Exoplanets Lab 25.09.2017

Today several thousand exoplanets have been detected, mainly by the radial velocity method and the transit method. The goal of this lab is learning about exoplanet statistics with the interactive catalogue of the Extrasolar Planets Encyclopedia through the NASA Kepler website and the interactive catalogue of the Extrasolar Planets Encyclopedia.

The Extrasolar Planets Encyclopedia

The Extrasolar Planets Encyclopaedia (http://exoplanet.eu/) is an online database for exoplanets. It contains the physical characteristics of exoplanets and their host stars for basically all confirmed exoplanets. The mass of an exoplanet must be known before it is considered confirmed (an exoplanet for which only the radius is known is labelled a candidate exoplanet); masses are generally obtained either by the radial velocity method or by detection of tiny variations in the transit signals caused by mutual perturbations be- tween planets in a planetary system (transit timing variation or TTV). The encyclopedia is maintained by Jean Schneider at Paris Observatory.

The Extrasolar Planets Encyclopedia is an excellent tool for professional astronomers as well as for students who wish to become acquainted with the vast catalogue of exoplanets. Start by going to the Extrasolar Planets Encyclopedia and follow the link to the 'Diagrams' page.

NOTE:

Clear plots are key to illustrating scientific results. Carefully consider your axis ranges and whether to use linear or logarithmic axis.

Exercise 1: Use Extrasolar Planets Encyclopedia to plot the mass of detected exoplanets on the y-axis versus the year of discovery on the x- axis. When was the first exoplanet discovered? Why do you think that the planets found in 1989 and in 1992 are generally not credited with being the first exoplanets? You can click on a planet to get information about the discovery and a list of all relevant papers.

Exercise 2: Plot now the eccentricity of the planet orbit versus planet mass. What trends do you see? Next limit the exoplanets to those for which a transit has been detected. Comment on the difference.

Task

Question 1: Plot the planetary mass versus semi-major axis. Identify the planets known as “hot Jupiters”. Identify the planets known as “super-Earths” or “mini-Neptunes” (hint: Neptune is 0.05 Jupiter masses, Earth is 0.003 Jupiter masses). Explain how these planets are di↲erent from the planets in the Solar System.

Question 2: Limit the plot to planets discovered by the radial velocity method, by entering the detection method in the field above the x-axis. Click the question mark for instructions. Describe the trend that you see for the mass of the heaviest and the lightest exoplanets found as a function of time.

Question 3: Plot now the radius of planets detected by the transit method. Compare the result to the radial velocity exoplanets (use the same axis range for best comparison). What is the trend for transiting planets before 2009 and what is the trend after 2009? Why is there a change in the trend?

Question 4: Plot the eccentricity of the planet orbit versus the orbital period of the planet. How is the eccentricity of exoplanet orbits compared to the planets in the Solar System? What happens to the eccentricity for planets in very short periods? Some planets have very long periods. How are those detected?

Question 5: Plot now the eccentricity of the planet orbit versus planet mass. What trends do you see? Next limit the exoplanets to those for which a transit has been detected. Comment on the difference. Place the Solar System planets on the plots and comment.

Hand in the report at the latest one weeks after the lab.