ASTR 407/507 Assignment 8 Due : Tues Apr 10, noon

Final deadline. No extensions.

1. Expected solid composition for Solar System solid bodies.
Using Table 3.1, compute the expected mass fraction of ice of solid bodies in the outer Solar System in the following way. Concentrate only on the major elements H, C, O, Mg, Si, S, and Fe. For the atomic weights (number of nucleons) assume H is a bare proton and the others have equal numbers of protons and neutrons except for Fe with a mass of 56 atomic mass units (amu ; equal to a proton mass as far as we are concerned). The picture is that a gradually cooling nebula extracts all the elements it can when T falls below the 'condensation temperature' of the species.

(a) Assume anhydrous rock has extracted all the Si, Mg, S, and Fe out of the nebula in the form of SiO, MgO, FeO, and FeS (since both of the latter two are present, explain how you know which one condenses at a higher T). Use up the entire inventory of these four elements and thus calculate the number of atoms of O left per million Si atoms.

(b) Calculate the mass of rock in amu/silicon atoms. Augment your result by about 10% to
account of rock-forming elements not included in your calculation.

(c) Assuming that all the C first goes into CO gas which *does not* condense, calculate the mass of water ice (in amu/silicon atom) present (assuming all remaining O combines with the abundant hydrogen), and the `water-ice to rock' mass ratio of all solids.

(d) Assume instead that the C all goes into methane (CH_4). Calculate the mass of water ice, the water-ice/rock ratio, and the (water- + methane ice)/rock ratio.

2. Text problem 15-3. In part (b) you are thus approximating that all energy not present in the kinetic and potential portions at the final state is now present in heat.