3/27/06

Chapter 9 - Black Holes

News:

Pic of the day; Moonquakes

Great conceptual differences between Newton and Einstein

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

SPACE - *The Final Frontier*

Dimensions - defined by the number of mutually perpendicular directions

0 D - point

1 D - line

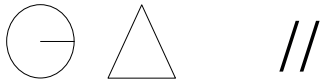
2 D - area

3 D - volume (secret hand sign)

4 D - ?

Hyperspace - space with more dimensions than the one under consideration

Euclidian - Flat Space Geometry



$C=2\pi r$ $\sum=180°$ never cross

Answers only good in ***flat space***: operational definition of flat space

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 point without necessarily knowing where the two points are in advance.

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.

Geometry on the 2D surface of the balloon

Exercises of drawing straight lines