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,

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 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
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.

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

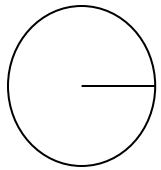
Still a deep mystery. Objects of different mass fall with the same acceleration.

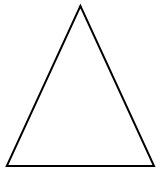
Explore how Einstein taught us to think about gravity: no f*orce of gravity*, but the effect of ***curved space***.

Explore the geometry of space with straight lines.

Straight line on a curved surface, possible or an oxymoron?

Euclidian - Flat Space Geometry



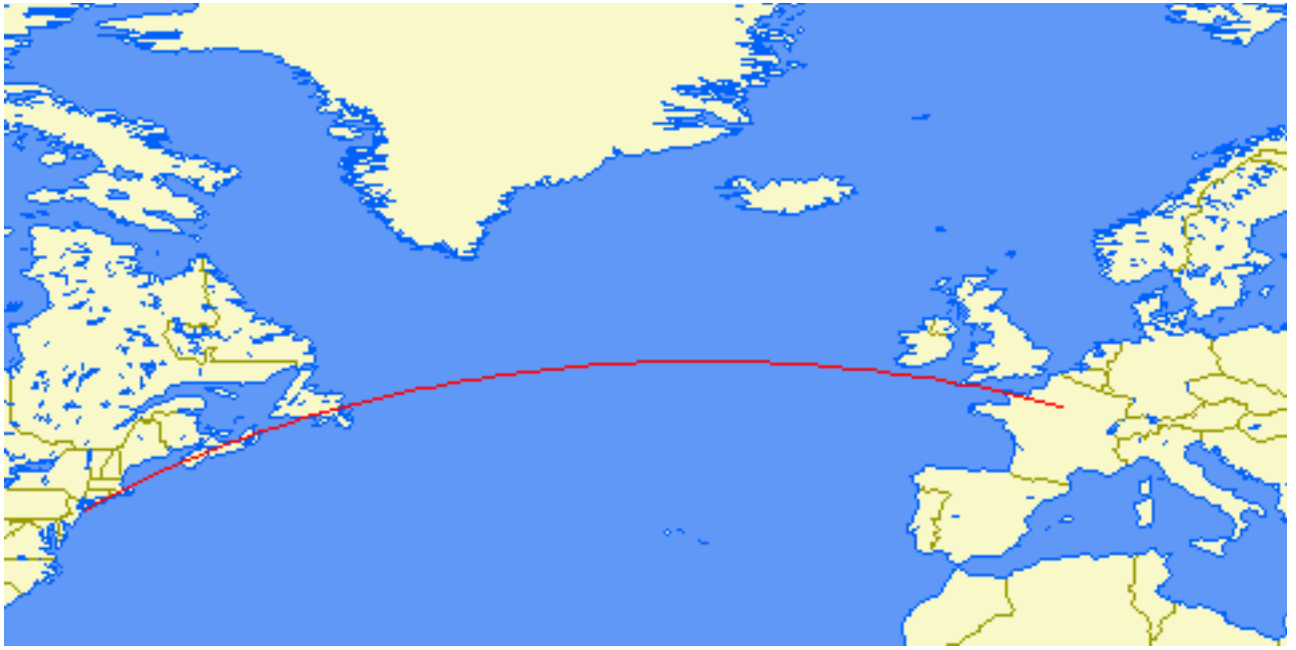


$C=2\pi r$ $\sum=180°$ never cross

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"



Route from JFK airport to Paris Orly.

Is this a straight line?