AST 250 – Spring 2018
Homework Due: Wednesday March 21

24. An accreting protostar has a luminosity that is associated with release of gravitational potential energy of the accreting material. In this problem, you will derive an expression for this accretion luminosity, L_{acc}.

(a) Write down the equation for the gravitational potential energy released for a blob of gas with mass, m_{acc}, falling from infinity onto a protostar with radius R_{proto} and mass M_{proto}. Note: this formula should ***NOT*** have numerical factors like ½ or 3/5.

(b) Now differentiate this equation with respect to time to relate the rate at which energy is released (equal to the accretion luminosity assuming 100% efficiency) to the mass accretion rate given by dm_{acc}/dt. Hint: Since M_{proto} and R_{proto} change very slowly, you may assume they are approximately constant.

(c) Use the formula you derive to calculate the accretion luminosity (in units of L_{sun}) of a solar mass protostar with R_{proto} = 3 R_{sun} and a mass accretion rate of $dm_{acc}/dt = 10^{-6}$ M_{sun}/year (i.e. at this accretion rate, it would take 1 million year to accrete 1 solar mass). Be careful about units!