Monday, November 14, 2011

Exam back Wednesday.

Reading: Chapter 12, Chapter 13, Chapter 14

Astronomy in the news? Soyuz rocket was successfully launched this morning, carrying two Russians and an American to the International Space Station. Unfortunately, the launch of the mission to Phobos seems to have failed in orbit.

The Fabric of the Cosmos, third installment, Quantum Leap, Wednesday, November 9, PBS (KLRU) 8 PM (re-runs http://www.klru.org/schedule/viewProgram.php?id=246736). Last installment, Wednesday, Nov 23.

Pic of the day: waterfall, rainbow and aurora in Iceland. Gravity, electromagnetic radiation, and magnetic fields.

Goal:

To understand the origin, shape, and fate of the whole Universe and how Type Ia supernovae have helped to revolutionize that understanding.

Chapter 12 Supernovae and the Universe

Expanding Universe - we observe all distant galaxies (so far away we cannot sense their individual gravity) moving away from us with speed proportional to distance: as if we were in the center of an explosion.

Our Universe is not a bomb in pre-existing empty 3-D space!

Lesson from Einstein - ***space itself can expand carrying the*** (almost motionless) ***galaxies***

All distant galaxies move away from all other distant galaxies.
No galaxy, certainly not us, is in the center.

The result: speed proportional to distance

Review:

What is hyperspace?

What is an embedding diagram?

Our Expanding Universe

Expanding ***surface*** of a balloon as an example

2D embedding diagram of a 3D expanding Universe

No 2D center, no 2D edge, no 2D outside

There is a 3D center, a 3D edge, a 3D outside, in 3D hyperspace

Our Expanding Universe

All 3D space expands - carrying essentially motionless matter (galaxies)

No 3D center, no 3D edge, no 3D outside

As 3D astronomers, we don’t have to ask what the Universe is expanding into, but if anything it is a 4 (or more) D hyperspace, just as a 2D balloon expands into 3D hyperspace.

Infinite flat rubber sheet could expand without expanding into any hyperspace (2D embedding diagram example).

Einstein’s theory says that for a Universe that is the same, on average, everywhere, there are only three basic shapes it can have

The 3D analog of a spherical surface - ***Closed Universe***

The 3D analog of a “saddle” or “Pringle” shape - ***Open Universe***

The 3D analog of a flat plane - ***Flat Universe***

The ***2D embedding diagrams*** of these 3D Universes are, respectively***, a sphere, an infinite saddle or Pringle, and an infinite flat plane.***

A closed universe is finite in space and time, the other two are infinite in space and time, but all must have started 13.7 billion years ago in the Big Bang.

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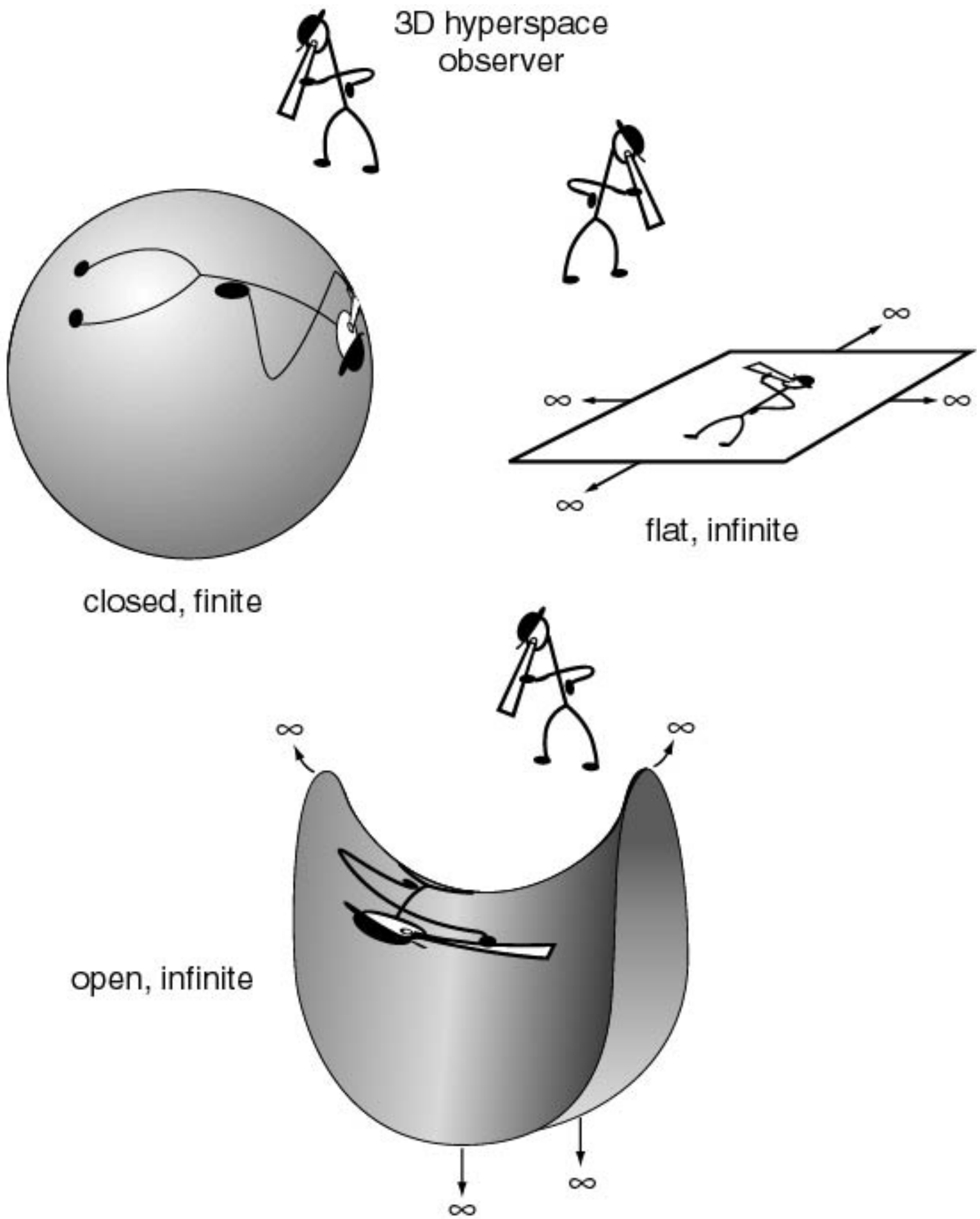

Fig. 11.1

2D embedding diagrams of possible shapes of our 3D Universe

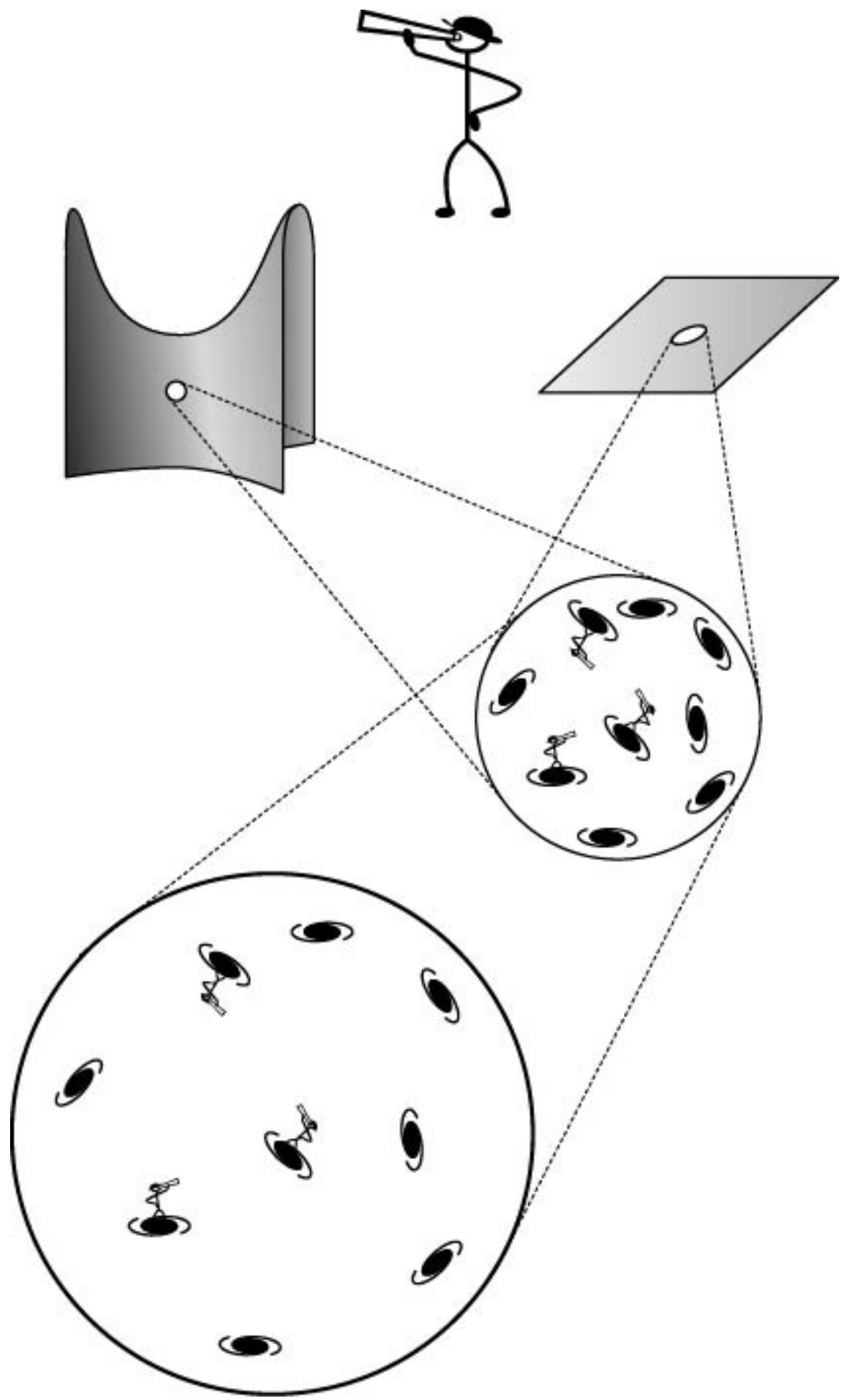

Fig 11.2

A patch of the space in a universe expands, drawing all galaxies away from all others, independent of the overall shape of the curvature of the universe.

Age and Fate of the Universe

All distances between distant galaxies are proportional to the time elapsed. Distance divided by the Velocity from the Doppler red shift
$\Rightarrow$ Age of Universe ~13.7 billion years

Fate of the Universe is intimately tied to the shape (we thought!)

Simplest choices:

finite age, re-collapse (***closed***, “sphere,” **high density**, high gravity)expand forever, $v > 0$ (***open***, “Pringle,” **low density**, low gravity)
Special Case: expand forever, $v \rightarrow 0$ as reach infinity (***flat***, **very special density** and gravity)

In principle, we can figure out the shape and fate of our Universe by doing 3-D geometry in our 3-D Universe, in practice we often try to measure the density of the matter.

One Minute Exam

Einstein says that more distant galaxies move away from us more rapidly because:

➡ The Earth is in the center of the Universe.

⬅ The Universe blew up in the Big Bang like a bomb blowing up in three-dimensional space.

⬆ Our 3D Universe expands into a 4D hyperspace.

⬇ Space expands, carrying all distant galaxies further apart from one another.

Hubble Deep Field – every speck a galaxy