HW6

Reading assignment: Feynman 6.1-6.3 on curved space.

1. By Tuesday at 6pm, please email me the topic of your project and if you are willing to present on Thursday.

2. (optional – spacetime intervals and black holes) Feynman and Einstein talk about spacetime intervals $ds^2 = dx^2 + dy^2 + dz^2 - dt^2$, specifying this interval is exactly what is meant by geometry of spacetime. Here dx etc are the infinitesimal lengths, and you may find it helpful to think of this as $\Delta s^2 = \Delta x^2 + \Delta y^2 + \Delta z^2 - (\Delta t)^2$. (a) Light travels along null curves (ds^2=0). Assuming the light emitted does not travel in y or z directions find the curve light follows. (HINT: first find the differential equation $(dx/dt)^2$ and then solve it). Draw this curve. (b) The non-spinning black hole of mass M has a spacetime interval (in polar r, θ, ϕ coordinates)

$$ds^2 = -\left(1 - \frac{2M}{r}\right) dt^2 + \left(1 - \frac{2M}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2$$

Assume the pulse of light only travels in the r direction, find the curve describing its path (HINT: it might be easier to find the curve $t(r)$ instead of $r(t)$). What happens at $r = 2M$?

3. (Physics of Back to the Future) Please be thinking about the movie and physics/paradoxes of time travel for tomorrow. In particular, there is the issue of internal consistency of the movie within the "universe" setup by the writers. Also we need to consider what our universe's physical laws say about that type of time travel. Finally, what general questions, principles, or issues need to be addressed. Some points to consider:

- How fast would light need to be for Marty to go 88mph and end up 30 years into the future and not age? Spacetime diagram of this?
- What is the ripple effect mentioned in the movie? Should one believe it?
- Does time travel violate energy-mass conservation?
- How are the character's memories influenced by time travel?
- When Biff goes back in 1955 to give himself the Almanac 1985 is change but not 2015. Is this OK?
- Will a paradox really destroy the universe? Does the universe have a mechanism in place to prevent them?
- Is the car accident Biff had destiny?
- Why can't docs letter prevent the event from happening?