13.75 BYA “Big Bang”

Universe was in a hot, dense state. It started expanding.

What was it like?

Because everything in the universe was really close together, there were a lot of collisions, and most everything was moving at nearly the speed of light. There was matter and antimatter, and all sorts of particles were popping in and out of existence.

How do we know?

The universe is expanding, as measured by movement of supernovas (novae) There is also background radiation, nearly like leftover heat. If everything is getting further apart and cooler, it must have been closer together and hotter in the past. By calculating when things were together, we can put the clock back at nearly 14 billion years.

One millionth of a second after the “Big Bang”

Basic particles such a protons and neutrons start to form

What was it like?

Temperatures were dropping, allowing the strong forces to hold protons and neutrons together. The anti-matter was no longer reacting with the matter, allowing the matter to remain.

How do we know?

Calculations based on particle-smashing experiments.

One second after the “Big Bang”

Electrons form

What was it like?

As the temperatures drop, more particles form.

How do we know?

Electrons are high energy particles. They need a little cooler temperatures to form. This is shown through collision experiments.

A few minutes after the “Big Bang”

The first atomic nuclei form – single protons and neutrons.

What was it like?

Temperatures drop to one billion degrees Celcius. Density of particles in the universe is similar to air. This is called “nucleosynthesis” (the formation of the nucleus), though most protons remain uncombined.

How do we know?

Particle collisions, and background radiation.

Later: 379,000 years after the Kaboom

Electrons and Nuclei combine into atoms.

What was it like?

The universe was cooling, and at this point, there was no longer enough energy to separate all of the electrons from orbiting protons. Most of the universe was made of hydrogen (still is), and radiation was no longer primarily in the atoms, but could travel through the empty spaces without collisions.

How do we know?

We know what energy is needed to separate an electron from the nucleus to make a plasma. We also have the background radiation still present.

Over the next couple million years – Phase 1

Denser places start attracting matter through gravity

What was it like?

Even though everything in the universe was becoming more spread out, gravity still worked. A particle floating past another particle would be attracted to it. This means that patches of the universe started to collect a lot of matter, and the more matter, the more attractive it got. Keep in mind, no stars had formed yet. This is nicknamed the “Dark Ages” of the universe.

How do we know?

The universe has these density pockets today where dust and matter are gathered.

About 400 million years after the Bang

The first stars form

What was it like?

As gravity pockets become more dense, there is a lot of pressure on the hydrogen at the center. When the pressure makes this hydrogen fuse into helium, large amounts of heat and light are released. These are stars. These stars were originally formed entirely of hydrogen and then helium.

How do we know?

Stars are still forming in our universe. The Hubble Telescope shows some of these nebulae (plural of nebula) or gas and dust clouds where baby stars are forming.

400 million years to 9 million years

Formation of galaxies, planets, and star cycles

What was it like?

Just like dust attracts duct, huge areas of density, like star fields, would tend to attract each other. Stars would attract other stars, and rotation would also be increased. Dust clouds around stars would condense as well, and large planets would form. Meanwhile, as the earliest stars died, they would explode (supernova) and release their dense cores. After the hydrogen burns to helium, fusion of helium into heavier elements (like carbon) would take place.

How do we know?

This is going on in the universe now. Also, humans have experimented with nuclear reactions.

Recent Times: 9 million years after the big bang

Star Formation Part 2 – Heavy elements

What was it like

Now that heavy elements exist, we get our “modern” planets, such as earth with its iron core and silicon-rich crust. Rocky planets and modern solar systems form, usually with the heaviest materials closest to the sun, and lighter elements further out. The cloud of gas and dust has condensed leaving the solar system as we know it.

How do we know?

Our solar system has dense materials, and some areas in the universe seem more “developed” like our region, while others look younger.