

The Big Bang

About 14 billion years ago, the Universe materialized out of nothing for unknown reasons. Infinitely smaller than an atom to begin with, the Universe expanded to billions of miles across in under a second—an event called the Big Bang.

Time came into existence when the Universe began, so the question “What happened before?” has no meaning. Space also came into existence. The Big Bang was not an explosion of matter through space—it was an expansion of space itself.

At first the Universe consisted of pure energy, but within a trillionth of a second some of this energy turned into matter, forming a vast soup of subatomic particles (particles smaller than atoms). It took nearly 400,000 years for the particles to cool down enough to form atoms, and then another 300 million years before the atoms formed planets, stars, and galaxies. The expansion that began in the Big Bang continues to this day, and most scientists think it will carry on forever.

The Universe began as something called a singularity: a point of zero size but infinite density.

The expanding Universe

The illustration below does not show the shape of the Universe, which is unknown. Instead, it is a timeline that shows how the Universe has expanded and changed since the Big Bang. We know the Universe is expanding because the most distant galaxies are rushing apart at rapid speeds. By running the clock backward, astronomers figured out that the expansion began 13.8 billion years ago at a single point: the Big Bang.

Rate of expansion increases

First galaxies form

Stars form

Atoms form

Protons and neutrons form

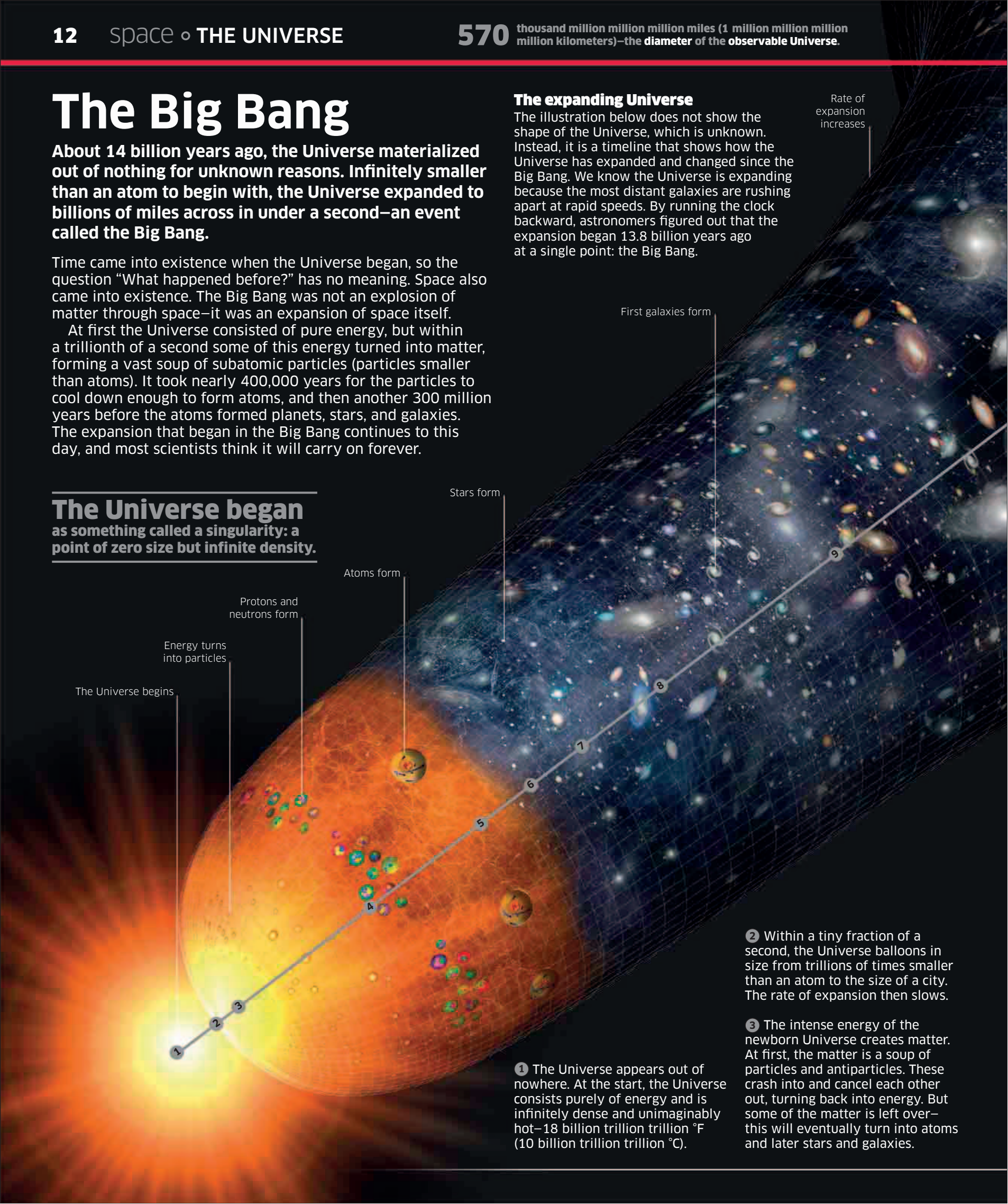
Energy turns into particles

The Universe begins

2 Within a tiny fraction of a second, the Universe balloons in size from trillions of times smaller than an atom to the size of a city. The rate of expansion then slows.

3 The intense energy of the newborn Universe creates matter. At first, the matter is a soup of particles and antiparticles. These crash into and cancel each other out, turning back into energy. But some of the matter is left over—this will eventually turn into atoms and later stars and galaxies.

1 The Universe appears out of nowhere. At the start, the Universe consists purely of energy and is infinitely dense and unimaginably hot—18 billion trillion trillion °F (10 billion trillion trillion °C).





Solar System forms

④ The Universe is now about 1 microsecond old and 60 billion miles (100 billion km) wide. The leftover particles begin to form protons and neutrons—the particles that today make up the nuclei of atoms. But the Universe is too hot for atoms to form yet. Light cannot pass through the sea of particles, so the young Universe resembles a dense fog.

⑤ After 379,000 years, the Universe cools enough for atoms to form. The Universe is now an enormous cloud of hydrogen and helium. Light can pass through space more easily, and the Universe becomes transparent.

⑥ Half a million years after the Big Bang, matter is spread out almost evenly in the Universe, but tiny ripples exist. Working on these denser patches, gravity begins pulling the matter into clumps.

⑦ At 300 million years, stars appear. Stars form when great clouds of gas are pulled into tight knots by gravity. The pressure and heat become so intense in the dense pockets of gas that nuclear reactions begin, igniting the star.

⑧ At 500 million years, the first galaxies are forming. Galaxies are enormous clouds of stars, held together by gravity.

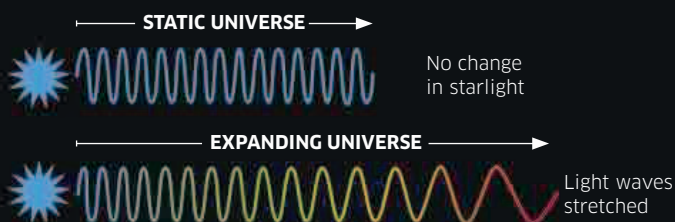
⑨ Now 5 billion years old, the Universe consists of vast clusters of galaxies arranged in threads, with gigantic voids between them. The voids get ever bigger as space continues to expand. At 8 billion years, the expansion of the Universe begins to accelerate.

⑩ Our Solar System forms at 9 billion years. When the Universe is 20 billion years old, the Sun will expand in size and destroy Earth.

⑪ The Universe will carry on expanding forever, becoming cold and dark everywhere.

Discovery of the Big Bang

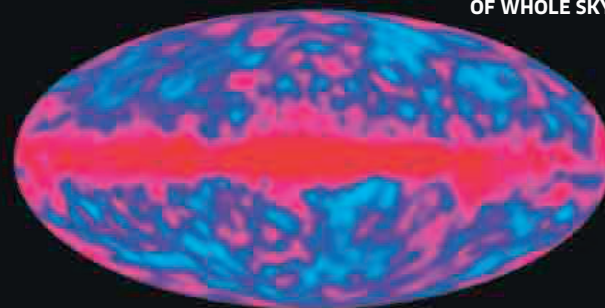
The first scientific evidence for the Big Bang was found in 1929, when astronomers discovered that light from distant galaxies is reddened. This color change happens when objects are moving away from us, making lightwaves stretch out and change color. The more distant the galaxies are, the faster they are rushing away. This shows that the whole Universe is expanding.



Big Bang afterglow

More evidence of the Big Bang came in the 1960s, when astronomers detected faint microwave radiation coming from every point in the sky. This mysterious energy is the faded remains of the intense burst of energy released in the Big Bang.

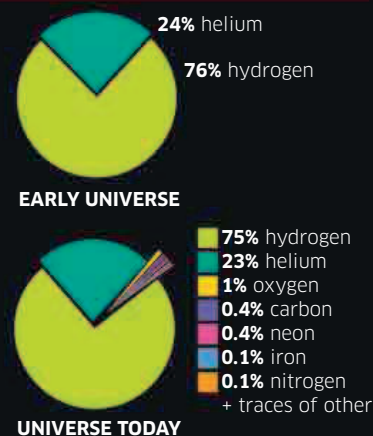
MICROWAVE MAP OF WHOLE SKY



Changing elements

For hundreds of millions of years, the Universe consisted almost entirely of hydrogen and helium—the very simplest chemical elements.

After stars appeared, new elements began to be made in the cores of dying stars. All the complex elements in our bodies were forged in dying stars this way.



Big Bounce theory

What caused the Big Bang? We may never know for sure, but some scientists have suggested that there may have been lots of big bangs, with the Universe expanding after each one and then shrinking again. This theory is called the Big Bounce because the process repeats itself.

