Homework assignment 1b, due October 2nd

Problem 1 - Comparing the Mestel cooling model to modern cooling models

(a) Make a figure of the luminosity as a function of cooling age according to the Mestel model derived during the class. Assume that the white dwarf is made of pure carbon and that it has a mass of 0.6 $M_\odot$.
(b) On the same figure, add the prediction of a more sophisticated modern cooling model, which you can download here. Note that in this model, "Age" is the cooling age of the white dwarf and is given in years, and "L" is its luminosity in erg/s.
(c) Briefly comment on the validity of the Mestel model (1-2 sentences max).

Problem 2 - When will the Sun crystallize?

In this problem, you will calculate how far out in the future the Sun will start to crystallize.

(a) Estimate how long it will take for the Sun to reach the white dwarf stage. To answer this question, you can assume that
   (i) The pre-white dwarf lifetime of a star is 10^{10} $(M_i/M_\odot)^{-3.5}$ years.
   (ii) The Sun is currently 4.6 Gyr old.
(b) Now we simply need to know how far along the white dwarf cooling track the Sun will be when it starts crystallizing. To answer this question, it is useful to know the following:
   (i) The relation between the final mass (mass of the white dwarf), M_f, and its initial mass (on the main sequence), M_i, is given by $M_f = 0.080\ M_i + 0.489\ M_\odot$ for the mass range relevant to the Sun.
   (ii) In the white dwarf cooling models available here, the quantity Mx/M corresponds to the fraction of the star that is crystallized. The files are named according to the mass of the white dwarf (e.g., "seq_055_thick.txt" is for a 0.55 $M_\odot$ white dwarf). Only use the model names ending with "_thick.txt"; this refers to the thickness of the hydrogen layer.
   (iii) You will need to interpolate in the mass space to answer this question accurately.