Friday, April 3, 2015

Reading:

**Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10**

**Chapter 9: all except 9.6.3, 9.6.4**

video on black holes,

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**Astronomy in the news?**

Wheeler in DC. James Webb Space Telescope remains on (revised) schedule and (revised) budget, funding for astronomy is very constricted for the foreseeable future.
Goal:

To understand the historical roots and basic theoretical concepts behind black holes and the huge conceptual differences between Newton’s and Einstein’s view of gravity.
Black Holes

Mitchell, Laplace, late 18th Century: with Newton’s Gravity could have bodies with escape velocity greater than the speed of light
=> light could not get out, completely dark, corps obscur.

Now know Newton was wrong.

Excellent approximation for weak gravity - “true” in that case

Conceptual problems $F = \frac{G M_1 M_2}{r^2}$

infinite force for zero separation
instantaneous reaction => infinite speed of gravity

In physics infinity => problem

Experiment – Newton’s theory predicts the wrong deflection of light.

Need Einstein and more!
Great conceptual differences between Newton and Einstein on the Nature of Gravity

Newton - Force between two objects

Einstein - Mass curves space, objects move with no force in curved space

Need to explore curved space - use geometry in multiple dimensions
Goals:

To understand how Einstein taught us to think about space, time, and gravity.

To understand what we mean by space.

To understand how space can be curved.
Dimensions - defined by the number of mutually perpendicular directions

0 D - point

1 D - line

2 D - area

3 D - volume (secret hand sign)

4 D - ?

Hyperspace - space with more dimensions than the one under consideration
Gravity

Still a deep mystery. Objects of different mass fall with the same acceleration.

Explore how Einstein taught us to think about gravity: no *force of gravity*, but the effect of *curved space*.

Explore the geometry of space with straight lines.

Straight line on a curved surface, possible or an oxymoron?
Euclidian - Flat Space Geometry

\[ C = 2\pi r \quad \Sigma = 180^\circ \quad \text{never cross} \]

Answers only good in flat space: operational definition of flat space
NOT necessarily two-dimensional!

Non-Euclidian geometry - curved space

Both flat space and curved space use concept of “straight line”
Route from JFK airport to Paris Orly.

Is this a straight line?