The Big Bang Theory

Big Bang Theory is about the origin of Universe. It suggests that about 1370 crore (13.7 billion) years ago, all matter and energy in the universe was concentrated into an area smaller than an atom. **At this instant, matter, energy, space and time were not existent.** Then suddenly with a bang, the Universe began to expand at an incredible rate and matter, energy, space and time came into being. As the Universe expanded, matter began to coalesce into gas clouds and the stars and planets. Some scientists believe that this expansion is finite and will done day cease. After this point in time, the Universe will begin to collapse until a Big Crunch occurs.

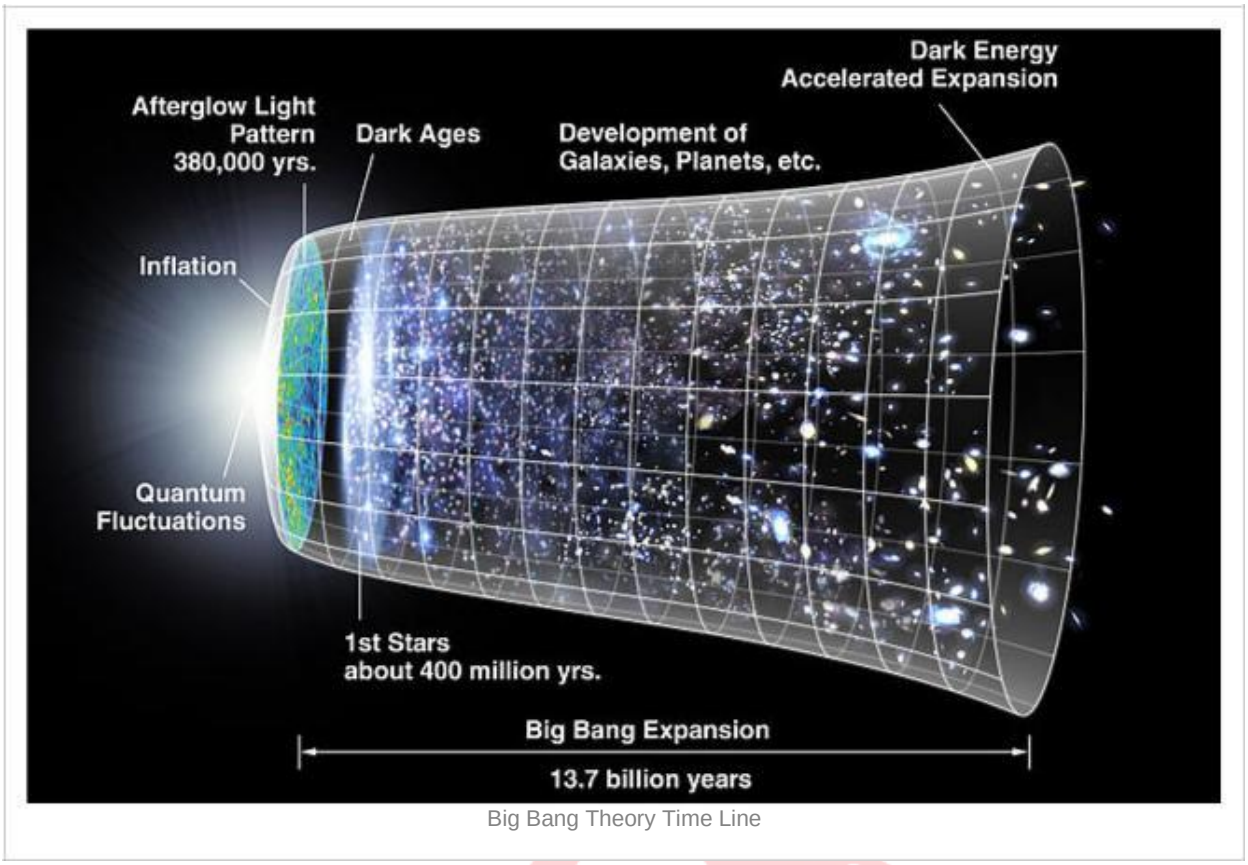
Just before the Big Bang

No one knows what the universe was like at this time. The best current theory, the “inflationary universe” model assumes that all of space is filled with an extremely concentrated, unstable form of **energy that will be transformed into particles of matter** at the instant of the Big Bang. But no one knows how space and time came into existence in the first place.

The first few minutes to next thousand years

After the initial expansion, the universe cooled sufficiently to allow the **formation of subatomic particles, including photons, electrons, protons and neutrons.**Though simple atomic nuclei formed within the first three minutes after the Big Bang, thousands of years passed before the first electrically neutral **atoms** formed. The majority of atoms that were produced by the Big Bang are hydrogen, along with helium and traces of lithium.

PS : *If the universe had remained this hot and dense for much longer, the hydrogen would all have been cooked into other chemical elements. Without hydrogen, there would be no water, and therefore no life as we know it!*



Big Bang Theory Time Line

Earlier Opaque Universe vs Later Transparent Universe

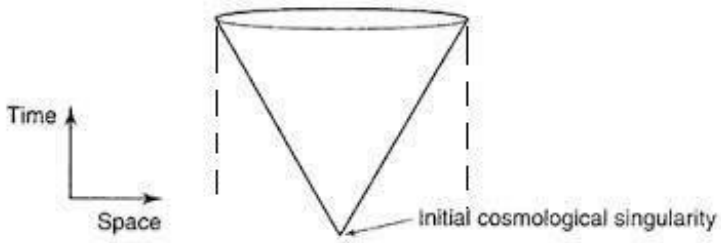
Photons (light) being elementary particles would have been formed soon after the Big Bang. But these photons would have been scattered by the early electrons. As the Universe continued to cool, it would have eventually reached the temperature where electrons combined with nuclei to form neutral atoms (recombination). Before this "recombination" occurred, the Universe would have been opaque because the free electrons would have caused light (photons) to scatter the way sunlight scatters from the water droplets in clouds. But when the free electrons were absorbed to form neutral atoms, the Universe suddenly became transparent. Those same photons – the afterglow of the Big Bang known as **Cosmic Background Radiation** – can be observed today.

Also read: Dark Matter vs Anti Matter vs Negative Matter

PS: *Opacity of the early Universe before recombination is, in effect, a curtain drawn over those interesting very early events. Fortunately, there is a way to observe the Universe that does not involve photons at all. Gravitational waves, the only known form of information that can reach us undistorted from the instant of the Big Bang, can carry information that we can get no other way. Two missions that are being considered by NASA,* ***LISA and the Big Bang Observer****, will look for the gravitational waves from the epoch of inflation.*

Rate of Expansion of Universe is not decreasing, but increasing due to Dark Energy!

It had always been assumed that the matter of the Universe would slow its rate of expansion. **Mass creates gravity, gravity creates pull, the pulling must slow the expansion.** But supernovae observations showed that the expansion of the Universe, **rather than slowing, is accelerating**. Something, not like matter and not like ordinary energy, is **pushing the galaxies apart**. This "stuff" has been dubbed dark energy, but to give it a name is not to understand it. Whether dark energy is a type of dynamical fluid, heretofore unknown to physics, or whether it is a property of the vacuum of empty space, or whether it is some modification to general relativity is not yet known.



Question of Equilibrium : Answer in Inflationary model

Our investigation shows that **the early Universe was too homogeneous**. How could pieces of the Universe that had never been in contact with each other have come to equilibrium at the very same temperature? This and other cosmological problems could be solved, however, if there had been a very short period immediately after the Big Bang where the Universe experienced an incredible burst of expansion called "inflation." For this inflation to have taken place, the Universe at the time of the Big Bang must have been filled with an unstable form of energy whose nature is not yet known. Whatever its nature, the inflationary model predicts that this **primordial energy** would have been **unevenly distributed** in space **due to a kind of quantum noise** that arose when the Universe was extremely small. This pattern would have been transferred to the matter of the Universe and would show up in the photons that began streaming away freely at the moment of recombination.

Also read: Ebola Virus Disease - A Challenge to India

Proofs of Big Bang

1. **Expanding galaxies:** Hubble in 1929, noted that galaxies outside our own Milky Way were all moving away from us, each at a speed proportional to its distance from us. He quickly realized what this meant that there must have been an instant in time (now known to be about 14 billion years ago) when the entire Universe was contained in a single point in space. The Universe must have been born in this single violent event which came to be known as the "Big Bang."
2. **Cosmic Background radiation:** Those early photons – the afterglow of the Big Bang known as cosmic background radiation – can be observed today.

Missions to study Big Bang

1. **Cosmic Background Explorer (COBE) : N**ASA has launched two missions to study the cosmic background radiation, taking "baby pictures" of the Universe only 400,000 years after it was born. The first of these was the Cosmic Background Explorer

(COBE).

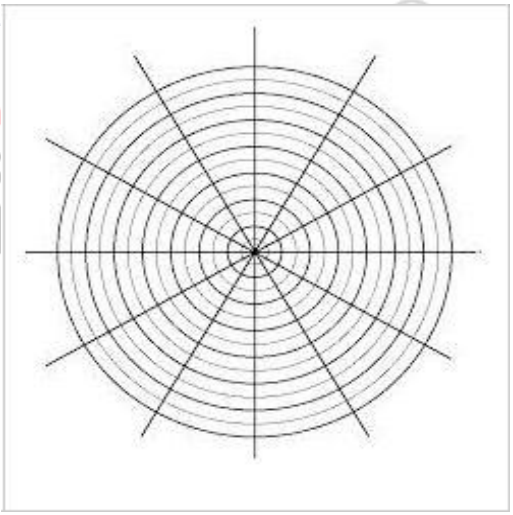
2. **Wilkinson Microware Anisotropy Probe (WMAP):** The second mission to examine the cosmic background radiation was the Wilkinson Microware Anisotropy Probe (WMAP). With greatly improved resolution compared to COBE, WMAP surveyed the entire sky, measuring temperature differences of the microwave radiation that is nearly uniformly distributed across the Universe. The picture shows a map of the sky, with hot regions in red and cooler regions in blue. By combining this evidence with theoretical models of the Universe, scientists have concluded that **the Universe is "flat,"** meaning that, on cosmological scales, the geometry of space satisfies the rules of Euclidean geometry (e.g., parallel lines never meet, the ratio of circle circumference to diameter is pi, etc).
3. **Planck:** A third mission, Planck, led by the European Space Agency with significant participation from NASA, was launched in 2009. Planck is making the most accurate maps of the microwave background radiation yet. With instruments sensitive to temperature variations of a few millionths of a degree, and mapping the full sky over 9 wavelength bands, it measures the fluctuations of the temperature of the CMB with an accuracy set by fundamental astrophysical limits.

Also read: Financial Market : Money Market and Capital Market

Telescopes: Today NASA spacecraft such as the **Hubble Space Telescope** and the **Spitzer Space Telescope** continue Edwin Hubble's work of measuring the expansion of the Universe.

The Big Bang Theory in Laymen Language

In the beginning there was only energy. This energy got converted to small particles (like photons). As there were earlier free electrons too, these earlier photons got scattered by first electrons. The result: a dark universe! But later, when electrons combined with protons and neutrons (atomic nuclei), atoms were formed. As then there were no free electrons to scatter photons then the Universe became transparent!



Universe is flat!

Some unknown energy kept particles pushing apart. Meanwhile the universe started too cool too. Atoms like Hydrogen were formed. Atoms formed molecules, molecules combined to form compounds and so on. The final result : all the big objects like what we see today planets, stars, galaxies and so on! But now when we analyse the universe, the shape of the universe is flat, ie as if explosion taken place on a 2 -dimensional table!

The two theories which formed the basis of the big bang theory are : (1) Einstein's General Theory of Relativity and (2) The Cosmological Principles, which states that the universe is homogeneous through out. Hope at least the basics of the 'not-so-easy-to-understand' Big

Bang theory of energy to mass conversion is clear! If not, have a look at 2-3 reference documents.

1. Timeline of the Big Bang.
2. Shape of the universe.
3. Beyond Big Bang Cosmology.