Wednesday, April 26, 2017

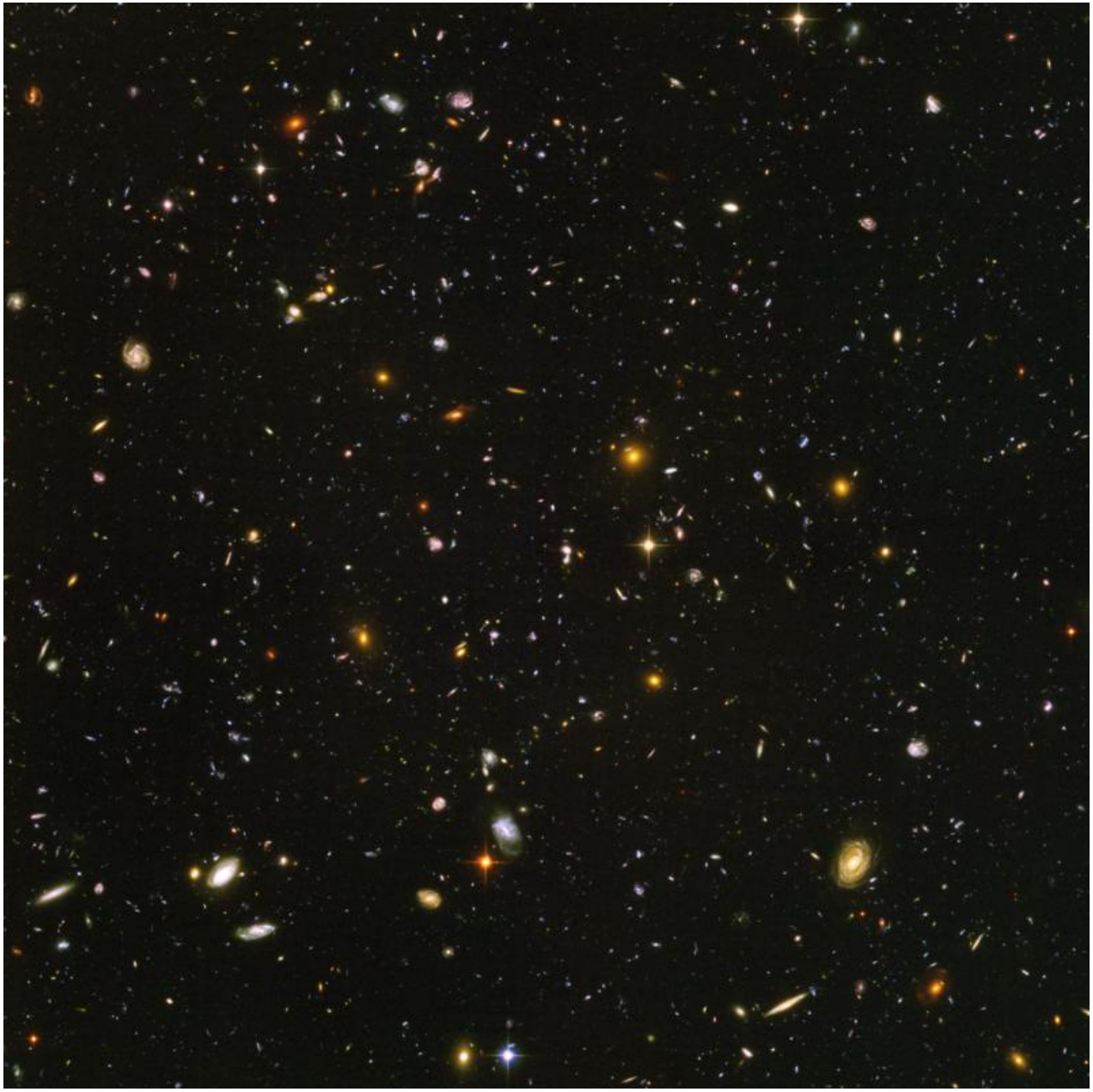
Fifth exam and sky watch, FRIDAY, May 5.

Reading for Exam 5: Chapter 9 – Sections 9.6.1, 9.6.2, 9.7; Chapter 10 - Sections 10.1-10.4, 10.9; Chapter 11 - all except Section 11.6 (abbreviated, focus on lectures); Chapter 12 - all; SKIP Chapter 13; **Chapter 14 – very abbreviated version.**

Electronic Course Survey is now available. Please respond, your feedback is very valuable.

Astronomy in the news?

Hubble Deep Field – every speck a galaxy



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 away from us, as determined by the Doppler red shift of the light from the galaxy, is proportional to distance

Review:

What is hyperspace?

What is an embedding diagram?

Our Expanding Universe

Expanding 2D ***surface*** of a balloon as an example

Expansion takes every point on the surface further from adjacent points.

This is the 2D embedding diagram of a possible 3D expanding Universe

For this 2D surface, there is no 2D center, no 2D edge, no 2D outside to the 2D surface

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 of how expansion does not necessarily mean intrusion into hyperspace)

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 both space and time, the other two are infinite in space and time, but any must have started 13.8 billion years ago in the Big Bang to describe our observed Universe.

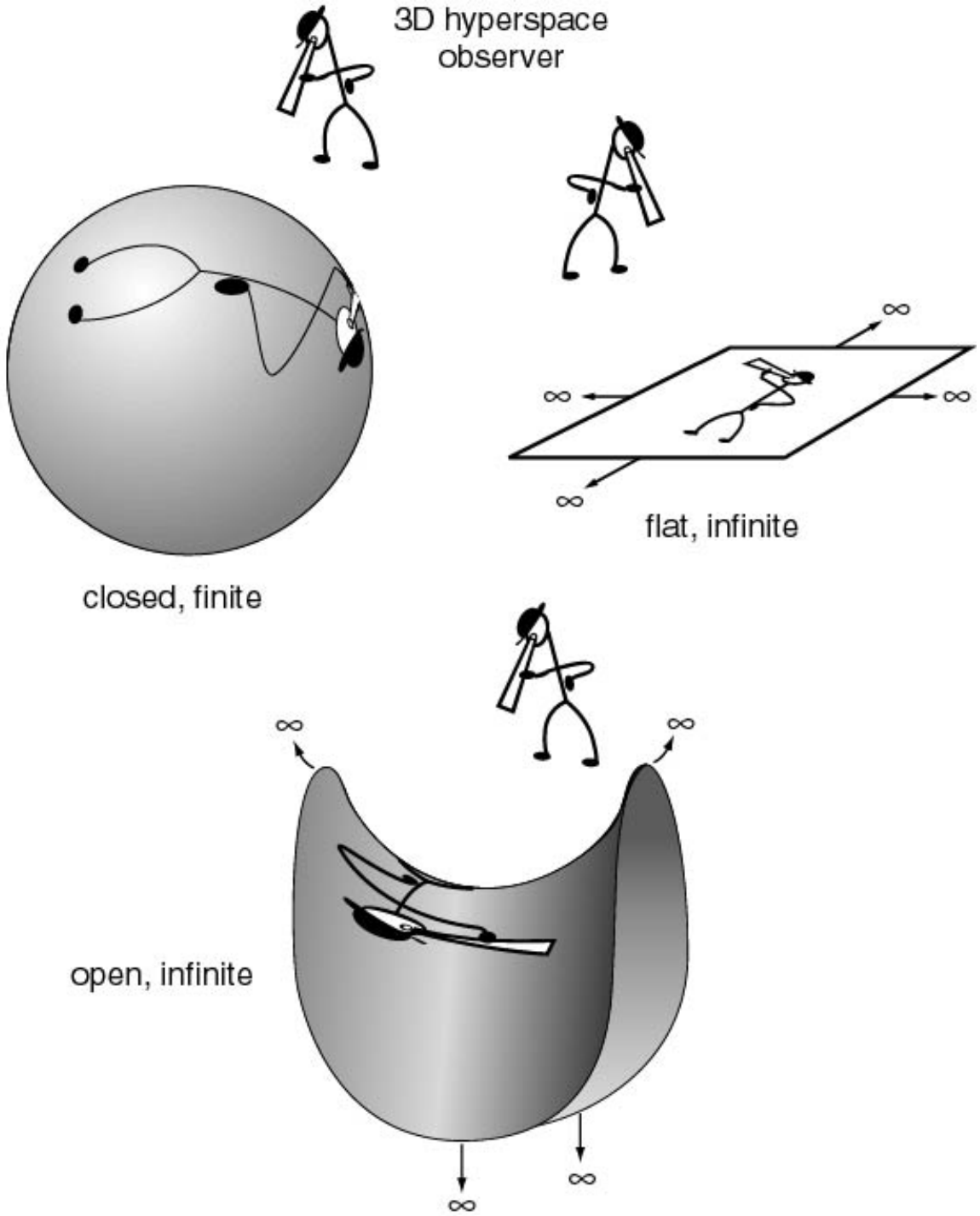


Fig. 11.1

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

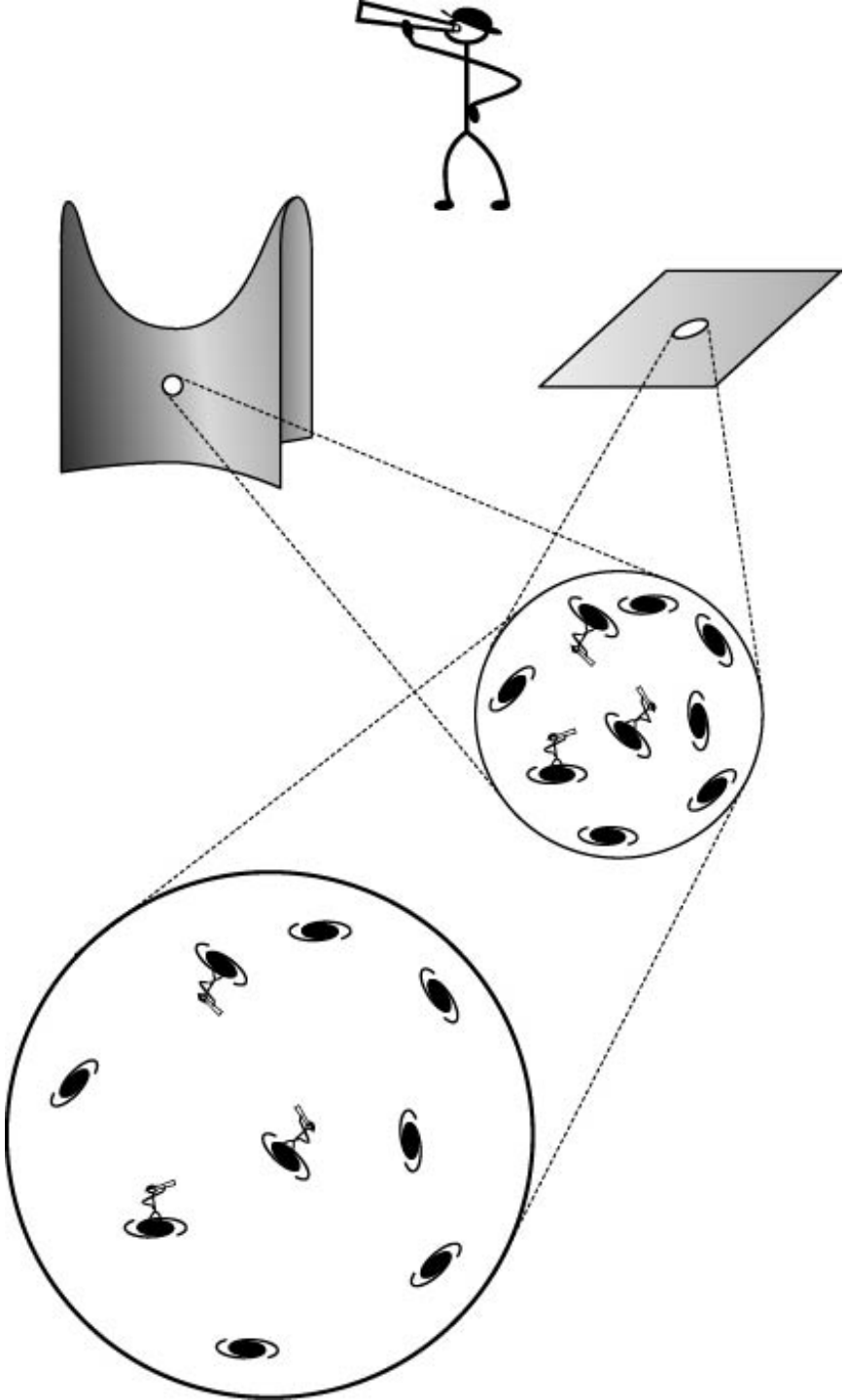


Fig 11.2

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.

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.

Space is smooth on average, but “dimpled” with the local effects of stars and galaxies.

Just as the desk top is composed of atoms and mostly empty space, but flat and smooth on a human scale.

The embedding diagram of the Universe would be a sphere, a “pringle” or a flat plane, dimpled by small cones representing the curved space around individual moons, planets, stars, galaxies.