**ESE 101:**

**Homework 1** (due October 12):

1. *Low-e glazing*. When we were remodeling Linde+Robinson Laboratory, we wanted it to become energy efficient but were constrained by the mandate to preserve its historical appearance. For example, we could not change the appearance of the windows. However, the window glazing in the historical windows is new.

   (a) We decided double glazing (two glass panes with an air or vacuum gap in between) to reduce heat conduction was not going to change the energy efficiency of the building much. Can you think of reasons why? (Strong hint: look at the windows and think about what the frames are made of.)

   (b) Regular glass has an emissivity of about 0.9 for thermal infrared radiation. If the outside temperature is 310 K, how much energy would the windows radiate into the building? What is the wavelength of maximum emission?

   (c) Using glass with a low-emissivity ("low-e") metal oxide coating was found to lead to substantial energy savings. What the coating does is to reduce the thermal infrared emissivity of the glass, to a value around $0.04$. Why does that reduce the buildings energy demand?

2. Jupiter's mean distance from the sun is $7.8 \times 10^8$ km (or 5.2 Astronomical Units). Its (Bond) albedo is $0.34$, and the solar luminosity is $3.8 \times 10^{26}$ W.

   (a) What is the total solar irradiance at Jupiter?

   (b) What would be the effective temperature of Jupiter if it were a perfect blackbody (in the longwave band) in equilibrium with the insolation?

   (c) The measured effective temperature of Jupiter is 125 K. How large is the additional energy flux that must be emanating from Jupiter's interior to lead to this effective temperature? *[This energy flux is somewhat analogous to the (small) geothermal energy flux on Earth, but it is much larger and arises through different processes: It arises primarily because Jupiter is still contracting, and the gravitational energy that is released by the contraction emanates as an internal energy flux.]*