THE UNIVERSE AND THE EARTH

The universe

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The universe

The universe contains hundreds of billions of **galaxies** separated by enormous distances. A galaxy is a huge group of stars. Each star is a huge cloud of dust and gases, mainly hydrogen and helium.

Galaxies are usually found in groups or **galaxy clusters,** which means they were formed from the same molecular cloud. Our galaxy cluster is the Local Group, and our galaxy is the Milky Way. The Milky Way is a spiral galaxy, which describes its disk-like shape. There are also elliptical, peculiar, and irregular galaxies in the universe.

Dark energy is a force scientists believe exists in the universe that pulls the universe apart. **Dark matter** accounts for the difference between the matter in the universe that we can observe and matter that is present, but cannot be seen.

Black holes occur in different ways, but many begin with the death of a star when a huge mass contracts and collapses in on itself. Nothing can escape this gravity, not even light.

The Big Bang theory

The universe began about 13,700 million years ago in an event called the Big Bang. This explosive expansion is the origin of time and space. It made it possible for the universe to continue expanding, even today.

It produced radiation that is found throughout the universe: Cosmic Microwave Background radiation. The expansion of the universe has stretched the radiation until it converted it into Cosmic Microwave Background (CMB) radiation, which can be detected and analysed.

CMB radiation, the Doppler effect and the chemical composition of the universe are scientific evidence supporting the Big Bang theory.

Phases of the Big Bang

The universe has continued to evolve since the Big Bang.

- **The inflation stage.** This occurred in the first fraction of a second. The super compacted universe expanded and grew at an incredible velocity generating all the existing mass in the universe,
- **The first elements.** In the first minutes, the expanding universe was made up of subatomic particles, like electrons and quarks. In a few minutes this particle soup cooled by millions of degrees. The quarks were able to bind together creating the first neutrons and protons.

- **The first atoms.** Over the next 300,000 years, approximately, nuclei of hydrogen and helium atoms were formed at about the same rate as today. The universe was dark and opaque.
- **Lighting of the universe.** As it expanded, the universe cooled, allowing the nuclei formed by protons and neutrons to combine with electrons, forming neutral atoms. Approximately 380,000 years after the Big Bang, photons multiplied freely, since they not interact with the electrons. Cosmic Microwave Background radiation began.
- **Formation of stars and galaxies.** Between 200 and 400 million years after the Big Bang, areas of space with slightly less density became centres of gravitational attraction. Matter collected around them forming nebulae, planets and stars. Soon after, the first galaxies were formed.

Since their origin, stars have been creating heavy chemical elements from hydrogen, so the global chemical composition of the universe has been enriched continually.

Distances in the universe

An **astronomical unit (AU)** is used to express distances within the solar system.

A **light year** is used to measure distances of objects outside the solar system.