AST 205
Problem Set 9
Due: Dec. 10, 2003

1. (6 pts) In the lecture on Dec 1 we considered an origins chronology in "Galactic time units". Another common conceptual tool for thinking about very long time periods is to map them onto a one year Cosmic Calendar. Construct such a chronology by taking the entire 13.7 billion year history of the Universe since the Big Bang to correspond to the year 2003, with the Big Bang occurring just as the year began on Jan 1 and the present corresponding to midnight on Dec 31. Include at least the following events in your chronology: the appearance of the first stars and quasars, the formation of the Sun and the Solar System, the origin of life on Earth, the development of an O_2 atmosphere and of eukaryotic cells, the appearance of land animals, the age of the dinosaurs, the K/T impact extinction event/impact, the appearance of homo sapiens, the BC/AD division date in our conventional calendar and the founding of Princeton University. You may add other events if you are so inclined. Identify the date of each of these events to the appropriate level of precision. (This might be only the month in some cases but might also correspond to a particular time of day on a specific date in others.)

2. (9 pts) As discussed in lecture on Dec 3, the starlight striking a planet will be either scattered directly back into space or absorbed and reradiated at a wavelength characteristic of the planet's temperature. These two processes create two broad spectral peaks or bumps in the radiation coming from the planet and correspond to the two most likely wavelengths at which future space observatories will study extrasolar planets. The fraction of the starlight falling on a planet which is scattered directly back into space is called its albedo and denoted mathematically as A; the value must therefore be $0 < A < 1$. Ignoring the effects of the planets' atmospheres (*i.e.,* greenhouse type effects) for simplicity, calculate the peak intensity wavelengths of the scattered and reradiated thermal radiation for Venus, Earth and Mars. Take the values of A for the three planets to be 0.75, 0.60 and 0.15, respectively. The Moon, which is at the same average distance from the Sun as the Earth, is an extremely low albedo object, with A = 0.07 it is actually blacker than almost all black paints! At what wavelengths will the two peaks in its spectrum occur? **Important note: Assume that *A* is wavelength independent over the optical and near IR bands where the Sun emits the large majority of its total luminosity but that the planets are perfect blackbodies (corresponding to *A*=0) at the wavelengths at which the planets reradiate their thermal energy. If the importance of this assumption is not clear to you, do not worry about it; it involves technical issues that we have not discussed in this course.** (Hint: You will need to use concepts, formulas and numerical data provided in lectures and notes from early in the course. Note also that your answers will not correspond extremely closely to reality due to the effects of the planetary atmospheres, particularly in the case of Venus.)