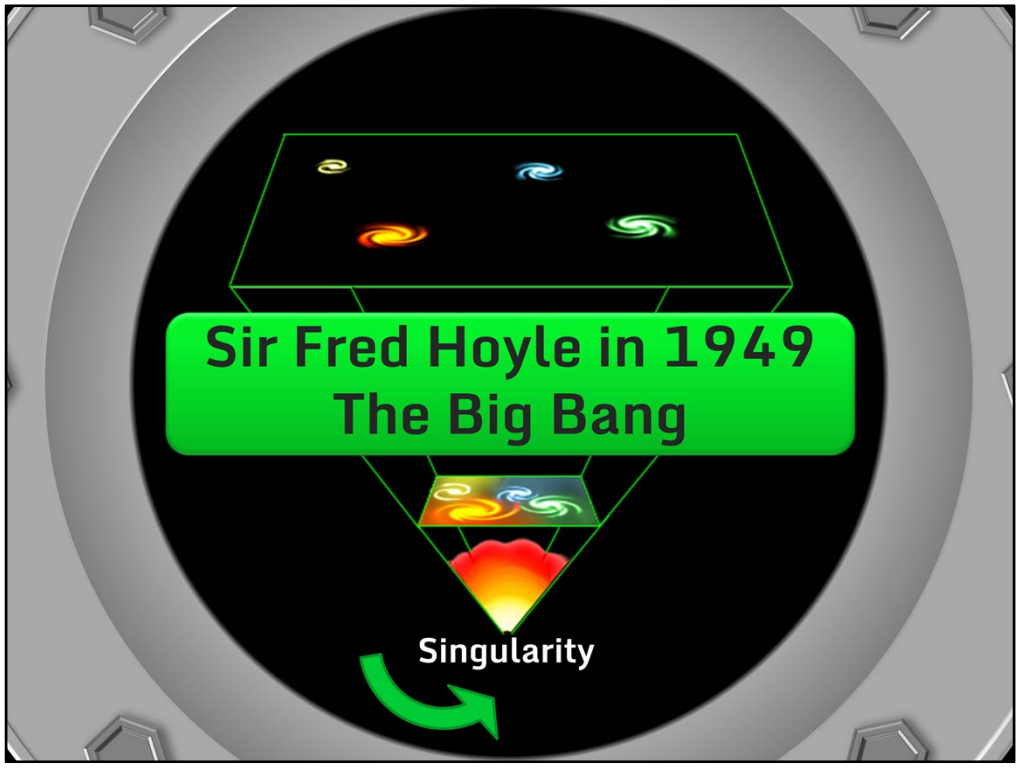
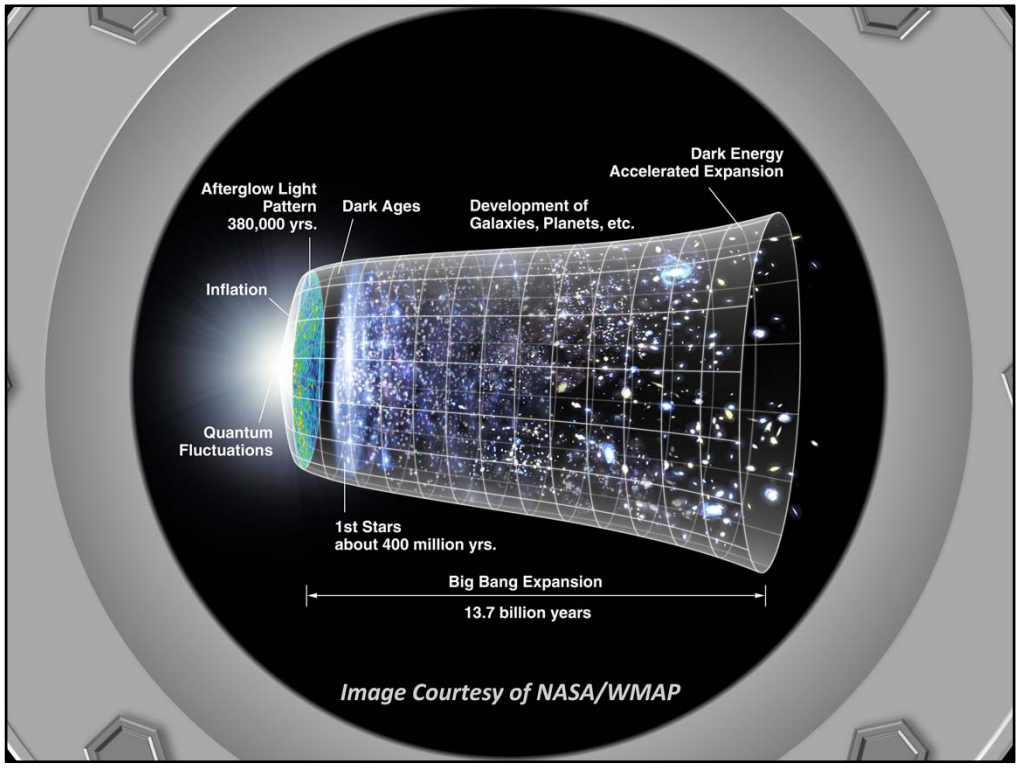
Module 8: Groups of Stars
Topic 4 Content: Cosmology Presentation Notes

Pretend that you have been given the opportunity to travel through time to explore cosmology. Cosmology is the study of how the universe formed and what will happen to it. Watch through your viewport as you journey billions of years into the past and then into the future. Hang on, it could be a bumpy ride!

Image source: NASA



Imagine a time almost 14 billion years ago. Picture a place where an infinite density of matter exists in an infinitesimal space. According to scientists, the singularity was an invisible point from which emerged all of the matter and energy that would eventually become the universe as you know it today. In 1949, Sir Fred Hoyle, an English scientist, named this phenomenon the Big Bang. Today, the theory that surrounds this idea is known as the Big Bang Theory.



Although scientists continue to study how the universe evolved, they theorize that the Big Bang was more of a big expansion of sorts, rather than an explosion. Around 13.7 billion years ago, an extremely hot and dense state of matter and energy suddenly emerged from the singularity. This hot and dense state expanded rapidly in all directions as it cooled over billions of years.

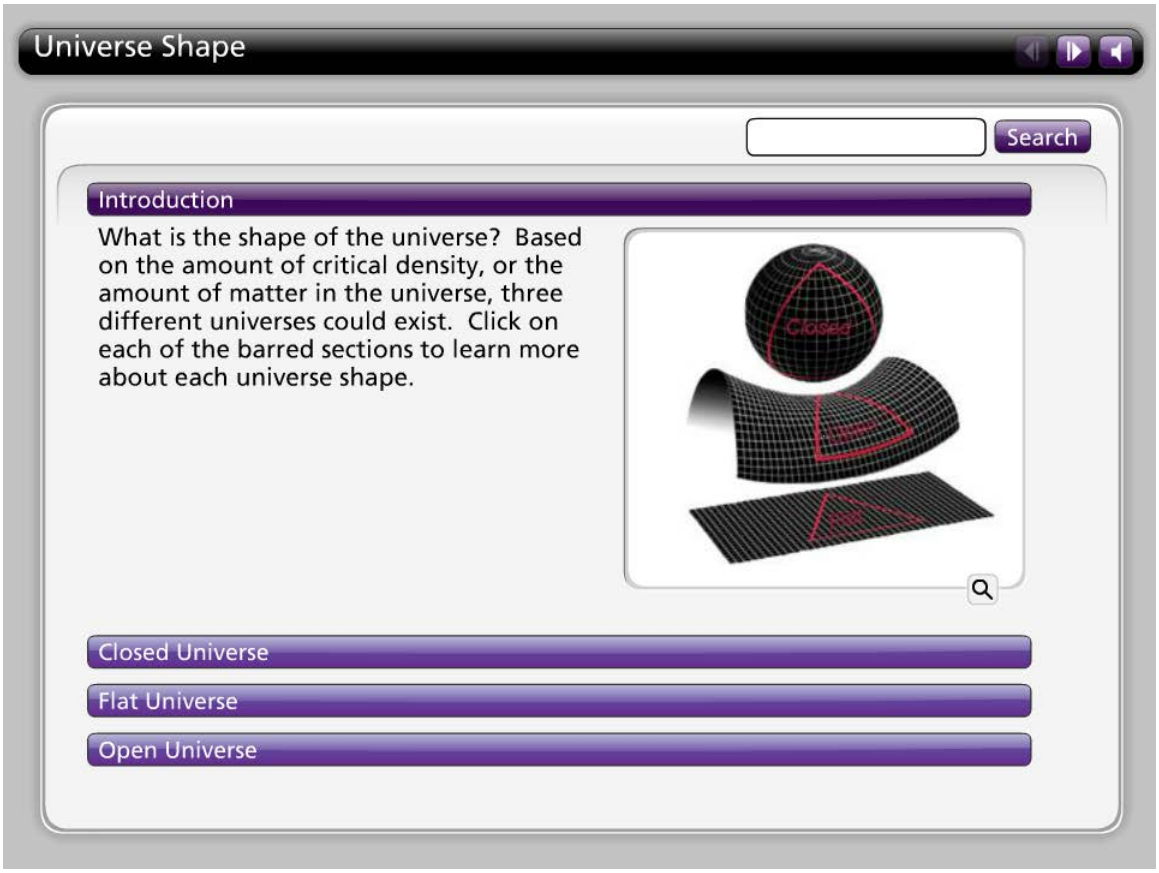
Gradually, the cooling matter and energy formed the elements that would become galaxies, stars, and eventually, planets like Earth. The image shown here illustrates one of the key pieces of evidence that makes the Big Bang Theory so widely accepted. Over time, galaxies expand and spread out. It was Edwin Hubble who first suggested that galaxies redshift, or appear redder in color on the electromagnetic spectrum as they move away from the viewer. This shows that the universe is continually expanding as time progresses.

Image source: NASA/WMAP

Prior to the Big Bang Theory, astronomers believed that the universe was eternal and unchanging. The leading theory of this time was the Steady State Theory. This theory simply states that the universe had no beginning; therefore, a Big Bang could have never occurred. The Steady State Theory states that new matter appeared from nothing to maintain the density of an expanding universe.

As technology advances were made in the field of astronomy, the Steady State Theory was abandoned. In 1965, astronomers discovered cosmic microwave background radiation. This type of radiation was not found to have a source. The leading explanation is that this radiation is leftover from the Big Bang. Using today's technologies, like radio and infrared telescopes, astronomers can collect clues that suggest a Big Bang event. Shown here is a high resolution map of microwave light that scientists theorize was emitted from the Big Bang. This image has helped astronomers define the universe.

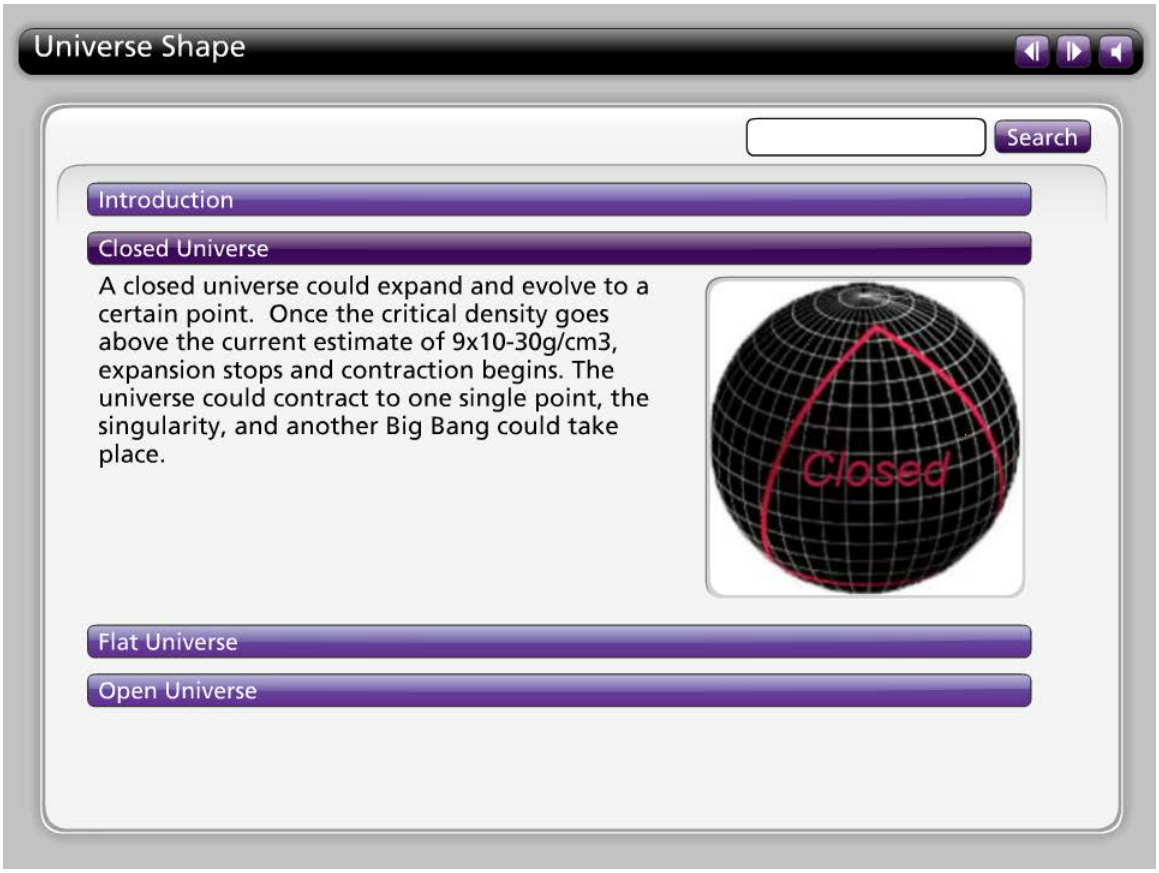
Image Courtesy of NASA



Universe Shape - Introduction

What is the shape of the universe? Based on the amount of critical density, or the amount of matter in the universe, three different universes could exist. Click on each of the barred sections to learn more about each universe shape.

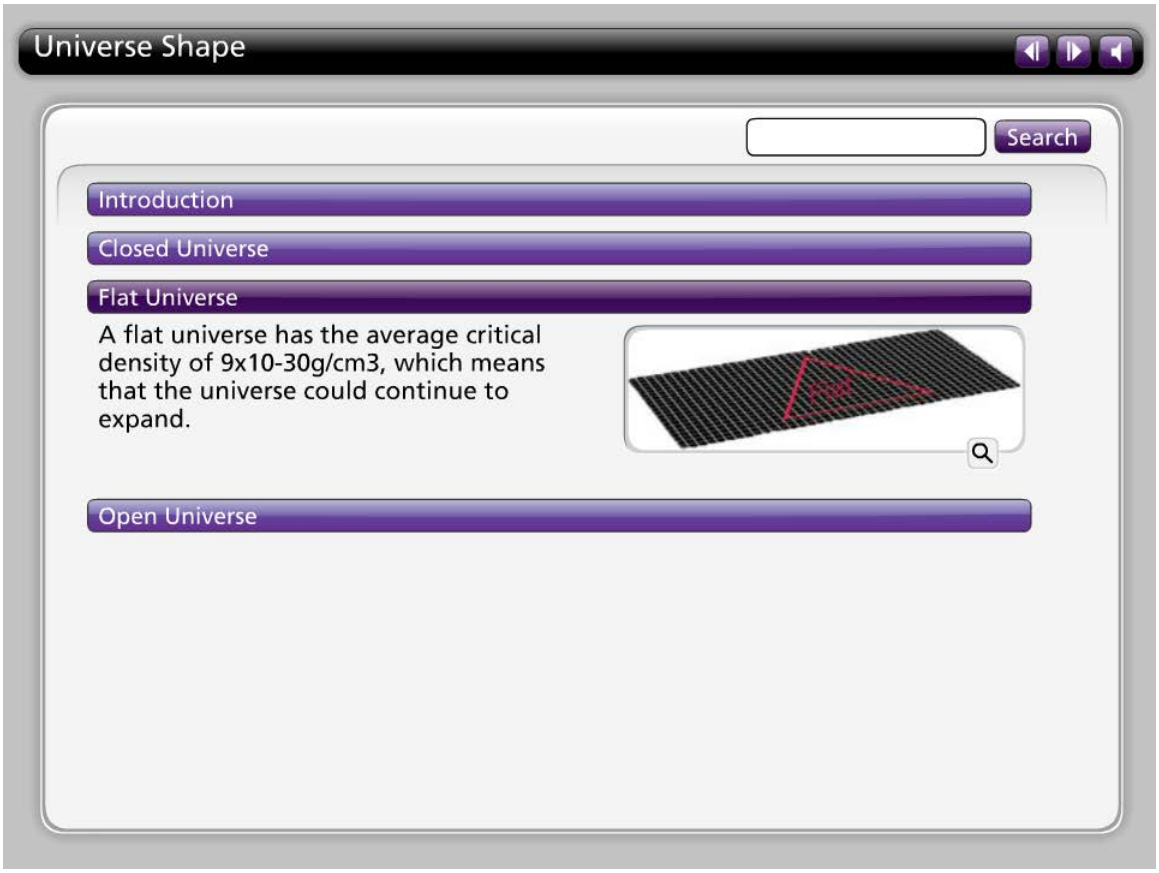
Image Courtesy of NASA



Universe Shape – Closed Universe

A closed universe could expand and evolve to a certain point. Once the critical density goes above the current estimate of 9x10-30g/cm3, expansion stops and contraction begins. The universe could contract to one single point, the singularity, and another Big Bang could take place.

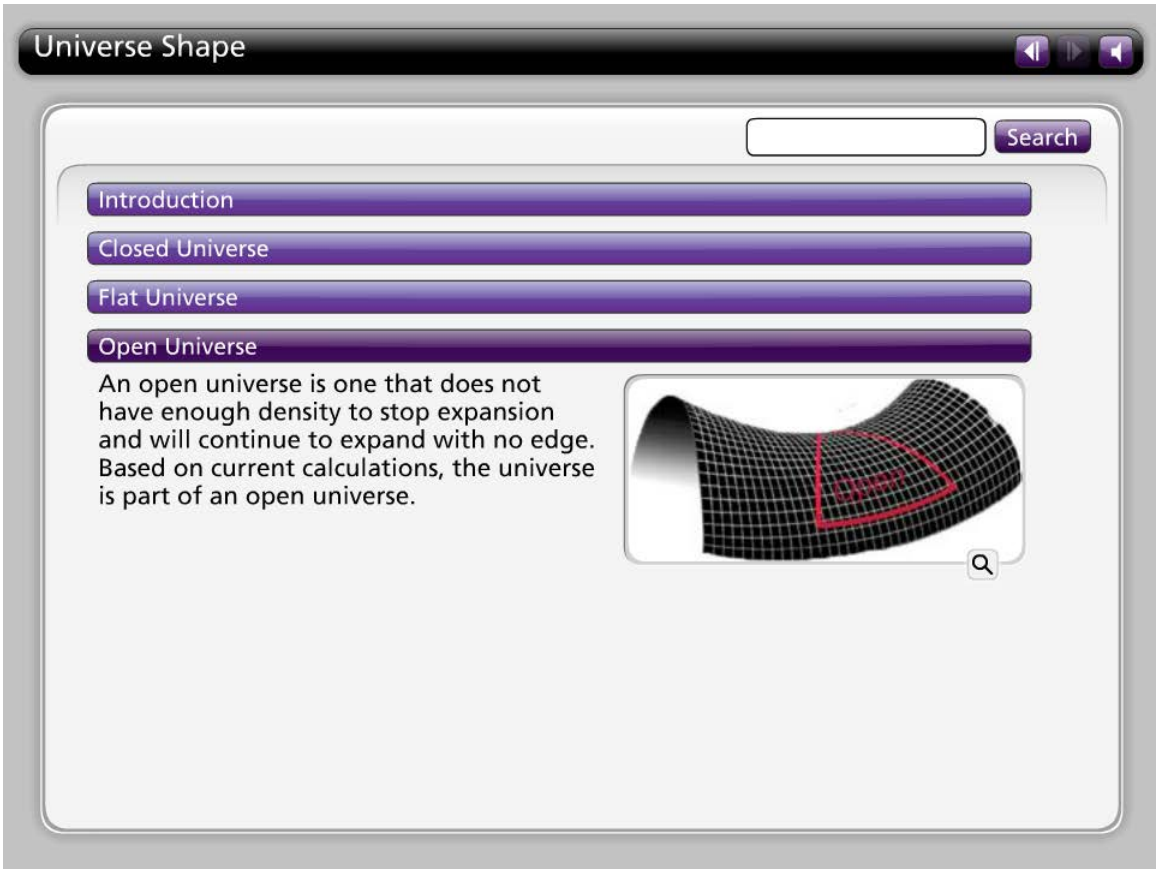
Image Courtesy of NASA



Universe Shape – Flat Universe

A flat universe has the average critical density of 9x10-30g/cm3, which means that the universe could continue to expand.

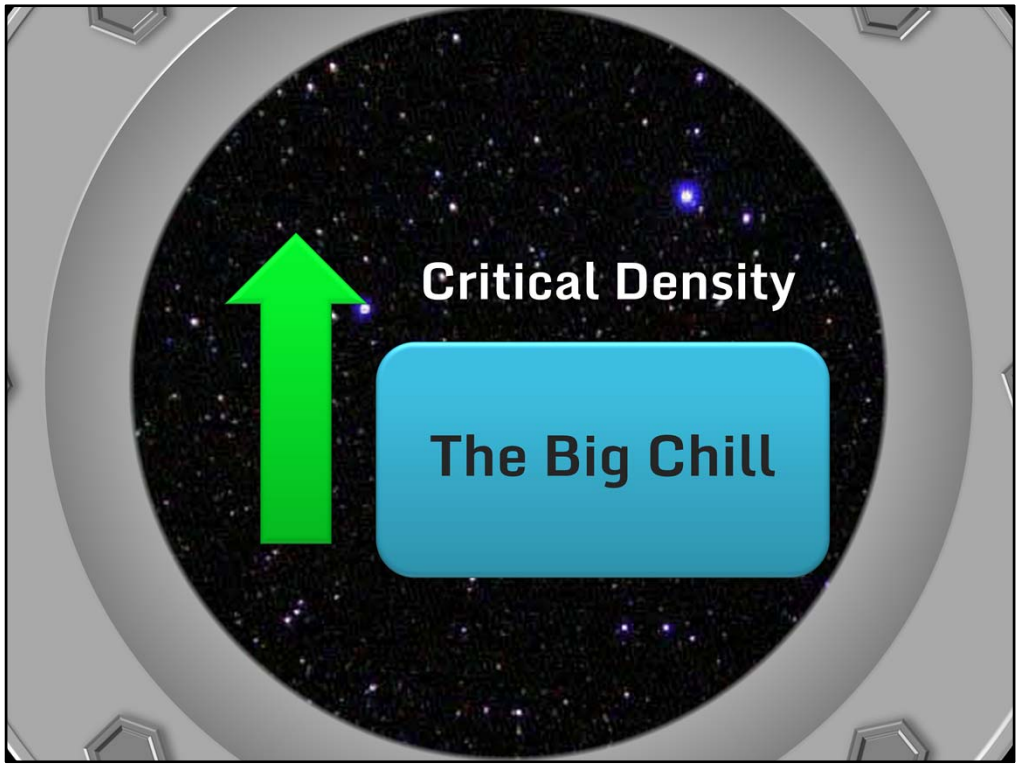
Image Courtesy of NASA



Universe Shape – Open Universe

An open universe is one that does not have enough density to stop expansion and will continue to expand with no edge. Based on current calculations, the universe is part of an open universe.

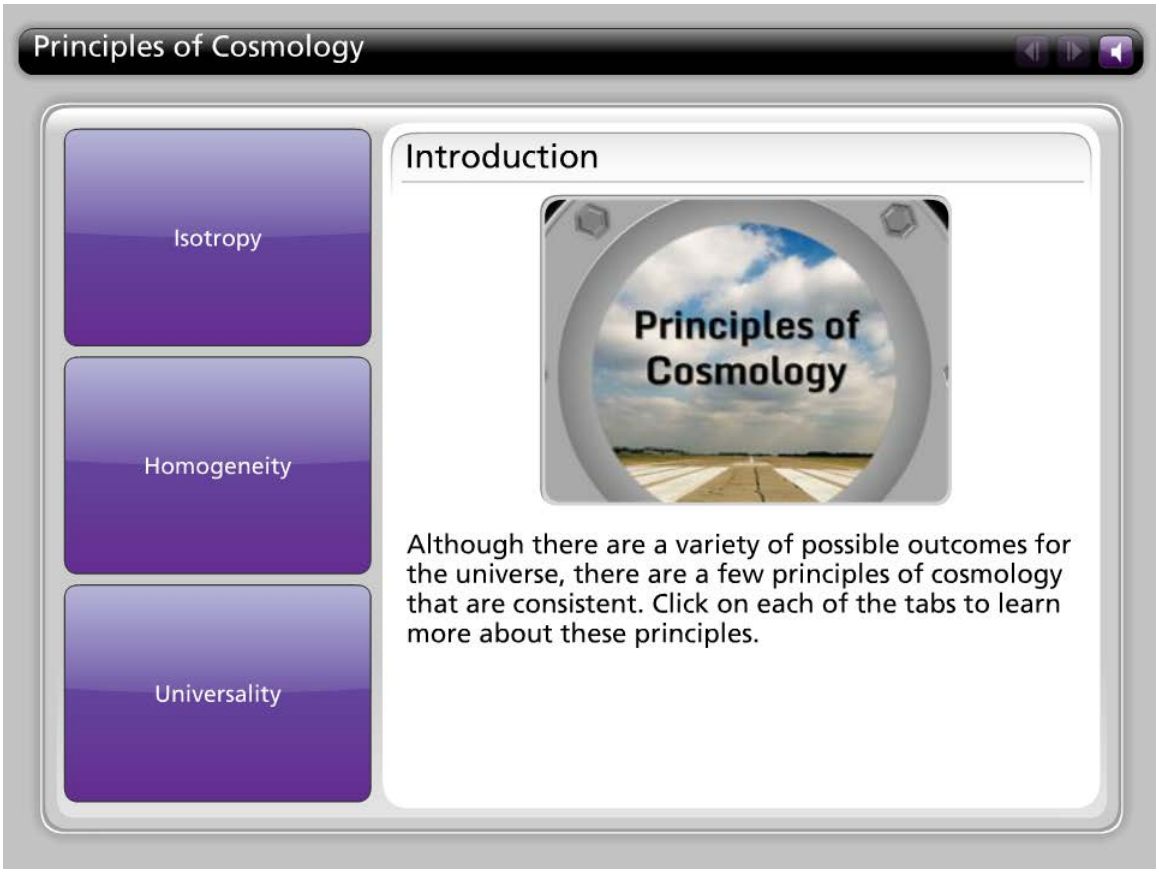
Image Courtesy of NASA



The fate of the universe will ultimately depend on the type of universe. For instance, if the critical density increases, then the universe may be pulled back together to start another Big Bang. This is called the Big Crunch.

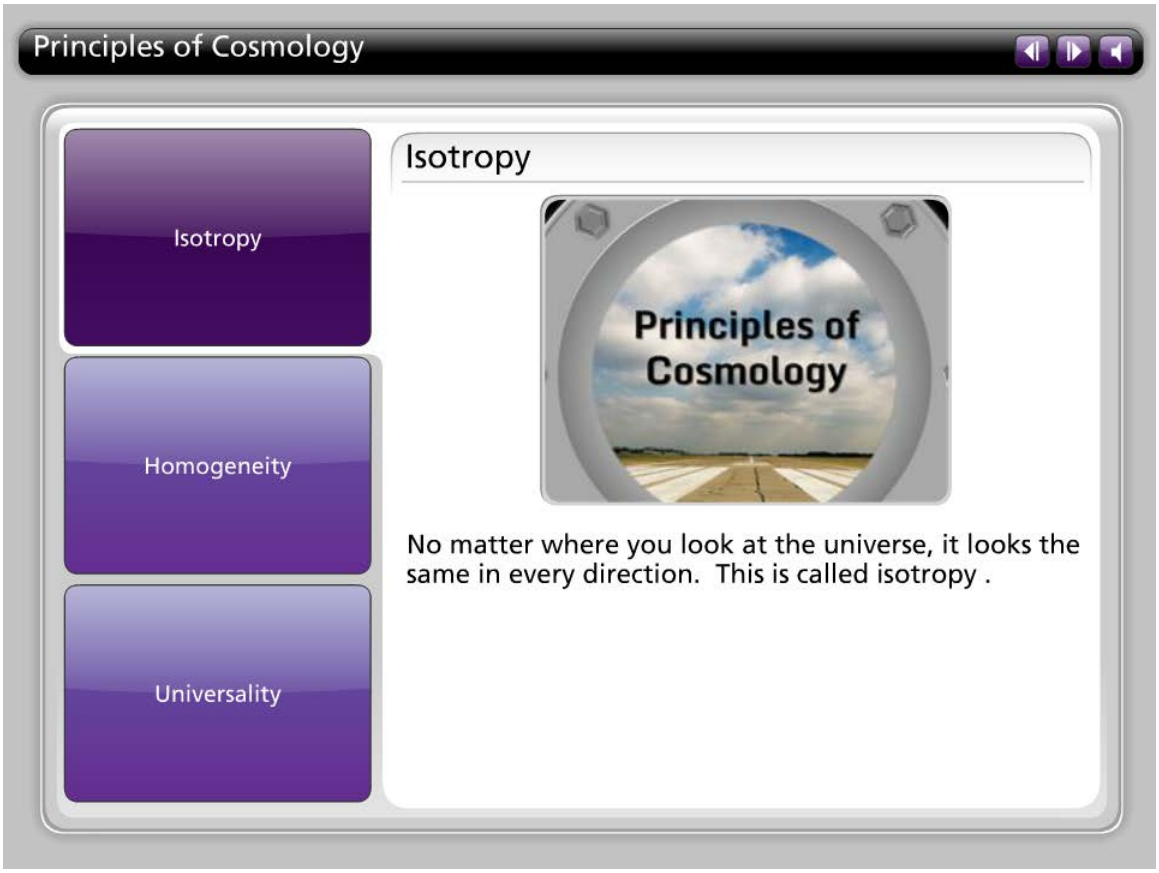
If the universe continues to expand and move away, then a Big Chill may take place. Over many billions of years, the Sun will no longer produce energy through fusion and will turn into a white dwarf. Eventually, it will stop producing light and energy of any kind. As the stars and galaxies are moving farther away from each other, so will the gas and dust. Stars will not be producing as much energy. As no new stars are created, the universe will grow dark and cold, hence the name, the Big Chill.

Wow! You made it back safely. Before you deboard, there are a few more principles of cosmology that you should know.



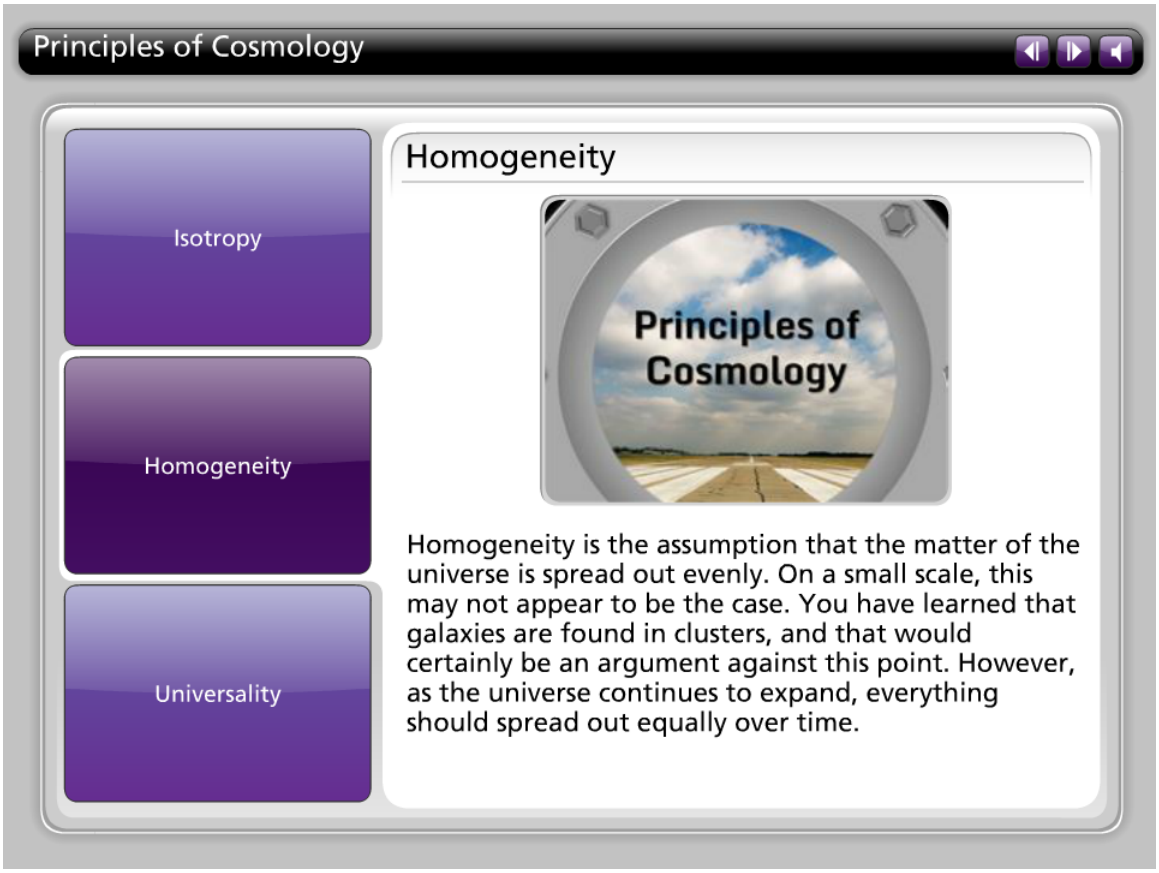
Principles of Cosmology – Introduction

Although there are a variety of possible outcomes for the universe, there are a few principles of cosmology that are consistent. Click on each of the tabs to learn more about these principles.



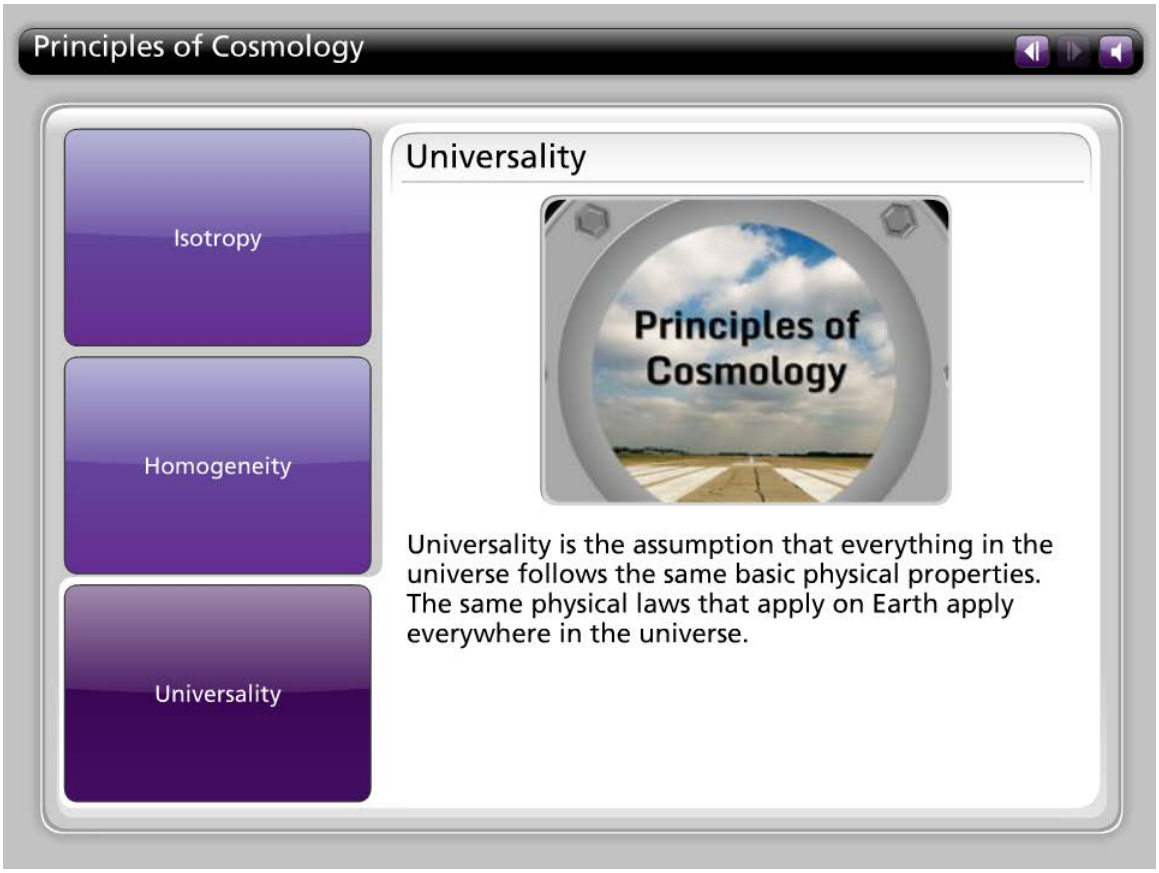
Principles of Cosmology – Isotropy

No matter where you look at the universe, it looks the same in every direction. This is called isotropy.



Principles of Cosmology – Homogeneity

Homogeneity is the assumption that the matter of the universe is spread out evenly. On a small scale, this may not appear to be the case. You have learned that galaxies are found in clusters, and that would certainly be an argument against this point. However, as the universe continues to expand, everything should spread out equally over time.



Principles of Cosmology – Universality

Universality is the assumption that everything in the universe follows the same basic physical properties. The same physical laws that apply on Earth apply everywhere in the universe.