

PHY 9A Discussion 10, Spring 2018

1. Binary System of Stars

Two stars of masses, M_1 and M_2 , are making a binary system, thereby orbiting in circular paths with a common center.

- i. Write down the equation of motion for each star.
- ii. Using the fact that they have the same angular speed, find the position of the center of the circular paths.
- iii. Considering the sun and the earth as a binary system, calculate the radii of the paths.

2. Black Hole Radius from Newtonian Gravity

Consider the situation where one shoots a ball of mass, m , vertically with a speed, v , from the surface of a star with mass, $M (\gg m)$, and radius, R .

- i. What is the total energy of the system when the ball shot?
- ii. According to many experiments conducted, a speed of any object is bounded from above by the speed of light, $c = 299,792,458$ [m/s] $\approx 3 \times 10^8$ [m/s]. How far can the ball reach in the given situation?
- iii. In order that the ball is considered to be not trapped by the star, and hence to be able to escape from the star, it has to be able to reach infinity. Find the minimum radius, R_0 , of the star that allows the ball to escape. Does it depend on the mass of the ball?
- iv. Calculate R_0 for a star with the mass of the earth, and compare it with the radius of the earth.