

Cosmo. 101 2005
Problem Set 1

1. The metric for spacetime in the gravitational field surrounding a neutron star is

$$-ds^2 = d\tau^2 = (1 - 2\Phi)dt^2 - \frac{dr^2}{1 - 2\Phi} - r^2d\Omega^2,$$

where $\Phi = GM/rc^2$ and M is $1.44M_\odot$. [Note: the mass of the sun $M_\odot = 2 \times 10^{33}$ g.] The parameters r and t are coordinates that must be tied to physical lengths that we measure with clocks and rulers. A building contractor is hired to cover the surface of the neutron star with linoleum. He finds that he needs 1.26×10^{13} cm² of linoleum to do the job.

- a) The workers punch a time clock (located a large distance from the surface of the star) just before and after doing the job and find that they will get paid for 8 hours of work. Curiously, their wristwatches show a different elapsed time. How much time did the workers actually put in? Are they pleased or annoyed? (The travel time to and from the surface is negligible).
- b) Another contractor is hired to install a second floor precisely 1 km above the first. How much linoleum will he need to do the job?

Solutions may be worked to astronomical accuracy.