12.425
Lecture 11
Tuesday October 30, 2007

The focus of this lecture is to discuss energy balance in terms of the flux from the host star and the energy absorbed by a planet, while considering atmospheric circulation. Students will derive the formula for energy balance and learn how scientists calculate planetary equilibrium temperatures.

The first in-class exercise asks students to order eight common, natural objects based on their scattering albedo, or apparent reflectivity. Students suggested that snow should have the highest albedo or reflectivity and soil would have the lowest. For more details, see the website http://en.wikipedia.org/wiki/Image:Albedo-e_hg.svg.

After a review of star flux and its relationship to a planet's reflectivity, students were asked to review secondary eclipse, transit light-curves to decide whether the surface temperature on the exoplanets differed by hemisphere. If the curve showed a "definite phase curve," suggesting a temperature change from one hemisphere to another, students were then asked to calculate that temperature difference.

Students found the curves on slides 23 and 27 showed definite phase curves, while slide 25 showed a possible or marginal curve. To calculate the temperature differences within the curve, the students referenced the last lecture's notes on the ratio of planet to star flux and its relationship to the temperature and radius of the planet and the star.

Students used the equation: $F_p/F_* = T_p R_p^2 / T_* R_*^2$.

HD189733 showed a definitive phase curve, for example. Students read the flux at the crest and trough of the curve, which were 1.0035 and 1.0025 respectively. Because the flux of the star is a baseline of one, the flux of the planet (total flux-1) was calculated at .0035 and .0025 respectively. Substituting these figures and the temperature and radius of HD189733 and its planet in the given equation, students found the higher temperature to be 630 K and the lower temperature to be 530 K, demonstrating the difference between the hottest and coldest hemispheres was 100 K. This difference might occur when the planet is tidally locked to the star so only one hemisphere experiences day and the other only night.