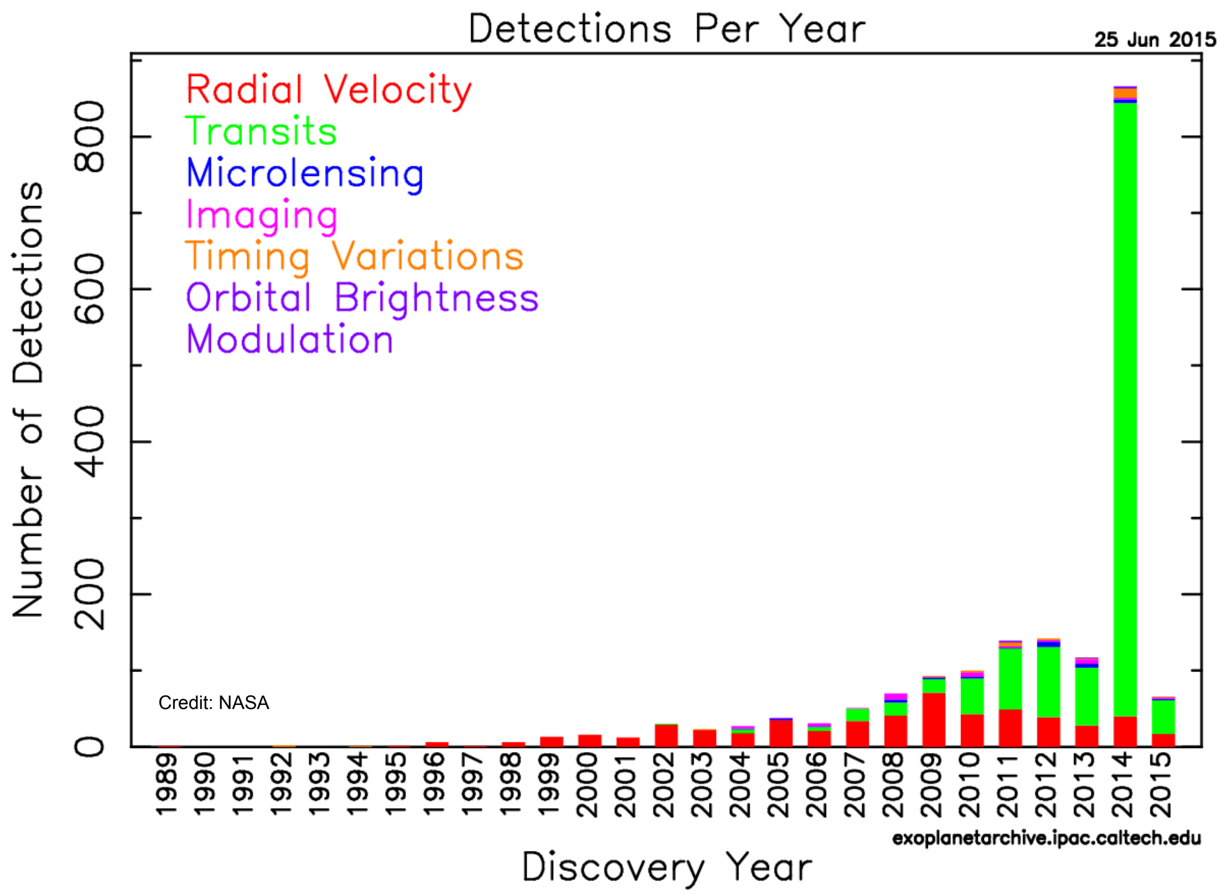
The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of star stuff.

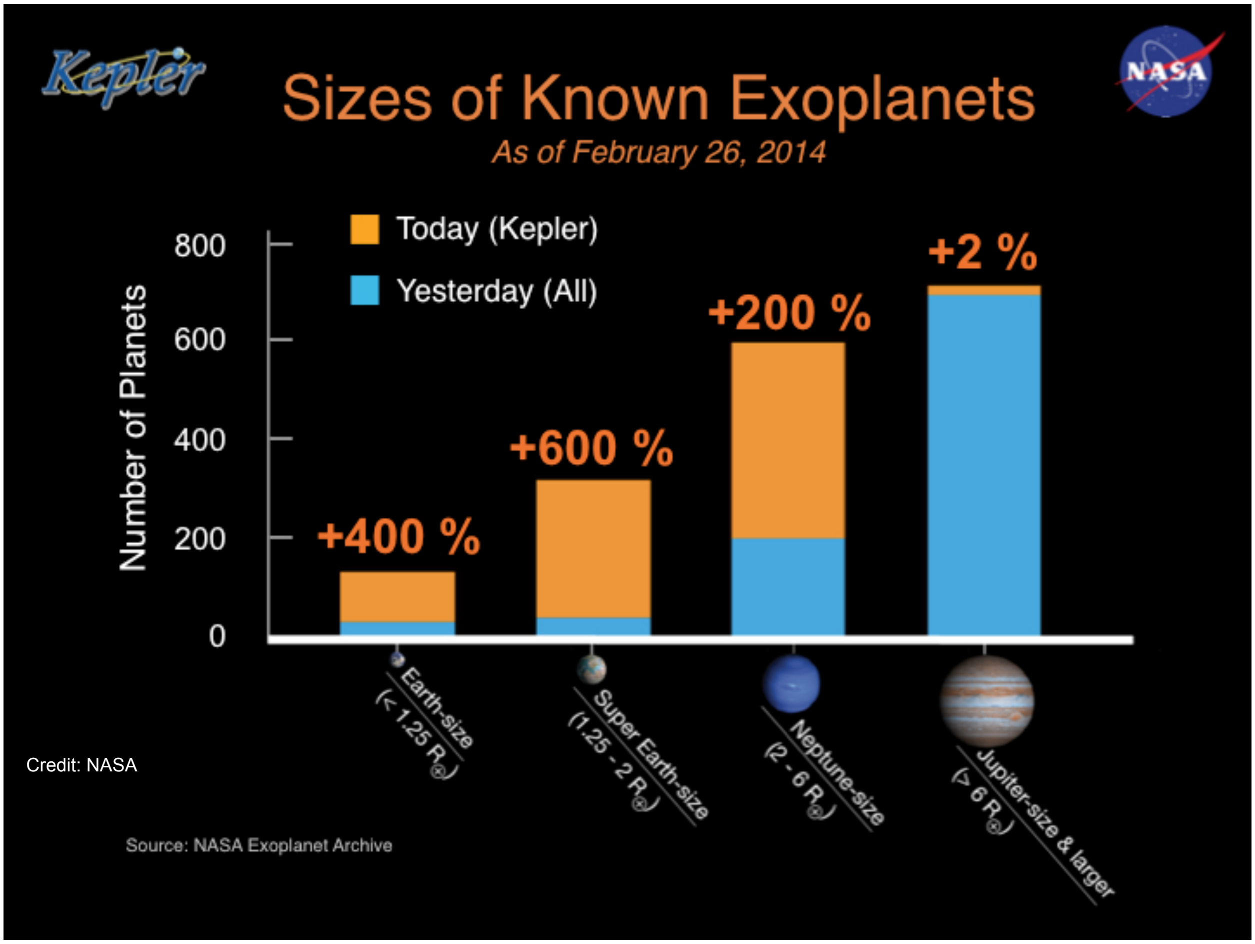
Carl Sagan

Hot Jupiters

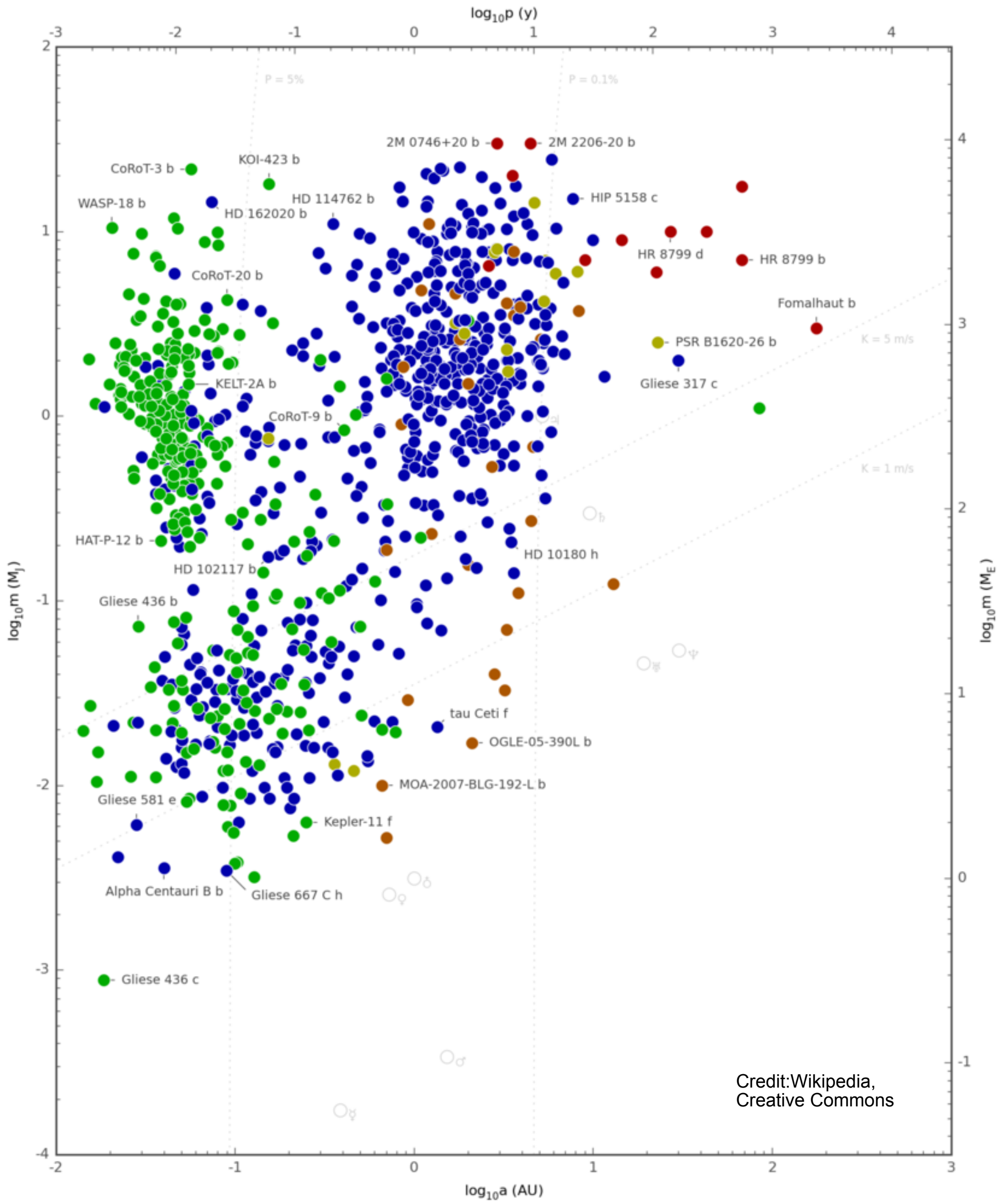
Greetings planet hunters of AST 111! In this module we'll explore what we have learned from our planet hunting activities. If you see fancier plots than usual, its because they are. But you are ready - they contain nothing that we haven't already explored in this course. No module will become outdated as quickly as this module, because this is science at a rapidly changing bleeding edge.



The plot above shows the number of exoplanet detection versus year. Clearly there has been a remarkable increase in the number of exoplanets discovered over the past few years. Future years will likely be just as fruitful. The colors on this histogram indicate the detection method. In years past the Doppler method, of radial velocity method, dominated. These days, transit photometry dominates mainly because of NASA's Kepler mission.



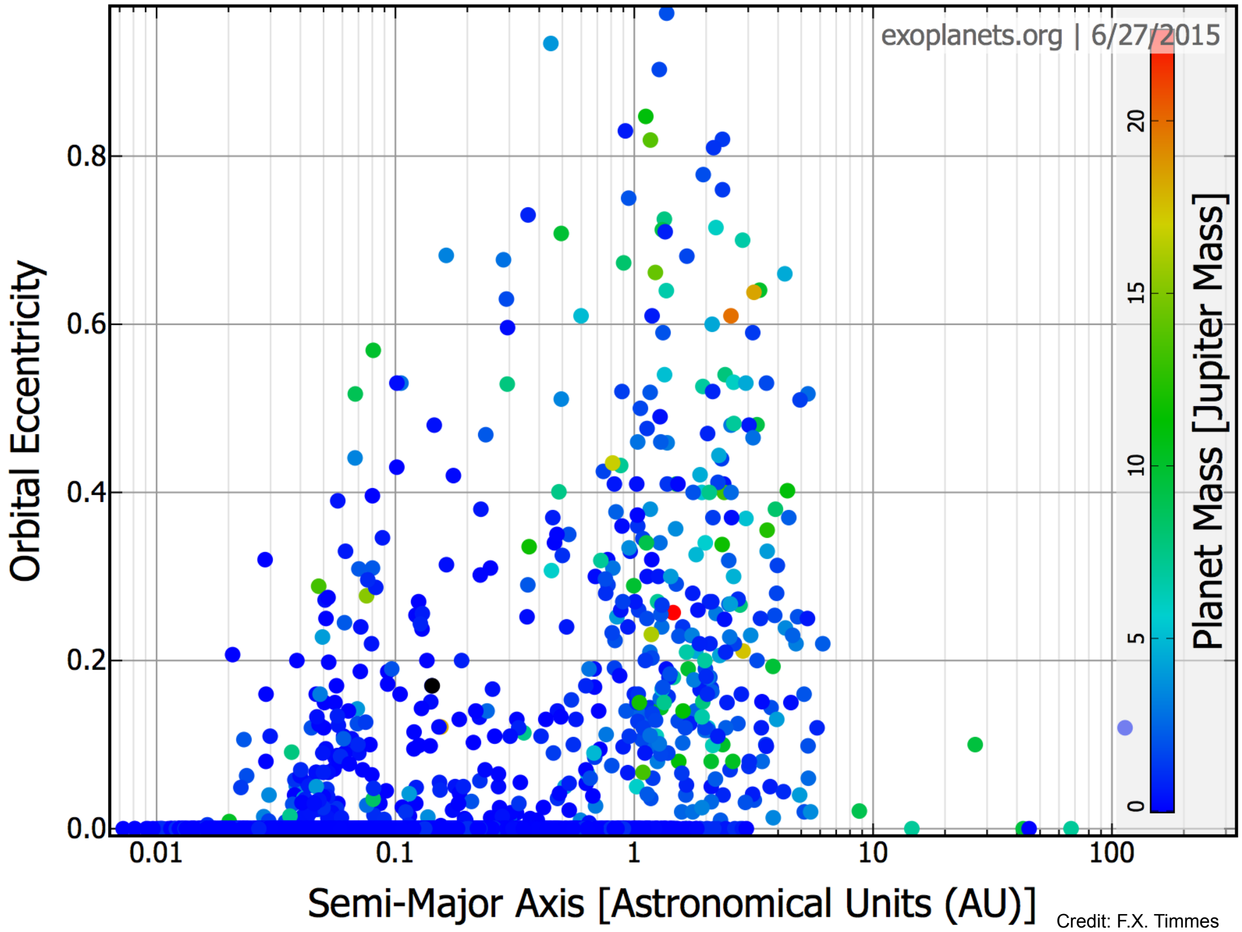
Most known exoplanets are larger than Earth. That's what the plot above shows. Most are Jupiter and Neptune sized. Some are so-called Super-Earth sizes ones with radii between 1.25 and 2 times the radius of Earth. Fewer are Earth-sized, defined as those with radii smaller than 1.25 times Earth's radius.The plot also shows the discovery rate as of 2014. Relatively more Super-Earth and Earth-size planets are being discovered than Jovian-sized planets. That may not be too surprising as the push is to find other Earth's, Earth-twins.



Most known exoplanets are more massive than Earth and orbit relatively close to their star.

The plot above shows the mass of the exoplanet versus distance from the star for a subset of the Kepler mission data. Masses are given in Jupiter masses on the right y-axis; here “0” corresponds to 1 Jupiter mass because the y-axis is logarithmic. Masses are given in Earth masses on the right y-axis; here “0” corresponds to 1 Earth mass because this axis is also logarithmic. The x-axis is our old friend the length of the semimajor axis. Here too, “0” corresponds to 1 AU, the average distance between the Earth and Sun. Notice, the fainter grey symbols - these are the traditional icons for the planets in our solar system.

Jupiter mass planets orbiting close to their star than Earth does to the Sun. This is the origin of the term “Hot Jupiters” for these exoplanets.



Credit: F.X. Timmes

Most known exoplanets have surprisingly elliptical orbits and orbit relatively close to their star.

The plot above shows the eccentricity - how elliptical the orbits are - versus how far away the planet is on average from the star - the semimajor axis. A value of “1 AU” on the x-axis is the average Earth-Sun distance. Most of the planets in our solar system hover around values of zero - meaning nearly circular orbits. The majority of exoplanets in this data slice have much more elliptical orbits. Again, they also orbit closer to their parent stars. The color of the circles gives the mass of the exoplanet. Blue tones are Jupiter mass planets. Red is exoplanets with 20 times or more the mass of Jupiter.

We have more limited information about compositions of the exoplanets, but the data are consistent with the idea that these exoplanets are Jovian in nature.

Hot Jupiters indeed!

Of course the push, to answer the ancient question of are we alone, is to find Earth-like planets. This means finding Earth-sized planets that are within their star's habitable zone - the zone where water can exist as a liquid. This is not to say life cannot find other venues - silicon based instead of carbon based, liquid methane instead of water and so on. But first you hunt for what you know. Progress is being made. The illustration below shows Earth-sized planets discovered that are within the habitable zone, at least as of the date in the figure of January 2015. There will be much progress in this area as time goes on!

Thanks! Bye Bye.