

April 12, 2010

Exam 4 This Friday. Remainder of Black Holes and Gamma-ray bursts

Reading: Chapter 9, Sections 9.5.2, 9.6.1, 9.6.2, 9.7, 9.8, Chapter 10, Sections 10.1-10.4, 10.9, Chapter 11 (not 11.6)

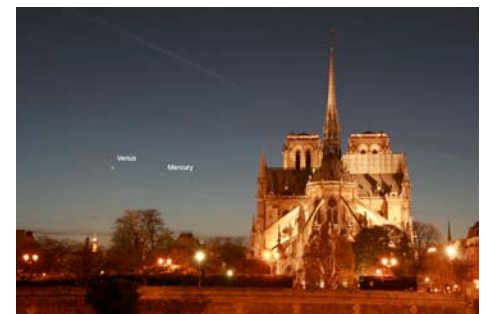
Small review in Wheeler's office Wednesday, 5 PM, Regular review Thursday, 5 PM place TBD. Review sheet posted today.

Fourth sky watch report due this Friday.

Astronomy in the News? New auditorium in Department of Physics and Astronomy at Texas A&M named after Stephen Hawking.

New element created - ununseptium,

Pic of the Day - Mercury and Venus over Paris



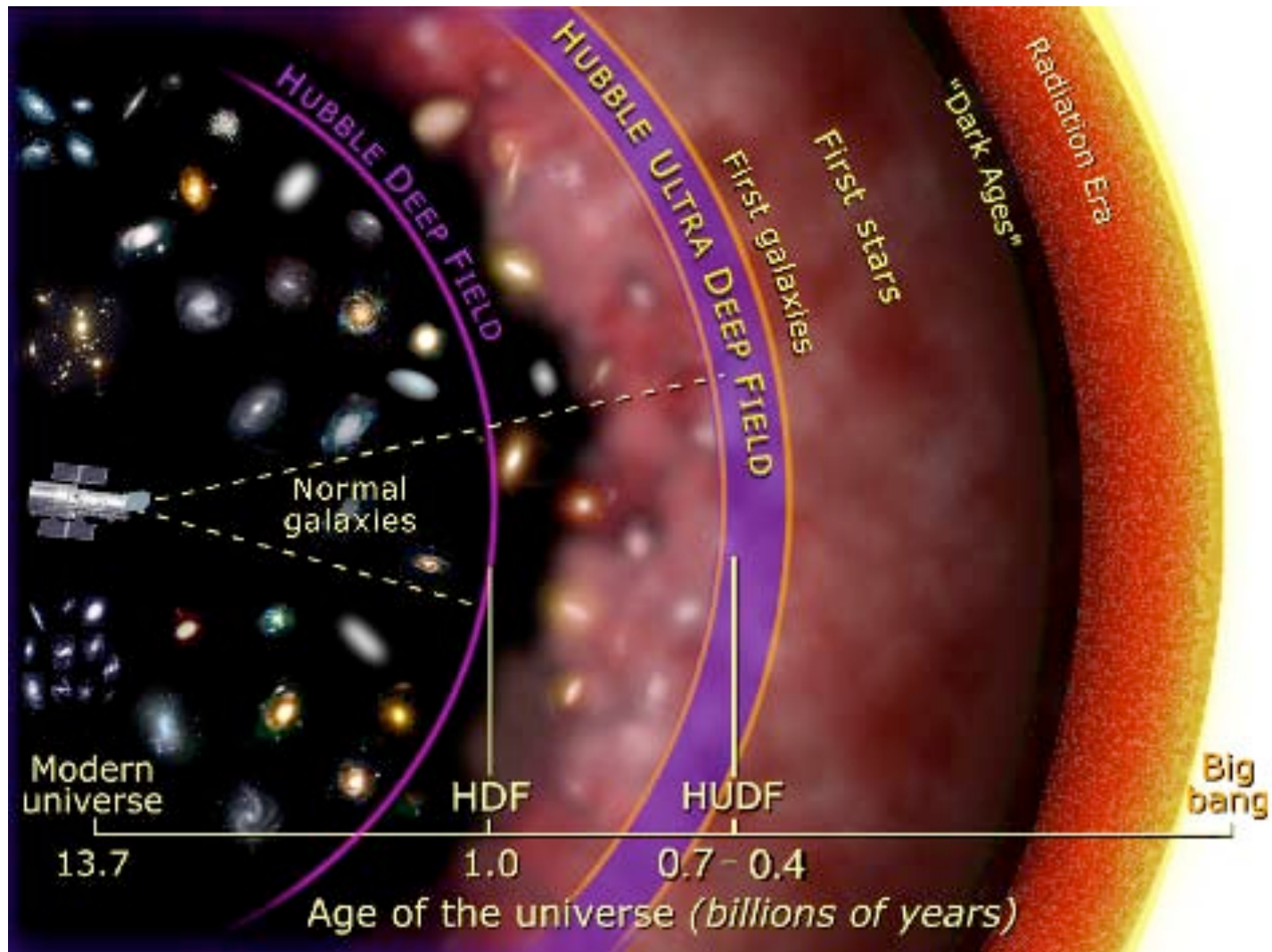
Lauren and Ellen!

<http://ellen.warnerbros.com/videos/?autoplay=true&mediaKey=31750c21-45a6-4c75-865a-b8cb5c2dcfbf>

# Review:

Supermassive black holes - deeply connected to the growth and evolution of galaxies.

Cosmic Gamma-ray bursts - maybe the birth of black holes (or magnetars), arise in Type Ic supernovae, may be the first objects seen in the young Big Bang.



Gamma-ray bursts could be the first objects seen at the end of the Dark Ages as the first stars are born and die, over 13 billion years ago. GRB 090423 is the first example.

END OF  
MATERIAL FOR  
EXAM 4

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*

# Our Expanding Universe

Expanding *surface* of a balloon as an example

2D embedding diagram of 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.