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Modern and Jain Cosmology: A comparison

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ABSTRACT

Cosmology or Lokavad is an integral part of Jain philosophy. Jainism subscribes to Steady State cosmology and is probably a multiverse theory. Several aspects like structure, shape, constituents of the universe and time cycles are described in detail. Law of conservation forms the back bone of all processes described in Lokavad, and it is not confined only to material aspects but is dominated by living (jiva) processes. In comparison, modern cosmolgy has a solid theoretical as well as observational foundation but it is still an evolving subject. Although Jain cosmology is conceptually very appealing, it differs in many respects from modern ideas ingrained in theories of origin (Big Bang Theory) and evolution (expanding phase) of the Universe.In this article we make an attempt to point out similarities and differences between some aspects of modern cosmology and Jain concepts.

Key words: Cosmology, Lokakash,Steady state theory, Big Bang, Conservation Law, Structure of the Universe, String theory, kaal chakra,cosmic cycles

Scriptures Quoted: Tilloy Pannati, Bhagavati Sutra

1. Introduction

Origin of life, origin of universe, origin of earth etc., are fundamental questions of enquiry in philosophy, religion as they are in science. The Nasadiya Sukta[1] in Rig-Veda (ca. 3000 BCE) ponders over the mystery of origins and illustrates the philosophic depth of thinking, contradictions, uncertainties and complementarity, which

1.The Nasadiya Sukta ponders over the question of "what was there in the beginning, before water, air, light and Earth, universe and God came into existence" and describes the conditions "there was neither non-existence nor existence then; no death, no immortality; no day, no night; no above, no below etc; Who really knows, it asks? Perhaps it created itself, perhaps it did not. May be it was the Hiranyagarbha, the primal nucleus. Perhap it did not. May be it was the Hiranyagarbha, the primal nucleus. Perhaps He who looks from the highest heavens knows or even he knows not, it says"

are the basic tenets of Jain philosophy as also of quantum mechanics to describe the true nature of the universe. The Jain principle of Syadvad puts a limit on knowledge, similar to quantum mechanics as discussed in an accompanying article by Bhandari and Pokharna (This volume).

Tremendous progress has been made in the field of cosmology, both observational as well as theoretical, during the past century. Even so, we are still far from a complete understanding of the origin, evolution and fate of the universe, as discussed in the preceding article by Rangarajan (2015). Hubble's observational evidence of galaxies speeding away from each other, indicated that the universe has been expanding. Extrapolating this expansion back in time led to the formation of the universe in the "Big Bang" event about 13.7 billion years ago. The universe has been expanding and cooling ever since, but whether this expansion will continue forever or not is highly debated. Various stages of physical and dynamical evolution since Big Bang have been quantitatively defined. In this scenario most of the matter was formed in a very short episode, starting at a tiny fraction of a second (10^{-35} seconds) to 3 minutes since the Big Bang and then slowly evolved into stars and galaxies, i.e. visible matter under the influence of various forces operating in nature. According to the current ideas, the strongly interacting, visible, luminous matter in the Universe, in the form of stars, is only 4%. The rest of the matter, ~ 26% is weakly-interacting, invisible or dark matter, inferred by its gravitational effects, and ~70% is dark energy, exerting a kind of repulsive force, resulting in expansion of the universe.

In spite of the success of the Big Bang model, what caused it and what was happening before Big Bang remains an enigmatic point. In this context other theories, like Steady State, cyclic and oscillating universe are appealing and philosophically satisfying. Hoyle, Bondi, and Narlikar proposed the Steady State cosmology but later, to make it consistent with Hubble's observation of expanding universe, Narlikar tried to accommodate the Big Bang event in the Steady State model and modified it to a "Quasi Steady State" theory, in which the universe is oscillating between contraction and expansion. One of the most discussed theories, at present, is the string theory, not yet fully established, but considered to be a good candidate for unifying all the three forces in nature (electromagnetic-weak nuclear, gravity, and strong nuclear) and can possibly lead to Theory of Everything (TOE). Efforts are underway to develop a model of the universe based on Quantum theory and General theory of Relativity.

Jainism subscribes to Steady State theory, in which the universe is eternal, without beginning and end. The Jain scriptures have discussed constituents, structure, size and time cycles (*Kaal Chakra*) operative in the universe in great detail. Jain cosmology, formulated about 2600 years ago, divides the universe in two parts - *Loka* and *Aloka*. *Loka*, the visible part of the universe, is finite, defined by the

presence of six basic constituents (*dravya*), *jiva* (soul), *pudgal* (matter), *akash* (space), *kaal* (time), *dharmastikaya* (considered to be responsible for motion) and *adharmastikaya* (responsible for the state of rest). *Loka* is immersed in the infinite *Aloka,* which is pure space, devoid of all other five constituents and is invisible. So far as material i.e. non-living (*ajiva, pudgal dravya*) and living-beings (*jiva*) are concerned, they are always in a dynamic state, continuously interacting with each other and changing their forms and modes.

The geometrical shape of the Jain universe i.e. *Loka* (pictorially described as a man in a standing pose with elbows stretched out), is quite peculiar. No such structure is found in nature and such a structure is unstable according to the laws of physics. We therefore take the view that the diagrams in the scriptures do not represent physical aspect (structure, shape etc.) of the universe and are symbolic and illustrative pictograms, like an artist's conception, representing something else,which needs to be decoded properly. One likely explanation is that this structure represents a multiverse, i.e. three universes side by side.

In Jain Steady State cosmology, the universe has always been, in a gross sense, like as it exists now. To circumvent the problems of formation and destruction of the universe within the framework of the Steady state theory, Jainism postulates cycles of various types within the steady state. The Jain concept of time cycle (*kaal chakra*) within a steady-state universe is as follows. One complete cycle is divided in two parts, *Utsarpini* and *Avasarpini* and each of these half cycles are further divided in six "*Aaras*". Recent observations suggest that several time cycles, ranging from diurnal, monthly, to hundreds of millions of years are operative on earth. These include solar, lunar, climatic, geological, astronomical, galactic and cosmological cycles in the order of increasing time periods.These cycles (*kaal chakras*) regulate creation, evolution, sustenance and destruction. Following earlier suggestions by Jain (2010) and Bhandari (2010), Jain et al and Jain, Bhandari and Surana, (2015), in accompanying articles, argue that these Kaal chakras (periodic cycles) are climatic in origin and govern the earth and not the whole universe. There may well be other cycles, of cosmic nature, which govern the solar system, galactic phenomena and the universe.

In spite of incomplete and imprecise description of subatomic particles, enunciated by the Heisenberg's Uncertainty principle, scientific observations show that every physical process in the universe is governed by certain laws, which are well defined and can be mathematically formulated with precision. Origin of everything that exists in the universe must follow these laws which are inviolable. These laws should have existed before anything came into being, so that they operate on every phenomena and all the constituents responsible for formation of the Universe. Observationally, we find that the universe has evolved over the ages but the laws of physics, which govern it, have remained invariant. Various attempts to

find even the slightest variation in these laws with time have so far not been successful. Thus these laws are universal i.e. applicable at all places, at all times. This possibility envisages that either the universe has not been created and has been as it is since eternity. This forms the basis of the "steady state theory" of the universe. Alternatively, the universe has come into existence spontaneously, *swayambhu*, i.e. self created. This is akin to the spontaneous breaking of super symmetry, a mechanism considered to be responsible for formation of the universe. At the present state of our knowledge, it is not possible to make a correct choice between various models mentioned above, some of which appear contradictory.

The questions that naturally arise are: How did these laws come into being and why are the laws in the form as they exist at present and not different? Are there other universes where the governing laws are different from those applicable to our universe? What makes these laws to be mathematically formulated with precision? These questions are not easy to answer, except to say that they are inherent in the very nature of the universe.

Jainism propounds that certain "entities" (*jîva*, and *ajîva* consisting of the six *dravyas*, mentioned above) are eternal[2] and the universe follows the steady state model according to which *jîva* and *ajîva* have always existed as they exist now. There is no origin or creation, causal or spontaneous. But the scientific evidence suggests that the universe, the Earth and life on Earth have originated at some point of time and gradually evolved to the present state and eventually they will be destroyed. It has also been observed that all the stars, galaxies, galactic clusters, molecular clouds, planets and other constituents of the universe are evolving, disintegrating and new stars and galaxies etc. are being formed. According to the fundamental Jain law, Tripadi[3], everything (living or non-living) which is created, continuously changes its form and is ultimately destroyed but its basic 'essence' (*dravyas*) is indestructible and permanent even though the cycles of changes continue *ad infinitum*. The quality of permanence is akin to the basic law of conservation in physics.

Even so, it is difficult to visualize the cause or the motive force responsible for creation of the universe. In this context, a Buddhist concept of *Karma* as the driving force, is appealing. According to this proposition, *karmas* of sentient beings are the motivating force for origination of the material universe, or at least various habitable planets including the earth (as well as hell-like or heaven-like habitats). Appropriate habitats and their environments are spontaneously created by nature where the sentient beings are reborn to expiate the consequences of their accumulated *karmas* of their past lives. Thus *karma* (or causality) is the prime force driving the universe.

Some gross features, like theories of origin, structure, constituents and time scales, etc of the modern and Jain cosmology are compared in Table-1.

Although many features of Jain cosmology do not agree with the modern

observations, it is quite amazing that the precision with which such calculations have been given in the scriptures, documented several millennia ago, are comparable to the precision obtainable presently. Unfortunately there is enormous confusion regarding the values of units of space and time appearing in various texts so that a comparison of jain cosmology with contemporary cosmology is difficult. In an accompanying article (Jain and Jain, this issue) an attempt has been made to rationalize the values of various units given in the scriptures. It is possible that these inconsistencies have crept in the undocumented records that were transmitted orally from one generation of Acharyas to the next over the intervening period of several millennia or due to the influence of other philosophies in vogue in India, by the time theJain texts were formally documented. Nonetheless, it appears that the basic concepts and approaches may have survived without much distortion. We now make an attempt to compare some features of modern concepts with the corresponding Jain concepts.

2. Modern Cosmology

One of the core assumptions on which some of the current theories of cosmology have been developed is that the universe is isotropic and homogeneous and is time-invariant (in its gross characteristics), an assumption known as the Perfect Cosmological Principle. Theoretical considerations imply that a static universe is not stable and therefore dynamic models (expanding, cyclic, oscillating universe etc.) have been proposed. Before we make an attempt to understand the way the universe originated, it is necessary to define what is meant by universe. One way of defining the universe is that it is the totality of space, time, matter and energy, i.e. universe includes everything that exists. The *jîva* (soul) has been given no role in the modern cosmology, although it is considered to be an important element of universe in Jain cosmology. In this respect Jain cosmology is much wider in scope.

2.1 Big Bang Origin of the Universe

The currently acceptable theory of origin of the universe, well supported by observations and theoretical calculations is the "Big Bang" theory but other models are also plausible. According to the Big Bang model, the universe originated as a singularity, a point source,which exploded about 13.7 billion years ago. There was nothing before this event; no matter, not even time existed before this event, and since space and time occur together in the 4 dimensional space-time continuum, even space may not have existed then. It is not clear what actually exploded, but according to the models, the universe subsequently underwent expansion, cooled

[2]*Beginningless and Endless Universe:*
Bhagavati Sutra,1-6-1, Q-9.
There is no sequence of beginning and end of the constituents of the universe, because it is eternal.

and evolved at progressively slower rates with time, and was sequentially controlled by quantum gravity, electroweak and subsequently by strong nuclear forces. The initial 10^{-43} second, called the Planck time, was the phase of quantum gravity when temperature of the nascent universe was higher than 10^{32} Kelvin. After this it entered the Grand Unification epoch which lasted till 10^{-34} second. Electroweak forces dominated its evolution up to 10^{-10} second and were followed by the radiation dominated phase. Thus in the beginning, events happened quickly, within a small fraction of a second.

To start with, there was only radiation which got quickly converted into matter as space expanded, time progressed and the temperature of the universe reduced. It took about 100 seconds after the Big Bang episode for the universe to enter the matter-dominated phase when fundamental particles were formed from radiation. The first to form was quark-gluon plasma and leptons (e.g. electrons). They quickly combined to form protons and neutrons, which in turn fused and subsequently interacted with electrons to form atoms of elements such as hydrogen, helium and lithium. These atoms combined in definite proportions to form matter as it exists today. As the universe expanded in space and time, the reduction in its temperature enabled the formation of cluster-like structures. The matter thus formed was dominantly Baryonic (nuclear) which is what one sees around today. As matter-dominated phase started, the cooling process became faster and the radiation got decoupled from matter. During this stage, the matter in the universe became optically transparent. Inside the clusters, formation of individual stars took place due to gravitational contraction of molecular clouds of hydrogen, which by the process of thermonuclear fusion produced various other, heavier elements. As the universe evolved further, various generations of stars formed, evolved and disintegrated, resulting in the formation of variety of objects including our solar system containing the earth and eventually life began to evolve. The radiation which decoupled from matter around 300,000 years after the Big Bang episode cooled and reached the present temperature of around 2.7 K as a nearly isotropic background radiation in the infrared wavelength region, as discovered about half a century ago.

In this way, starting with nothing, the whole universe with its galaxies, stars, planets etc. were created. One of the major problems with this scenario is that matter and antimatter should have been formed in equal proportions but what we actually see around today is only matter and there is no trace of antimatter. The question that is still unanswered is: where has all the antimatter gone? It may have formed another isolated universe, because matter and antimatter cannot coexist since they annihilate each other instantaneously, producing intense radiation.An accompanying article by Kachhara and Jain discusses this problem in some detail.

Thus we have seen that the universe has been expanding and cooling ever since it came into existence. In this theory most of the matter was formed in a very

short episode, starting at a tiny fraction of a second (10^{-35} seconds) that lasted up to 3 minutes. Thereafter the changes in its composition and structure were very slow. It took a billion years for galaxies to start forming. The theory of expanding universe is primarily based on the observations of Edwin Hubble (1889-1953), a pioneer in the field of extragalactic astronomy, that all the galaxies are receding, i.e. moving away, from each other. He found that, farther we go, the light emitted by a galaxy shifts progressively towards red (longer) wavelengths. According to the Doppler Effect, when a source of light moves away from an observer the wavelength of source/light becomes longer, shifting towards red wavelength. Based on the red-shift measurements, Hubble came to the conclusion that farther a galaxy, redder is the light received from it, implying that faster it is receding away from us.

2.2 Steady State and other theories

Whereas there is a general agreement among scientists on the expanding universe model, there have been competing theories to Big Bang, i.e. the expanding universe model proposed by Hubble in 1929-30. Cosmologists Fred Hoyle, Thomas Gold, Hermann Bondi, and Jayant Narlikar proposed the Steady State cosmology in 1948, although it contradicted the expanding universe model.The expanding universe model requires continuous creation of matter, to compensate for the expansion, for which no evidence has been found. To accommodate the Big Bang event in the Steady State framework, Narlikar subsequently modified it to a "Quasi Steady State" theory, in which the universe is oscillating. The expanding universe is just the current phase which is ultimately going to enter a contraction phase. In this theory, the Big Bang is the current expanding phase of this cyclic Quasi-Steady State universe. Other proposed theories include cyclic universe, which repeats itself, between formation and destruction with a certain time period, and oscillating universe which periodically expands and contracts.

3. Visible Universe

We first look at the modern concepts describing the nature of the universe. After the Big Bang episode, the universe underwent a short phase of rapid expansion early in its history, called 'inflation' and has been slowly expanding ever since (Rangarajan, this volume). But, since we are located within it, we can only see or observe only a part of the universe, because farthest we can see is the point wherefrom the light can come to us over the age of the universe, i.e. 13.7 billion years. What lies beyond this region (13.7 billion years × velocity of light = $\sim 3\times10^{23}$ km) is and will never be visible to us. This is due to the fact that light originating from a source beyond this distance would take more than 13.7 billion years, i.e. more than the age of the universe to travel to us, and therefore can never reach us, particularly in an expanding universe. Therefore, there is an observable part of the universe and an unobservable part.

Secondly, universe, by definition, contains everything and hence there could be only one universe. However, for the last few decades, it has been debated whether the universe is actually a multiverse, comprising of many universes and ours is only one of them. Can we observationally infer their existence, or is our universe completely isolated from other universes? Theoretically, we can address these questions using the General Theory of Relativity. The quantum theory of gravity combines quantum mechanics, the rules governing small, elementary particles and the General Theory of Relativity in which gravitation plays a dominant role. It is known that at the minutest level, there are elementary particles of matter (quarks, leptons and carrier particles etc., in all 18 of them, together with their anti-particles of various types (see Kachhara and Jain (2015); Bhandari, 2010) and the three forces of nature (gravitation, electroweak and strong nuclear forces), which govern the behavior of these particles. Together, these constitute the universe. Can all of these be described by a single theory, supposed to be the Theory of Everything (TOE). Attempts to integrate various theories of matter and forces into a single theory have so far not met with much success, although many propositions have been put forward.

4. Shape of the universe

Simply stated, the shape of the universe is determined by competition between the outward momentum produced by expansion and the inward pull due to gravity as a function of space and time. The rate of expansion is expressed by the "Hubble Constant" while the strength of gravity depends on the density and pressure of the matter contained in the universe. The fate of the universe is then governed by its density; if it is less than a certain value called the "critical density" which is proportional to the square of the Hubble constant, then the universe will continue to expand forever. If the density of the universe is higher than the "critical density", the gravity will eventually dominate and the universe by itself will collapse back into the so called "Big Crunch". These two conditions give rise to a closed spherical universe and a saddle like open universe respectively (Fig. 1). If the density of the universe is exactly equal to the critical density, the universe will remain flat, as shown in Fig. 1. The density of the universe also determines its geometry; if it exceeds a certain critical density ($Ù_o$), then the geometry of space is closed and positively curved like the surface of a sphere. If it is less than the critical density, then the geometry of space is open and negatively curved like the surface of a saddle. If it exactly equals the critical density, then the geometry of the universe is flat like a sheet of paper. Thus, there is a direct link between the geometry of the universe and its fate — whether it will continue to expand, eventually contract or will maintain status quofor ever.

Results of a recent study suggest that the expansion rate of the universe is actually increasing and not slowing down (Riess *et al.*1998). One way this can

happen is if a certain form of matter (or energy) exists which exerts a strong negative pressure. This is sometimes referred to as "dark energy" which is responsible for the accelerated expansion of the universe, during its infancy. In a sense the dark energy, being responsible for motion, which led to inflation of the universe, may be equivalent to *dharmastikaya* of Jain universe, as will be discussed later. If, however, dark energy were to play a significant role in the evolution of the universe then, in all likelihood, the universe will continue to expand forever.

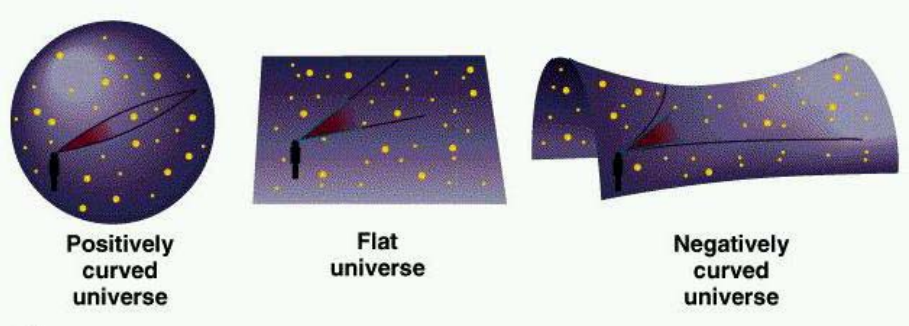

Figure1 : Various shapes of the universes with positively curved sphere having closed geometry with critical density Ù> $Ù_0$, plain geometry, flat (Ù= $Ù_0$) and saddle- like negatively curved, open geometry Ù< $Ù_0$. If they are juxtaposed one above the other, we get a shape similar to the Jain universe according to N. L. Kachhara (2011).

Recently the temperature of the universe has been measured using spacecrafts (Hinshaw et al, 2009). The density of the universe, based on the observed fluctuations of the microwave background radiation temperature, is found to be close to the critical density, $Ù_0$, and, therefore, it appears that the geometry of the universe is flat. It may, however, be noted that the observations have a small (about 2%) error, which can influence this conclusion.

Two things are clear from the data obtained from observational astronomy. Firstly, everything in the universe is rotating, around its own axis as well as around the centre of the system, be it planets, sun, galaxy or other celestial objects. Secondly, everything in the universe is expanding and contracting, in howsoever miniscule a manner (akin to breathing)[4], be it the sun, earth (together with its atmosphere), or stars. While discussing the Jain cosmology these two points must be borne in mind.

5. Jain Cosmology

Jain texts have described the origin, constituents, shape and dimensions of the universe in form of short shlokas and in a series of questions, asked by Gautam swami and answered by Bhagvan Mahavir. At places, some inconsistencies are encountered. We therefore summarise below some of these aspects but we refrain

to discuss the dimensions because they are difficult to convert in to modern space or time units (see Jain and Jain for rationalisatio of Jain units).

5.1 Constituents of Jain Universe

As has already been mentioned, Jainism has divided the universe into two parts - *Loka* and *Aloka*. *Loka*, the visible part of the universe, is finite, defined by the existence of six entities (called dravyas or reals) : *jîva* (soul), *pudgal* (matter), *aakash* (space), *kaal*(Time), *dharmastikaya* and *adharmastikaya*.The equivalents of the last two entities are not understood in terms of modern cosmology, but according to the scriptures, they are related, respectively, to motion and state of rest of jiva or matter (pudgal). They have been frequently mentioned in Jain texts as medium of motion and medium of rest respectively. In the context of the above discussion we may speculate that they are related to some kind of accelerating and retarding forces, respectively. Dark energy could be a possible candidate for *Dharmastikaya*. There may be a serious objection to this statement because forces and dark energy are matter (*pudgal*) and *Dharmastikaya* is not *pudgal* (although it is *ajiva*) according to scriptures. We will continue this discussion later in this article.

The Loka is finite in size and its extent is defined by the presence of the six *dravyas*, mentioned above. The Loka is immersed in infinite Aloka, which is pure space and does not contain any of the other*dravyas* existing in the Loka.

5.2 Shape of Jain Universe

The shape of the Jain universe (*Loka*) is quite peculiar (Figure 2). According to physics, spheroids, ellipsoids, discs and annular shells or annular rings and cylinders have a stable structure in nature. This is because of various natural forces acting on them. Trapezoidal or parallelepiped, rhomboidal and conical structures with sharp edges and corners are not stable ad even if they are formed, they quickly acquire one of the above stable shapes. Astronomers have observed a large part of the visible universe. They find that only a few structures, like an ellipsoid (or its special case spheroid, such as the sun and the various planets) and a disk (such as a galaxy) are stable over long periods of time. Certainly a static, multi-cornered body like Jain *lokakash* immersed in an infinite *Aloka* is inherently an unstable configuration according to the laws of physics. Therefore, there is no way in which the universe can have this shape. We take the view that this diagram does not represent the actual shape of the universe, but some other, more fundamental, feature of the universe. Several possibilities have been invoked to get an agreement between such a structure (Figure 2) and modern cosmology. We discuss three of these propositions here.

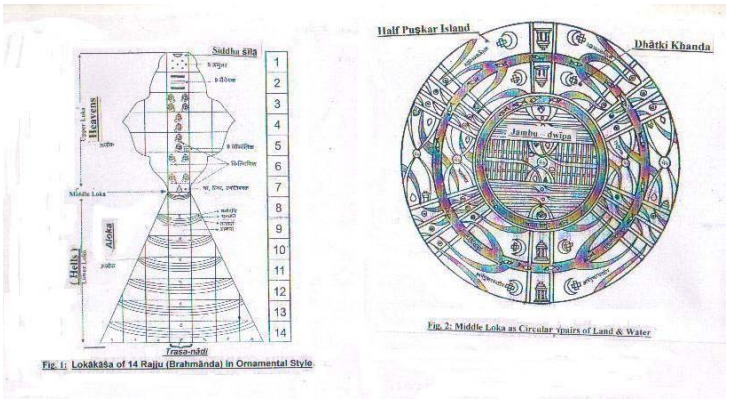

Fig.2 Shape of the Jain Lokakash (front view) likened in shape to a man standing, with his elbows stretched. On the right is shown the top view of Middle loka, containg humans and animals.

Jain *Lokåkåsh* is sometimes pictorially depicted as a hexagon resting on an inverted conical section with a flat base with finite thickness, as shown in Fig. 2. In some versions (e.g. in *Shvetamber* Jain tradition) the sides of this structure are smoothened to various degrees and are shown as rounded. Various parts, from top down, are called *Siddhashila* (space of purity, stated to be the abode of *Siddhas*), of *devas*, of humans (animals and other living beings), and hell respectively. Both *Urdhvaloka* and *Adholoka*, each are further subdivided into 7 distinct regions, as marked by faint lines. In addition, there is *Trasanadi* connecting the top of the *loka* to the bottom, half way along the depth of *loka*, as shown in this figure. The soul can instantaneously (in a few (1 to 4) "*samay*", the smallest unit of time) travel from one part of the universe to another through this *Trasnadi*.

1. Theoretically, three types of universes are possible, characterized by positive curvature, flat, and with negative curvature, with density values greater than, equal to and less than the critical density respectively (Figure 1), as discussed above. N. L. Kachhara (2011, 2013) has pointed out that if the universe is created as a triplet with all these three types of universes juxtaposed one above the other, with spherical universe being at the top, the flat one in the middle and the saddle like universe at the bottom, we may geometrically get a structure approximating the shape of Jain Lokaksh mentioned in Jain cosmology. The flat universe, called Madhya loka, containing *manushyaloka,* in which humans live, acts as an interface between the other two universes that have negative curvature (called 'hell' in Jain terminology) and the closed, spherical universe at the top (called heaven or *devaloka* by Jains), as shown in Figure- 1b. If this is true, then Jain Loakaksh is a multiverse theory.

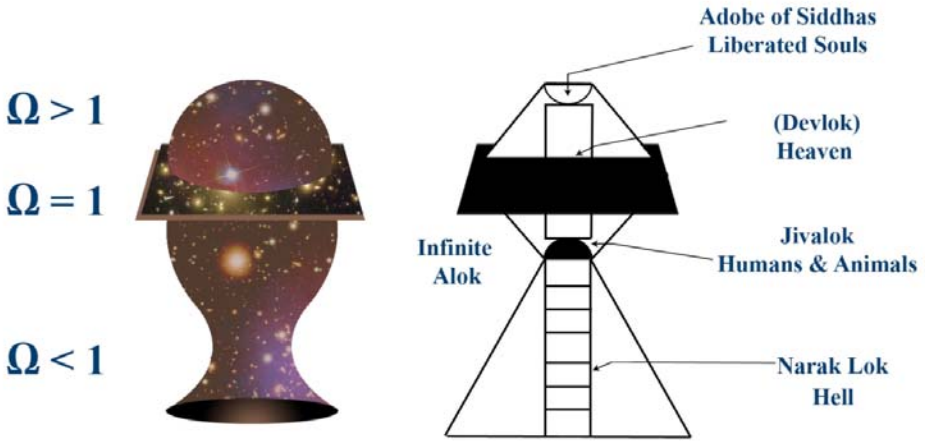

Figure 3 : The three universes with positive, flat and negative geometries, produced as a triplet, juxtaposed one above the other to match the structure of the Jain Universe, as proposed by N. L. Kachhara (2011).

Some current theories e.g. Kaluza-Klein Theory suggests that the universe may have 11 dimensions, ten of space and one of time, instead of the four dimensional space-time universe, with which we are familiar (see Wesson, 1999). It is difficult to draw a multidimensional object on a two- dimensional paper. The sketch of the Jain *Lokåkåsh* (Figure 2) may be pictorial projection of a four (or 11) dimensional object (see e. g. P. D. Ouspensky) on to a 2- dimensional sheet of paper.

2. There is another possibility that this is not a geometrical sketch representing the structure of the universe but symbolically shows some other fundamental features of the universe. J.R.Jain (2012) has pointed out that the diagrams given in the Jain texts are artist's conception or pictorial depictions (pictograms), symbolically showing some peculiar features, and are not geometric sketches as are mistakenly construed. In this context we note that the diagram in Figure 2 has 11 arms, as marked. We have also marked Trasnadi in this diagram.The *Trasanadi*, sometimes shown as cylindrical in shape, represents an imaginary region of the universe, in which all the mobile living-beings of the universe.

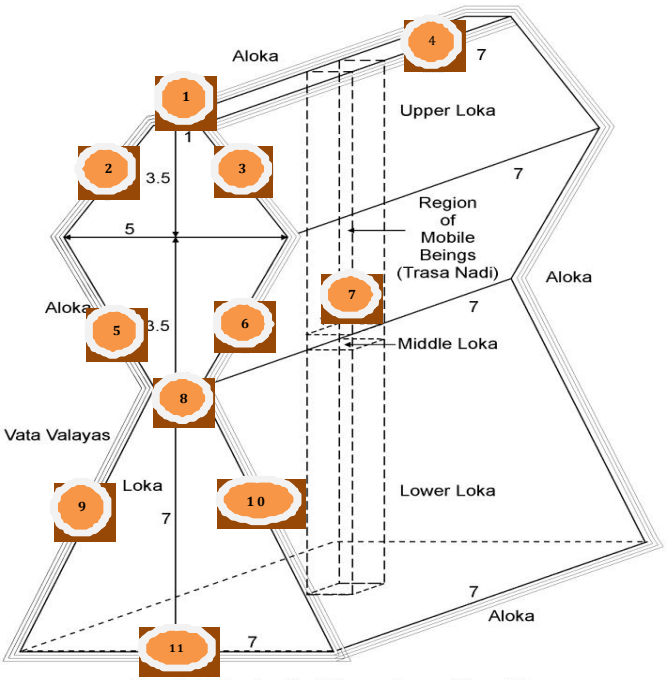

Figure 3: Jain *Lokåkåsh* showing its 11 arms, as marked. Each arm may symbolically represent a dimension of the universe and may agree with the string theory (M-theory) which envisages an 11- dimensional universe, with 10 dimensions representing space and the eleventh dimension, marked by #4, representing time. The *Trasanadi*is proposed to be a wormhole that connects various parts of the universe.

Trasanadi serves as an ultra-fast channel through which a soul can move instantaneously and spontaneously from one part of the universe to the other, say from *manushya loka* to *siddhashila* or *devaloka*. This reminds us of the characteristics of wormholes deduced on the basis of the General Theory of Relativity. The sketch in Figure 2 can therefore be understood as representing the 11 dimensions of the universe as envisaged in the string theory and *Trasanadi*, resembling a wormhole. However, it may be noted that wormholes require a special, highly dense space-time geometry and hence may be very rare. Also many properties of worm holes are quite different from that of the *Trasnadi*, mentioned in the scriptures. Eventhough, this comparison of *Trasnadi* with wormholes is highly speculative, in support of the above proposition, we will discuss here some features of the string theory and wormholes in section 7.

Table 1:Comaprison of some features of Modern and Jain cosmology, at a glance

Parameter	Modern Cosmology	Jain Cosmology	Comments
Origin	Big Bang; alternative models which are cyclic, oscillatory and Quasi steady state have been proposed.	Eternal, Steady state	Big Bang took place around 13.7 billion years before present
Size	Infinite	Finite, but immersed in infinite Aloka.	Loka's has dimension of 14 Raaju
Constituents	1.Space, 2. Time 3. Matter (radiation, energy) 4. Three forces (electroweak, strong nuclear and gravitation) and their associated fields	1.aakash, 2. kaal, 3.Pudgal 4.Dharmastikaya 5. Adharmastikaya 6. Soul and jiva[1]	In modern cosmology jiva is not considered as a separate constituent but emerges from matter. In Jainism there is no mention of any forces or fields.
Structure	Three dimensional vast structure depending upon the following two aspects (Fig 2). 1.Its Local geometry depends on curvature produced by the observable universe, which is about 46 billion light years in radius. 2. Its global geometry concerns the topology of the universe as a whole.	Consists of loka of finite size covered by Aloka of infinite size. The Loka is full of the six components, while Aloka is vacuum. The Loka is well defined in ancient units of Rajju/ yojans etc. which are not converted in modern units of space.	
main objects	Sun. moon, planets, comets, asteroids, stars, galaxies, interstellar dust/ plasma	Sun, moon, planets, comets, siddha kshetra, Urdhva Lok, Madhya lok, Narak Lok are described.	In Jain cosmology there is direct connection between Madhya lok and siddha kshetra through a channel known as ***Trasnadi***
State	It is highly dynamic; The whole universe is expanding in size, and is filled with isothermal backgroundof ~2.7K.	Static, isotropic, homogeneous, and uniform	
Time scales	Origin: 13.7 billion years ago, earth formed 4.56 billion years ago, Life on Earth appeared 3.5 billion years ago and evolved by Darwinian evolution; Diurnal, lunar, annual (solar),astronomical and cosmological cycles operate as solar system moves in the galaxy with 250 million year period	Kaal chakra defines a full cycle of kodakodi time, divided into two half cycles, utsarpini and Avsarpint, each of which are further divided into six Aaras. The kodakodi time scales have not been converted into modern units of time	These Kaalchakra cycles are probably climatic cycles, as argued byJain et al, 2012; 2014.

Currently, one of the most debated theories is the string theory, not yet fully established, but considered to be a possible candidate for the Theory of Everything (TOE) and appears to have some relevance to the Jain view of *lokakash*. We, therefore, describe the essential aspects of the String theory here.

According to Jain cosmology, the finite *Lokakash* is immersed in the infinite *Alokakash*. For stability, there are three requirements: (i) The structure should

[5]***Trasnadi.*** *Tras-jeevas are not confined to Trasnadi only, but are scattered throughout the Loka.*

have a stable shape, like a sphere, disk or cylinder; angular shapes like Jain Lokakash (trapezoidal or parallelepiped, rhomboidal and conical structures with sharp edges and corners etc. are intrinsically unstable as pointed out earlier (ii) The Jain Lokakash should be rotating with respect to *Alokakash*. A static body is unstable and only if it rotates, it can have a stable configuration, (iii) There should be a region of interface between Lokakash and Alokakash, to allow for a smooth transition from one to the other. Such interface regions, called *vatavalayas*, have been mentioned for many celestial bodies but are not specifically proposed around Loka immersed in Aloka[1]. Some gross features, like theories of origin, structure, constituents and time scales, etc. of the modern and Jain cosmology are compared in Table 1.

6. Jain and modern view of space and time

According to Jain concepts, space and time are the two of the six essential constituents of the universe, besides matter, living beings, *dharmastikaya* and *adharmastikaya*. The philosophical, historical and modern aspects of these dravyas have been very lucidly discussed by Muni Mahendrakumar in his book on Enigma of the universe. In comparison, according to modern cosmology, space and time, in addition to matter (particles, radiation), three basic forces (nuclear, electroweak and gravitation) and their fields constitute the universe. As far as Jiva is concerned, modern cosmology subscribes to chemical or abiological origin whereas Jainism considers soul to be eternal and jiva to be a combination of soul and matter. As far as matter is considered, there is a good agreement between Jainism and modern concepts (see Kachhara and Jain, This volume), although in Jainism, matter is eternal and in modern cosmology, it is created immediately after Big Bang. When the matter has an appropriate configuration or structure, the soul enters it and forms jiva. Regarding space and time there are some similarities and some dissimilarities as we discuss below. *Dharmastikaya* and *adharmastikaya* will be briefly mentioned later since there is no clear idea about them.

Jain scriptures consider space as just empty (void), in which all other constituents of the universe exist. Thus space gives place to everything that exists in Loka. It is eternal (without beginning and end), cannot be created or destroyed, is homogeneous and uniform in all properties, and it is static. Most importantly it is passive and non-interactive with any other coexisting constituent. Thus it permeates the whole universe, but is only a facilitator, not partaking in any process, and remaining unaffected by anything present in it, such as *jiva* (soul), matter (*pudgal*) or any forces. Akash fills the Loka, has the same expanse as the Loka and exists even in Aloka. It indivisible and continuous but sometimes it is considered to be made up of infinitesimally small units of space, defined as "*pradesha*" or "unit space". In comparison, modern concept of space is that it is continuous, is three dimensional, and together with one dimensional time, it makes four dimensional space-time continuum. However, space is affected by matter, force and fields (i.e. by the

gravitational force that the matter exerts). Gravitation curves the space around the object, to the extent governed by its gravity, and in turn, space governs the motion of matter. Thus the two types of spaces: pure, passive space or Jain- space (aakash) which is non-interactive and modern space (dynamic space) which is interactive are conceptually very different.Thus we see that according to the General Theory of Relativity, the modern concept of space is not the same as Jain concept of Aakash. To differentiate between them we henceforth call Jain-space as *aakash*.

Time is more difficult to define (see the accompanying article by Prasanna for concepts of time). According to Jainism, there are two types of time: Absolute and Empirical. Jainism postulates that Absolute time is eternal, without beginning and end, and is *apredeshi*, that is, it does not occupy space. It is linear and flows at a uniform rate. Empirical time (from the point of view of *vyavahar naya*), according to some scholars is a construct of mind and can be defined in different ways under different conditions. Jain scriptures, as also modern physics, invoke empirical or relative time as a measure of change i.e. the rate of change of a physical process is defined by time. Although Newton defined time as absolute, according to the Theory of Relativity, time is relative and depends on the "frame of reference", and its motion i.e. the motion of the object with respect to the observer. Time is thus contextual and physical (i.e. empirical) and can be defined in many ways. There is astronomical or cosmic time, defined with respect to the motion of the earth around the sun; sidereal time with respect to the stars; atomic time defined by radioactive decay; and psychological time to which the mind is conditioned. The psychological time is controlled by thoughts. There is also the concept of "timelessness" (*akaal*), a state of mind in which time stays "still" and does not flow. We do not discuss psychological aspects of time here and confine only to the physical time. Modern cosmology postulates that time did not exist before the birth of the universe i.e. before Big Bang; time, space and radiation (i.e. energy which later converted into matter) came into existence simultaneously with the Big Bang event. In physical processes, time is reversible at a microscopic level, i.e. every physical process can proceed either way and is valid even when one changes the direction of time. Increase in entropy is sometimes defined as the direction of time. The Special theory of Relativity postulates that measure of space and time depends on relative motion of the frame of reference of the object and the observer. Length of an object contracts (Fitzgerald contraction) and time can be dilated (time dilatation) if the frame of reference of the object accelerates away with respect to the frame of reference of the observer, so that relative motion of an object reduces its size and a moving clock runs slower; neither time nor length are absolute.

Thus there are basic differences in the concepts of time and space in Jainism and modern science. A basic tenet of Jainism is that everything in the universe has

[6] *Jiva (living beings) is defined as embodied soul.*

infinite types of *paryays* (modes), which manifest at different times at different places, depending on the prevailing conditions. Thus every entity behaves in a manner de termined by the perspective from which it is observed. To explain the behaviour of various entities, Jainism postulates various types of *nayas*, i.e standpoints or perspectives. We consider here two types of *Nayas*: absolute (*nischaya*) *naya* and practical or behaviorial (*vyavahar*) *naya*. To explain the differences in the properties of space and time, according to these two standpoints, we have two types of these entities. In the real sense, the *aakash* and *Kaal* of Jainism are absolute, according to *nischaya naya* and the space and time of modern science are their practical modes from the point of view of *vyavahar nayas*.The absolute space and absolute time are then constituents of the universe but what we observationally deal with in science are the practical space and time. Absolute time, is considered to be made of "unit time" or *"kalanu"*, similar to the modern hypothesis of "chronon" and absolute space is made up of *pradesha* or unit space. In practice, from vyavahar naya point of view, both of them appear continuous.

Mahendra muni (2010) has discussed various aspects of space and time (including their units mentioned in scriptures and their equivalents in terms of modern units) and compared them with their descriptions given in the Jain texts. If the properties of modern "space" and empirical "time" used in modern cosmology can arise from *aakash* (absolute or pure space) and kaal (absolute time) respectively, then Jain and modern concepts can be reconciled.This appears to be a good problem for further investigation. Alternatively, if *dharmastikay* and *adharmastikay* can make absolute space or Loka space behave like space of modern cosmology, which gets curved around matter and, in turn, affects the motion of matter, then Jain concepts and modern concepts can be reconciled.

6.1 *Dharmastikaya* and *adharmastikaya*

Thus we see that there is an agreement between cosmology and Jainism on the three constituents of the universe, i.e. matter, space and time, but this is only apparantly so. In their innate characteristics, there are fundamental differences. Also,there is no clarity about *dharmastikaya* and *adharmastikaya*. According to the experiments conducted by Michelson and Morley, in late 19th century, the concept of medium of motion (postulated as the all pervading, stationary luminiferous aether, considered to be equivalent to *dharmastikaya)* has been disproved. We do not have much idea of what is *adharmastikaya* (interpreted as a medium of rest) in terms of modern scientific concepts, although some candidates, like inertia or friction, have been proposed and debated. We propose here three possibilities which may be investigated further.

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[7] *An example in Agams mentions that if somebody stretches an arm from Loka towards Aloka, it will not enter Alokakash because the six Tattavas do not exist in Alokakash.*

(i) We have seen that the same three constituents (space, time and matter) are mentioned in Jain and modern cosmology. The only difference is that Jain cosmology mentions *dharmastikaya* and adharmastikaya whereas modern cosmology contains three forces (gravitation, electroweak and strong nuclear) and their fields. Efforts must therefore be made to see if *dharmastikaya* and adharmastikaya can, in some way, produce the observed forces and their fields.

(ii) *Dharmastikaya*, being responsible for motion, can be considered to be equivalent to dark energy, responsible for expansion of the universe, as already mentioned earlier.

(iii) In this context, it is pertinent to recall here the Newton's first law of motion (law of Inertia), according to which everything continues to move with a uniform velocity or remain in the state of rest, unless acted upon by an external force. The origin of continuous state of motion or rest, i.e. inertia, may have origin in *dharmastikaya* and *adharmastikaya* respectively. This also is a topic worth further exploration.

The objection with the first two alternatives is that forces, fields, and dark energy are materialistic properties and *dharma* and *adharma* can not be derived from any of the other *dravyas* (pudgal, *jiva* (soul), aakash or kaal). We may ask, what is that which operates all over the universe, does not take part in any processes, is eternal and yet is not any of the other *dravyas*.The only thing which operates all over the universe and is not any of the *dravyas* are the laws of science. The last alternative therefore looks more plausible.

7. Relativity, Wormholes, String theory and dimensions of the universe

The General Theory of Relativity predicts that extremely intense gravitational fields can warp up both space and time which can provide shortcuts from one part of our universe to another. If our "universe" is a multiverse, consisting of many universes, a route opens up from our universe to some other universe through such wormholes. A wormhole is, in principle, like a tunnel with two ends, each end being at a separate point in space-time.Thus a wormhole is an Einstein-Rosen Bridge, a hypothetical topological feature that would be fundamentally a "shortcut" through space-time and there could exist intra-universe as well as inter-universe wormholes. Such wormholes are very rare because of the requirement of very intense gravitational fields. Some of the aspects of General theory of Relativity, wormholes and time are discussed in detail in an accompanying paper by Prasanna (2014).

In the 19th century, space was considered to be three dimensional: up-down; front-back and left-right. Subsequently, time was integrated with space as the 4th dimension by Minkowski, who introduced the concept of Space-Time continuum .

In 1919, Theodor Kalutza showed that if one extra dimension exists in the universe, electromagnetism can also be incorporated with gravity. Thus universe may be five dimensional: four of space and one of time. In 1926, the Swedish physicist Oskar Klein gave a physical interpretation of the extra dimension - it is wrapped up into small circles which are too small to be seen and, therefore, this dimension is unobservable.

The string theory postulates that the fabric of space is such that at the fundamental level, the elementary particles (i.e. electrons and quarks) within an atom are not 0-dimensional point objects, but rather 1-dimensional oscillating lines ("strings") that vibrate, resonate and manifest as various particles, depending on their frequency, mutual interaction and presence of nodes. The "superstring theory" proposes that miniscule strands of energy vibrate in 11 dimensions (10 of them related to space and one to time). The extra dimensions, other than the four known dimensions of space-time, have been compressed to extremely small scales so that they are not easily observable.

After ruling out the possibility that sketch in Fig.2 represents the shape of the universe, for reasons discussed above, we may now speculate as to what features the Jain Lokakash diagram actually describes. Looking at the sketch of Jain *lokakash*, we find that it has 11 sides (arms). May be this structure with 11 sides is a way of symbolically representing 11- dimensional world. The *Madhya Loka* is connected to *siddha shila*, *Urdhva Loka* (heaven), *Adholoka* (hell) through *Trasnadi*, and it mentioned that the soul can swiftly move from *Madhya Loka* to either of these three regions, depending on its *karmic* balance, over time scales of the order of a few "Samaya*". This is possible only if these regions are connected with wormhole like pathways. We thus propose that ***Trasnadi*** is like a wormhole, which allows instantaneous movement of souls from one part of loka to the other (see Prasanna (2015) for wormholes and multiverses).

Some points related to this suggestion, as mentioned in the ***agams***, need to be recounted here. Firstly, soul is not a physical entity and all the souls are not confined to *Trasnadi*; most of the immobile living-beings are located outside *Trasnadi*. Although all the souls can pass through the middle (*Madhya*) *loka* (which includes *Manushya Loka,* the abode of humans), they do not necessarily do so for every rebirth and may remain in the same region of the *Loka* without passing through *Trasnadi*. Only when the soul attains moksha, it moves to *Siddhashila* located in the "uppermost" part of Lokakash. Further, it may be noted that the soul cannot move back and forth between any of the four regions but all the pathways are routed through *Madhya Loka.*

Thus many of the disagreements between modern concepts of universe and Jain *lokakash*are resolved if the *lokakash* diagram is not reckoned as a geometrical figure, depicting its shape, but it is assumed that each one of its arms represents a

dimension of space-time. In such a case the 11- armed *lokakash* is consistent with the M-theory in which the universe has eleven dimensions, ten of space and one of time. Further, transit from *Madhyaloka* to *Adholoka* and *Urdhva Loka* is possible if *Trasanadi* behaves like a wormhole.

8. *Jiva*

According to Jainism, *atma* (soul) is an important and independent constituent of the universe. *Jiva* is often considered to be synonym of *atma* but, for this discussion here, we prefer to distinguish between soul and *jiva* which should be taken to be embodied soul. *Atma* in Jain philosophy is considered to be eternal, unborn, undestroyable, pure and can not be defiled, but jiva are born, evolve, die and are reborn. In contrast, modern cosmology considers life to be a mere product of matter and it is not given much importance. Several accompanying articles (e.g.Jain and Jain) deal with *jiva* in detail and therefore we discuss only a few aspects, like its origination here.

8.1 Origin and evolution of Life-Jain view

As mentioned above, Jainism does not subscribe to the concept of origination of life; *Jiva*, in its varied forms, existed since eternity and will continue to exist for ever. Since all the life forms exist all the time, it is taken to imply that Jainism does not subscribe to evolution. This concept has been taken to mean that interaction with the surrounding environment does not lead to evolution, it is the karma which is the deciding factor and Jainism is anti-Darwinian. Some of these aspects have been discussed in the accompanying articles by Jansma and others and will not be dealt with here.

We show here that the above inferences are erroneous. We present a series of arguments to show that Jainism considers interaction with surroundings as an important trait of Jiva, it is not anti-evolutionary and it is consistent with some modern concepts of origin and evolution of life, such as chemical (abiogenic) origin, Darwinian evolution etc.

According to Jainism, there are two reservoirs, where infinite number of souls exists: *nigoda* and *siddha*. *Nigoda* is a single sensed *jivastikaya*, with only one sense organ of "touch" , having the lowest form of consciousness and *Siddha* is the pure soul, *atma*, with highest form of consciousness.

Jainism postulates that immobile *nigoda* jiva are embodied by earth, air, water, energy and plants and recognises 5 types of immobile living-beings, viz, earth-bodied (*prithvikay*), water-bodied (*apkay*), radiance-bodied (*Teukay*), air-bodied (*vayukay*) and plant-bodied (*Vanaspati kay*). Scientfically, plants were not considered to be living till about a century ago when J.C. Bose showed that they are alive, although Jainism always treated them as alive. Scientifically, earth, air,

water and energy are considered inert, non-living but, according to Jainism, Earth, air, water, energy and plants can exist in two forms: *sachitta* (conscious) and *achitta* (inert). Jain and Jain in an accompanying article have discussed these class of *jiva* in detail and therefore we discuss this aspect here only briefly. These concepts would be consistent with chemical or abiogenic origin in the following manner:

Earth (solid substances), water (liquid substances), air (gaseous substances) and fire (energy) are normally considered inert. Let us take the case of water. Water is made of H_2O molecules as shown in Fig 4.The water molecules exist individually in steam but in the liquid form, water molecules do not stay as individual molecules but join with other molecules of water to form a chain of structure as shown in Figure 4. In ice phase these structures become more organised. Similarly other elements present in dissolved form in water e.g. sodium, chlorine etc., as in common salt solution, form a chain of molecules.

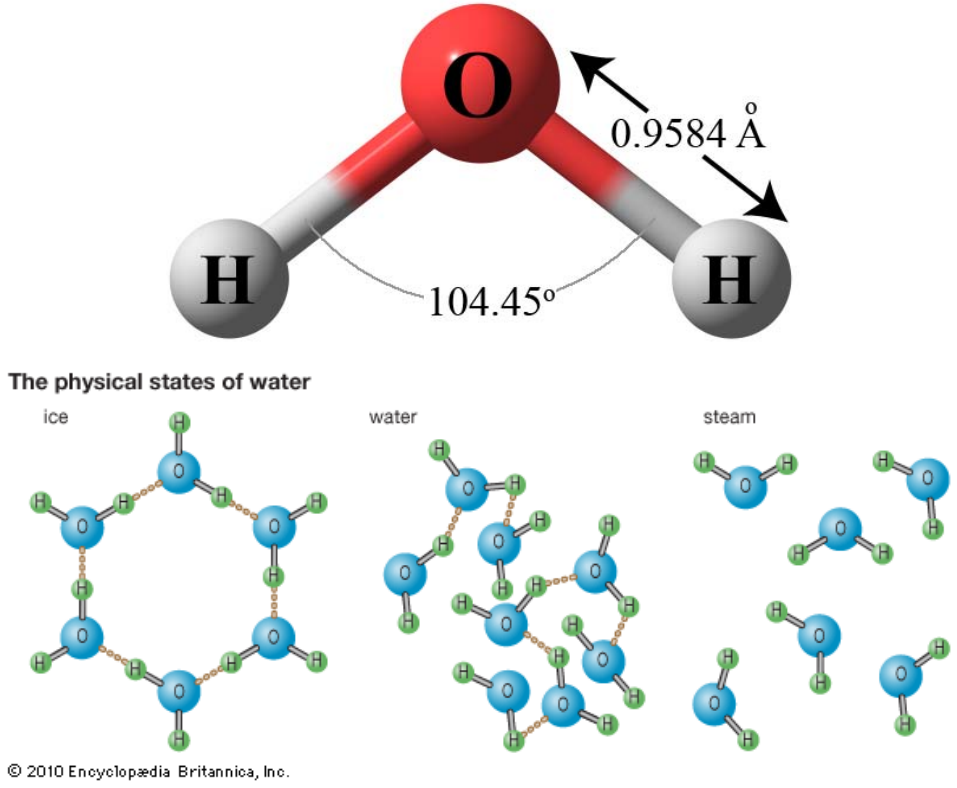

Fig 4. Water molecule consists of two negatively charged hydrogen atoms (blue) at an angle of 104.5°, attached to a positively charged oxygen atom (red) through a chemical divalent bond. In steam, water molecule may float individually (lower right) but in liquid form (water) they do not remain independent and many of them join by a delta bond to form structures. In

ice they form large molecular structures, as shown in the lower left (courtesy, Wikipedia). Such structures form and exist in earth, air and in a group of energetic material particles any where, besides water, and can act as receptacles for soul (we can call Receptable Molecular Structures for Soul, or RMSS), in which souls from the infinite ocean of souls in the universe, can descend and make them alive. This stage, when suitable structures for soul (RMSS) are formed can be taken as the beginning of life. Such orgnised structures can be considered as *sachitta* (live) phase, but with a slight disturbance (heating) or vibration (touch), the structures break down and the matter becomes *achitta* (life-less). This *sachitta* kind of RMSS form the infinite reservoir of Nigoda. More details are given in an accompanying article by Jain and Jain and the book by J.R. Jain.

Thus, to summarise, Jainism proposes that when chemical, non-living structures are having a configuration suitable to sustain a particular type of life, an appropriate soul descends in the molecular structure (RMSS) and make it alive. Such structures, which have one sense of touch, can be considered as the point where life can originate. Such a scheme of structures exist for liquids, and gases, earth etc. Dr. Jack Szostak has proposed that this is the way life originated. If molecules of N, P, C and H are present in water, they form a linear or circular or other forms of a chain. When the configuration is right, i.e. it acquires a helical structure, it may become a protein and eventually form a DNA like structure. This is the abiogenic or chemical origin of life. Thus life can be created chemically and Jainism provides a mechanism of integration of soul and body for this purpose whereas scientists are working on the possibility that chemical compounds can, by themselves, start reproducing and in this sense can be considered alive.

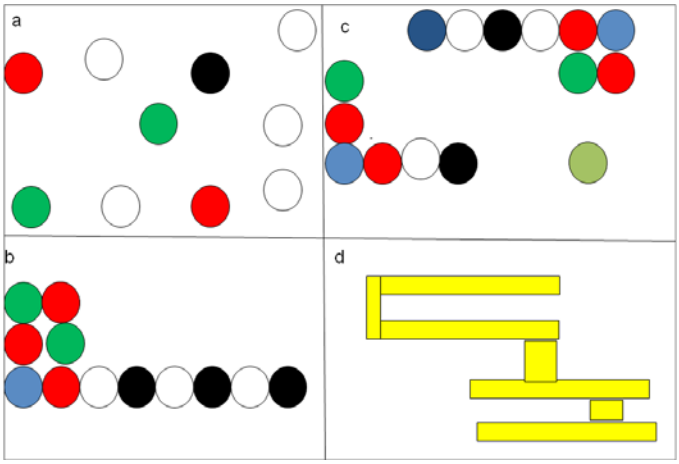

Fig. 5. a) random floating molecules, *achitta* b) chains of molecules *sachitta*, c) replicate chains and d) organised structures.

It is easy to break the structure, e.g. by boiling a liquid or by a mechanical disturbance when it will lose the sense of touch and will become *achitta*. This is illustrated in Fig. 5a which shows a number of molecules, randomly moving in the medium. In Fig. 5b, they start forming a chain of organised molecules. There is always a bond which is not fully satisfied and whenever a suitable molecule come by, it joins the chain. These chains can be easily broken or divided either by mechanical or thermal disturbances, for example by vibrations, currents, waves or heating or by presence of absorbing surfaces, the liquid becomes *achitta*, a purely chemical solution. In course of time, these chains break into two or more groups and each daughter chain, inherits the parents properties and continues to grow and replicate. A sort of competition sets in and a polymer chain which grows faster, dominates the population. At the same time, new templates are formed and the process continues. If suitable conditions prevail and supply of various molecules is adequate, and given enough time, they will continue to form long chains, vesicular and tubular structures or colonies and large, complex molecules of proteins, sugars, amino acids, polymers etc. and eventually, at a suitable time, a soul will descend and a living organism will emerge.This is the beginning of chemical synthesis, resulting in biotic molecules and origination of life and subsequently biological, Darwinian evolution takes over (J.R. Jain, 2012). Chemical aspects of formation of large molecules, including amino acids, proteins etc. which are building blocks of life, have been experimentally demonstrated by Urey-Miller reaction, in which an energy source in form of electric spark and ultraviolet light is provided to a water solution having a mixture of simple molecules like carbon di oxide, ammonia, methane, hydrogen etc. No living cells were produced in this reaction but this reaction established that it is easy to produce precursors of biomolecules. If life can be synthesized from chemicals, biochemists will claim that they have synthesized life whereas Jains will claim that the molecular structure that they have synthesized is suitable for a soul, from the omnipresent infinite reservoir of *Nitya Nigoda* (having a single sense of touch) to enter the structure and make it alive. Thus Jain concepts are consistent with synthesis of life; only their explanation is different, since they consider soul as a *dravya*, independent of matter, which cannot be formed from matter. Recent scientific experiments have showed that DNA can be synthesized and when it is injected in a living cell, it starts taking part in the biological reactions of the cell. An accompanying paper (Jain and Jain, 2015) discusses various aspects of one-sensed living-beings and the role of *nigoda*. Some of these ideas are experimentally testable. If large biomolecules are stored for a long time, an infinitesimal fraction[2] of them will acquire a soul from the nigoda and they should become alive.

Coming to the question of Darwinian evolution, we may quote the famous Jain principle of "*Parasparopagraho jivanam*", which clearly states that living beings are mutually dependent (or entangled with each other). This dependence arises by interaction with each other , directly or through matter, and results in Darwinian evolution.

9. Concluding Remarks

Modern cosmology is firmly based on observational astronomy, theoretical modeling and laws of physics. Many evolutionary aspects of the universe and their time scales are well understood. Even so, the origin of the universe remains an enigmatic topic and none of the theories, be it Big Bang, Steady state, Quasi Steady state, oscillatory or cyclic, is convincing.The ultimate fate of the universe, whether it will expand forever or eventually contract back to its initial state also cannot be predicted from the current observations of COBE (cosmic background explorer) satellite or anisotropy measured by Wilkinson Microwave Anisotropy Probe (WMAP). Some basic concepts of cosmology described in Jain texts are appealing, at least aesthetically, and may be useful in this context. Jain cosmology is wider in scope because it considers *jiva* to be an important constituent of the universe and, in addition to matter, it also deals with living beings in contrast to the modern cosmology which is confined only to the material aspects. It may be mentioned that the Jain texts discuss many concepts in short, and sometimes mysterious, sutras and diagrams, which have not been properly interpreted and decoded. The discussion given in this article shows that some concepts are basically common in Jain and modern cosmology although several fundamental aspects of modern cosmology (existence of various forces, particles etc.) are not mentioned in the Jain texts. Even so it may be worthwhile to reconcile and reinterpret Jain texts in terms of modern understanding of the universe. It appears that integration of Jain and modern concepts may lead to a better understanding of the origin of the universe.

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References

Bhandari N. and Pokharna S. (2014) Syadvad and Anekantavad in the modern scientific context,This issue.

Hinshaw, G. et al. (2009) Five-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Data Processing, Sky Maps, and Basic Results. *Astrophysical Journal Supplement* **180** (2): 225–245.

Hoyle, F., Burbidge, G., Narlikar, J. V. (1995)."The basic theory underlying the quasi-steady state cosmological model". *Proceedings of the Royal Society A* **448**:191.

Jain A.K. and Jain J.R. Earth Bodied Beings: Air- Bodied Organisms: Spontaneous Beings *(Sammurchhana Jiva*):This volume

Jain J.R., Bhandari, N. and Surana J.K. Jain Geography: a reappraisal, This volume.

Jain, Jeoraj (2013) Lokakash – Ek Vaigyanik Anusheelan, Samyag Gyan Pracharak Mandal, Jaipur, (in Hindi).

Jain J.R. (2012), Science of Dhovana Water, Samyag Gyan Pracharak Mandal, Jaipur.

Jain, J.R. (2014)Discovering the Total Contents of the Universe,Astrophysics & Aerospace Technology, 2:1http://dx.doi.org/10.4172/2329-6542.1000102

Kachhara N. L. (2011) Jain Metaphysics and Science,Prakrit Bharti Institute, jaipur

Kachhara N.L. (2013) Scientific Explorations of Jain Doctrines, Motilal Banrasidass

Mahendra Muni, 2010, Enigma of the Universe, Jain Vishva Bharati, Ladnun.

Mohanty S, Cosmology, This volume

Narlikar, J.An Introduction to Cosmology ISBN-13: 978-0521793766

Ouspensky, P. D. (1922) Tertium Organum.

Prasanna A.R. (2014) The Enigma of time, this volume.

Riess A.G. et al. (1998). "Observational evidence from supernovae for an accelerating universe and a cosmological constant". *Astronomical J.* **116** (3): 1009–38.

Szostak J. (2014) The Origin of Life - Abiogenesis -www.youtube.com/watch?v=U6QYDdgP9eg

Wesson, Paul S. (1999). *Space-Time-Matter, Modern Kaluza-Klein Theory*. Singapore: World Scientific. ISBN 981-02-3588-7.

Wesson, Paul S. (2006). Five-Dimensional Physics: Classical and Quantum Consequences of Kaluza-Klein Cosmology. Singapore: World Scientific. ISBN 981-256-661-9.

[8]*Agams claim that 608 jivas from the infinite reservoir of nigoda, in a period of six months and 8 samayas, get embodied.*

Appendix 1 : Divisions of Lokâkâsha

The Lokakash (Figure 2) is divided in several regions:(Bhagvati Sutra13-4-5):

(i) Urdhva- Loka.

The upper part is called Urdhva- Loka. It has a height of 7 Rajjus (unit of length). It consists of 8 regions, depicted by a horizontal bar. Each bar represents one type of heaven, (called Deva Loka), abode of Empyrean celestial-beings.

(ii) The Middle- Loka

The Middle loka is located around the mountain Meru. Innumerable pairs of circular land-water masses exist in the Middle- Loka. Its innermost circular land mass, termed *Jambu dvîpa*, is surrounded by a circular ring of saline ocean (*Lavaña-Samudra*).*Manushya Loka*,where humans reside, is part of Middle loka.

(iii) Adho-Loka

The Lower- Loka consists of7 regions each depicted by a bar. Each bar represents a type of land, called Hell, abode of Empyrean infernal-beings.

(iv) Siddha shila

A region of absolutepurity exists above the Urdhva Loka. It is the eternalabode of Siddhas. When a soul attains enlightenment, it moves to this land of purity.

Prof. RAJMAL JAIN. M.Sc. PhD (physics), FGSA, Outstanding Professor and Dean, Kadi Sarva Vishva Vidyalaya, Gandhinagar. Expert in solar astronomy. Professor, Udaipur Solar Observatory and Physical Research Laboratory, Ahmedabad. Carried out satellite borne observations of Solar X rays aboard Indian space Mission SOXS. Jain scholar of eminence and social service, specifically related to children's education. Awards: Fellowship Award, Royal Astronomical Society, London, International Young Astronomer Award from NOAO/USA; Vigyan Purskar, Govt. of Rajasthan; Jain Ratna; Lifetime Achievement Award, Govt. of Madhya Pradesh; Social service and education "Sadbhavna Foundation"; Over 150 Research papers and 200 articles. mobile 9427001972email: rajmal_9@yahoo.com;

Dr. JEORAJ JAIN, Ph.D. Engineering (Dr.-Ing.) from Germany. Worked with Tata Motors and as Tech nical and Investment Consultant Recipient of National Award in Fabrication Technology. He has several Technical papers to his credit. Research involves structure and quality of water. Authored several books. Proposed a theory of life without DNA and RNA and a theory on the mechanism of characterization of water. Developed a new code to decipher the ancient Lokakash maps.

Professor NARENDRA BHANDARI (Ph.D., Physics). Research in Planetary and Space Sciences , Tata Institute of Fundamental Research, Mumbai, University of California, San Diego, and Physical Research Laboratory, Ahmedabad. Studied moon samples brought by Apollo and Luna missions of NASA and USSR. Made pioneering contributions to India's first Mission to Moon, Chandrayaan-1, Member, Moon Mission Task Force, Science Advisory Board of ISRO and Mars Orbiter Mission .Eelected President, International Lunar Exploration Working Group (2005-2007). Awarded Outstanding Achievements Award of ISRO, Vikram Sarabhai award in Planetary and Space Sciences, National Mineral Award of Government of India and Special Certificate of NASA. Authored several books, notably Jainism: The Eternal and Universal Path to Enlightenment (Hindi and English), The Mysterious Moon and India's Chandrayaan-1 Mission (Hindi, English, Marathi and Gujarati) . Over 250 Research papers.