Monday, April 3, 2017

Glitch in grading scantrons. Redone, reposted. Multiple choice posted.

Exam back Wednesday, key posted.

Exam 4, Skywatch 4, Friday, April 21.

Reading for Exam 4:

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

Chapter 9 Theory of Black Holes: 9.1 to 9.5

Astronomy in the news

Last Tuesday, President Trump signed an authorization bill for NASA for $19.5 billion and made sending humans to Mars a formal priority.
Wheeler was invited to write an opinion piece.
http://www.dallasnews.com/opinion/commentary/2017/03/29/nasa-budget-good-science-funding-may-wither Twitter reaction.

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)

Embedding diagrams allow us to visualize some aspects of the curvature of space from a higher dimensional “hyperspace” perspective.

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

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 and are **true in the original 3D space**:

$C < 2\pi r$

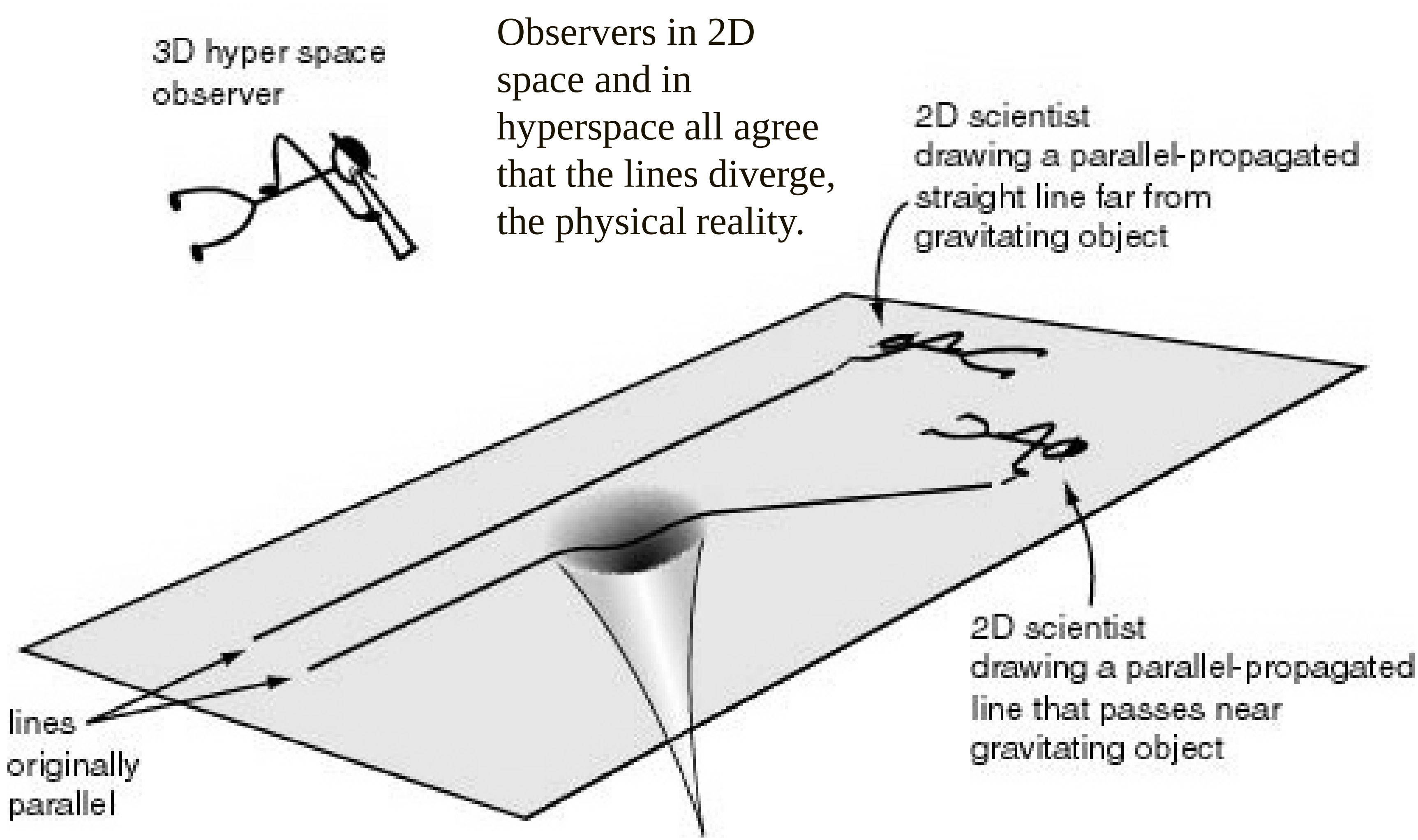
Sum of angles of triangle not equal 180° (can be > or <)

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.

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

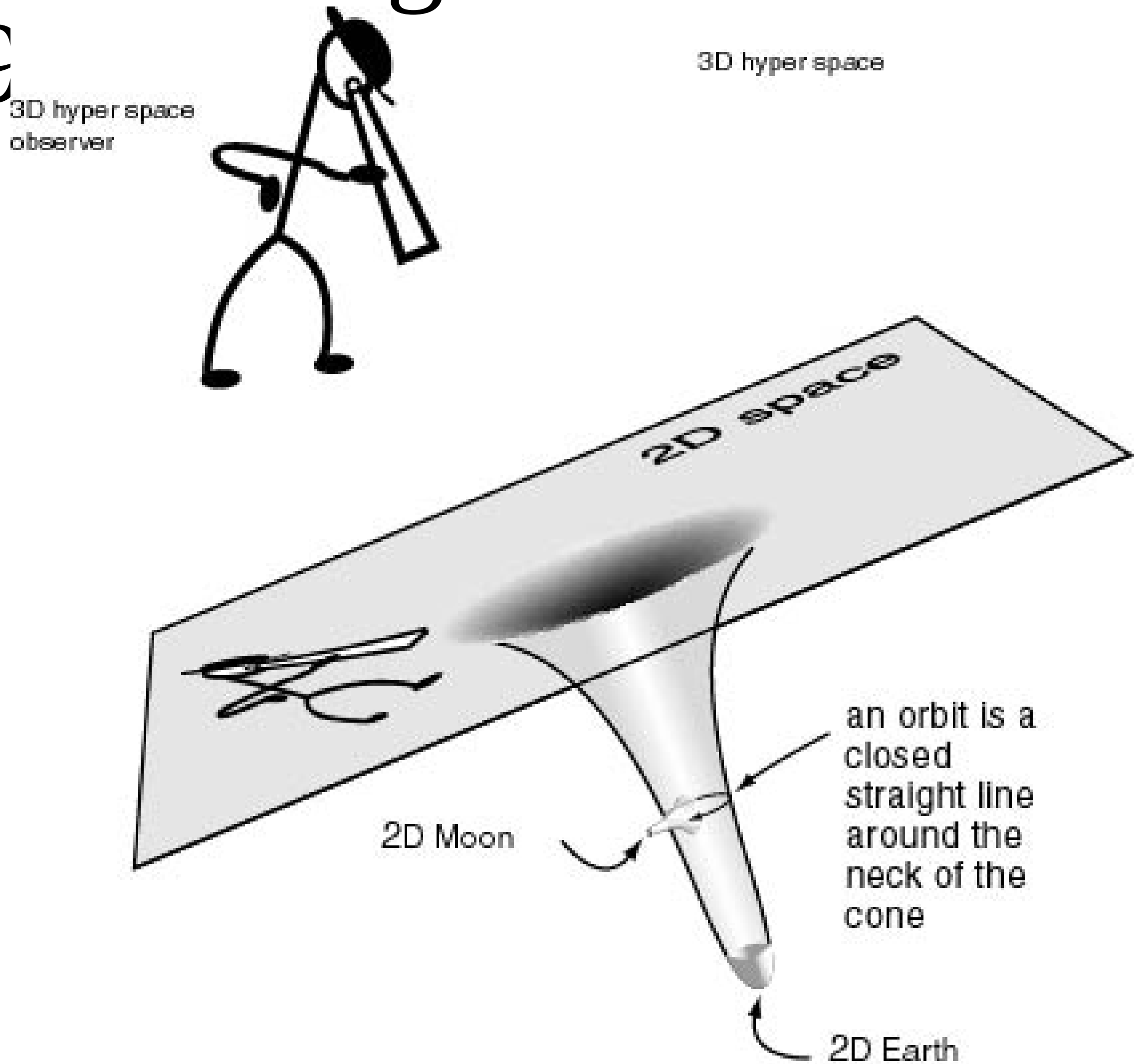
This is how gravity works for Einstein - no Newtonian Force -

Gravitating objects curve the space around them - nearby objects move *with no force* in that curved space

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

Figure 9.5

Figure 9



Orbits in curved 2D embedding diagram of gravitating space

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:

$C < 2\pi R$ (True for a circle drawn around the Earth)

Δ not equal 180º

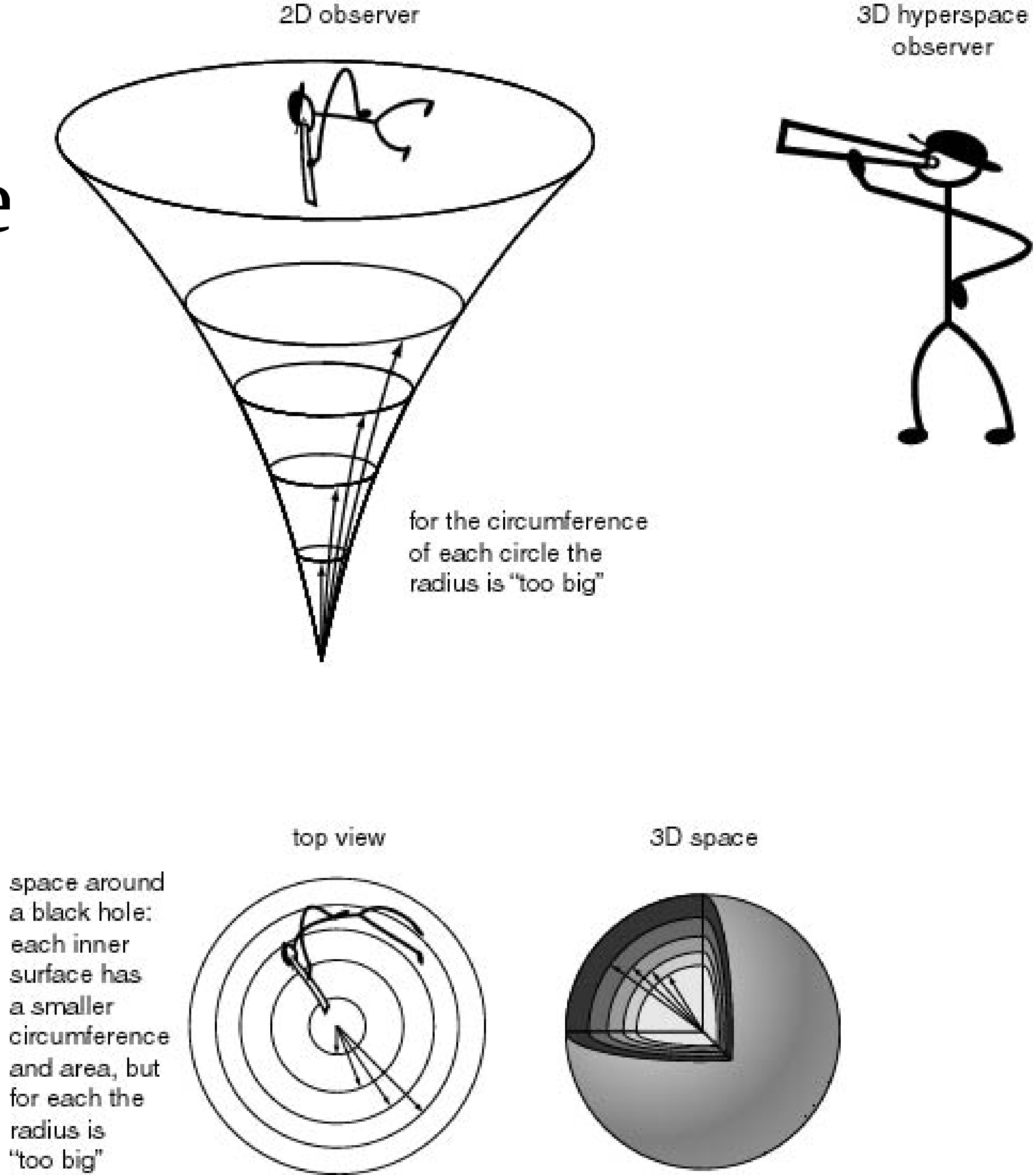
// lines cross or diverge

light is deflected (this one has been experimentally verified)

Goal:

To understand the “real” curved space of a gravitating object in three dimensions

Figure 9.6



Curved 3D space

First edition book cover…