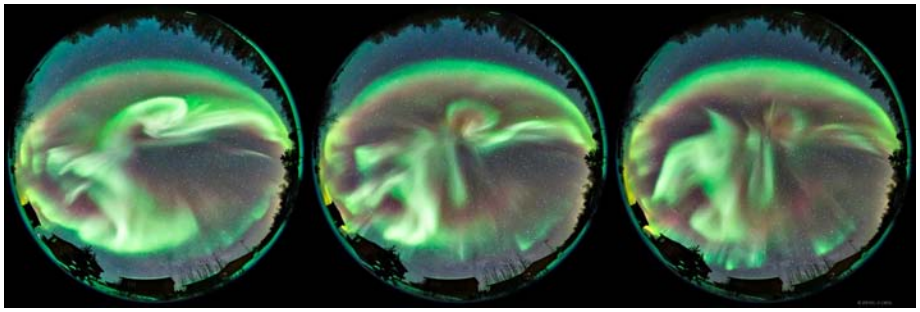
March 25, 2011

Exam 3, Friday April 1.

Reading: Chapter 7, Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10, Chapter 9 – Sections 9.1 – 9.5.1

Astronomy in the news? Public lecture last night by Lars Bildsten: supernovae currently being discovered at the rate of 20 per day. Essentially all secret. Supernovae are announced about once per day.

Pic of the day: All sky photos of aurorae over Yellowknife, Canada. Solar wind interacting with magnetic field of the Earth



Goals:

To understand how Einstein taught us to think about space, time, and gravity.

To understand what we mean by space.

To understand how space can be curved.

Check out

Dr. Quantum in Flatland

Right in spirit, wrong in some essential details. See if you can figure out what those are.

http://youtube.com/watch?v=KhbGYn7aAUk

Plan II sponsors screening of "Flatland"
Description: "Flatland" (2001) is a feature film adaptation of the 1884 novel by Edwin A. Abbott. It is the creation of independent filmmaker Ladd P. Ehlinger Jr., who directed, animated and edited the film. Producers Seth Caplan ('99) and Dano Johnson ('01), Plan II alumni, will introduce the film and talk with audience members about it and their own collaboration with Plan II Math Professor Michael Starbird.

Time: Saturday, 2-3:30 p.m.
Location: Texas Union Theater
Admission: Free and open to the public
URL: http://www.flatlandthefilm.com/

Up to 5 points extra credit on 3rd exam for those who attend and write up a report (minimum 500 words, typed).

One Minute Exam

In a curved space:

 Straight lines always connect to themselves

 Straight lines are the shortest distance between two points

 There are no straight lines

 The sum of the interior angles of a triangle is 180 degrees

One Minute Exam

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

 A two-dimensional hyperspace

 A three-dimensional hyperspace

 A four-dimensional hyperspace

 Accessible to a two-dimensional creature

One Minute Exam

An intelligent ant crawls around on a surface, drawing triangles as the intersection of 3 straight lines. She finds that the sum of the interior angles is always more than 180 degrees and that triangles of the same size always give the same results. She deduces that the following will be true:

➡ If she draws two straight lines that are initially parallel they will begin to diverge.

⬅ The surface she is walking on is three-dimensional

⬆ If she walks off in a straight line she will never return to her point of origin

⬇ If she walks off in a straight line she will return to her point of origin

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”

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:

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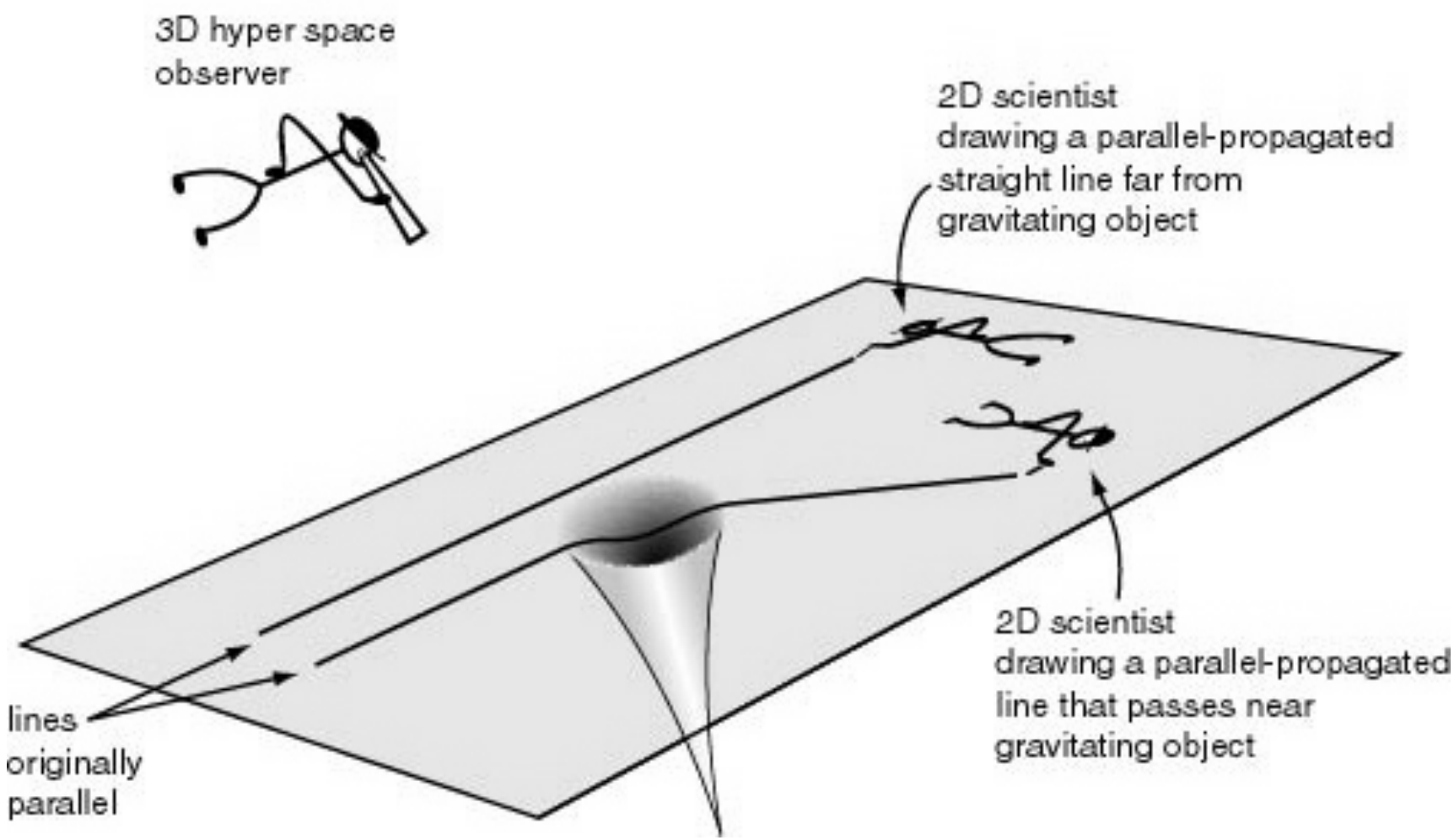
Figure 9.4



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

Goal:

To understand what Einstein means by an orbit.

Orbit - circle around “cone”

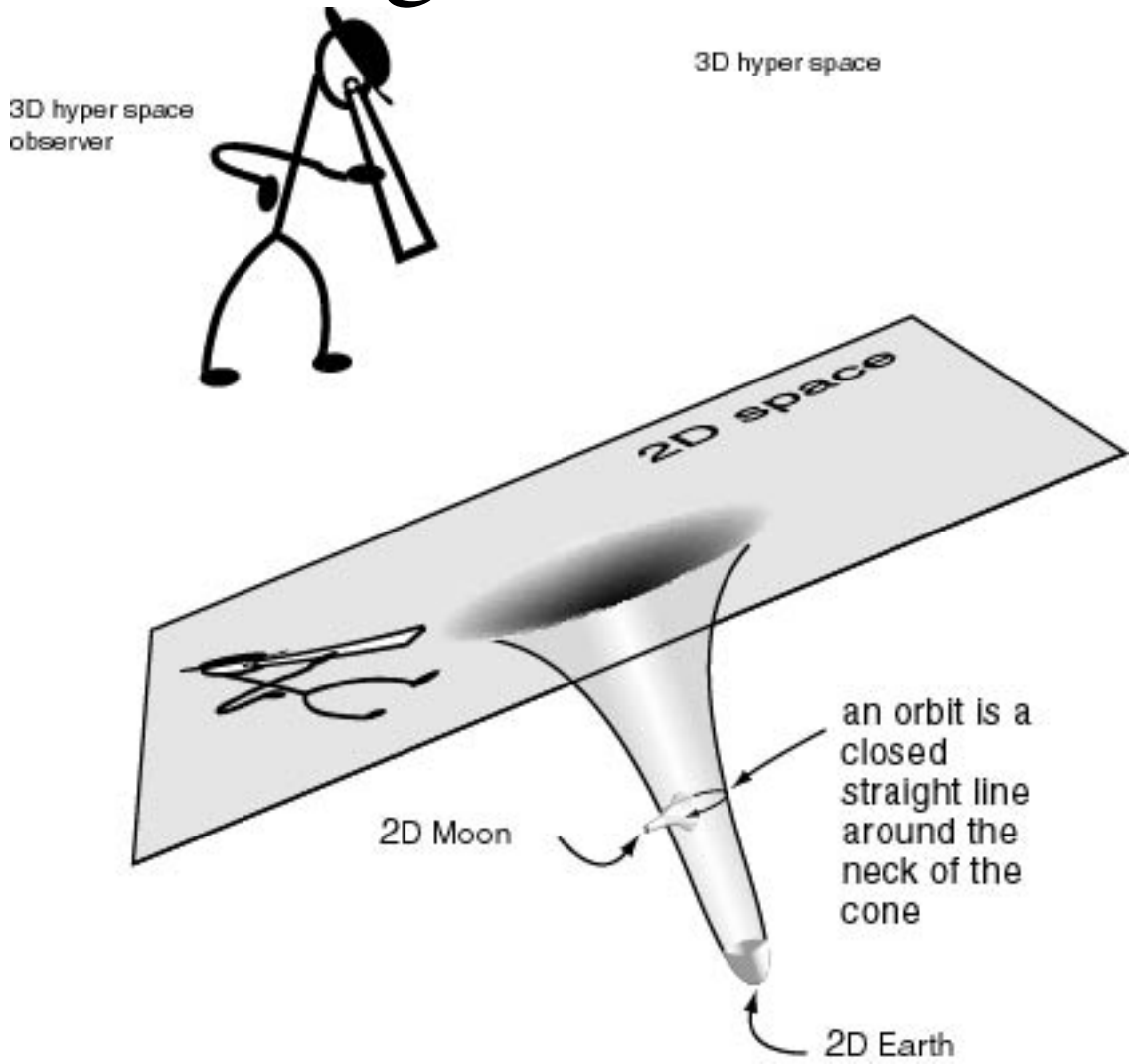
Moon is going as straight as it can in curved space around the Earth

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.

Figure 9.5



Orbits in curved 2D embedding diagram of gravitating space