Topic 4.4 — Big Bang Theory and the Expanding Universe

Title

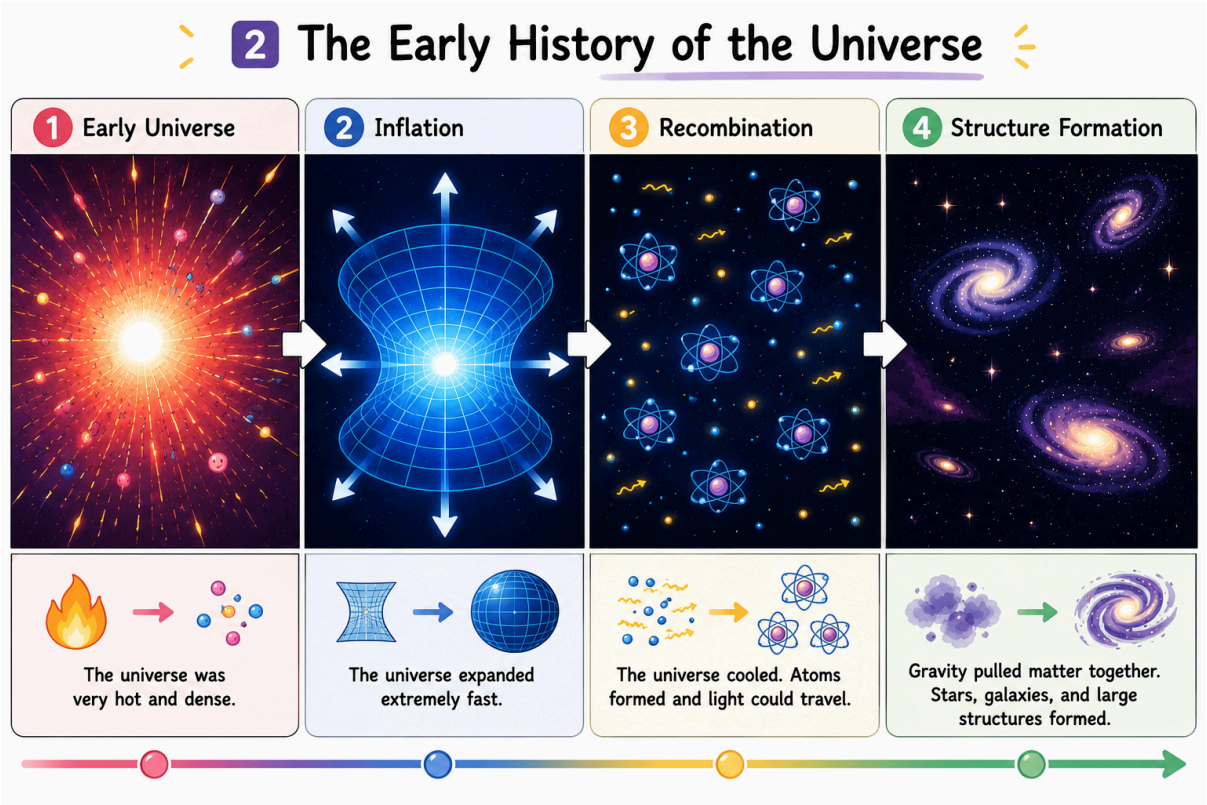
Big Bang Theory: Evidence, Expansion, and Mystery

Big Question

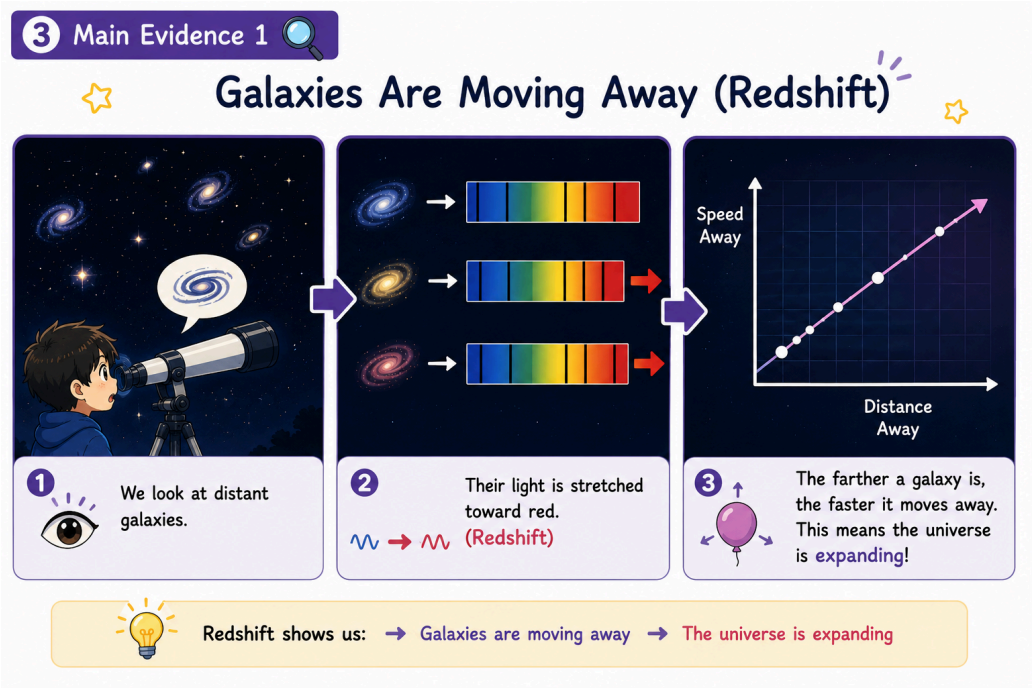
How does the big bang theory explain what we know about the universe?

Big Bang Theory





The Early History of the Universe			
1. <u>Early Universe</u> : The universe was very hot and dense.	2. <u>Inflation</u> : The universe expanded extremely fast.	3. <u>Recombination</u> :The universe cooled. Atoms formed and light could travel.	4. <u>Structure Formation</u> :Gravity pulls matter together. Stars, galaxies, and large structures formed



Vocab	What it means	
Big bang theory	it says that 1) the universe began very hot and very dense 2) space expanded	
Evidence supporting the big band theory		
Redshift	Light from galaxies is stretched toward red	As a light source moves away, its light shifts toward the red color. (Wavelength is <u>short</u>) Purple I Navy

		I Blue … Yellow I Orange I Red (Wavelength is <u>long</u>) *Long wavelength = more distant
CMB radiation	Leftover light from the early universe	We detect light from the past. The light tells you the early universe was really hot and dense. The Universe cooled. Atoms formed and light could travel freely in all directions. We can detect this faint microwave radiation from all directions today.

Easy Explanation

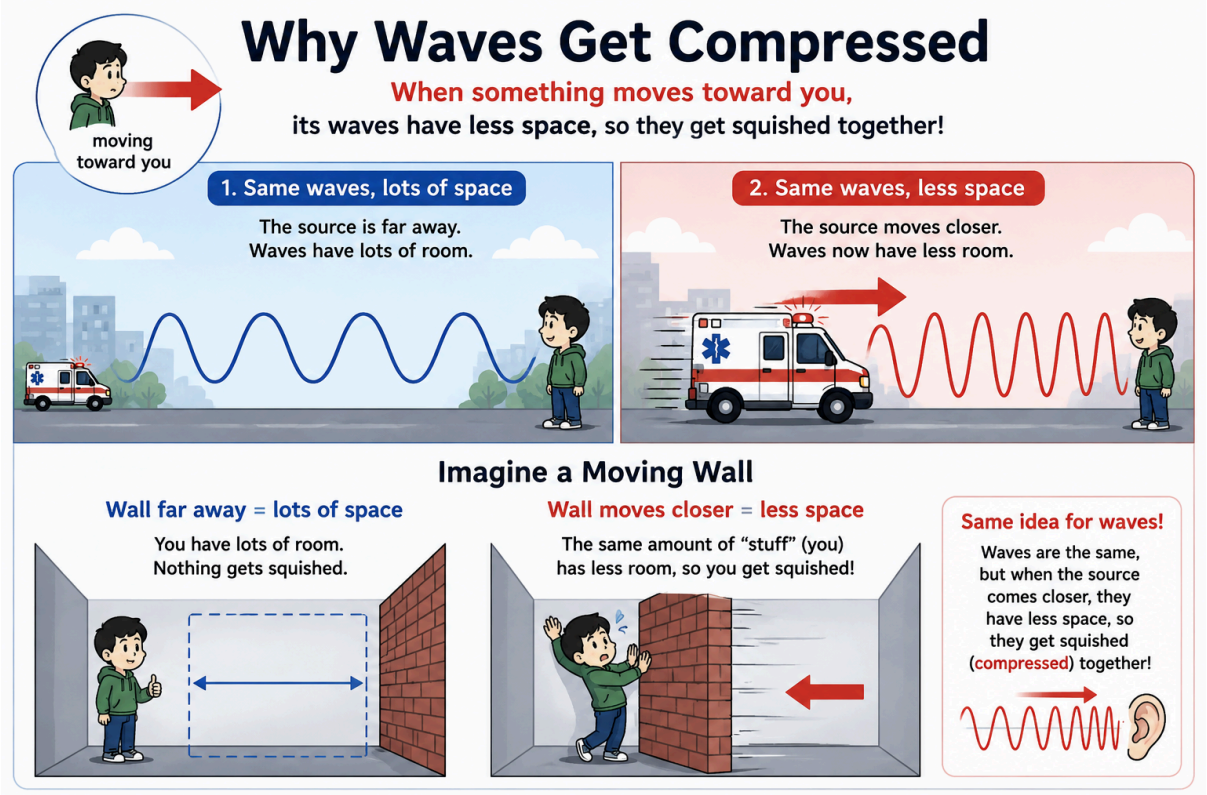
The big bang theory explains how the universe began and changed over time.

It says the universe began very hot and very dense.

Then space expanded.

The main evidence is **redshift** and **cosmic microwave background radiation**.

Doppler Effect



Why Waves Get Compressed When something moves toward you, its waves have less space, so they get squished together!		
Waves less compressed	the source is far away	waves have lots of room (nothing gets squished)
Waves more compressed	the source moves closer	waves now have less room (squished)

Vocab	What it means
Doppler effect	The change in the frequency or height of a wave when the source and the observer (me) move closer to or further away from each other

Easy Explanation

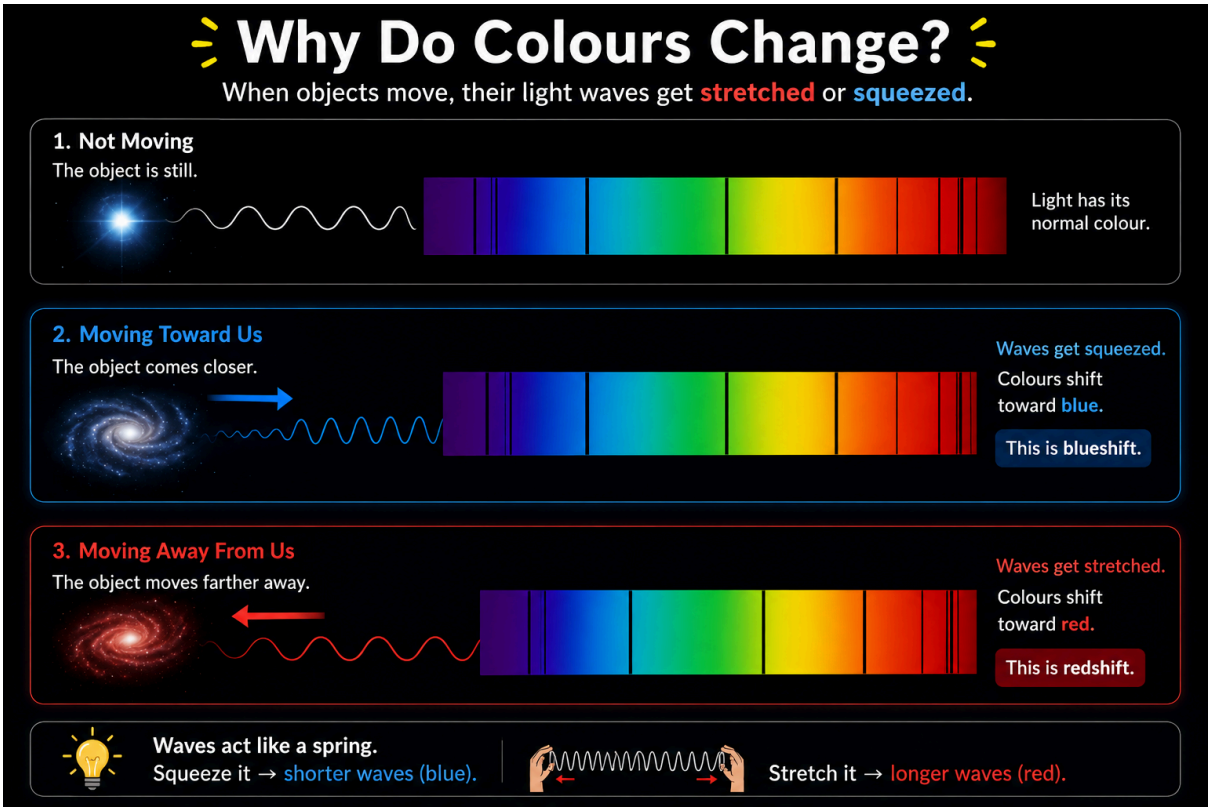
The Doppler effect happens when waves change because the source is moving.

When something moves toward you, its waves are compressed.

When something moves away from you, its waves are stretched.

This happens with sound waves and light waves.

Redshift and Blueshift



Vocab	What it means
Blueshift	Colours shift toward blue Why? - The object comes closer - Waves get squeezed
Redshift	Colours shift toward red Why? - The object moves farther away - Waves get stretched

**Recap : Purple - Navy - Blue - Green - Yellow - Orange - Red

Purple is the **shortest reach-point** (If color shifts toward purple, it means the object comes closer)
Red is the **farthest reach-point** (If color shifts toward red, it means the object moves away)

Easy Explanation

Light waves change colour when objects move.

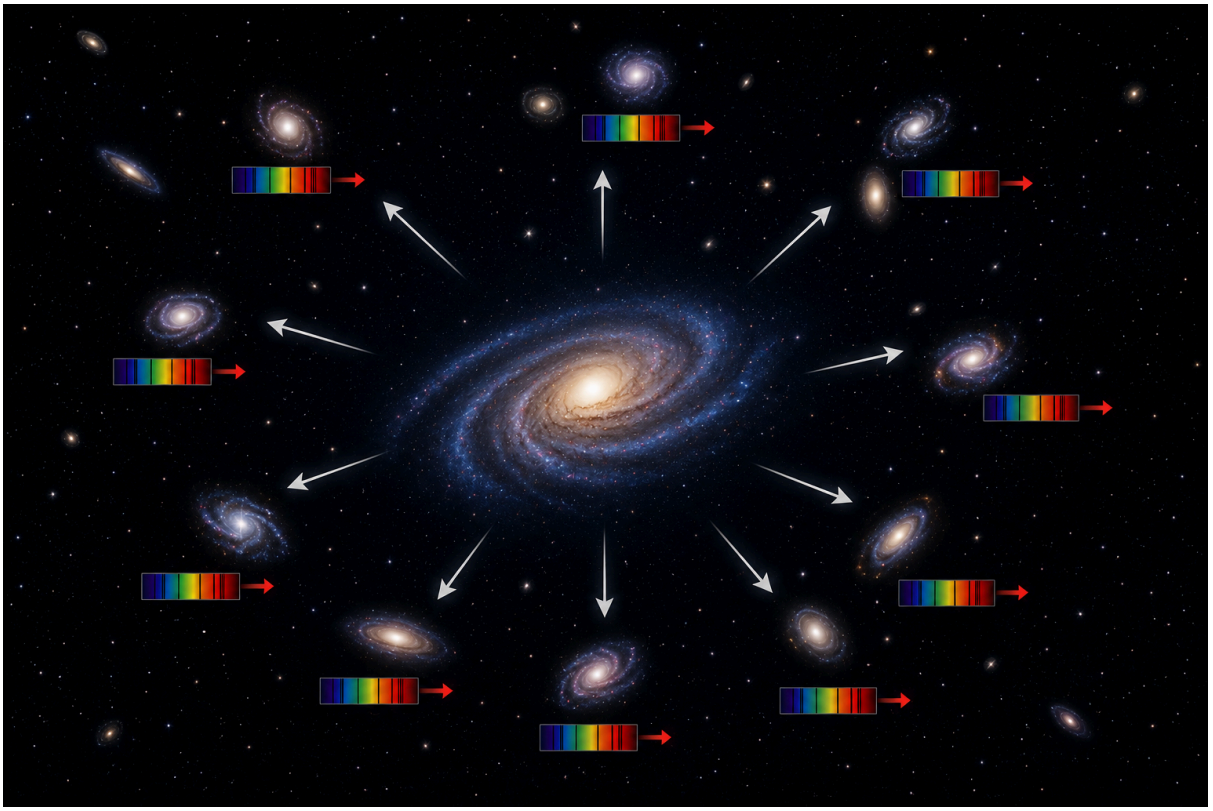
If an object moves toward us, its light shifts toward blue.

This is called **blueshift**.

If an object moves away from us, its light shifts toward red.

This is called **redshift**.

Galaxies Are Moving Away



Easy Explanation

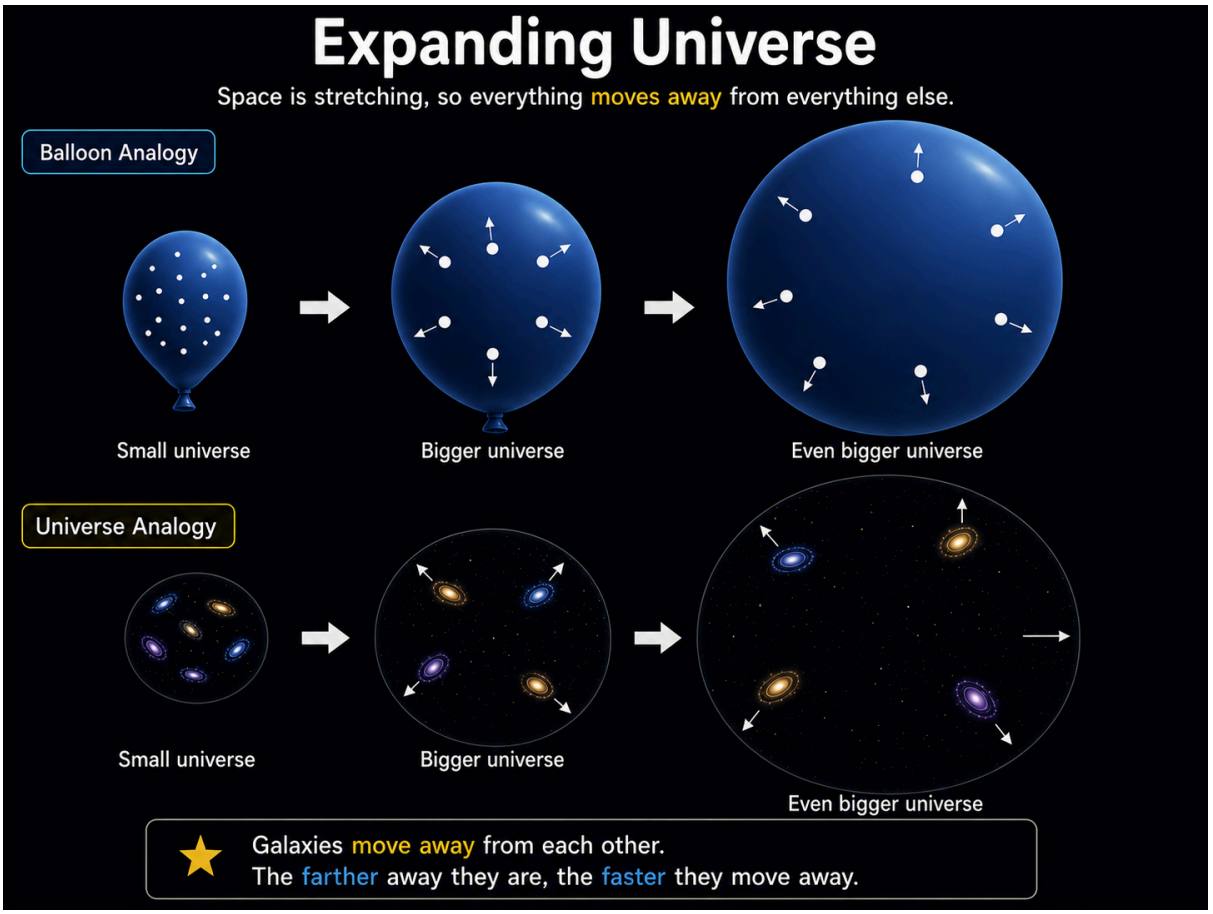
Hubble studied light from distant galaxies.

He found that most distant galaxies are redshifted.

This means most galaxies are moving away from us.

This was evidence that the universe is expanding.

Expanding Universe



Easy Explanation

The universe is expanding.

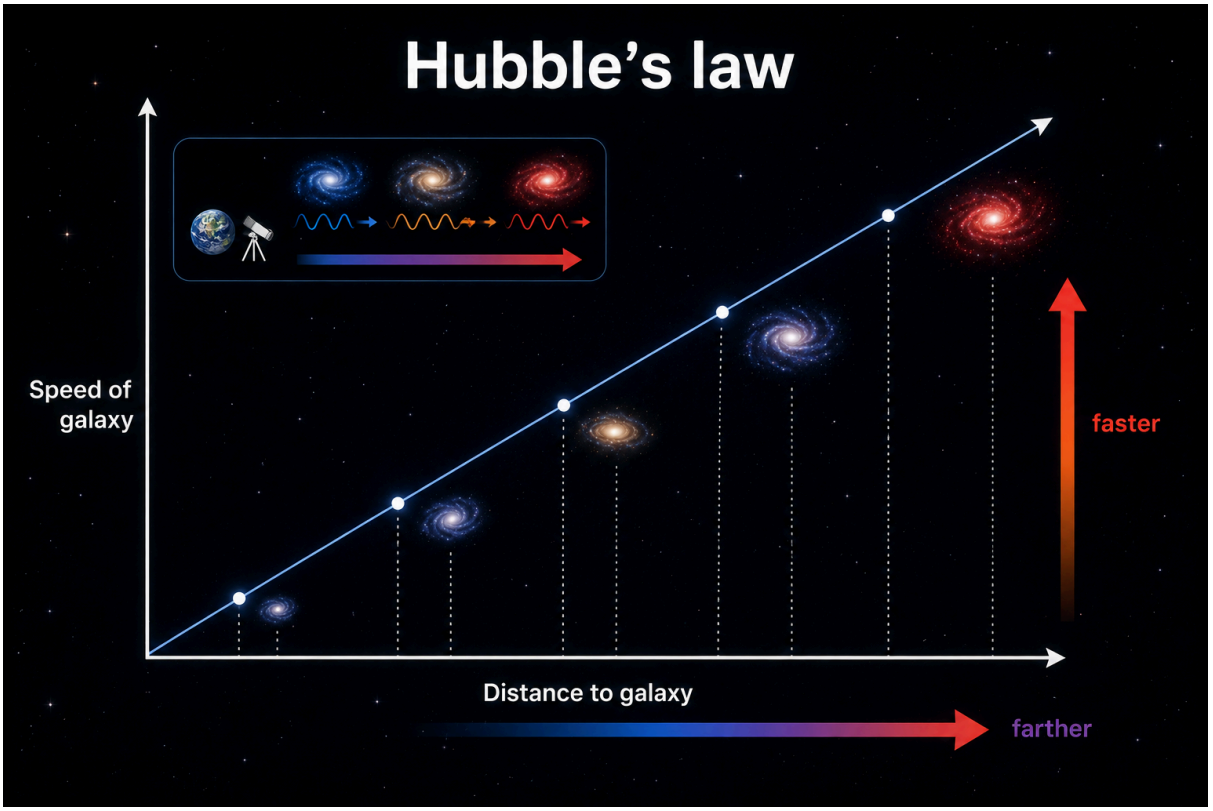
This does not mean galaxies are flying through empty space like rockets.

It means the space between galaxies is increasing.

A balloon with dots can model this idea.

As the balloon expands, the dots move farther apart.

Hubble’s Law



Vocab	What it means
Hubble’s law	it says farther galaxies move away faster

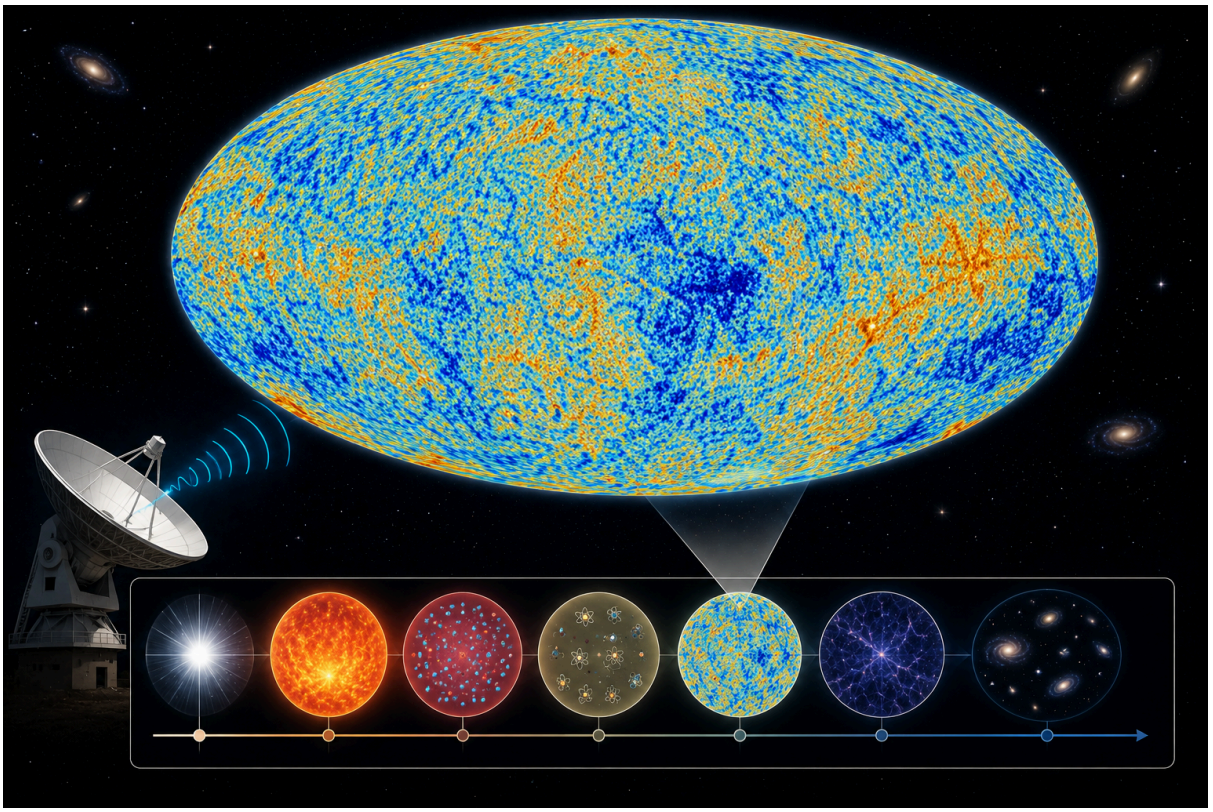
Easy Explanation

A graph shows this as an upward line.

The farther a galaxy is, the greater its redshift (it means far).

Most galaxies are moving away from us. This supports the idea that the universe is expanding because galaxies must have been closer together in the past.

Cosmic Microwave Background Radiation



(The line above shows the time line of the universe)

Vocab	What it means
Cosmic Microwave background radiation	• Leftover radiation from the early universe • It shows how hot the universe was

Easy Explanation

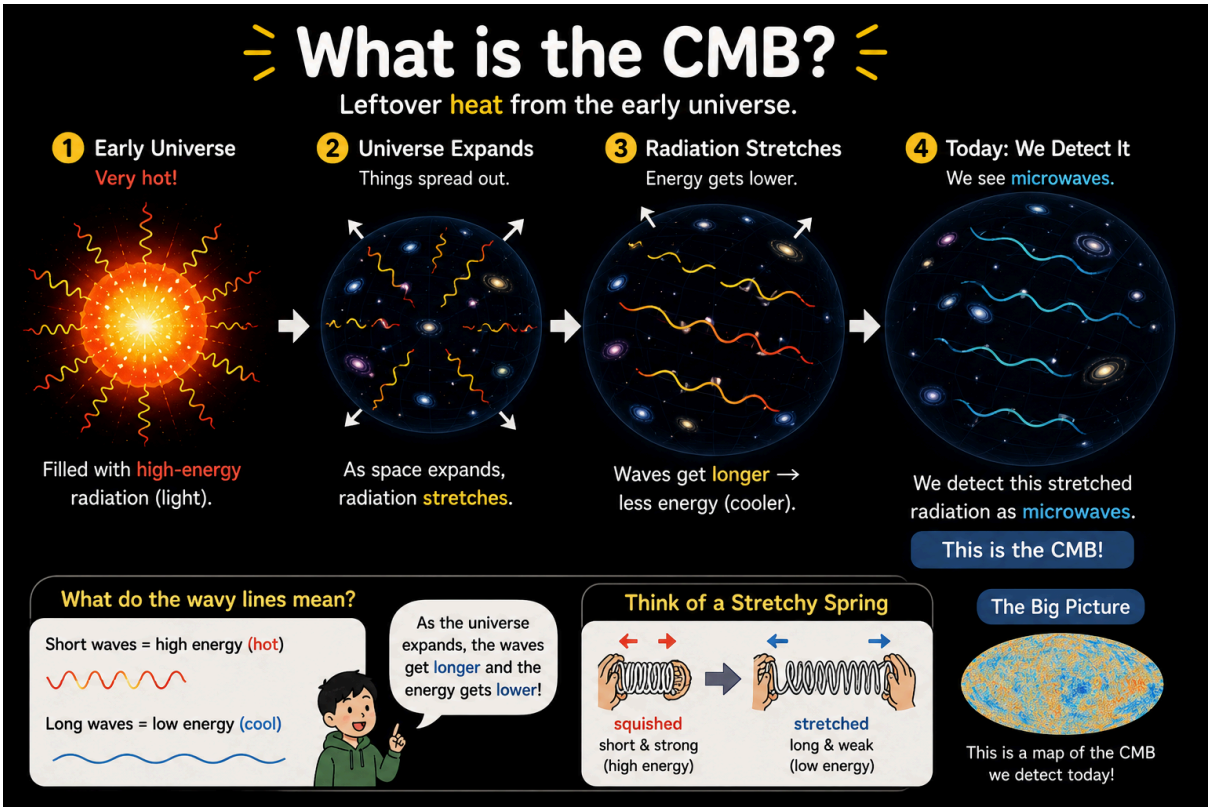
Cosmic microwave background radiation is leftover radiation from the early universe.

It fills the universe.

It is very cold today.

It is evidence that the universe was once very hot and dense.

Why CMB Supports Big Bang Theory



Vocab	What it means
CMB	The stretched radiation as microwaves when the universe expanded

Easy Explanation

The early universe was very hot.

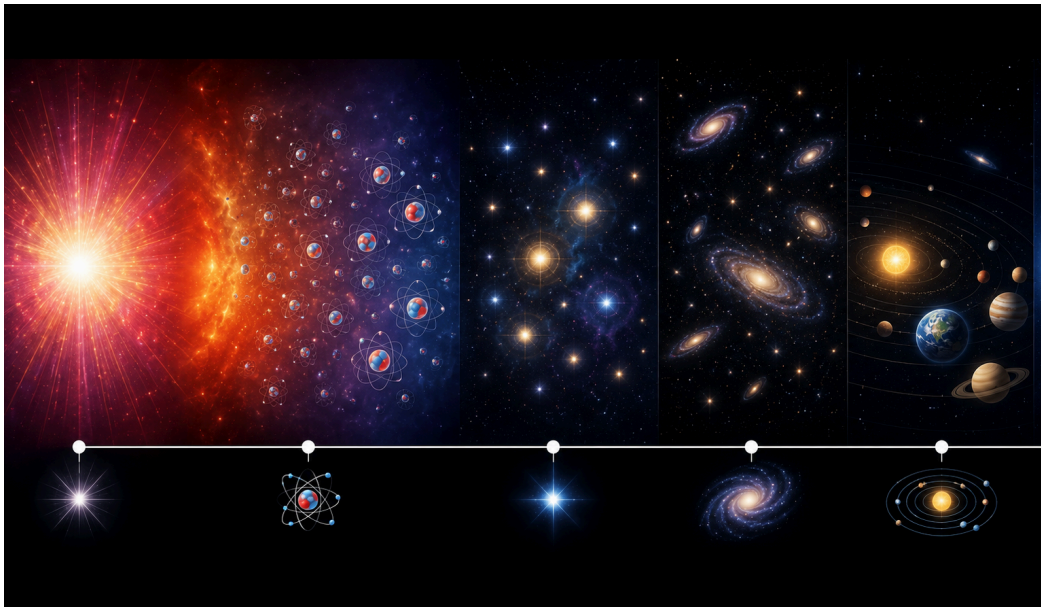
It was filled with high-energy radiation.

As the universe expanded, the radiation stretched.

Today, we detect this stretched radiation as microwaves.

This is the CMB.

Timeline of the Universe



Easy Explanation

The big bang theory helps describe how the universe changed over time.

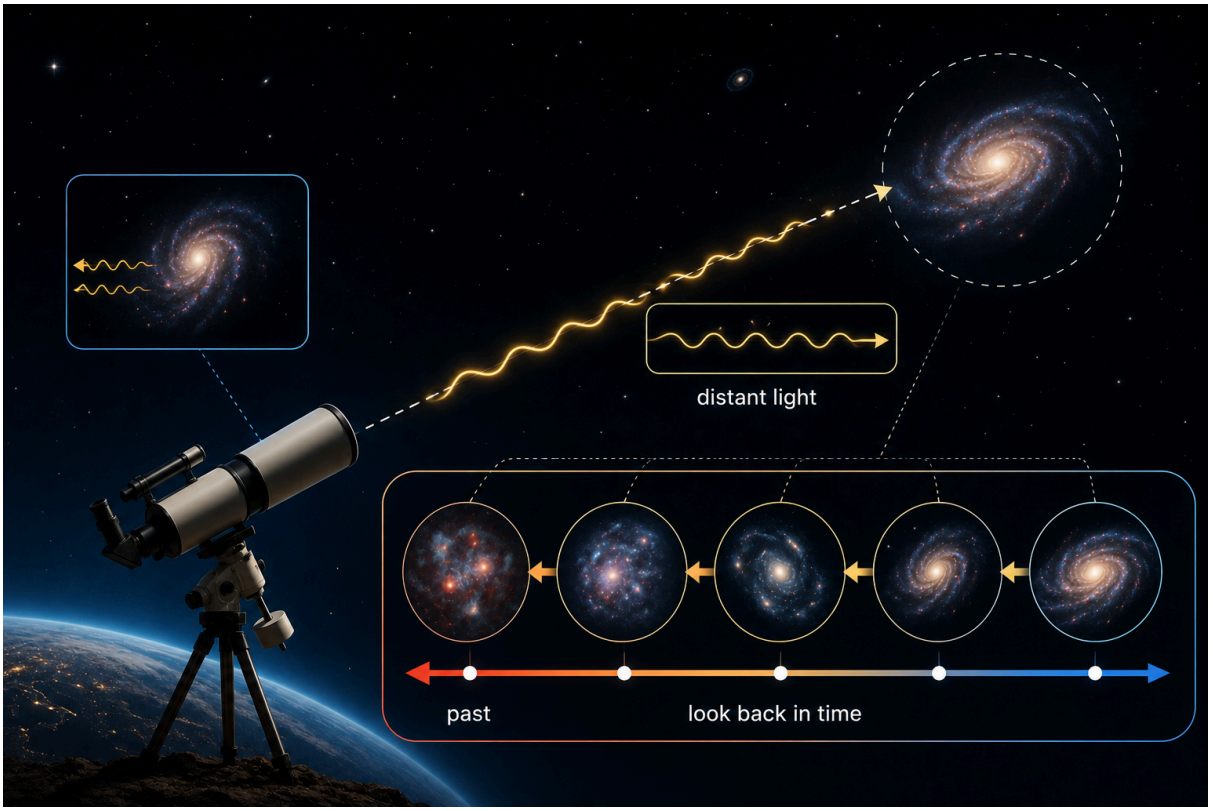
First, the universe was extremely hot and dense.

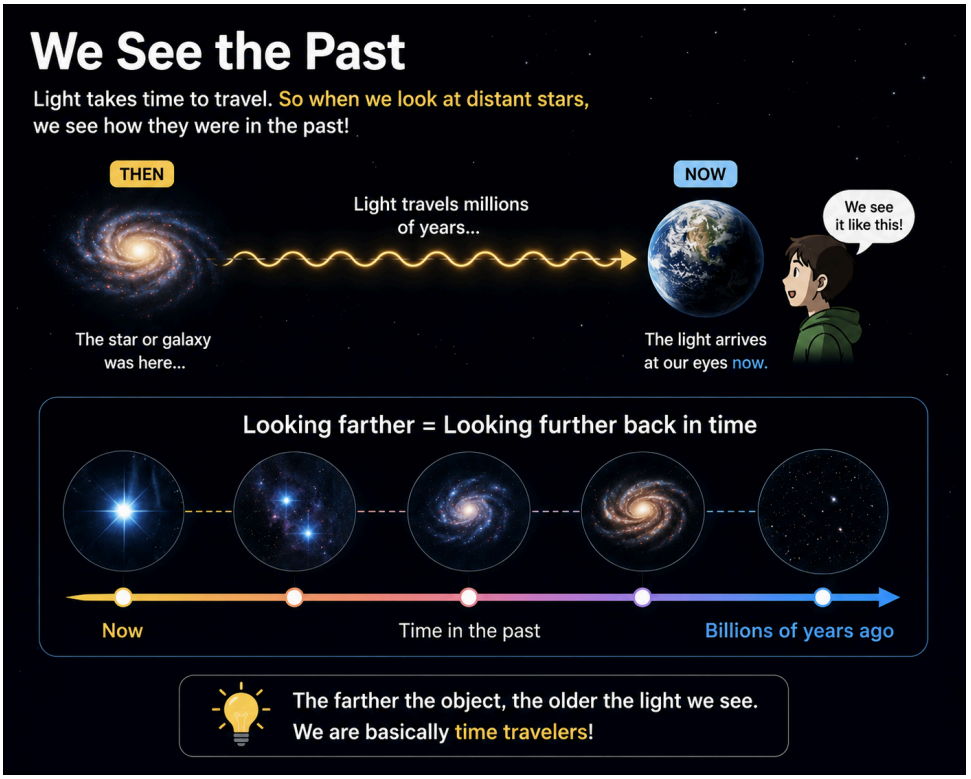
Later, atoms formed.

Then stars and galaxies formed.

Much later, the Sun and solar system formed.

Looking Back in Time





Easy Explanation

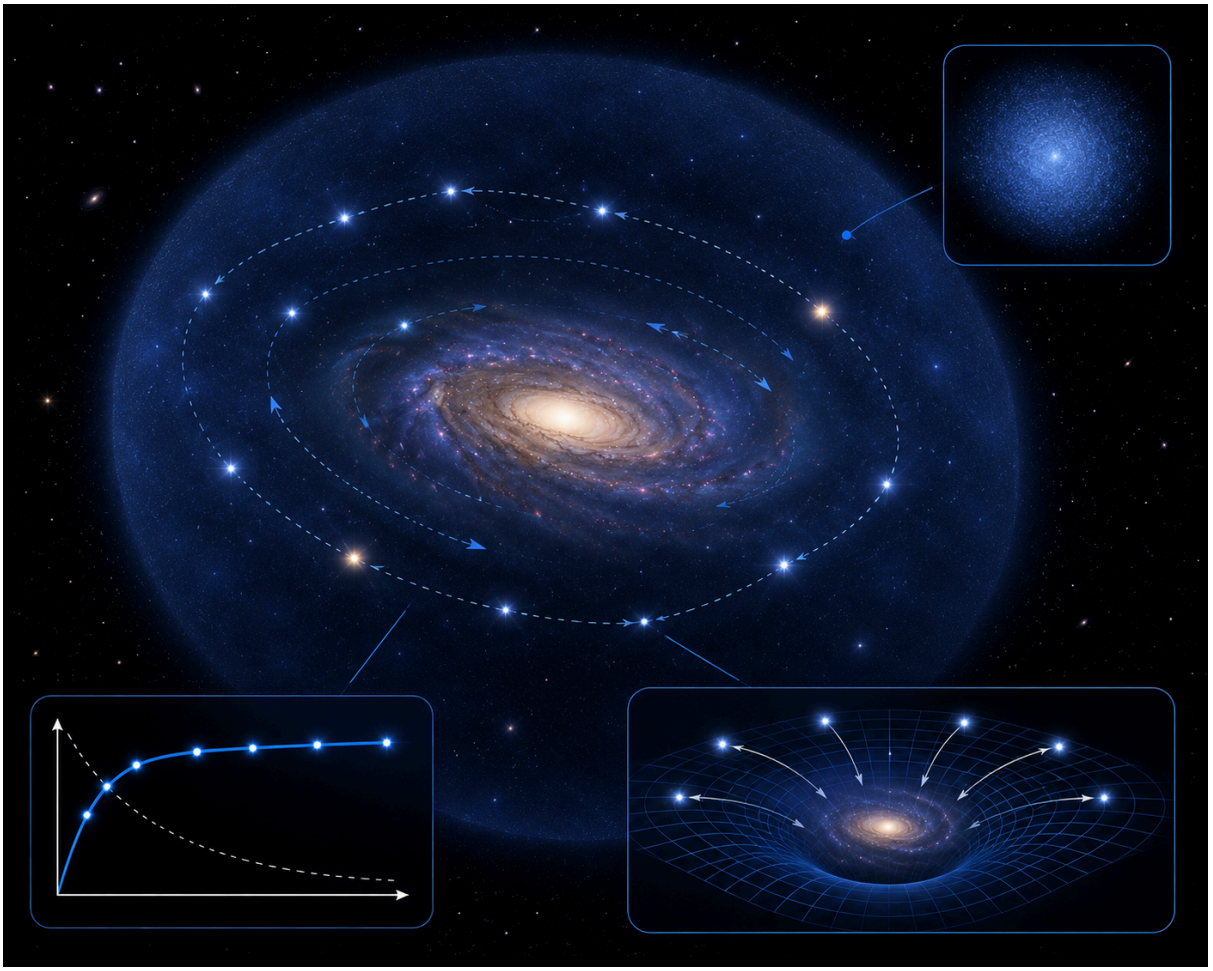
Light takes time to travel.

When we look far into space, we see old light.

That means we are looking into the past.

Modern telescopes help us study the early universe.

Dark Matter



Easy Explanation

Dark matter is matter we cannot see directly.

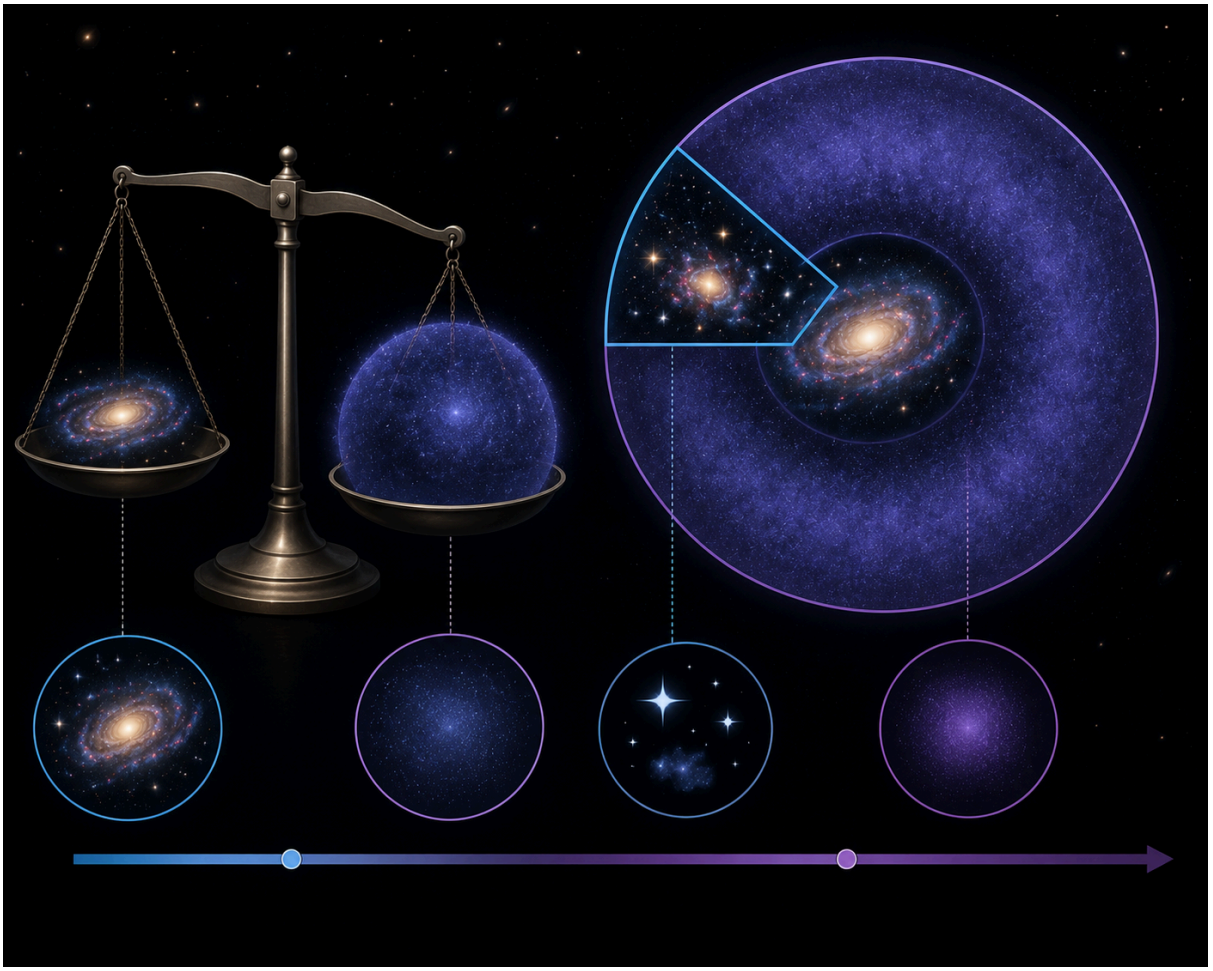
It does not give off light.

Scientists infer it exists because of gravity.

Galaxies move as if there is more mass than we can see.

So scientists think invisible matter surrounds galaxies.

Dark Matter and Visible Matter



Easy Explanation

Visible matter is the matter we can see.

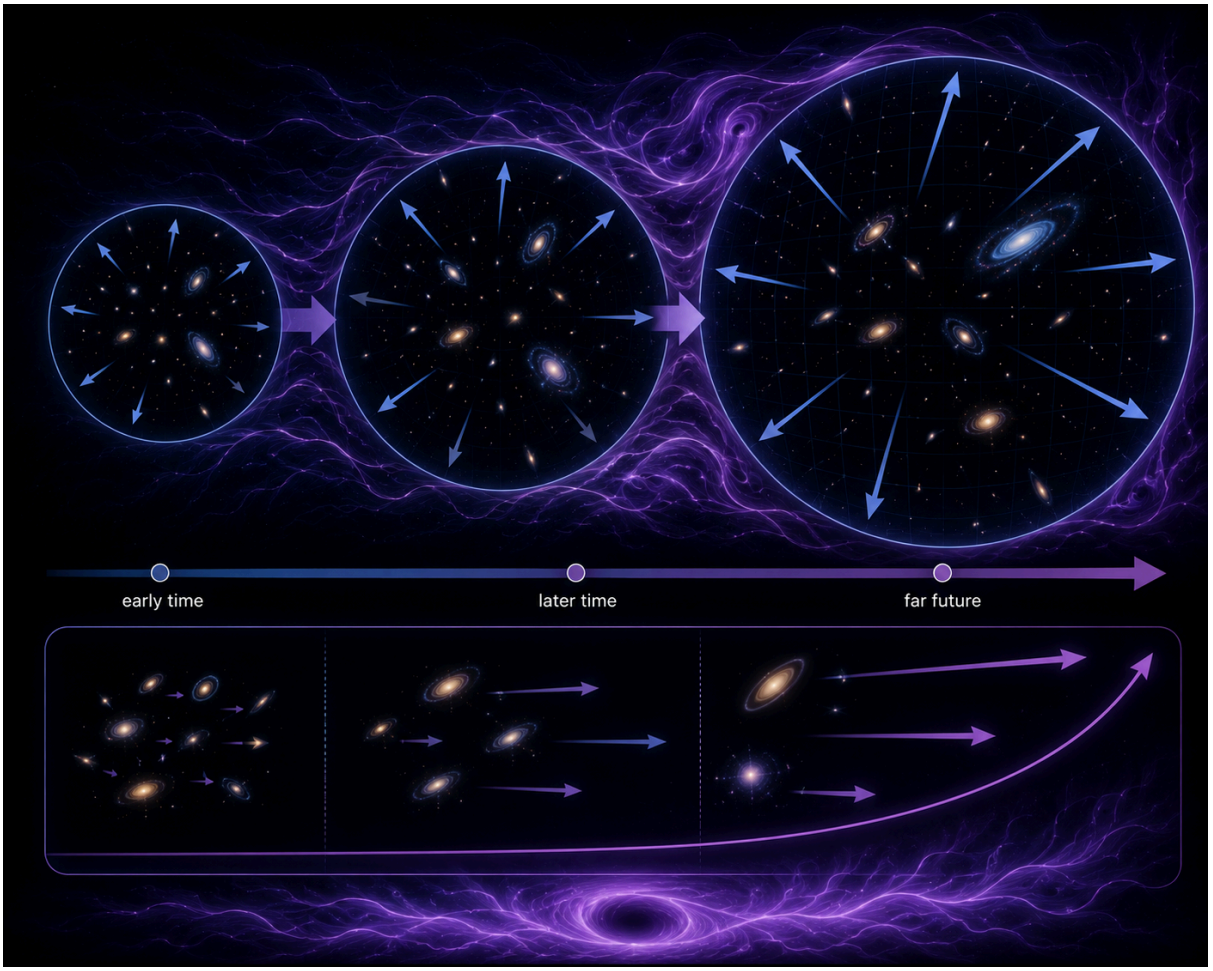
Stars, planets, gas, and galaxies are visible matter.

But visible matter is not enough to explain galaxy motion.

Dark matter may make up much more mass than visible matter.

Vocab	What it means
Visible matter	The matter we can see
Dark matter	The matter we cannot see directly

Dark Energy



Vocab	What it means
Dark energy	The unknown cause to speed up the expansion of the universe

Easy Explanation

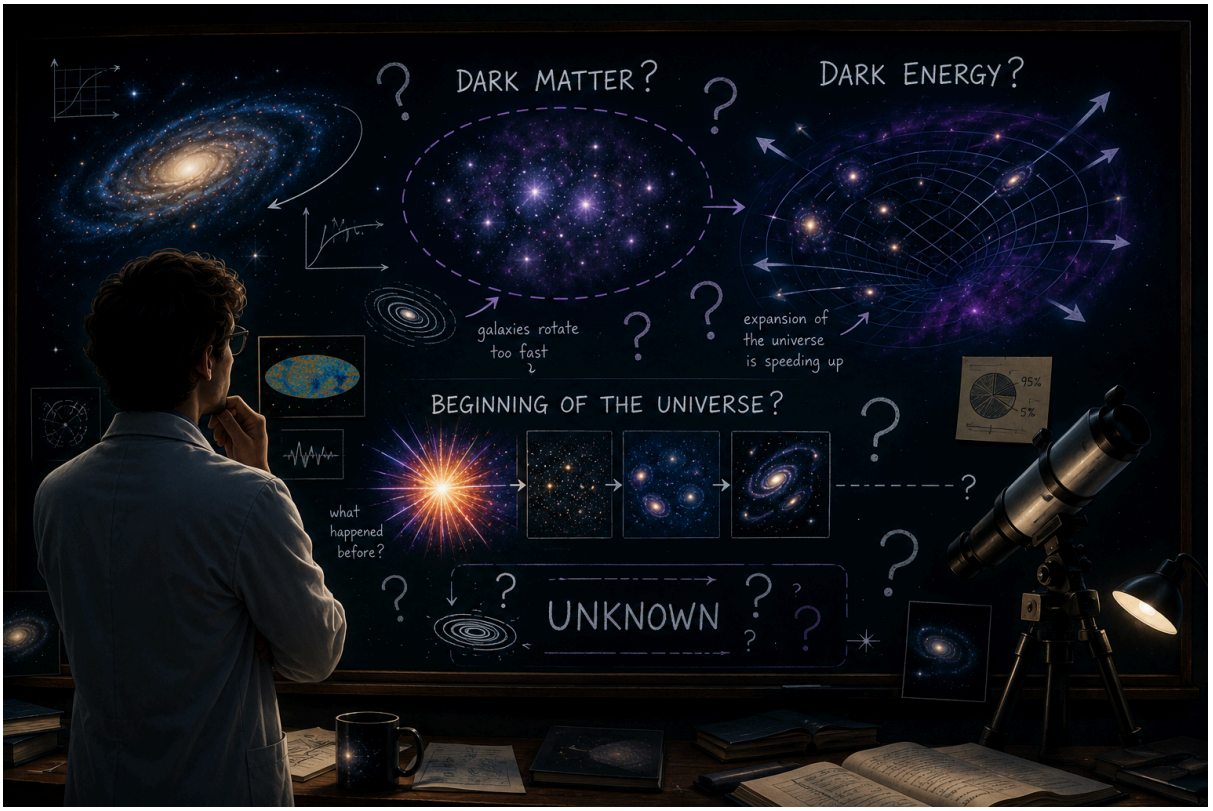
Scientists expected gravity to slow the expansion of the universe.

But observations showed that expansion is speeding up.

Scientists call the unknown cause to speed up the expansion of the universe **dark energy**.

Dark energy is still not fully understood.

What We Still Cannot Explain



Easy Explanation

Science has explained many things about the universe.

But there is still much we do not know.

Dark matter and dark energy are major mysteries.

The big bang theory is strong, but it does not answer every question.

Final Summary

Final Explanation

The big bang theory explains that the universe began hot and dense and has expanded over time.

Redshift shows that most galaxies are moving away.

Hubble’s law shows that farther galaxies move away faster.

CMB radiation is leftover radiation from the early universe.

Dark matter and dark energy show that the universe still has many mysteries.