Homework #2
Due 9/17/2018 by 5:30 pm

Professor Gerardo Dominguez
Physics 480 - Special Topics in Astrophysics

September 9, 2018

1 Earth's Orbit and Virial Theorem

According to the Virial Theorem, the gravitational self-energy can be used to calculate the overall kinetic energy in a system bound by that same gravity.

(a) Consider the orbit of planet Earth, which is established by the interaction between the Sun and Earth masses. Please evaluate what is the ratio of kinetic energy (KE) to gravitational potential energy (PE). You may assume that the Earth has a circular orbit for simplicity.

(b) Compare your answer in part (a) to the prediction made by Virial Theorem.

2 Gravitational Self-Energy of Celestial Bodies

In this problem, we are going to take a first crack at understanding the conditions found in the Sun by applying the Virial Theorem.

(a) Consider a spherical celestial body with radius R and total mass M. Using unit analysis of the gravitational potential energy expression, please write down an expression using G, R, and M that may describe the gravitational self-potential energy of this body (Hint: Don't overthink it).

(b) Please derive the gravitational self energy of this body by assuming that the mass density as a function of r, the radial distance, is uniform. Compare to your answer from part (a)

3 Gravitational Self-Energy of Celestial Bodies

(a) Assuming that the kinetic energy of the Sun is dominated by random thermal energy, please use the Virial theorem to estimate the total thermal energy found within the Sun. Please express in terms of G, M, and R.

(b) Assuming that the mass of the Sun is dominated by hydrogen atoms (m=m_p), use the results of part (a) to estimate the average thermal velocity (v_T) for hydrogen atoms found in the Sun.

(c) Use the ideal gas law or kinetic theory and your results from part (c) to estimate the average temperature inside the Sun.

4 Extra Credit

(+3 out of total of 10 points for HW)

Solve Problem 3.10 in Ryden & Peterson (page 82).