PROBLEM SET 2 – Astronomy 113

1. Calculate the gravitational redshift of radiation emitted from the surface of the sun, a white dwarf, and a neutron star, if they all have a mass of 1 $M_\odot$ and radii of 7×10^{10} cm, 10^9 cm and 10^6 cm respectively.

2. Find the shortest distance between two points on the surface of a cylinder.

3. Starting from an inertial frame O, find the metric in a uniformly accelerating frame $\tilde{O}$. Use the transformation $t = \tilde{t}$ and $x = \tilde{x} - \frac{1}{2}a\tilde{t}^2$. Using this metric, write the equation of motion for a particle in $\tilde{O}$.

4. Write the equation of motion for a particle in a Robertson-Walker metric constrained to move in a radial direction.

5. At constant time in an open Robertson-Walker universe with $k = -1$, find the surface area of a sphere as a function of physical radius.

6. Find the deceleration parameter $q = -\ddot{R}R/\dot{R}^2$ as a function of redshift z in a Friedmann universe with $\Lambda = 0$. What are its limiting values when $z \to \infty$ and when $t \to \infty$?