PHY140Y

Spring Term – Tutorial 14 Discussions

January 17, 2000

1. Consider two suns of equal mass M orbiting each other at a radius R. Both stars are now rotating about each other.

   (a) Where is the centre of mass of this system?

   (b) What is the orbital period of this "binary" system?

2. Larry Niven (at least I think it was him) wrote a story about a fearless adventurer who unfortunately found himself in a hyperbolic orbit around a black hole. Assume that the black hole has a mass 5 times that of our sun.

   (a) The "event horizon" is the spherical surface centred around the black hole with a radius such that the escape velocity from that surface is equal to the speed of light, $c = 3.00 \times 10^8$ m/s. What is the radius of the event horizon for this black hole?

   (b) What would be the minimum velocity of our intrepid explorer if he whips around the black hole with a closest approach of 5 km?

   (c) He realizes (perhaps too late!) that tidal forces are going to be a problem. Oh, no! He starts thinking furiously! How should he align himself and his ship as he comes in proximity with the black hole to minimize the tidal forces on him?

   (d) At a radius of 5 km from the black hole, what would be the tidal force acting on him if he is standing straight-up with his feet pointing towards the black hole? Is this a good idea?

3. (a) What equal positive charges must be placed on the Earth and the Moon to neutralize the force of gravity?

   (b) Do you need to know the radius of the Moon's orbit to answer this question?

   (c) How many tons of ionized hydrogen (ie., protons) is needed to provide this positive charge?