Wednesday, April 8, 2015

4th Exam, Skywatch, Friday, April 17

Reading:

Chapter 8 Neutron Stars - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Chapter 9 Theory of Black Holes: all except 9.6.3, 9.6.4

Astronomy in the news?

"A sequence of freaky cryptic signals from outer space, known as Fast Radio Bursts, have gotten astronomers scratching their heads and wondering if they are possibly picking up some kind of extraterrestrial messages." FRB last several milliseconds, might be happening 10,000 times per day, not all detected. Distance unclear. *Connection to extraterrestrial beings speculative hype*.

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: Removes one dimension, but preserves key aspects of the geometry, curved or not, and how curved.

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:

$C < 2\pi r$

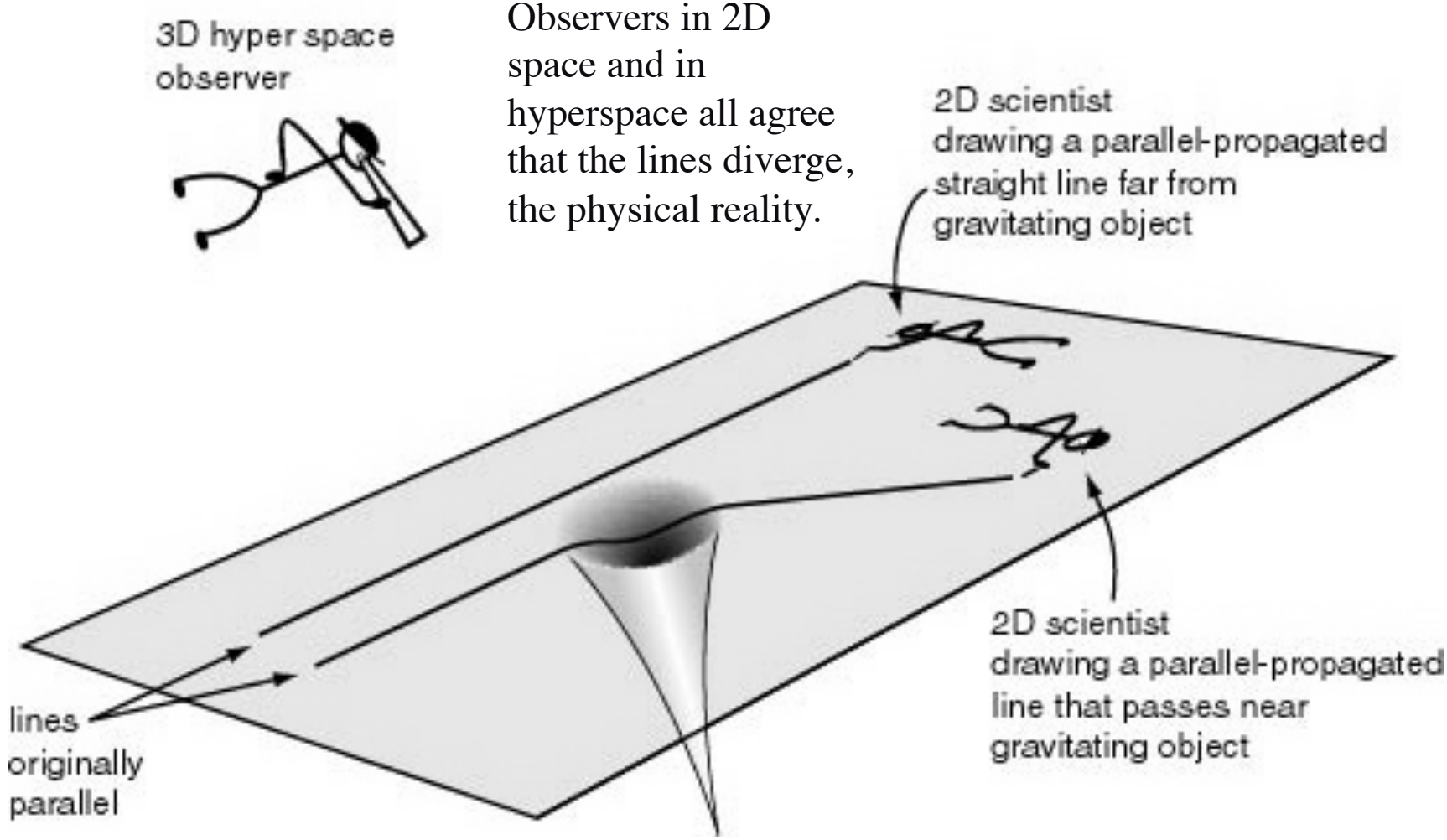
Sum of angles of triangle not equal 180^o (can be > or <)

Parallel lines diverge or cross

Orbits around "cone"

Far from a gravitating object, the curvature and hence gravity, gets very weak, 3D space becomes FLAT, and the corresponding embedding diagram is a flat 2D plane (can't show this with the balloon).

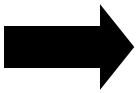
Figure 9.4



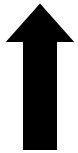
Straight lines in the 2D embedding diagram of curved, gravitating space.

One Minute Exam

In the corresponding two-dimensional embedding diagram, the interior volume of a real, three-dimensional planet would be represented as:

 A point

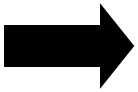
 A line

 An area

 A volume

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

Goal:

To understand what Einstein means by an orbit.

Orbit - circle around “cone”

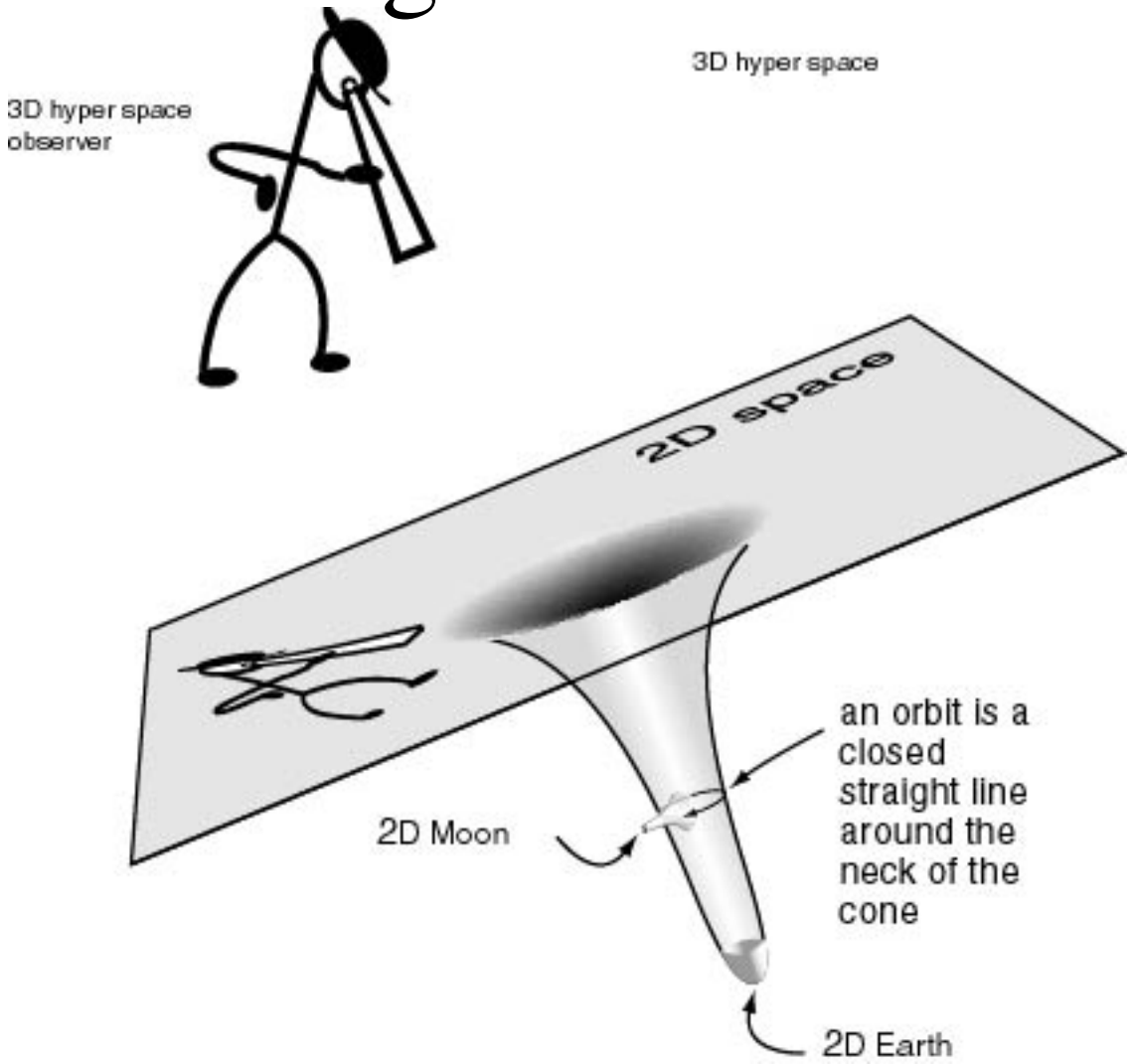
Moon is going as straight as it can in curved space around the Earth

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.

Figure 9.5



Orbits in curved 2D embedding diagram of gravitating space