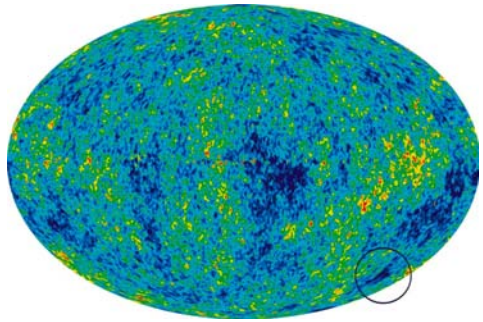
March 21, 2011

Reading: Chapter 7, Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10, Chapter 9 – Sections 9.1 – 9.5.1

Astronomy in the news? "Super Moon" full Moon on Saturday, Equinox, first day of spring yesterday.

This bomb in Libya was a detonation. The rising plume - a hot, expanding, turbulent ball of gas - has properties in common with the "broccoli" structure of the remnant of Tycho's supernova, possibly a leftover of the deflagration phase.

Pic of the day: the "cold spot" in the cosmic microwave background: a statistical fluctuation or quantum entanglement with a parallel universe?



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 escape velocity greater than the speed of light => light could not get out, completely dark, *corps obscurs*.

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 (in physics infinity $\Rightarrow$ problem)

instantaneous reaction => infinite speed of gravity

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.

SPACE - *The Final Frontier*

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

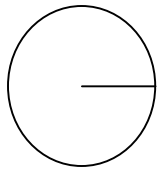
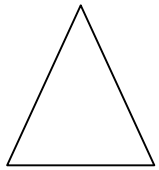
Still a deep mystery. Objects of different mass fall with the same acceleration.

Explore how Einstein taught us to think about gravity: no f*orce 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


$C=2\pi r$ $\sum = 180°$ 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”