

A black and white photograph of a starry night sky. The foreground shows the dark, cylindrical structure of a telescope dome, partially illuminated. The sky is filled with numerous stars of varying brightness, creating a dense field of light points. The overall tone is dark and atmospheric.

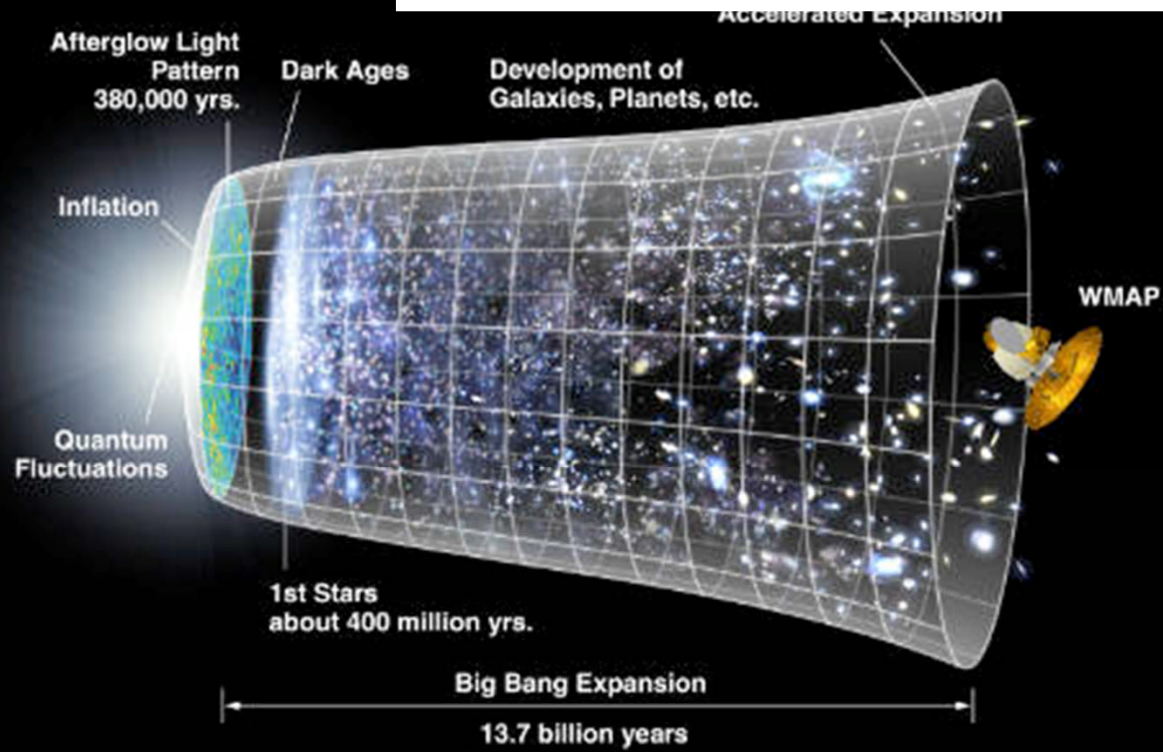
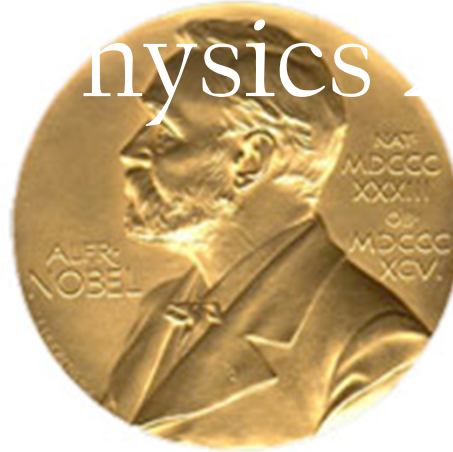
Dark Energy: A Universe Out of Control

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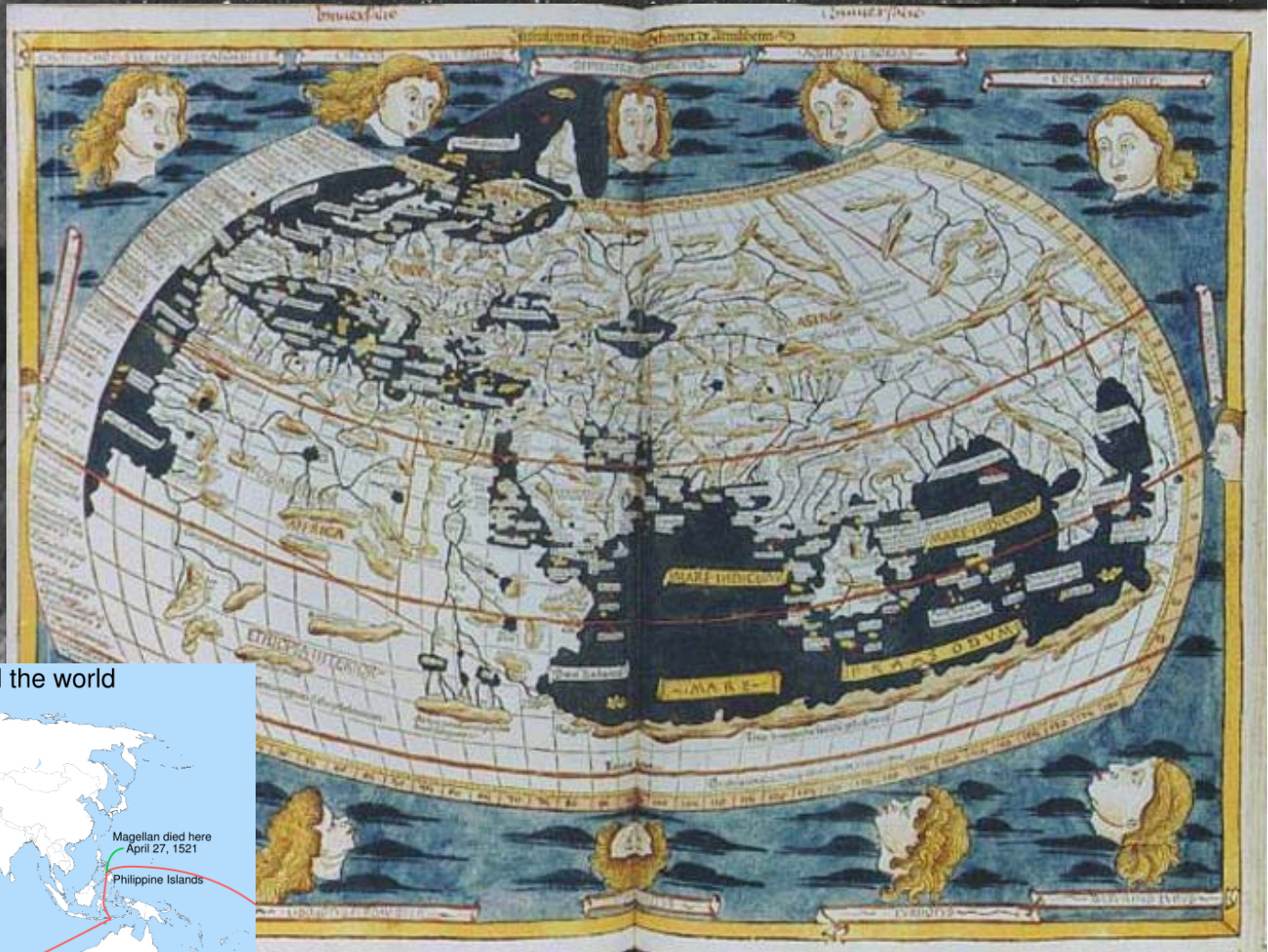
Texas A&M University

Nobel Prize in physics



NASA / WMAP SCI

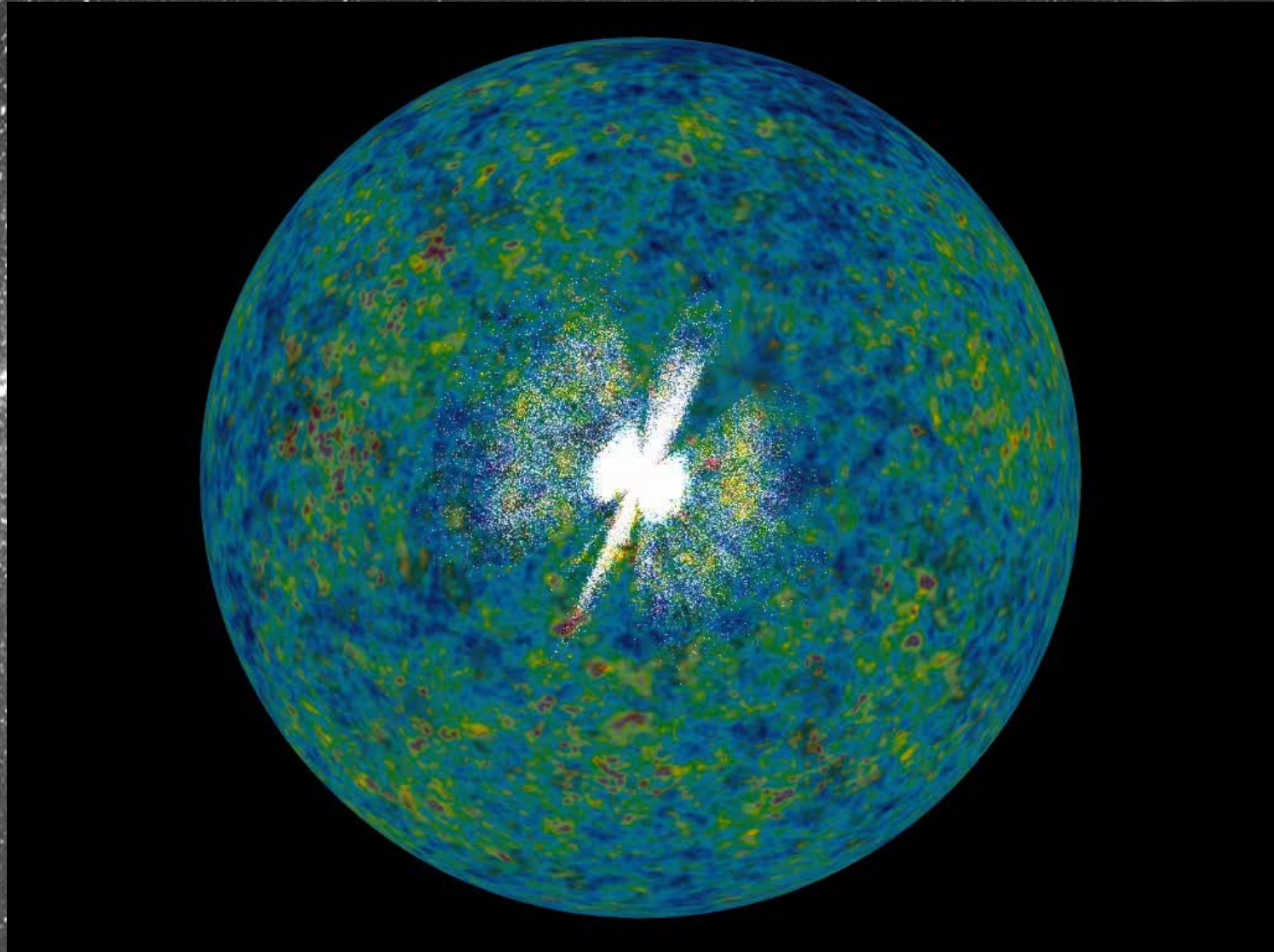
Ferdinand Magellan (1519-1521)



Magellan's voyage around the world



Our Universe

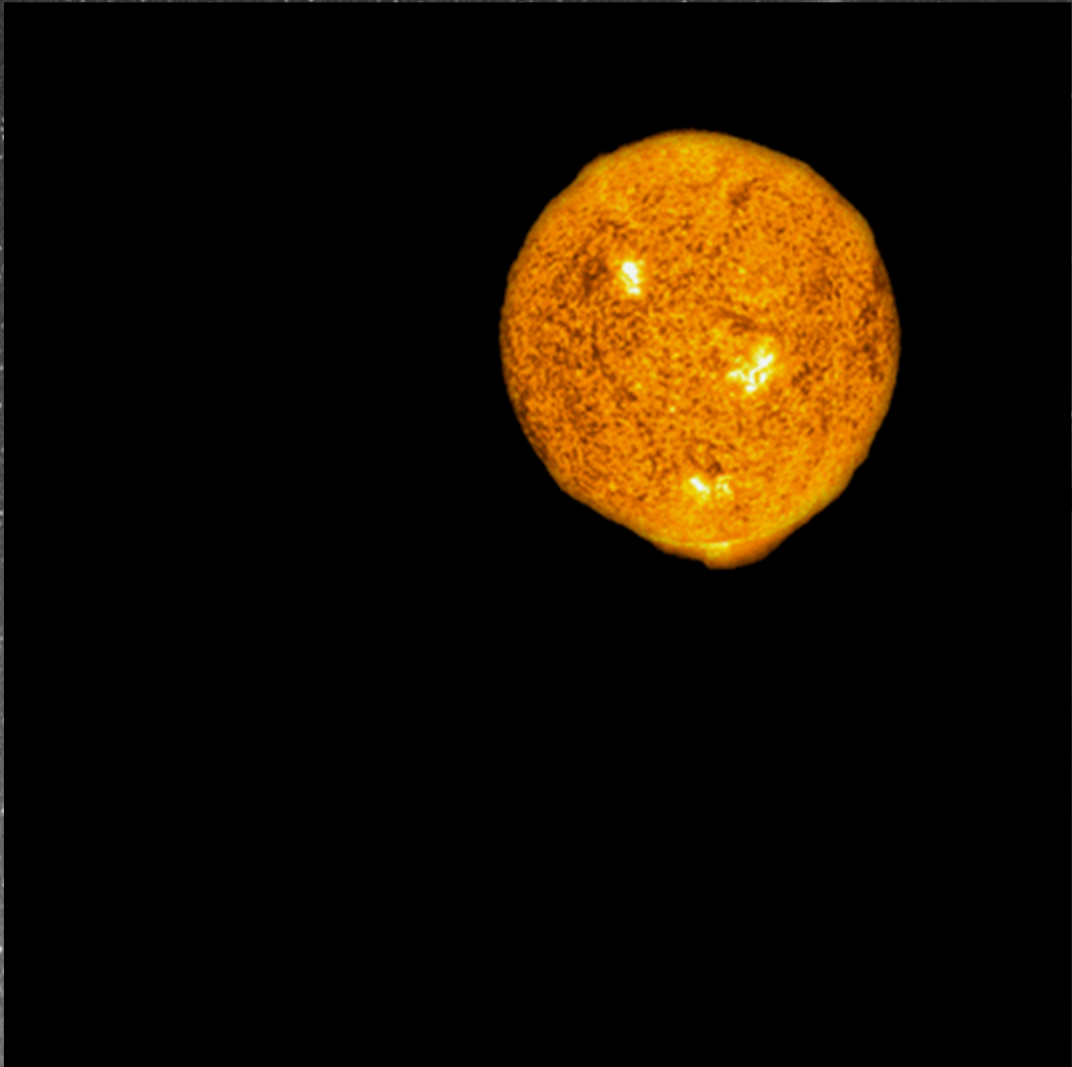
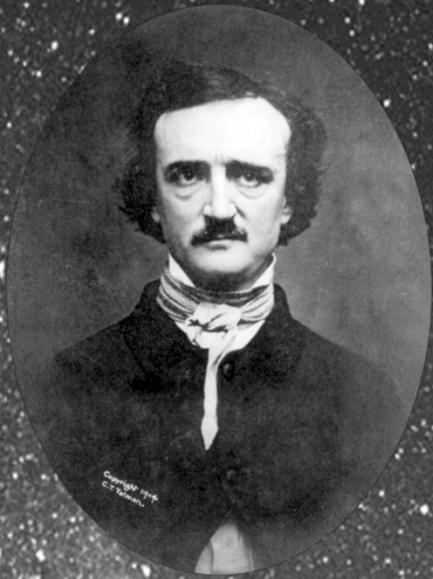


The most profound
observation in modern
cosmology is
?

Why is the sky black at night?

Olber's Paradox





Weird stuff about the Universe

- When you look deep into the sky
 - it is the same everywhere
 - galaxies we see in one direction have not seen the galaxies we see in the other direction
- It is expanding and has an age of 14 Billion years.
- Pushing mass is the same as gravitational mass
- Where is the anti-matter?
- Where is there no magnet with a N pole but not a S??
- 96% of the stuff out there we cannot see with light. *“The Universe is 96% dark”*
- It is flat.

More weird stuff

- We can see the Big Bang as the cosmic microwave background radiation which is 3degrees above absolute zero.
- The Universe is expanding – “the Hubble expansion” (or is it?)
- The fundamental values of physics – speed of light, gravitational constant, do not change in time
- What causes time?
- Why is the Universe not more chaotic? $\log_{10}(S)\sim 120$ but we observe 80.
- **WHERE ARE THEY?**
- I'm getting tired here...

A black and white photograph of a starry night sky. In the foreground, the top of a telescope dome is visible, partially obscuring the view of the stars. The sky is filled with numerous stars of varying brightness, and a faint, diffuse band of light, likely the Milky Way, is visible on the left side. The overall scene is dark and atmospheric.

Lots of weird stuff in the Universe

To me – the weirdest

The Universe is basically dead.

What is the Universe expanding into?

The Local Universe

- 73% dark energy ←
 - 23% dark matter (about 3 H m^{-3})
 - 3% missing “baryons” (i.e. normal matter)
 - 1% is us
-
- This is too weird? Maybe we are fooling ourselves??
 - And why is Dark Energy ~ Dark Matter

Dark Energy

There is no picture...
So I will wave my hands a lot here.

What we discovered in 1998

- 73% dark energy
 - 23% dark matter (about 3 H m^{-3})
 - 3% missing “baryons” (i.e. normal matter)
 - 1% is us
-
- This is too weird? Maybe we are fooling ourselves??
 - And why is Dark Energy ~ Dark Matter

Here I wave my hands a lot about Dark Energy

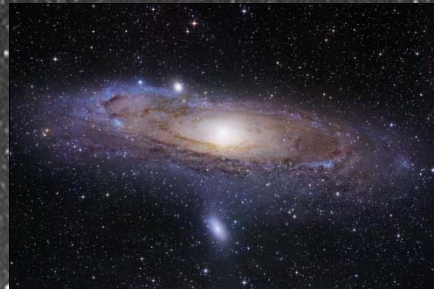
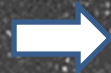


Supernova!

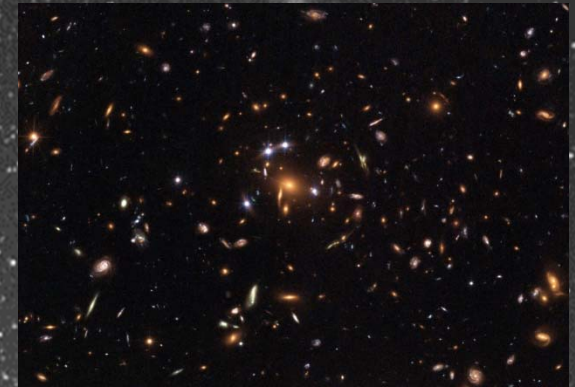
Let's run the clock back



Milky Way 20,000yr



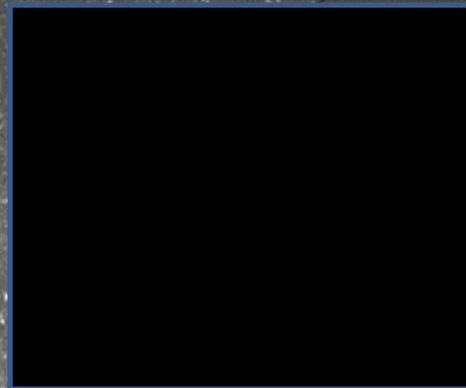
Andromeda Galaxy 1Myr



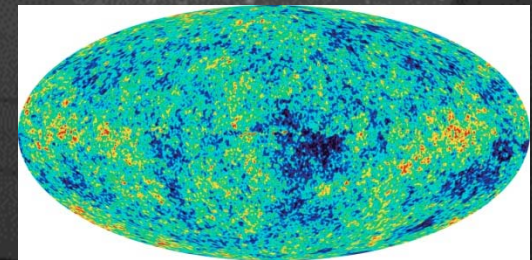
Galaxy cluster 1Gyr



Hubble Ultra Deep Field
10Gyr



The Dark Ages 12.5Gyr



The Cosmic Background 13.3Gyr

What Happened at $t=0$?

- Inflation?
- We can't see $t=0$ really
- There is no $t=0$?
- Maybe there are two types of time?

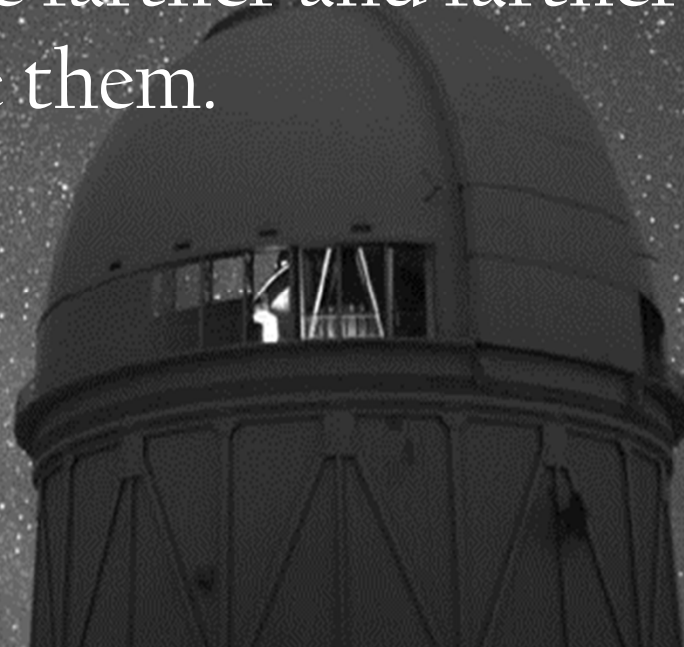


Inflation



Now run the Universe forward

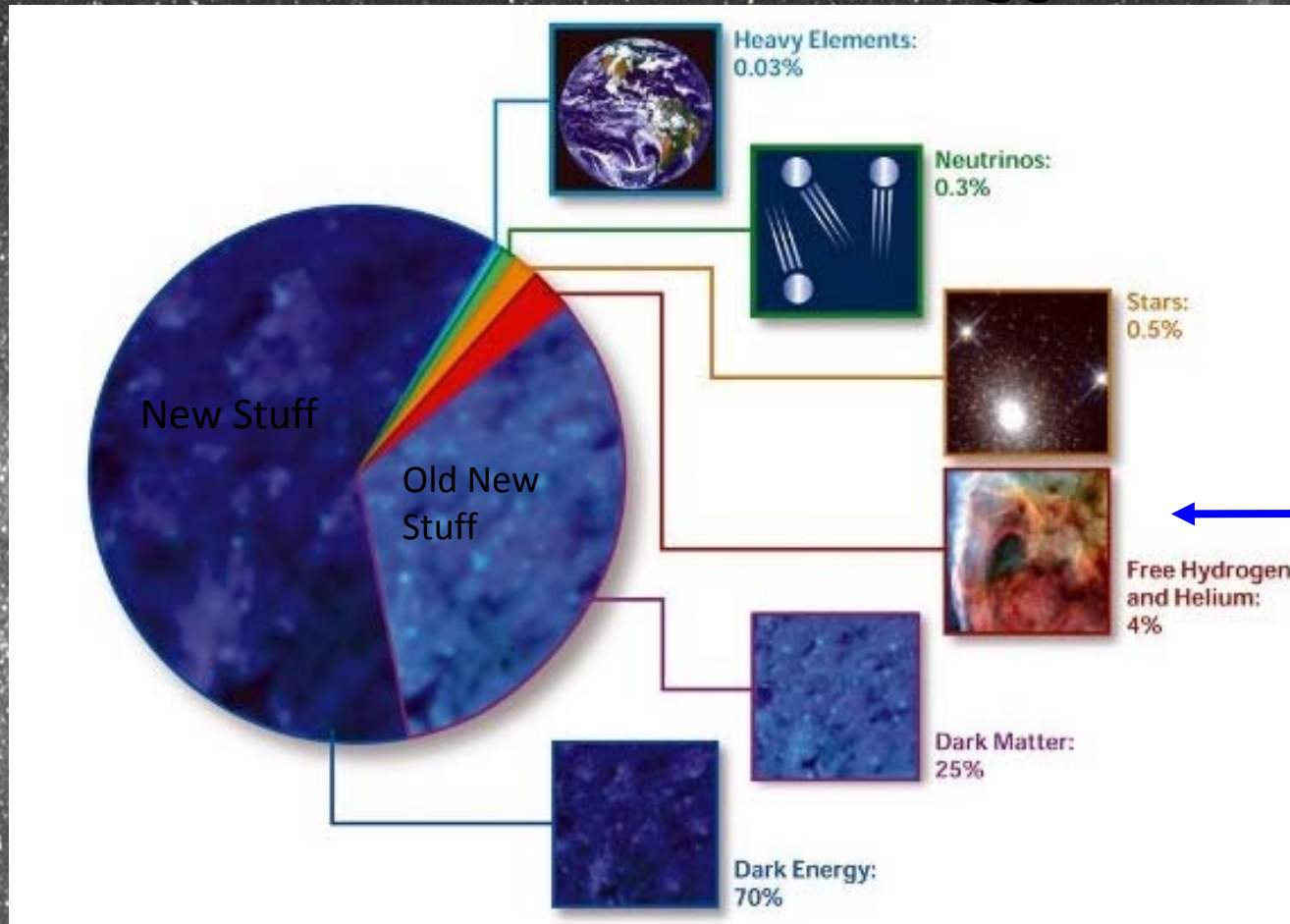
- Dark Energy drives it faster and faster
- Dark Matter is too dilute
- The small amount of gas in galaxies is used up
- The galaxies move farther and farther away until we don't see them.



The Big Rip...

Describing Our Universe

← Us



← Us

STScI

Our Universe

