Wednesday, March 21, 2012

Third exam, Friday, March 23.

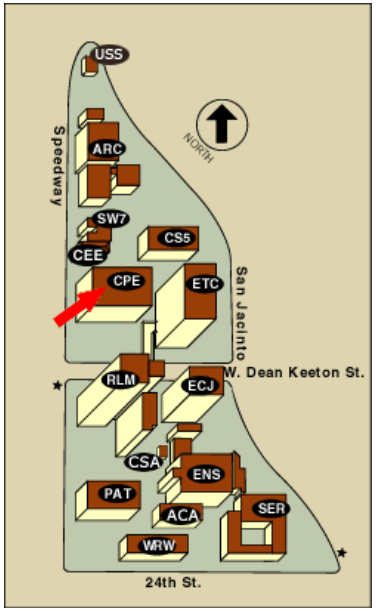
Third sky watch.

Review sheet posted. Missing item, speed of light circle, origin of gamma rays from pulsars.

Review Session Thursday, 5 – 6 PM, CPE 2.214

Reading: Chapter 6, Section 6.7, Chapter 7, Superluminous Supernovae not in book, Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Astronomy in the news? What was astronomically special about yesterday?



News:

Yesterday, March 20 was the Vernal Equinox, first day of Spring.

Also Nowruz, start of new year according to the 3000 year old Persian calendar.

# New Topic: Black Holes

Chapter 9

Reading, Chapter 9: all except 9.6.3, 9.6.4

# 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 $F = \frac{G M_1 M_2}{r^2}$ Newton's gravitational force

infinite force for zero separation (in physics infinity ⇒ 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

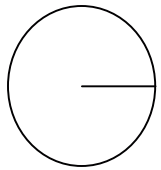
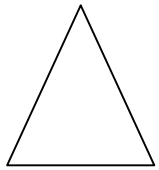
Still a deep mystery. Objects of different mass fall with the same acceleration.

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”

Curved Space - explore with straight lines

Definition of straight line

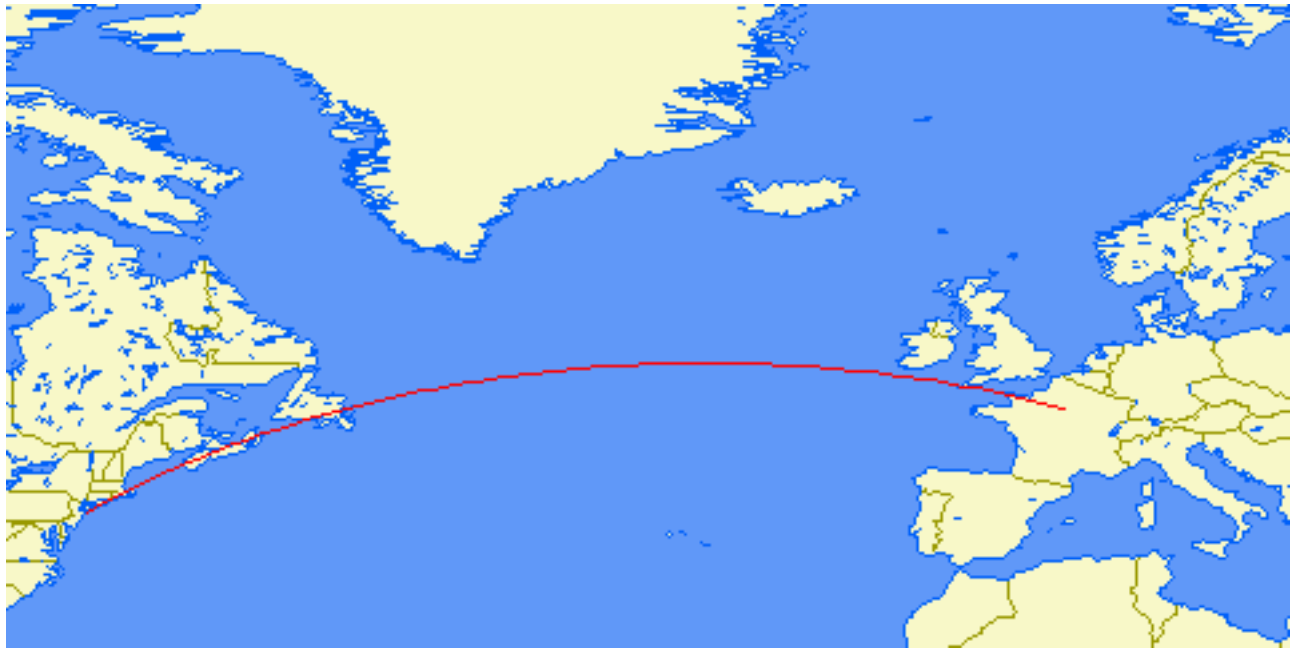
Shortest distance between 2 points - rubber band

Draw a free hand straight line

***Parallel propagation*** - rulers

Parallel propagation will give the shortest distance between two points without necessarily knowing where the two points are in advance.

Parallel propagation works easily, even when the space is *curved*.



Route from JFK airport to Paris Orly.

Is this a straight line?