

Extrasolar Planets:  
Thursday, September 27, 2007  
12.425 Class Summary  
Lecture 5

The focus of this class was to continue the previous lecture discussion on radial velocities. The lecture introduced students to radial velocity curves, specifically how to read and understand their key features and use those to derive planet mass. Lecture began with a review of the derivation of planet mass using the equation for an elliptical orbit in the plane of the motion of orbit, finding planet motion in the direct line of sight, and then using Kepler's second law of motion to calculate the planet mass.

Lecture then continued with a review of stellar spectra with discussion of blackbody radiation and how scientists use the idea curve of blackbody to determine the temperature and composition of a star. Students reviewed Wien's law, which indicates that hotter stars will appear blue and have temperatures between 10,000 and 50,000 K; medium-hot stars will appear yellowish orange and have temperatures around 6,000 K; and the coolest stars will appear red with temperatures at 3,000 K and then used data of a star and its planet to understand how astronomers can approximate a star as a blackbody and then use that information to compare to a planet's reflected light of that star to deduce the composition of that planet.

Continuing on the theme of spectra, students were challenged as to whether a body could produce emission lines. Naturally a star will show absorption lines because it is hotter at its core than at its surface. But some bodies produce a temperature inversion where they are cooler at their core than at their atmospheric creating the opposite effect of a typical star. They object then can produce emission lines.

The next part of class was spent reviewing the lifecycle of stars with explanations of the Hertzsprung-Russell Diagram, which prepared students for the "In the News" reading they discussed in class. Prior to that, lecture continued with a review of Doppler Shift, where the students performed an in-class exercise to calculate the velocity of Barnard's star using the flux data of the star's spectrum as compared to the sun. The velocity was calculated at around  $10^5$  m/s, strikingly fast as compared to the planets, which moved at their quickest at about 50 m/s. The final note about Doppler shift was on how scientists measure radial velocities at m/s using the iodine cell technique.

Revisiting the Hertzsprung-Russell Diagram, the students discussed a September 13, Nature "News and Views" article, which explained how a star had exploded as a Red Giant, then lost half its mass and became a B subdwarf. A planet that orbited 1 AU away from the star while on the main sequence survived the star's bloated stage and as the star shrunk to sub-dwarf status, the planet moved from 1AU to 1.7 AU in its orbit, most likely a shift to conserve angular momentum. This example led to the discussion of the blackbody radiation of a white dwarf star and how around it orbited a dust disk, specifically showing the spectral fingerprint of silicate, an element found in abundance on Earth.