Modern Cosmology and Buddhism

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Introduction

SINCE ancient times, human beings have always pondered philosophical questions relating to living organisms, the planet Earth and the universe itself. What is life? Are human beings special living organisms? What is that twinkling star in the night sky? What is the universe? How big is the universe and where does it begin and end? These are just a few questions. However, these questions can hardly be answered yet. That is, life, the earth, and the universe are still deep with mysteries in modern day science. In this article, we would like to explore the topic of the universe and compare modern cosmology with Buddhist cosmology.

Inflationary Big Bang Theory

The most accepted theory in cosmology today is the Inflationary Big Bang theory. This theory about how the universe was born is supported by two specific observations describing the expansion of the universe and its background radiation.

The expansion of the universe is considered the single most important observation in the Big Bang theory. This observation is known as Hubble's law. Hubble discovered in 1929 that there is a particular proportion between the magnitude of red-shift and the distance between the Earth and galaxies. In other words, the larger the expansions of wavelength towards the red end of the spectrum (red-shift), the faster the expansion rate of the galaxy. It is understood that the larger the distance of a galaxy from Earth, the faster the galaxy moves away from the planet. In short, this phenomenon describes that the universe is expanding.

A. A. Penzias and R. W. Wilson discovered background radiation (cosmic microwaves) in space in 1965. This is electromagnetic radiation which exists in all directions in the universe and has a spectral peak at 1–2 mm in the electromagnetic wavelength spectrum. It is sometimes referred to as cosmic background radiation since it fills the entire uni-

verse and all of the background of space. Background radiation has two important attributes: 1) background radiation in the universe is extremely uniform without a particular directionality and 2) it accounts for the relatively stable temperature of the universe at 2.7 K or −270ºC.

The Big Bang theory is a method of recovering the history of the universe by returning to the origin of the universe which is theoretically expanding today. Further, the following facts have been recently clarified by observations from the WMAP (Wilkinson Microwave Anisotropy Probe) satellite. They are, 1) the history of the universe is about 13.7 billion years old, 2) at about 380,000 years after the universe was born in exponential expansion, the background radiation was dispersed, 3) the universe is geometrically flat (this is described later), and 4) at about 200 million years after the universe started, the first stars and galaxies were born. The most interesting findings from the WMAP is that the universe, aside from all of the galaxies, is comprised of substantial proportions of baryonic material, unknown matter (dark matter) and mysterious energy (dark energy) which are not easily observed. As a result, it is speculated that the universe is comprised of 4% so-called baryonic material, 23% dark matter and 73% dark energy. Unfortunately, the problem is that the universe is mostly comprised of dark matter and energy that cannot be easily observed.

Steady-State Cosmology

Another cosmology theory besides the Big Bang theory exists. This theory is called the Steady State theory which was advocated in 1948 by Fred Hoyle, Thomas Gold, and Hellman Bondi. This cosmology, unlike the Big Bang theory, suggests that the universe has fundamentally always had the same appearance up to the present time. The feature of this cosmology is that there is neither a beginning nor an end in the universe. In this scenario, the universe is naturally expanding. The universe generally appears the same whenever newly-born stellar bodies expand and fill the universe. Thus, there is always a constant balance between matter and energy in space.

The steady state cosmology has recently evolved into the quasi-steady state cosmology which explains prior unexplained phenomena. The quasi-steady state cosmology asserts that many small-scale mini-bangs occur continuously with the passing of time. Since the appearance of matter and energy from nothing appears similar to that of the Big Bang theory, the quasi steady state theory is a mini-inflation concept. The observed background radiation is explained by minute dust particles of

iron or carbon that exists innumerably in the universe between galactic systems and emits light by low temperature degree.

Problems of Modern Cosmology

Between the two current cosmologies, the Big Bang theory is overwhelmingly supported. However, each cosmology also has respective problems that need to be addressed and solved.

According to the Big Bang theory, the universe is comprised of two competing energy sources. One is the energy from the initial explosion by the Big-Bang, that is, the energy of expansion, and the other energy is that of gravity within the expansion such as gravity found in galaxies, that is, the energy of contraction or shrinkage. The universe becomes geometrically flat if these two energies are balanced and expanding. The expansion is expected to stop after an infinite amount of time. On the other hand, if the energy of the expansion is larger than that of gravity, it becomes an open universe. The universe would keep expanding in this case through all eternity. Adversely, if the energy of gravity is larger than the energy of the expansion, it becomes a closed universe. In this case, the universe will contract and shrink over time and finally settle towards a single point. This is called the Big Crunch. The current observations support the idea that the energy of a geometrically flat universe is balanced by expansion (Big Bang) energy and shrinkage (gravitational) energy. In both the inflationary Big Bang theory and the quasi-steady state theory cosmology, the universe is expanding. The problems with these two theories lie in the explanation of the red-shift of energy from galaxies. Both theories assume that the red-shift phenomenon is attributed to expansive movement. However, there are other possible explanations for the red-shift phenomena such as the natural diminish (loss of energy) of light or red-shift due to contraction.

In addition, there is another problem. The biggest problem common to both cosmologies is the simple creation of matter in the vacuum of space. In the inflationary Big Bang theory, the idea is that the entire universe was created from a vacuum of nothing 13.7 billion years ago while the quasi-steady state cosmology suggests that matter is created constantly in the vacuum of space. To put this simply, there is no difference in the conceptualization of matter from a vacuum of nothing.

The biggest problem for inflationary Big Bang cosmology is the existence of dark matter and dark energy. Dark matter and dark energy are not necessarily relevant in the quasi-steady state theory since the universe has not changed over time. However, calculations of the mass-bal-

ance of the universe suggest that the mass of galaxies (gravity) is less than that of the expansion energy. This anomaly is not possible in physics. Thus, most astrophysicists attribute the compensation to the mass of dark energy and dark matter. In other words, it is necessary to assume that the dark matter and the dark energy compensate for the in equality in balance. Thus, the two cosmologies are difficult to confirm based on these discrepancies.

Cosmological and Anthropic Principles

There are philosophical cosmologies besides that of scientific cosmology. These are cosmological and anthropic principles.

In the case of the cosmological principle, the universe does not have a special place, that is, it is uniform and does not have direction. In this case, human beings are merely a product in the history of the universe. On the other hand, the anthropic principle requires a reason for the existence of human beings in the present state of the universe. In this case, the universe is suitable for human beings. If this were not the case then the principle stands at the logical deduction that human beings cannot observe the universe or the universe is unobservable.

In 1957 Robert H. Dicke suggested the age of the present universe at 13.7 billion years old. The calculation of this age was partly related to the scientific experiences of human existence. In other words, the age should range within an extent of ten billion years old based on the human experience that heavy elements such as carbon could not have been made if the universe were too young. Further, if the age of the universe were too old, stable planet systems would no longer exist. However, when considering the age of the universe, we must also take into account the bias or privileged conditions of the human existence. In 1974 Brandon Carter advanced Dicke's argument suggesting that if intelligent organisms such as human beings did not exist then the universe could not be readily observed and therefore not exist. This is the concept of anthropic principle. That is, the universe exists because an observer exists at a particular epoch, and the universe must have structure so that intelligence (human beings) can exist.

From the standpoint of anthropic principle, this universe is miraculously well-balanced. This balance is based on blended scientific observations and scientific theories. For example, if the physical constants in nature (dimensionless physical constants) were variable in time and space, then life on the planet could not exist and even a fixed star could not exist. The possibilities in the universe, e.g. the physical constants in

nature, are not uniform and thus space could not be three dimensional. However, why does the universe have a suitable structure for generating a high-degree living organism (intelligence)? Steven W. Hawking suggested that our universe is neither open nor closed, but exists with no-boundaries in space and time. He discusses that although we can envision various possible universes, the expansion of the universe is mysteriously balanced. If the universe were expanding too quickly and powerfully, then living organisms and galactic bodies could not evolve in time, yet if the universe were expanding too slowly and weakly then living organisms and galactic bodies could not yet exist. The only certainty from this deduction is that the universe is keenly balanced for the existence of life and planetary bodies.

Buddhist Cosmology

The most interesting aspects of self-consistent ancient Indian Buddhist cosmology are the conceptualizations of vast space, incomprehensible time and the considerations of life existence. Buddhist cosmology is well expressed in a category of Buddhist scriptures that explains all worldly phenomena called the *Abhidharmakośa-bhásya* by Vasubandhu (*Seshin*) in 5 A.D. The vast cosmology is described allegorically where Mt. Sumeru (*Shumisen*) is located at the center amongst a ring of seven mountains ranges and dividing seas. There are also four continents surrounding the rings of mountain ranges and seas. Human beings live on one of the four continents shaped in the form of a trapezoid called the Embudai (*Senbushu*). The world of the Hell exists vertically under the Embudai continent, while Heaven (*Ten*) and Meditator (*Zenjo-sha*) exists vertically above it. The sun and moon rotate around the entire one-world system.

The allegoric concept of the one-world system in Buddhism with Mt. Sumeru at its center extends 13 million Yojana (*Yujun*) or 90 million km, which is comparable to the distance between the Earth and Sun. This is in exact accordance with our solar system both in name and reality. Further, 1000 one-world systems are called a small-thousand-world system, 1000 small-thousand-world systems are called a medium-thousand-world-system, and 1000 medium-thousand-world systems are called a large-thousand-world system. This system is called a three-thousand-world system which equates to 1 billion one-world systems! The galaxy including our solar system has about 200 billion fixed stars. There may be several hundred million planet systems in the galaxy. In this sense, the galaxy corresponds to the medium-thousand-world system in Bud-

dhism and the large-thousand-world system may correspond to the whole universe. There is no other ancient cosmology that grasps the vastness of the universe like Buddhism at a time when scientific knowledge was non-existent. When considering other ancient cosmology, i.e. ancient Babylonia, Egypt, Greece, and China, we find that these cultures were only able to grasp a limited one world centered on the planet Earth. In comparison, Buddhist cosmology is astronomically robust.

There are other concepts of worlds and universes in Buddhism. For example, allegorically Aksobhya-buddha (*Ashuku-butsu*) lives in the Abhirata-buddha land (*Myoki-koku*) located one thousand Buddha lands to the east of the planet Earth, Amitabha-buddha (*Amida-butsu*) lives in the Sukhavati land (*Gokuraku-jodo*) 10 trillion Buddha lands to the west while Bhaisajya-guru (*Yakushi-nyorai*) lives in the Vaidūryanirbhāsa land (*Joruri-sekai*) over ten Ganga-nadi-valuka (*Gogasha*) Buddha lands to the east. Here the distance of Ganga-nadi-valuka Buddha lands is 10^{52} which is equivalent to the number of sand granules in the Ganges River. Current cosmology suggests there are 200 billion galaxies each of which includes the 200 billion fixed stars. Therefore, there are 4×10^{22} fixed stars. In short, the universal view of the Buddha land suggested in Buddhism grasps a far larger world than those prescribed by modern science. One concept in present cosmology is the idea of a multi-dimensional cosmology which includes many universes. Thus, Buddhist cosmology can be said to be most similar to or resemble the multi-dimensional cosmology.

Buddhism also discusses the concept of the time continuum using the four kalpa periods, i.e., *jo-ko*, *ju-ko*, *e-ko* and *kuu-ko* which are the four steps from construction to destruction of a star, galaxy and universe. Individually, they are; *jo-ko*: a period of creation, *ju-ko*: a period of continuity at a stable state, *e-ko*: a period of destruction, and *kuu-ko*: a period of transition in a state of emptiness. Each period is 20 kalpas. The term kalpas literally means a very long time in Buddhism, but in Hinduism it means 4.32 billion years. From this context, each step or period is about 80 billion years equating to a full cycle at 320 billion years, which is an extremely long time. These four periods are one cycle and continues eternally; the history from creation to extinction drawn in Buddhism. Therefore, the period from creation to extinction of the universe in Buddhism is about 13.7 billion years in accordance with modern cosmology.

Here it is important to note some interesting points about the relationship between life and the four kalpa periods. During the pre- *jo-ko* stage a faint wind begins to blow creating a one-world system with Mt.

Sumeru at the center. The faint wind is generated from the karma of sentient beings. Once the one-world system is created the sentient beings are reborn, returning and descending, for example, from heaven or the *kuu-ko* stage. When all sentient beings are reborn from the *e-ko* stage via the *kuu-ko* stage, the *jo-ko* is completed. In Buddhism, the expression of the faint wind is the force of increasing karma, the common karma of sentient beings which creates their own environment, such as a planet, a star, a galaxy and the universe. Furthermore, the living entity is constructed by the five aggregates (i.e., body, mind and their behaviors of sentient being) from individual karma. In the Buddhism, the body and mind of life is temporarily harmonized.

Conclusion

The inflationary Big Bang theory described in modern cosmology adheres to a linear method of conception, because the open or flat universe in the theory has a starting point. On the other hand, a closed universe would be an oscillating enigma which repeats the expansion and contraction cycle eternally; the universe would restart at the turning point of the Big Crunch. However, based on recent observations it appears as though the closed universe is not a possibility. The quasi-steady state cosmology continuing in a constant condition is similar to that of Buddhist cosmology not having a beginning or an end. Buddhism is circular in thought due to the fact that the four kalpas in stars and galaxies repeat. Therefore, Buddhist cosmology might be similar to the quasi-steady state cosmology. Whether it is true or not, it is interesting to ponder why ancient people in India were been able to recognize such expansive world-systems and incomprehensible time continuums. Perhaps, it might not be that ancient India recognized it physically, but that they were able to perceive inconceivable worlds through the connection between the spiritual world and the universe.

There is a large difference between modern cosmology and Buddhist cosmology. While science is fixed on the functionality and creation of matter, Buddhism is focused on the life-centric view. A life in Buddhism does not necessarily point only to a living entity, but also characterizes life force as a fundamental power or principle. Modern science investigates all phenomena from the perspective of the evolution of matter in cosmology. This is the cosmological principle. However, there is actually a large gap between material (matter) and life (living entities), and science has yet to resolve this gap. In other words, science is tasked to solve very large universal questions from only the viewpoint of the evo-

lution of material. The anthropic principle, categorically evaluates human beings or intelligence. This principle standpoint is different from that of Buddhism by evaluating intelligence or human beings only, because Buddhism formulates a life-centric view.

The perspective of life and the universe in Buddhism positions life at the center of everything. In Buddhism, since the universe and the Earth are the environment for sentient beings, they are constructed by the common karma of the sentient beings themselves. The theory of "the Earth as Gaia" by Lovelock in 1979 is similar to that of Buddhism. In the hypothesis of Gaia, life on Earth controls the environment and creates a suitable environment on the planet. In Buddhism, life activity is not only regulated by materials (matter) recognized by science, but that individual karma (life activity) also regulates and produces life itself from material accumulated in the environment. Therefore, the concept of karma persistently plays a central role in the functioning of the universe. Buddhism has the depth to explain well the functionality and importance of life and the environment in parallel with scientific evidence. In that sense, modern times may require a conversion of ideals.