**BIG BANG THEORY**

The Big Bang theory is the prevailing cosmological model of the observable universe from the earliest known periods through its subsequent large scale evolution. The model describes how the universe expanded from an initial state of high density and temperature, and offers a comprehensive explanation for a broad range of observed phenomena, including the abundance of light elements, the cosmic micro-wave background radiation and large scale structure.

Crucially the theory is compatible with Hubble-Lemaitre law – the observation that the farther away galaxies are, the faster they are moving away from the earth. Extrapolating this cosmic expansion backwards in timing using the known laws of physics, the theory describes an increasingly concentrated cosmos preceded by a singularity in which space and time lose meaning (typically named the Big Bang singularity). Detailed measurements of the expansion rate of the universe place the Big bang singularity at around 13.8 billion years ago, which is thus considered the age of the universe. After its initial expansion, an event that is by itself often called ‘the Big Bang’, the universe cooled sufficiently to allow the formation of subatomic particles and later atoms. Giant clouds of these primordial elements mostly hydrogen with Helium and Lithium – later coalesced through gravity forming early stars and galaxies, the descendants of which are visible today. Besides these primordial building materials, astronomers observe the gravitational effects of an unknown dark matter surrounding galaxies. Most of the gravitational potential in the universe seems to be in this form and the Big bang theory and various observations indicate that this excess gravitational potential is not created by Baryonic matter, such as normal atoms. Measurements of the red shifts of supernovae indicate that the expansion of the universe is accelerating, an observation attributed to dark energy’s existence.

The Big Bang explains the evolution of the universe from a starting density and temperature that is well beyond humanity’s capability to replicate, so extrapolations to the most extreme conditions and earliest times are necessarily more speculative. The Big Bang theory is built upon the equations of classical general relativity, indicating a singularity at the origin of cosmic times and such an infinite energy density may be a physical impossibility. However, the physical theories of general relativity and quantum mechanics as currently realized are not applicable before the Plank epoch and correcting this will require the development of a correct treatment of quantum gravity. Certain quantum gravity treatments such as the wheeler-Dewitt equation, imply that time itself could be an emergent property. As such, Physics may conclude that time did not exist before the Big Bang. While it is not known what could have preceded the hot dense state of the early universe or how and why it originated or even whether such questions are sensible, speculation abounds on the subject of ‘cosmogony’. The theory by which the astronomers explain the way of beginning of universe is the ‘Big Bang’. It is the idea that the universe began as just a single point and then expanded and stretched to grow as large as it is right now and it is still stretching. The Big Bang theory explains that the universe came into being from a single, unimaginably hot and dense point more than 13 billion years ago. It did not occur in an already existing space. Rather it initiated the expansion and cooling of the space itself.

The Big Bang theory offers a comprehensive explanation for a broad range of observed phenomena including the abundances of the light elements, the CMB, large-scale structure and Hubble’s law. The theory depends on two major assumptions: the universality of physical laws and the cosmological principle. The universality of physical laws is one of the underlying principles of the ‘Theory of Relativity’. The cosmological principle states that on large scales, the universe is homogeneous and isotropic – appearing the same in all directions regardless of location. The ideas were initially taken as postulates, but later efforts were made to test each of them.

The large-scale universe appears isotropic as viewed from earth. If it is indeed isotropic the cosmological principle can be derived from the simpler Copernican principle, which states that there is no special observer or vantage point. To this end the cosmological principle has been confirmed to a certain level via observations of the temperature of the CMB. At the scale of the CMB horizon, the universe has been measured to be homogeneous with an upperbound on the order of 10 percent inhomogeneity, as of 1995. The expansion of the universe was inferred from early 20th century by astronomical observations and is essential ingredient of Big bang theory. Mathematically, general relativity describes space time by a metric, which determines the distances that separate the nearby points. The points which can be galaxies, stars or other objects are specified using a coordinate chart or grid that is laid down over all space-time. The cosmological principle implies that the metric should be homogeneous and isotropic on large scale, which uniquely singles out the Friedmann-Lemaitre-Robertson-Walker (FLRW) metric. This metric contains a scale factor, which describes how the size of the universe changes with time. This enables a convenient choice of a coordinate system to be made, called co-moving coordinates. In this coordinate system, the grid expands along with the universe and objects that are moving only because of the expansion of the universe, remain at fixed points on the grid. While their coordinate distance or co-moving distance remains constant, the physical distance between two such co-moving points expands proportionally with the scale-factor of the universe. The Big Bang is not an explosion of matter moving outward to fill an empty universe. Instead, space itself expands with time everywhere and increases the physical distance between the co-moving points. In other words, the Big Bang is not an explosion in space but rather an expansion of space, because the FLRW metric assumes a uniform distribution of mass and energy, it applies to our universe only on large scales – local concentrations of matter such as our galaxy do not necessarily expand with the same speed as the whole universe.

Big bang space-time can be determined by the presence of particle horizons. Since the universe has a finite age, and light travels at a finite speed, there may be events in the past whose light has not yet time to reach us. This places a limit or a past horizon on the most distant objects that can be observed. As space is expanding and more distant objects are receding ever more quickly, light emitted by us today may never catch up to very distant objects. This defines a future horizon, which limits the events in the future, that we will be able to influence. The presence of either type of horizon depends on the details of the FLRW model that describes our universe. Our understanding of the universe back to very early times suggests that there is a past horizon, though in practice our view is also limited by the opacity of the universe at early times. So, our view cannot extend further backward in time though the horizon recedes in space. If the expansion of the universe continues to accelerate, there is a future horizon as well.

One of the common misconceptions about the Big bang model is that it fully explains the origin of the universe. However, the Big bang model does not describe how energy, time and space were caused but rather it describes the emergence of the present universe from an ultra-dense and high temperature initial state. It is misleading to visualise the Big Bang by comparing its size to every objects. When the size of the universe at Big Bang is described, it refers to the size of the observable universe and not the entire universe.

As a description of the origin of the universe, the Big Bang has significant bearing on religion and philosophy. As a result it has become one of the liveliest areas in the discourse between science and religion. Some believe the Big Bang implies a creator, while others argue that Big bang cosmology makes the notion of a creator superfluous.