March 22, 2010

Third Exam this Friday, Review Session Thursday, 5 - 6 PM, WEL 2.246 (special review for those with whom I've talked, Wed, 5 - 6 PM in my office).

Reading: Chapter 7, SN 1987A, Chapter 8, Neutron Stars - Sections 8.1, 8.2, 8.5, 8.6, 8.10, Chapter 9, black holes, curved space, Sections 9.1, 9.2, 9.3, 9.4, 9.5.1.

Astronomy in the News? New soft gamma-ray repeater outburst, magnetar, near Sagittarius. New recurrent nova outburst in Cygnus with Red Giant and White Dwarf binary.

Pic of the Day - cold dust in the Galaxy from the new Planck satellite.

Old lecture notes if you want to browse ahead. I may modify these a little, but not much.

http://www.as.utexas.edu/astronomy/education/fall09/wheeler/309n.html?a=lec

Add to Sky Watch

New Soft Gamma-ray repeater outburst, SGR 1833--0832, in direction of Sagittarius, center of Milky Way, is a magnetar with a “pulsar” spin period of 7.56 seconds.

Recurrent Nova outburst, V407 Cygni, first ever seen in a binary system with a Red Giant and White Dwarf. Possible precursor to a Type Ia supernova.

Goal:

To understand the nature of curved space, and hence of gravity, in the vicinity of a massive object, a planet, star, or black hole.

To understand the role of an “embedding diagram,” in helping to explain that curved space.

Embedding diagram - 2 D "shadow" of 3 D curved space, preserves basic aspects of geometry, whether curved or not, and, if curved, how.

Meaning of ***flat space*** in 3 (or higher) dimensions

If 3 D space is flat: $C=2\pi r$; sum of angles of triangle $=180°$; parallel beams of light never cross ***in 3D***.

The embedding diagram of 3D flat space is a flat 2D plane

In curved 3D space, the flat space answers will be wrong: 2D embedding diagram will help to illustrate that.

Embedding diagram:

Real Space -> Embedding Diagram Space

Volume (3D) -> Surface (2D)

Surface (2D) -> Line (1D)

Line (1D) -> Point (0D)

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:

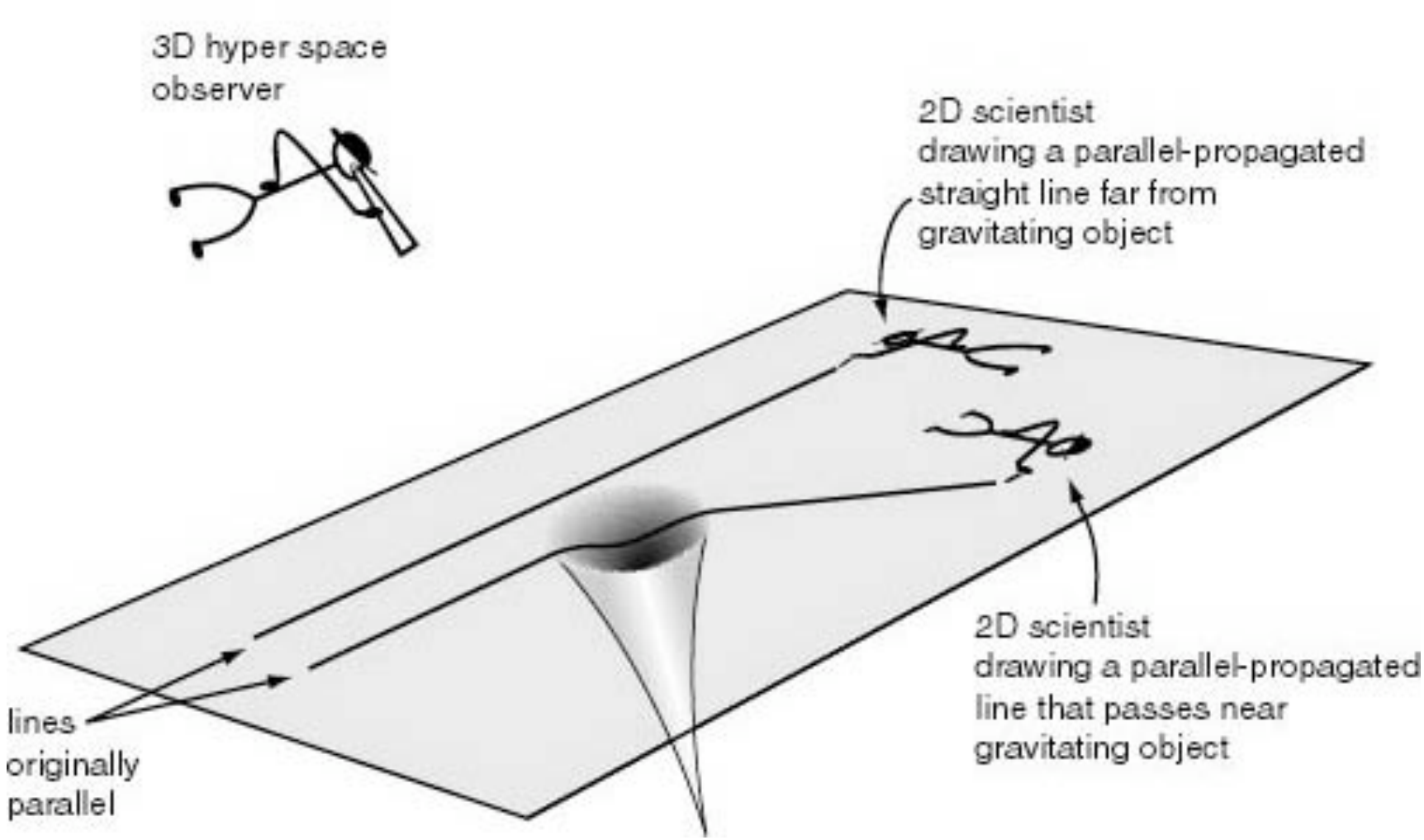
$C < 2\pi r$

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

Parallel lines diverge or cross

Orbits around “cone”

Figure 9.4



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

Goal:

To understand what Einstein means by an orbit.

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

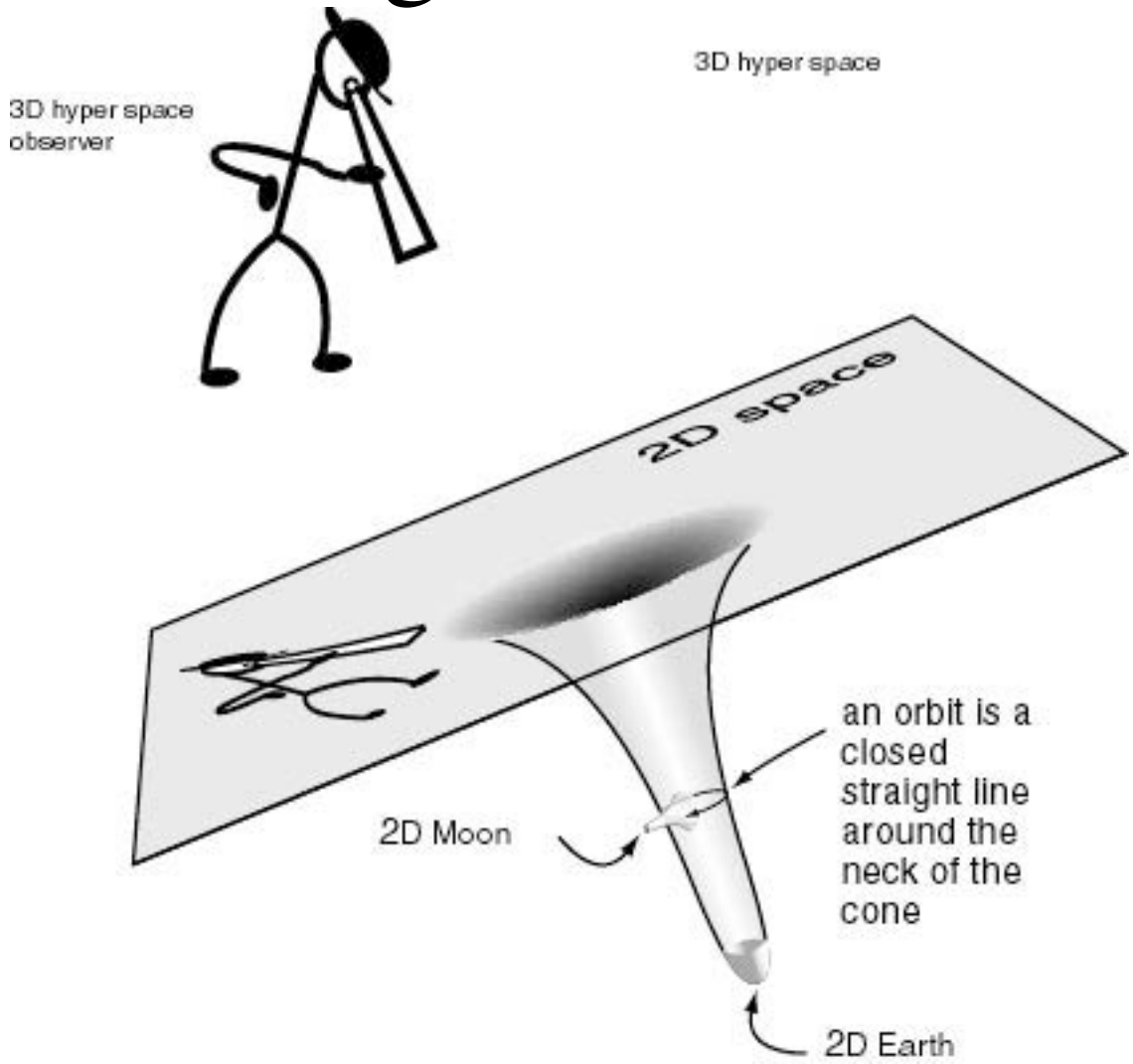
The parallel-propagated straight lines of their force-free motion are warped by the curved space.

One Minute Exam

In a two-dimensional embedding diagram of the Earth, the surface of the Earth would be represented by:

- ➡ A volume
- ⬅ A surface
- ⬆ A line
- ⬇ A point

Figure 9.5



Orbits in curved 2D embedding diagram of gravitating space

One Minute Exam

An astronomer fires two laser beams so they will pass near a distant black hole. The beams are initially parallel. An astronaut on the far side of the black hole tracks the two beams and finds that they are diverging, but that they never crossed. This means that:

one of the beams entered the black hole

the beams passed on opposite sides of the black hole

the beams passed on the same side of the black hole

one of the beams had more energy than the other