March 23, 2011

3rd exam, Friday, April 1

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? Iodine-131, 53 protons, 78 neutrons, half-life 8 days, Cesium-137, 55 protons, 82 neutrons, half-life 30 years, formed when uranium (formed in supernovae) decays.

President Obama in Chile, praises astronomy as an important factor in US/Chilean interactions.

Pic of the day: Red Square Nebula around dustenshrouded, massive star, maybe like rings of SN 1987A seen directly from the side.



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.

Euclidian - Flat Space Geometry



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?

Geometry on the 2D surface of the balloon

Exercises of drawing straight lines

Balloon

Surface is curved 2 D space

3 D space around the balloon, inside the balloon is *hyperspace* with respect to the 2D surface

Imagine a 2 D creature that can only perceive 2 D space.

2 D creatures can learn all about the curvature of the space they inhabit by doing geometry in 2 D - they never need to know about or care about "hyperspace."

That's us in 3 D! There might be 4D (or higher!) hyperspace around us, but we don't perceive it.

We can, in principle, learn everything we need to know about our 3D Universe by doing 3D observations and experiments in the confines of our own dimensionality, just as 2D creatures could learn of their universe, the surface of the balloon. What you need to know about the surface of the balloon -

What is a straight line, what is not?

What is "inside" the surface? What is "outside" the surface

Where is the "center" of the **surface**?

What does it mean to go from surface point to surface point "through" the balloon interior?

How do you determine the shape of the surface by doing geometry?

Real 3 D curved space (for us!!) might curve in a 4 D "hyperspace," but we do not directly perceive that hyperspace.

We can determine the curvature, shape of our real 3 D space by doing 3 D geometry.

Do not need to ask about 4 D (but will!)