Introduction to Astronomy
Exercises week 8

29 November 2019

1. The light curve (i.e. intensity – or magnitude – as a function of time) of an eclipsing binary is mostly flat, except at superior and inferior conjunction, when one of the stars moves in front of the other one, causing a complete eclipse. At these times only the brightness of the eclipsing star can be seen. Using apparent magnitudes, these values are $m_{\rm A}$ and $m_{\rm B}$ respectively; the combined apparent magnitude (away from the eclipses) is $m_{\rm Tot}$. If the effective temperatures of the stars are $T_{\rm A} = 5000\,{\rm K}$ and $T_{\rm B} = 12000\,{\rm K}$ respectively, calculate the size of the eclipses in magnitudes (i.e. calculate $m_{\rm B} = m_{\rm Tot} - m_{\rm A}$ and $m_{\rm A} = m_{\rm Tot} - m_{\rm B}$). Assume the stars have equal radii.

2. A planet with mass m orbits a star with mass M at a distance of a in a circular orbit. If the distance of the Star's centre to the common centre of mass is a', then show that:

$$MP^2 = a^2(a - a'),$$

where P is the orbital period in years, distances are in AU and masses are in Solar masses.

3. (a) If the Sun were to collapse into a neutron star with a radius of 8 km, what would be its density? (Assume no mass loss.)

   (b) What would be its rotational period if we assumed conservation of angular momentum and assumed that both the Sun and the pulsar are homogeneous spheres? (Remember the rotational period of the Sun is about a month – you can assume 30 days.)

4. The escape velocity of an object is given as $v_{\rm esc} = \sqrt{2GM/R}$. If the Sun were to turn into a black hole (without mass loss), how small would it need to be?