Name: ____ Due October 7, 2003 9:30 a.m.

Physics/Astronomy/Planetary Sciences 589 Homework 3

1) There is such a thing as "limb darkening" of a stellar disk, the change of the specific intensity I_ν with angle with respect to the normal to the stellar surface. A good approximation to I_ν is:

$$I_\nu = F_0/2\pi(1+3\mu/2)$$

.

This is the Eddington-Barbier Relation. a) Calculate, using this formula, the flux from the star of radius R at a distance r ($r > R$). b) What is maximum brightness contrast (ratio) for light from the star?

2) A black mountain at a distance x can be seen by our eyes because of the brightness contrast between it and the surrounding airlight. The airlight is caused by the scattering of sunlight into our view by air molecules (actually, the fluctuations of their density) and dust along the line of sight. If the effective scattering mean-free-path in the air is λ (= 50 km) and the solar flux at noon (90°) is F_0, what is the apparent brightness (I) of the black mountain? Ignore multiple scattering, assume the scattering is isotropic, and remember that there is airlight along the line of sight to the mountain. If our eyes can not discern brightness contrasts ($(I_2 - I_1)/I_2$) less than 2%, at what distance x will the black mountain be invisible?

3) A space capsule is 10 meters on a side and contains air with initial density ρ_0 at a comfortable temperature (at which it is always maintained). A piece of space debris crashes into the capsule and leaves a hole 10 cm on a side. a) If the density is assumed to be uniform (independent of position), what is the approximate $\rho(t)$ in the capsule? Make whatever assumption you care to about the γ of the gas and, in fact, the γ dependence of the answer (the answer need only be approximate). b) What is the timescale for the loss of air from the capsule? c) What is the approximate wind speed of the air in the "middle" of the capsule during decompression? (Hint: 10 meters >> 10 cm.)