O'CONNELL PROBLEM SET

DUE TUESDAY, FEBRUARY 10

(1) Stars condense from the very dilute "interstellar" gas, which has a number density of about 1 atom per cubic centimeter. The Sun, a typical star, has an average mass density of about 1 gram per cubic centimeter. How large a volume of the interstellar medium would have to be compressed to yield a single cubic centimeter of solar material? Give your answer as the side of the cube containing the material.

> Your answer should be surprising to you. It is remarkable that such a dramatic compression is regularly achieved in the process of star formation. The ultimate cause, of course, is gravity.

(2) The luminosity of a generation of stars declines with the age of that generation. [The "luminosity" is the total luminous power output (measured, say, in watts) of a stellar system.] Based on models for stellar evolution in the visual band, to which our eyes are sensitive, the luminosity of a single generation containing a total of one solar mass of stars is given by the expression

$$L = 50\, t^{-0.8}$$

Here, L is in units of the Sun's visual luminosity and t is the age of the generation in units of tens of millions of years.

Suppose a starburst, like those discussed in the lecture, has been continuing for 100 million years with 100 solar masses of gas per year being converted to stars. (This is typical for a bright starburst.) What will be the total luminosity of the resulting stellar population? Give your answer in units of the Sun's visual luminosity.

[Hint: you can do this problem by integration, or you can approximate the situation by dividing up the 100 million years into ten equal bins of ten million years each and adding up the contribution of each bin.]