

PHYS633 Introduction to Stellar Astrophysics

Spring 2008

Homework 3: Gravitational Potential Energy

Due in class on Monday, March 10th, 2008

The gravitational potential energy of a star is given by

$$\Omega = -\int_0^M \frac{Gm}{r} dm.$$

- 1) By considering a uniform density model, show explicitly that the gravitational potential φ is not equal to

$$-Gm/r.$$

(The gravitational potential is related to gravitational acceleration by $\mathbf{g} = -\nabla\varphi$.)

- 2) Show that for any spherically symmetric density distribution

$$-\int_0^M \frac{Gm}{r} dm = \frac{1}{2} \int_0^M \varphi dm.$$

(Hint: Use integration by parts.)

- 3) Show explicitly that the equation in part 2) is satisfied for a uniform density star.
- 4) Explain, on physical grounds, why there is a factor of $\frac{1}{2}$ before the integral on the right hand side of the equation in part 2).