Thursday, April 2, 2009

Third Exam, Thursday, April 16. Neutron Stars and Black Holes

Astronomy in the News:

Jupiter Red Spot shrinking

International Year of Astronomy, 100 hours of astronomy

Pic of the Day - see above



Invert balloon - 2 D embedding diagram of curved 3 D space around gravitating object

Properties of this curved space that are preserved in the embedding diagram:

 $C < 2\pi r$

Sum of angles of triangle not equal 180° (can be > or <)

Parallel lines diverge or cross

Embedding diagram:

- Real Space -> Embedding Diagram Space
- Volume (3D) -> Surface (2D)
- Surface (2D) -> Line (1D)
- Line (1D) -> Point (0D)

Figure 9.4



Straight lines in the 2D embedding diagram of curved, gravitating space.

Orbit - circle around "cone"

Moon is going as straight as it can in curved space around the Earth

This is how gravity works for Einstein - no Newtonian Force -

Gravitating objects curve the space around them - nearby objects move in that curved space

The parallel-propagated straight lines of their force-free motion are warped by the curved space.



Orbits in curved 2D embedding diagram of gravitating space

One Minute Exam

Compared to the two-dimensional surface of a balloon, the inside is:

- A) A two-dimensional hyperspace
- B) A three-dimensional hyperspace
- C) A four-dimensional hyperspace
- D) Accessible to a two-dimensional creature

3 D gravitating space is not a "cone;" that is just an artifact of the 2 D embedding diagram.

Real 3 D space around gravitating objects has the properties:

 $C < 2\pi R$

 Δ not equal 180°

// lines cross

light is deflected (this one has been experimentally verified)



Fig 9.6



Basic properties of a (non-rotating) black hole



Tidal Forces



2D embedding diagram of 3D curved space around a black hole

Black holes and Time (Section 5.2)

If a clock moves away from an observer it ticks more slowly.

If a clock is deep in a gravity well it ticks more slowly according to an observer at large distance where gravity is absent.

Get both effects if you drop a "clock" into a black hole and watch it fall in from a safe distance where gravity is weak (flat 3D space).

What does it mean to fall? Rather deep and strange phenomenon! Drop things, fall at same rate...