

11/08/04

News?

Sky watch: Betelgeuse, Cassiopeiae (Cas A), Taurus (Crab Nebula), Cygnus, many other constellations relevant to the class.

Extra credit possible 5 points, half a grade.

Pic of the day: Venus and Jupier



Our Expanding Universe

Expanding Universe - we observe all distant galaxies moving away from us with speed proportional to distance

Space itself expands carrying the galaxies

All distant galaxies move away from all other distant galaxies

The result: speed proportional to distance

No galaxy, certainly not us, is in the center.

Expanding *surface* of a balloon as an example - no 2D center, no 2D edge, no 2D outside

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

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

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.

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

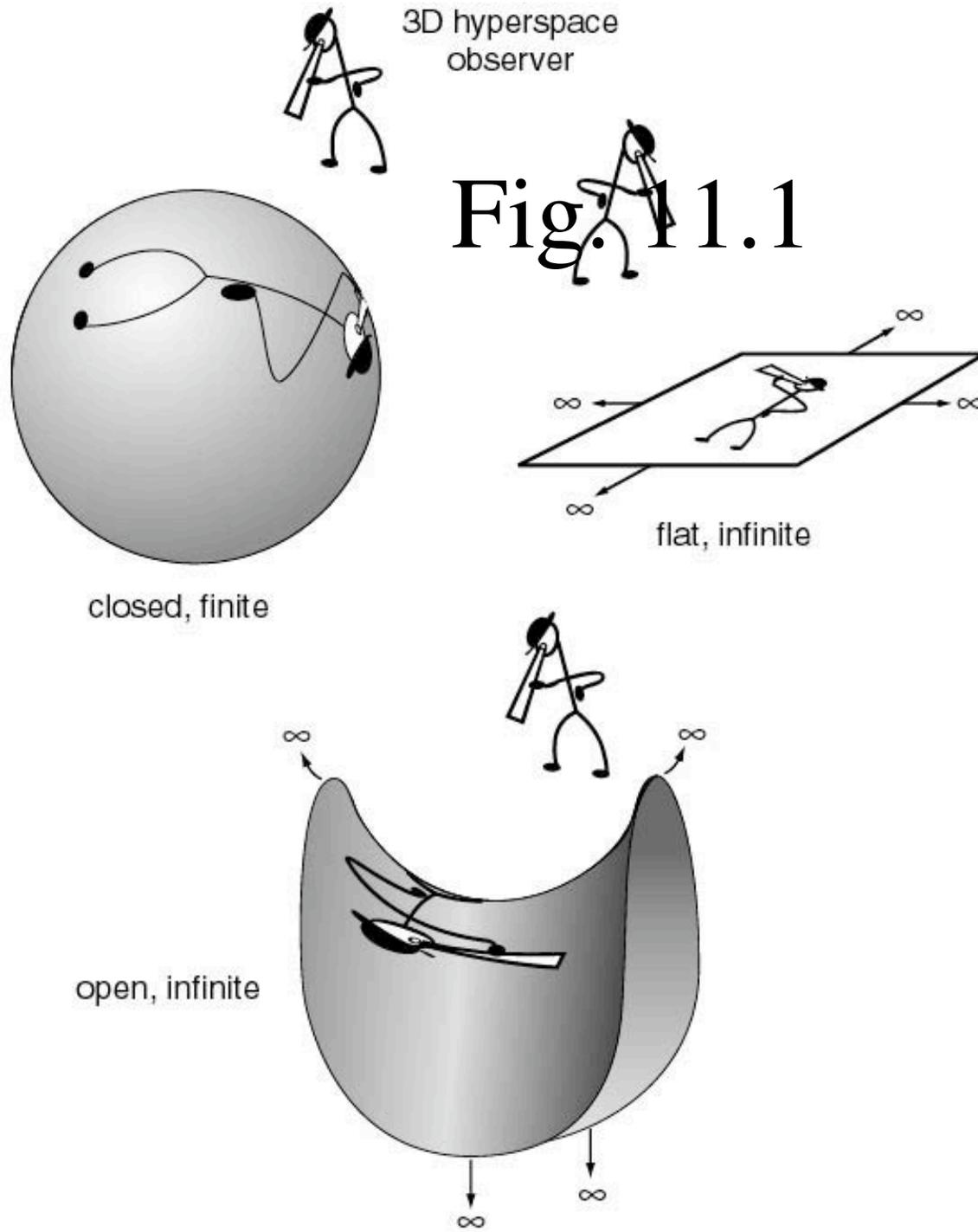
The 3D analog of a spherical surface - *Closed Universe*

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 14 billion years ago in the Big Bang.



3D hyperspace
observer

Fig. 11.1

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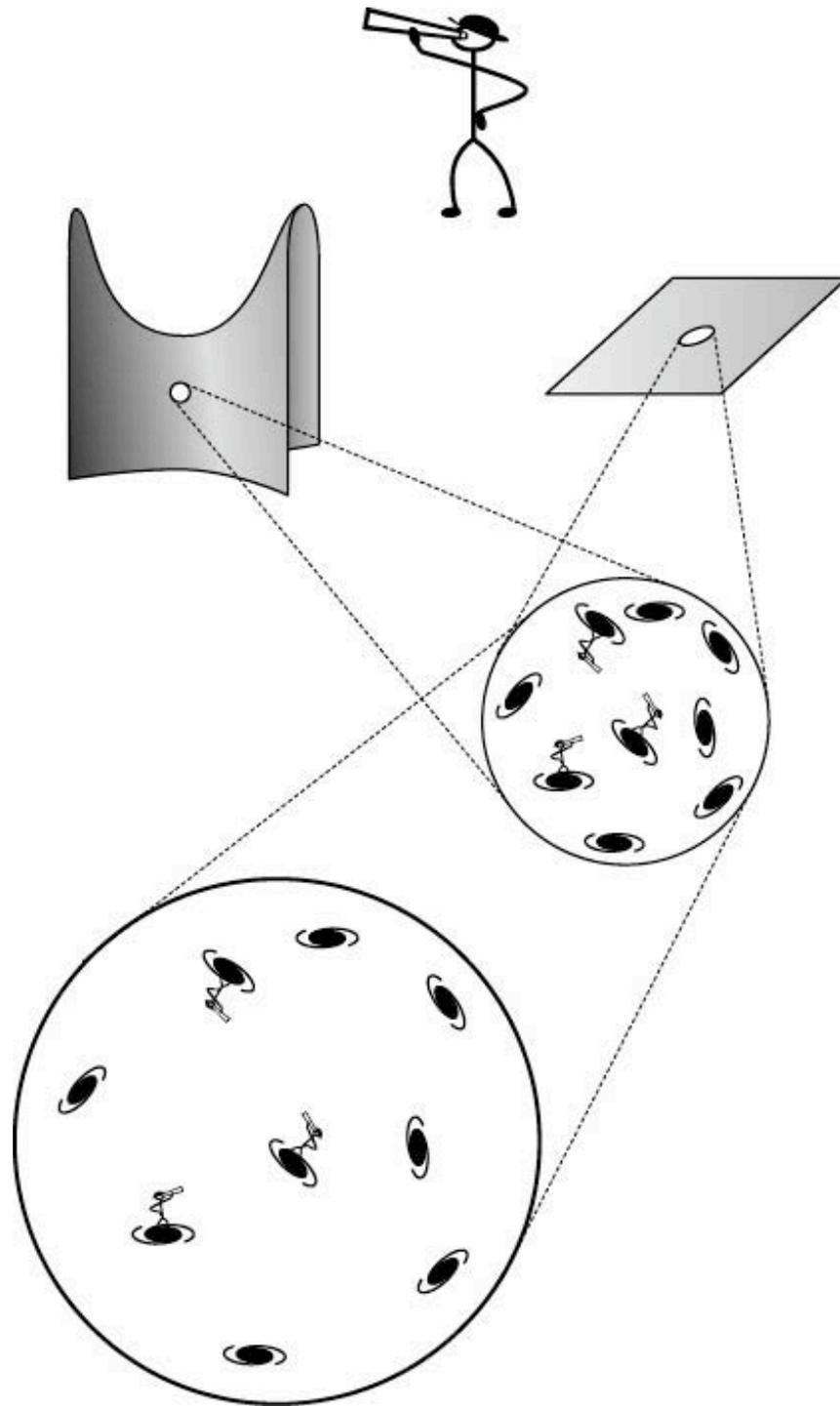


Fig 11.2

Age and Fate of the Universe

All distances between distant galaxies are proportional to the time elapsed. Distance/Velocity \Rightarrow Age of Universe ~ 14 billion years

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

Simplest choices finite age, recollapse (“sphere,” high density, high gravity)

expand forever, $v > 0$ (Pringle, low density, low gravity)

Special Case: expand forever, $v \rightarrow 0$ as reach infinity (flat, very special density, gravity)

In principle, we can figure out the shape and fate of our Universe by doing 3-D geometry in our 3-D Universe