

Concepts of matter in Jain Philosophy and Modern Science

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Abstract

Pudgalastikaya is one of the six constituent *dravyas* of *loka* in Jainism and is the only substance that is sense perceptible. The sense attributes of *pudgala* are colour, taste, smell and touch properties which become the basis of its diversity of forms and structures. The smallest constituent of *pudgala* is *paramanu*, the other forms are its combinations. The combination of these *parmanus* forms various states of the matter.

According to modern science, the universe is composed of visible, dark matter and dark energy in the proportion of about 4%, 21% and 75% respectively. However, currently, the dark matter and dark energy have not been detected with positive evidences. On the other hand, the fundamental particles detected so far form the two families: **Fermions** and **Bosons** are 24 and equal number of particles has been proposed as Hypothetical particles, and the race to detect them is of highest importance over the globe.

The paper describes the properties and dynamics of the *parmanus*, different types of combinations and modes, rules for combinations and properties of aggregates known as *varganas*. Based on the four fundamental properties we suggest the possibility of fundamental particles to be more than 100 and thus the modern science has huge scope to discover many more fundamental particles. Moreover, based on the electrical and temperature sensitivity of particles (*pudgalas*) proposed in Jainism may be of greater help to understand the **Fifth state of matter**, recently being discovered and proposed but not established. We discuss this new aspect briefly in the current paper.

Modern science has studied matter, at micro to macro scales, in detail and has advanced theories, classical and quantum, and principles for its behavior and interactions. The paper briefly describes the scientific developments and their strengths and limitations. Different forms of matter and their properties are also discussed.

The concepts of Jainism are compared with the scientific concepts and possibility is examined how **Jaina** concepts can help in further development of modern science.

Introduction

It has been conventional understanding that everything around us is matter and is made of atoms and molecules. However, modern science refers matter that occupies space and has mass even at rest. This suggests that subatomic particles *viz.* protons, neutrons and electrons are the building blocks of the matter because they have both volume and rest mass. However, by contrast, radiation formed of mass less photons is not considered matter, because they have

neither rest mass nor volume. On the other hand it is not necessary that all particles with rest mass have a classical volume, since fundamental particles such as quarks and leptons (sometimes equated with matter) are considered "**point particles**" with no effective size or volume. Nevertheless, quarks and leptons together make up "ordinary matter", and their interactions contribute to the effective volume of the composite particles that make up ordinary matter.

However, according to **relativity** mass is not an additive quantity, in the sense that one can add the rest masses of particles in a system to get the total rest mass of the system. Thus, in relativity usually a more general view is that it is not the sum of rest masses but the **energy–momentum tensor** that quantifies the amount of matter. This tensor gives the rest mass for the entire system. "Matter" therefore is sometimes considered as anything that contributes to the energy–momentum of a system, however, except to pure gravity. This view is commonly employed in cosmology. In this view, sometimes, modern science also considers the light and other mass less particles and fields as part of matter. The reason for this is that electromagnetic radiation (such as light) as well as the energy of electromagnetic fields contributes to the mass of systems, and therefore appears to add matter to them. For example, light radiation (or thermal radiation) trapped inside a box would contribute to the mass of the box. Nevertheless, in modern science isolated individual particles of light (photons) and the isolated kinetic energy of massive particles are normally not considered to be *matter*.

On the contrary, the matter in Jainism, *Pudgalastikaya*, one of the six constituents of *loka*, integrally comprised of four important attributes *viz.* colour, taste, smell and touch, reveal that it is sense perceptible. It has further been emphasized that all attributes in general and **touch** property in particular are sensitive to thermal and electromagnetic forces *i. e.* energy-momentum transfer similar to that described in the modern science. Though we find few similarities but when we compare the two schools of thoughts we find many differences and therefore it is utmost necessary to improve our understanding on the matter in greater detail considering science as well as Jainism.

“Matter” in Science

Based on physical and chemical structure the “matter” is made up of *atoms*. This definition has been extended to include charged atoms and molecules, so as to include plasmas (ionized gas) and electrolytes (ionic solutions), which are not obviously included in the atoms definition. Therefore, definition of the matter goes further down adapting to protons, neutrons and electrons, fundamental particles forming the atom. So a definition of "matter" at more fine-scale is anything made of positively charged protons, neutral neutrons, and negatively charged electrons. This definition goes beyond atoms and molecules. However, at a microscopic level, the building blocks and constituent "particles" of matter such as protons, neutrons, and electrons obey the laws of quantum mechanics and exhibit wave–particle duality. At an even

deeper level, protons and neutrons are made up of quarks and the force fields (gluons) that bind them together. Therefore, with the advent of new technology and thereby discovering new fundamental particles, the science has been modifying the definition of matter. Accordingly, the elementary and composite particles made of the *quarks* (cf. Figure 1 - in purple) and *leptons* (in green) would be matter - while the gauge bosons (in red) would not be matter. However, interaction energy inherent to composite particles (for example, gluons involved in neutrons and protons) contribute to the mass of ordinary matter.

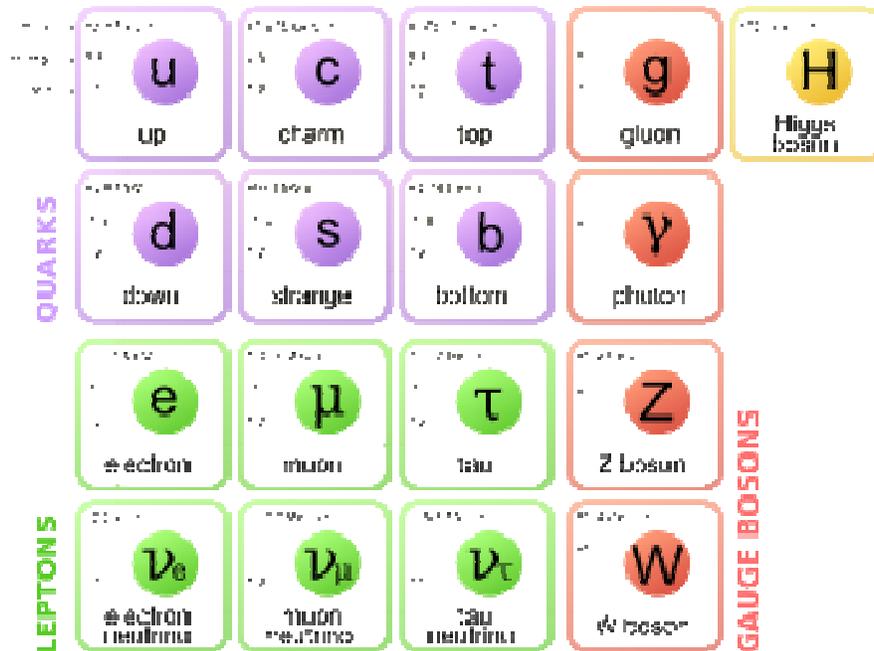


Figure 1: Pictorial description of fundamental particles, and the fields, that makes up the elementary and composite particles.

Fundamental Particles

As discussed in the previous section, the ordinary matter is everything that is composed of elementary particles *viz.* quarks and leptons. We briefly describe these fundamental elementary particles in this section.

Leptons are the most famous being the electrons, and quarks form baryons such as protons and neutrons. The leptons and quarks combine to form atoms, which in turn form molecules. Because atoms and molecules are said to be matter, it is natural to redefine the matter as anything that is made of the same things that atoms and molecules are made of, which in turn leads to further define the matter as being *quarks and leptons*. The leptons and quarks are the two types of elementary fermions so we may say that the *ordinary matter* is composed entirely of *first-generation particles, namely the [up] and [down] quarks, plus the*

electron and its neutrino (Carithers and Grannis (1995; cf. Figure 1) [1]. However, the higher generations particles quickly decay into first-generation particles, and thus are not commonly encountered (Green, 2005) [2]. Thus all the particles that make up ordinary matter (leptons and quarks) are elementary fermions, while all the force carriers are elementary bosons (Smolin, 2007) [3]. The W and Z bosons that mediate the weak force are not made of quarks or leptons, and so are not ordinary matter, even if they have mass (Amsler *et al.*, 2008) [4]. Therefore we conclude that mass is not something that is exclusive to ordinary matter.

The quark–lepton definition of ordinary matter, however, identifies not only the elementary building blocks of matter, but also includes composites made from the constituents (e.g. atoms and molecules). Such composites contain an interaction energy that holds the constituents together, and may constitute the bulk of the mass of the composite. As an example, to a great extent, the mass of an atom is simply the sum of the masses of its constituent protons, neutrons and electrons. However, digging deeper, the protons and neutrons are made up of quarks bound together by gluon fields and these gluons fields contribute significantly to the mass of hadrons (Aitchison and Hey, 2004) [5]. In other words, most of what composes the "mass" of ordinary matter is due to the binding energy of quarks within protons and neutrons (Povh *et al.*, 2004) [6] For example, the sum of the mass of the three quarks in a nucleon is approximately $12.5 \text{ MeV}/c^2$, which is low compared to the mass of a nucleon (approximately $938 \text{ MeV}/c^2$). The bottom line is that most of the mass of everyday objects comes from the interaction energy of its elementary components.

Structural properties of fundamental particles:

The Standard Model groups matter particles into three generations as shown in Figure 1, where each generation consists of two quarks and two leptons. The first generation is the **up** and **down** quarks, the **electron** and the **electron neutrino**; the second includes the **charm** and **strange** quarks, the **muon** and the **muon neutrino**; the third generation consists of the **top** and **bottom** quarks and the **tau** and **tau neutrino** (Staley, 2004) [7]. It may be noted from the Figure 1 that the quarks and leptons of higher generations are excited states of the first generations. If this turns out to be the case, it would imply that quarks and leptons are composite particles, rather than elementary particles, and hence the search for the fundamental particles must be on.

According to Fermi–Dirac statistics the Fermions can be *elementary*, like the electron or *composite*, like the proton and neutron. In the Standard Model, there are two types of elementary fermions: **quarks** and **leptons**.

The quarks are particles of spin $-\frac{1}{2}$ implying that they are fermions. They carry an electric charge of $-\frac{1}{3}e$ (down-type quarks) or $+\frac{2}{3}e$ (up-type quarks). For comparison, an electron has a charge of $-1e$. They also carry colour charge, which is the equivalent of the

electric charge for the strong interaction. Quarks also undergo radioactive decay, meaning that they are subject to the weak interaction. Quarks are massive particles, and therefore are also subject to gravity. In Table I we present structural and electrical properties of quarks.

Table I
Properties of Quarks

Name	Symbol	spin	electric charge (e)	mass (MeV/c ²)	mass comparable to	antiparticle	antiparticle symbol
up-type quarks							
up	U	1/2	+2/3	1.5 to 3.3	~ 5 electrons	antiup	u
charm	C	1/2	+2/3	1160 to 1340	~1 proton	anticharm	c
top	T	1/2	+2/3	169,100 173,300	to ~180 protons or ~1 tungsten atom	antitop	t
down-type quarks							
down	D	1/2	-1/3	3.5 to 6.0	~10 electrons	antidown	d
strange	S	1/2	-1/3	70 to 130	~ 200 electrons	antistrange	s
bottom	B	1/2	-1/3	4130 to 4370	~ 5 protons	antibottom	b

The Leptons are particles of spin $-\frac{1}{2}$, meaning that they are fermions. They carry an electric charge of $-1e$ (charged leptons) or $0e$ (neutrinos). Unlike quarks, leptons do not carry colour charge, meaning that they do not experience the strong interaction. Leptons also undergo radioactive decay, meaning that they are subject to the weak interaction. Leptons are massive particles, therefore are subject to gravity. Properties of leptons are presented in Table II.

Table II

Lepton properties

Name	symbol	spin	electric charge (e)	mass (MeV/c ²)	mass comparable to	antiparticle	antiparticle symbol
charged leptons							
<u>electron</u>	e ⁻	1/2	-1	0.5110	1 electron	<u>antielectron</u>	e ⁺
<u>muon</u>	μ ⁻	1/2	-1	105.7	~ 200 electrons	antimuon	μ ⁺
<u>tau</u>	τ ⁻	1/2	-1	1,777	~ 2 protons	Antitau	τ ⁺
neutrinos							
<u>electron neutrino</u>	ν_e	1/2	0	< 0.000460	< 1/1000 electron	electron antineutrino	$\bar{\nu}_e$
<u>muon neutrino</u>	ν_μ	1/2	0	< 0.19	< 1/2 electron	muon antineutrino	$\bar{\nu}_\mu$
<u>tau neutrino</u>	ν_τ	1/2	0	< 18.2	< 40 electrons	tau antineutrino	$\bar{\nu}_\tau$

Matter in the universe:

The universe is composed of baryonic matter, dark matter, dark energy, black holes and various forms of degenerated matter. Baryons are strongly interacting fermions, and so are subject to Fermi–Dirac statistics. Amongst the baryons are the protons and neutrons, but many other unstable baryons exist as well. The term baryon usually refers to tri-quarks *i. e.* particles made of three quarks. "Exotic" baryons made of four quarks and one anti-quark is known as the pentaquarks, but their existence is not generally accepted.

Microwave light seen by Wilkinson Microwave Anisotropy Probe (Bennett et al. 2003) [8] suggests that only about 4.6% of the universe is visible and this part is made of baryonic matter. "Five year results on the oldest light in the universe" (NASA, 2008) reveal larger fraction of the universe matter is dark comprising of about 23%, and about 72% is dark energy. The reason behind the philosophy proposing the existence of dark matter and dark energy is **Baryon**

asymmetry *i. e.* there is far more matter than antimatter in the observable universe instead of equality of matter and antimatter.

In particle physics and quantum chemistry, **antimatter** is matter that is composed of the antiparticles of those that constitute ordinary matter. If a particle and its antiparticle come into contact with each other, the two annihilate; that is, they may both be converted into other particles with equal energy in accordance with $E = mc^2$. These new particles may be high-energy photons (gamma rays) or other particle–antiparticle pairs. The resulting particles are endowed with an amount of kinetic energy equal to the difference between the rest mass of the products of the annihilation and the rest mass of the original particle–antiparticle pair, which is often quite large. Antimatter is not found naturally on Earth. The philosophy behind this is that the antimatter that came to exist on Earth during solar system formation would almost instantly have met the ordinary matter that Earth is made of, and be annihilated. Therefore, in the early universe, it is thought that matter and antimatter were equally represented, and the disappearance of antimatter, however, requires an asymmetry in physical laws called the charge parity (or CP symmetry) violation. Currently observed apparent asymmetry of matter and antimatter in the visible universe is one of the great unsolved problems in physics. However, such outstanding unsolved problems, perhaps, may be solved considering attributes/properties of **Jain Paramanu**.

In order to resolve theoretically the anomaly of matter-antimatter asymmetry dark matter and dark energy have been proposed as major fraction of matter in the universe. Thus current cosmological models propose that the ordinary matter formed by the quarks and leptons, constitutes about 4% of the energy of the observable universe, and the remaining energy to be due to exotic forms, of which 23% is dark matter (Pretzl, 2004 [9]; Freeman and McNamara, 2006 [10]) and 73% is dark energy (Wheeler, 2007 [11]; Gribbin, 2007 [12]). The **dark matter** is matter of unknown composition that does not emit or reflect enough electromagnetic radiation to be observed directly, but whose presence can be inferred from gravitational effects on visible matter (Majumdar, 2007) [13]. On the other hand, observational evidence of the early universe and the big bang theory require that this dark matter has energy and mass, but is not composed of either elementary fermions or gauge bosons (*cf.* Figure 1). The commonly accepted view is that most of the dark matter is non-baryonic in nature (Majumdar, 2007). On the other hand, **dark energy** is the name given to the anti-gravitating influence which accelerates the rate of expansion of the universe. However, dark energy is proposed not to be composed of known particles like protons, neutrons and electrons, nor of the particles of dark matter, because they all gravitate (Wheeler, 2007; Smolin, 2007).

Thus in conclusion as far as **“matter”** is concerned $\geq 75\%$ of the matter density in the universe appears to be in the form of dark energy and $\approx 21\%$ is dark matter. Only 4% is ordinary matter. **So less than 1 part in 25 is made out of matter we have observed experimentally or**

described in the standard model of particle physics. Of the other 96%, apart from the properties just mentioned, we know absolutely nothing.

In order to demonstrate the existence of proposed dark matter and dark energy in the universe search for the particles like axions and chameleons is of highest importance over the globe. Employing the data from the various space missions Jain *et al.*, (2015) [14] are planning to demonstrate the existence of axions and chameleons using gravitational lensing techniques.

“Matter” in Jainism:

Matter has been studied by every system of Indian Philosophy. According to Jain metaphysics one form of *Ajivadravya* (Non-living substance) is *pudgalastikaya* (matter substance) which exists in the Universe in various forms such as earth, water, fire, air, shadow, objects of four senses- hearing, smell, taste, and touch, physical mind, speech, bodies, *etc.* up to karmic matter and *paramanu* (ultimate particle). *Pudgala* is tangible reality within the sensuous and super sensuous experiences in perceptible and imperceptible conditions. *Pudgala* is permanent, non-living, extensive, physical, corporeal and concrete, active, disintegrating and integrating, and changeable substance [15]. It is characterized by origination, decay and permanence without giving up its essential nature of existence.

Pudgala is the only substance which is *murta* (corporeal) and perceivable. *Rupatva* (form) / *murtatva* (corporeality) or sensory perceptibility is the sum total of the four sensuous qualities as follows [16].

- ❖ Colour-five types of primary colour : Black, blue, red, yellow, white
- ❖ Taste- five types of taste: Sweet, bitter, pungent, sour & astringent
- ❖ Smell- two types of odour: Good smell and bad smell.
- ❖ Touch- eight types of touch: Cold, hot, smooth (positive charge), rough (negative charge), light, heavy, soft and hard.

All colours, tastes and smells can vary in magnitude and range.

Based on above qualities the matter substance in nature is of three types [17].

- (i) Matter substance having one colour, one smell, one taste and two touches.
- (ii) Matter substance having five colours, two smells, five tastes and four touches.
- (iii) Matter substance having five colours, two smells, five tastes and eight touches.

Paramanu is the two-touch matter substance (*pudgala*); it has only one colour, one smell and one taste [18]. The four-touch *pudgala* comprise the subtle (*suksama*) class of matter substance, as aggregates (*skandha*), which has substantial energy. This matter has five colours, two smells and five tastes. On the other hand the eight-touch matter constitutes the gross (*badar*) class of aggregates comprising of energy and matter. These aggregates have the five colours, two smells and five tastes. Thus according to Jaina all aggregates, containing a large

number of *paramanus*, necessarily possess all colours, smells and tastes. Generally only one or a few of the colours, smells and tastes manifest in gross state at a time, the others remain unmanifest. The manifestation of colours *etc.* is dependent on the mode of the substance. Some attributes manifest in the natural mode while some other attributes manifest in the alienated modes. The manifestations are both intrinsic and extrinsic. For example, some colours, smells and tastes manifest in a fruit in the green state and other colours, smells and tastes manifest in the ripen state.

Cold, hot, smooth and rough are primary touch qualities of *pudgala*. The smooth touch is also regarded as positive charge and the rough touch is regarded as negative charge. The other four touch qualities viz. light, heavy, soft and hard are secondary touch qualities. These touch qualities are supposed to develop when bonding between infinite *paramanus* produces a gross aggregate. If number of negative *paramanus* is more in the bonding process the aggregate contains light touch quality and if positive *paramanus* are more than heavy touch is produced in the aggregate. When positive *paramanus* are in majority and they bond in cold condition soft touch is produced and when a majority of negative *paramanus* bond in hot condition hard touch is produced in the aggregate [19]. The weight (or mass?) of the aggregate is said to relate to the light and heavy touch qualities. The four touch aggregates and *paramanu* are weight (mass) less. The weight is a property of gross aggregates having eight- touch [20]. This aspect is further discussed below.

In the true sense the *paramanu* and aggregates as a class have no beginning; they have always been in existence. But a particular aggregate or *paramanu* has a beginning and a life. The minimum life of a *paramanu* as free *paramanu* and that of an aggregate can be one '*samaya*'¹ and maximum life can be innumerable '*samayas*' [21]. Thereafter they undergo change. The *pudgala* are of two types, subtle and gross, as said earlier. The subtle does not remain subtle and gross does not remain gross for all time. After innumerable '*samaya*' the subtle changes to gross and gross splits into subtle form [22]. Similarly, the colour and other attributes of *pudgala* also change with time. A black colour of one degree can stay in the same condition for a minimum time of one '*samaya*' and a maximum time of innumerable '*samaya*'. Thereafter, one degree black shall change to innumerable degree black by the internal process of '*sadguna – hani – vridhhi*'. Intrinsic modification occurs in every substance every moment. Extrinsic modification of gross aggregates is also certain after innumerable '*samaya*'.

Integration (*Bandh*)

All physical matter is produced either by integration (*bandh*) or by disintegration (*bheda*) process. The integration is of two types – (i) natural (*vaisrasika*) and (ii) by animate organisms (*prayogika*) [23]. The natural kind is again of two types – (i) with a definite beginning and (ii) without a beginning. Some instances of natural integration, which have a beginning, are clouds, lightening, rainbow *etc.*

Integration made by living organisms necessarily has a definite beginning and can be divided into two kinds [24].

- (i) Integration of one kind of matter with another, e.g., production of chemical composites.
- (ii) Combination of matter with soul in worldly living beings.

The last one is again of two types – (i) *karma-bandh*, bondage of *karma-vargana* (with soul), and (ii) *no-karma-bandh*, combination of other groups of *pudgala* with soul in vital functions and formation of gross body.

1 *Samaya* is the smallest indivisible unit of time and is the time taken by a *paramanu* moving at slowest speed to move from its present *pradesa* location to the next adjoining *pradesa*.

Jain philosophy provides elaborate rules for bonding among *paramanus*. The bonding takes place due to positive and negative charge of *paramanus* [25]. The charge of a *paramanu* varies in a range. Let q be the minimum indivisible unit charge, positive (q_+) or negative (q_-), and that the charge increase in multiples of 1, 2 or 3 etc. units. The *paramanu* can have a charge q , $2q$, $3q$, $4q$, etc, q being positive or negative. The rules for bonding between *paramanus* are given in Table III [26, 27]. It is seen that there is some variation in the rules of bonding in Svetambara and Digambara traditions. In both traditions a *paramanu* having a minimum charge does not bond with other *paramanu*. If charge is more than the minimum value and differs by two units or more then the two *paramanus* can bond according to both traditions. These rules are also applicable to bonding between an aggregate and a *paramanu* or between two aggregates.

Table III: Rules for Bonding of paramanus

	Value of charge of two <i>paramanus</i> bonding $q_1 + q_2$	Svetambara Tradition		Digambara Tradition	
		Similar charge <i>paramanu</i>	Dissimilar charge <i>paramanu</i>	Similar charge <i>paramanu</i>	Dissimilar charge <i>paramanu</i>
1	$q + q$	No	No	No	No
2	$q + 2q$	No	No	No	No
3	$q + 3q$	No	No	No	No
4	$q + 4q$ and up to nq	No	No	No	No
5	$2q + 2q$	No	Yes	No	No
6	$2q + 3q$	No	Yes	No	No

7	$2q + 4q$	Yes	Yes	Yes	Yes
8	$2q+5q$ and up to nq	Yes	Yes	Yes	Yes

The qualities of the aggregate produced by bonding depend on the qualities of the constituent *paramanus* or aggregates. For instance one unit black *paramanu* on combining with higher degree white *paramanu* becomes white. When one degree black *paramanus* combines with one degree white *paramanus* a grey colour is produced in the aggregate

Paramanu

The canonical literature in general and the Bhagwati Sutra in particular defines *paramanu* in various ways from different perspectives. It is the basis (ultimate constituent) of the physical universe. It is indivisible, indestructible, impenetrable, incombustible and imperceptible to sense organs [28]. It cannot be split or destroyed by any means whatsoever. It has no half-portion, no middle portion and no *pradesa*. It has no length, no breadth and no depth. It is dimensionless. It is truly infinitesimal.

Paramanu is the pure form of *pudgala* and possesses the intrinsic qualities of touch, taste, smell and colour. These qualities are attributed to a *paramanu* for a fundamental reason. It is the basic assumption in Jain philosophy that the fundamental properties of a substance are also eternal; they are neither created nor destroyed. Hence the basic properties observed in aggregates are also present in *paramanu*. A *paramanu* has one of the five primary colours, one of the two smells, one of the five tastes, two of the four primary touch i.e. one either hot or cold and two either smooth (positive charge) or rough (negative charge) [29]. Although the four qualities are permanently possessed by a *paramanu*, the intensity of the qualities does not remain constant. A *paramanu* possessing one unit of blackness at any moment may sometimes later possess two, three or many units of blackness [30]. In the *free-state* the mutation is only in the intensities of colour, etc. i.e. x unit black changes to y unit black but black does not become white or red *etc.*,-however during and after union with other *paramanus* change in colour *etc.* may also take place. It follows from this that at any given moment there would be *paramanus* with different intensities of blackness etc. In the same way there would be *paramanus* with various degrees of other qualities.

A single free *paramanu* is invisible not only to the naked eyes but also to other physical instruments. Its existence is to be inferred by the collective action and reaction of aggregates of infinite *paramanus*. Only the omniscient (*kevalajnani*) and those possessing superlative visual intuition (*paramavadhi jnani*) can perceive and cognize the nature of a free *paramanu*.

The *paramanu* is the direct unit of physical substance (*pudgala*) and also the indirect unit of space, time and quality magnitude of attributes [31]. The quantitative and qualitative

difference in the various form of the matter (aggregates/ pudgala) in space and time domain ultimately depends on the action/ reaction of attributes of *paramanu*. Thus, being the fundamental constituent of physical composite bodies, it may be considered to be the determinant of the difference of aggregates, and for the same reason it is also their substantial cause. By its own motion it becomes the measure of time unit '*samaya*'.

The *paramanus* have the innate capacity of uniting with one another to form composite bodies. The composite bodies are liable to the process of disintegration and the united *paramanus* may become free *paramanus* and thus the process of association and dissociation goes on eternally [32]. *Paramanu* is capable of being dynamically active (*kriyavan*). When dynamic, it may have spin, vibratory and migratory motions [33]. The activity of a *paramanu* is not continuous, rather it is quanta. The dynamics of *paramanu* in some respect follow certain rules but it also follows some rules of uncertainty. *Paramanu* generally cannot be stopped or hindered by any object (*apratighati*) and at the same time it does not cause hindrance to others [34].

A *paramanu* in a given space-time domain has various energy states: potential, electro-thermal, kinetic etc. in view of their embedded attributes and their variation as a consequence of change in energy states, which reveals that a ***paramanu is a vibrating and moving charge***. It has also been said that infinite number of *paramanus* can occupy one space point [35]. This means that *paramanu* is bosonic in character. As the *paramanu* is indivisible the energy of a *paramanu* is the smallest amount of energy that can exist in Free State and therefore it can be regarded as energy quanta.

It should be mentioned that the atom described by modern science is not the same as *paramanu*. The *paramanu* is weight less (it has infinitesimal mass and energy) and has one colour, one taste, one smell and two touches whereas an atom has mass and belongs to the class (iii) matter; it has five colours, five tastes, two smells and eight-touches. According to Jainism an atom, rather each of its elementary particles, contains infinite number of *paramanus* as described below. These *paramanus* may have positive or negative charge and bond together according to the rules prescribed. That is, there is bonding between positive and positive, positive and negative, and negative and negative *paramanus*. The particle formed in this manner has a net charge depending on the majority population of a particularly charged *paramanus*. For example an electron has majority population of negative *paramanus* and a proton has a majority population of positive *paramanus*. The total negative charge of electrons is equal to the total positive charge of protons for a stable structure. Jainism does not rule out formation of particles having fractional or multiple charge of electron or proton, but such particles are not known to form a stable structure and have no practical value.

Vargana (Energy Fields)

Vargana is an important concept to understand nature particularly at subtle level. *Vargana* has been defined as *pudgala* aggregate made up of similar *paramanus* or as a cluster of *paramanus* [36]. There are infinite numbers and types of *varganas* according to Bhagwati Sutra but eight types are important from the point of view of their association with the soul [37]. Gommatsara Jivakanda provides another type of classification of *varganas* on the basis of number of *paramanus* present in the cluster [38]. According to this there are 23 types of main *varganas* found all over *loka*. The *varganas* fall into two broad categories, one has four- touch and the other having eight-touch. The 2nd to 14th order *varganas* are four-touch type and weight less. The 16th to 23rd order *varganas* are eight- touch type and have weight. The 15th order *vargana* falls in between the two categories and its nature is uncertain [39].

The lower order weight less *varganas* can be divided in two groups.

1. Associable *varganas* – *varganas* that associate with the soul and form various kinds of subtle bodies and other structures that assist the soul in its worldly functioning.
2. Non associable *varganas* – *varganas* that do not associate with the soul.

The following are the associable *varganas*.

- 1) *Ahara vargana*. This *vargana* constitutes the gross, protean (*vaikriya*) and migratory (*aharaka*) bodies of organisms.
- 2) Fiery (*Tejas*) *Vargana*. These *vargana* constitute the fiery body of organisms.
- 3) Sound (*Bhasha*) *vargana*. The sound *vargana* is suitable for producing all kinds of sound including the sound produced by inanimate objects like musical instruments and natural phenomena like thundering of clouds and sound produced by living organisms including speech by humans.
- 4) Mind (*Mano*) *Vargana*. This *vargana* constitutes the physical mind (*dravya manah*) of organisms.
- 5) *Karman Vargana*. This *vargana* constitutes the karma bodies of organisms.

The higher order *varganas* can be divided in three groups.

- 1) *Varganas* that is helpful in formation of gross bodies of plants and small microorganisms (*nigodas*), belonging to category of non-mobile (*Sthavara jivas*). These *varganas* assist in formation of plant bodies and bodies of small microorganisms. The *vargana* that assists in formation of plant body compares with sun light (photons).
- 2) Permanent Nil (*Sunya*) *Varganas*. Detailed information about these *varganas* is not available in scriptures.
- 3) Gross Matter (*Maha skandha*) *Vargana* (GMV). This *vargana* is supposed to constitute all ordinary matter, visible and invisible, in the universe including bodies of mobile beings.

The charge in *vargana* produces an electric field. A moving electric charge in *vargana* also produces a magnetic field. In view of modern science a field is nothing but a charge in the space-time continuum. All fields, magnetic, electrical and gravitational, are physical realities. A *vargana* contains a bundle or packet of energy. The energy density or energy intensity increases with the order of *vargana*. As mentioned above *varganas* of 15th and higher order are supposed to have eight- touch i.e. in addition to four basic touches, namely cold, hot, positive and negative charge, other four secondary touches - light, heavy, soft and hard are also present. These additional touch properties are supposed to come in existence due to bonding between *paramanus*. The light and heavy touches are supposed to produce the property of weight. In the lower order *varganas* of four touch types the *paramanus* cluster but do not bond.

The act of bonding between *paramanus*, interaction, requires energy. When two *paramanus* bond a part of their energy (potential energy) is used up in bonding reducing the free energy of the *vargana* that exists as kinetic energy of motion and vibration. Therefore the maximum velocity of a two-*paramanu* bonded *vargana* will be less than the maximum velocity of a single *paramanu* or a two *paramanu* unbound *vargana*. We thus see that lower order *varganas* having four- touch must have higher maximum velocity than eight touch *varganas* of higher order. The *paramanu* having two- touch has the highest maximum velocity. The lower order *vargana* are weightless and must be free of gravitational effect. The higher order *vargana* have gravitational property.

Gross Matter Vargana (GMV) and Matter.

All ordinary matter (visible or invisible) is made up of GMV according to Jain view as mentioned above. We examine now how the sub atomic particles may be produced from GMV [40]. Consider the case of leptons first. The neutrino is the smallest lepton having negligible mass and no charge. If neutrino is made of GMV then it must be a combination of at least two GMV, one having positive charge and the other a negative charge. This will be the case when the two GMV have equal and opposite charge. As *varganas* exist with differing charges it is very likely that more than two GMV combine to produce a neutral charge in neutrino. So a neutrino of negligible mass should be made up of many GMV. There are three types of neutrinos. The mass of all three types is negligible but still there is a minor difference between them. Such minor variation in mass is obtained by variation in number of GMV in the three types of neutrinos. It may be noted that when the mass of a neutrino is considered to be negligible, the mass of GMV is still less.

Now consider another lepton, the electron. The mass of electron is 0.511 MeV, which is millions of times greater than the mass of a neutrino. This means that an electron is made of millions of GMV. In an electron the number of negative charge GMV exceeds the positive charge GMVs giving a net negative charge of -1.6022×10^{-9} coulomb. This also shows that the

charge of one GMV is millions of times smaller the charge of an electron. And since a GMV contains infinite *paramanus*, the quantum charge of a *paramanu* is really unimaginably small. The lepton muon is more than 200 times heavier, and tau is about 3500 times heavier than electron and therefore, they must contain more GMV in the same proportion.

Next consider the stable baryon particles proton and neutron. These particles are supposed to be made up of quarks. The mass of a proton is 1836.12 times greater than that of the electron and neutron is very slightly heavier than proton. The mass of a quark is uncertain but it is many times more than that of the electron. So a quark is made from that many times more GMV than an electron. There are six types of quarks having fractional charges, both positive and negative, and masses ranging from 2 MeV to 18000 MeV. According to Jain view the fractional charges of quarks are possible by appropriate combination of positive and negative GMV. Another thing we observe is that the charges of up quark, charm quark and top quark are same but their masses vary considerably. Similar is the case with down quark, strangeness quark and bottom quark. Formation of these quarks is clearly possible with suitable combination of GMV. So, in Jain view quarks and leptons are composite particles and subject to gravity. Many more types of particles can be formed, including those not discovered so far.

Mass of matter is nothing but transformation of energy, that is, both matter and energy are but two modifications of a single principle, has been only recently realized in science. Jain physics has identified all forms of matter and energy as modification of the same substance *pudgala*. Intra - convertibility of various forms of energy - mechanical into electrical , electrical into heat, light, sound etc., - which is the basis of modern technology - has been recognized by Jain philosophers as the basic attributes of *pudgala*, since all forms of energy are fundamentally the modification of the same substance, *paramanu pudgala*.

Dark Energy and Dark Matter

There is no direct mention of dark energy and dark matter in Jain scriptures. The existence of dark energy in science has been postulated to satisfy the condition of expanding and accelerating universe and it is supposed to have anti gravity property. The non associable *varganas* described above are weight less and gravity free. These *varganas* may comprise a good fraction of the total mass present in the *loka* that is gravity free but do not possess anti gravity property as postulated by modern science. The Permanent Nil Varganas may be considered to constitute the dark matter as they are not detected by ordinary means. These *varganas* may constitute a significant portion of mass present in the *loka*. The matter formed by these *varganas* could be non-baryonic as the baryonic matter is formed by higher Gross Matter *Vargana* (GMV). Jainism supports the scientific view that mass is not the exclusive property of ordinary matter. According to Jainism even photons have mass.

Jain scriptures mention about bodies on which even beings having great powers e.g. heavenly beings fear to go. Jain canon Bhagvati Sutra describes existence of dark structures in

space comparable to black holes. These structures are of two types, one Tamaskaya, Mass of Darkness, and two Krsnaraji, Black Streaks [41]. Both are pitch dark structures containing no parts like stars, sun, moon, planet etc and no life. Both have rains meaning thereby that they attract neighbouring matter that appears as showers on the surface. The light of other stars and moons becomes dim as they approach these structures. Tamaskaya is a huge structure extending from a location far away from Jambudweepa, supposed to be our Earth, and going up to fifth heaven in the upper loka. This is said to have been formed by transformation of water bodies of organisms and other matter. The Krsnaraji, eight in number in a closed loop structure located in fifth heaven in upper loka, is said to have been formed by transformation of earth (bodied beings) and other matter. This indicates that dark holes (or dark matter) can be formed in two ways one from water source i.e. fluidic matter and the other from earth like solid matter.

The Laws of Subtle Cosmos

Modern science has discovered that as we go down from the macro to the micro state of matter, new attributes of matter come in action and the number of attributes increase. The macro world is deterministic and follows the laws of classical mechanics. The micro world follows the laws of quantum mechanics. Some laws of classical mechanics are not valid in the micro world. It may be noted that macro and micro world of science are comprised of 8-touch gross aggregates containing mass, which consists of higher-order *varganas* in bonded form. The weight less four-touch *vargana* subtle aggregates which exist only in energy form is a different class of matter. The weight less, four-touch *varganas* do not carry the fundamental forces as their *paramanus* are supposed to be in unbound state. Their behavior, therefore, must not be governed by known laws of science. On extrapolating, we expect that at subtle level of the physical world e.g. weight less four-touch *vargana* there may be yet another set of principles in operation, which is still not discovered by science.

Motion

(a) Motion of a *paramanu*.

A *paramanu* is *apratigati*, in independent state it does not interact with any other object. Hence there is no external influence of any kind on the motion of a *paramanu*. Its motion is *asparshad gati* type [42]. A *paramanu* moves due to its intrinsic characteristic of dynamic action. Its motion is hindered only when it collides with another *paramanu*, a very rare possibility. It may be noted that the laws of motion of science and the limit imposed by special theory of relativity does not apply to *paramanu* as the forces on which these laws and theories are based are absent in this case. The dynamic activity of a *paramanu* is uncertain as described before and it may move with low, medium or high velocity as determined by the property of *sadgun-hani-vridhi*. In the extreme case of highest velocity the *paramanu* can travel from one end to another end of loka in one *samaya* if not hindered by another *paramanu*.

(b) Motion of four - touch *Vargana*

A four – touch *vargana* may contain two to infinite number of *paramanus*. The fundamental forces are still absent in this type of *vargana* and its motion is not governed by known laws of science and the special theory of relativity. However, there is affinity between *paramanus* in a *vargana* and so the maximum velocity of this *vargana* would be less than the maximum velocity of a *paramanu* as explained above. Due to large number of *paramanus* the chances of its colliding with other *vargana* are significant. On collision the two *varganas* may merge and form a bigger *vargana* of the same kind or a *vargana* of another kind.

(c) Motion of eight – touch *Vargana*

Eight – touch *vargana* contains *paramanus* in the bound state and all the fundamental forces must be present in it. All electromagnetic radiations fall in this category. This eight – touch type of *varganas*, therefore, are expected to obey the known laws of science and the limit on speed imposed by the special theory of relativity may apply. On account of small mass the gravitational force must be negligible and the motion is largely governed by electromagnetic force e.g.in the case of a photon and small microorganisms (*nigodas*).

(d) Motion of particles (made of *Mahaskandh Vargana*)

In the case of matter formed of GMV, at the level of subatomic particles and atoms the gravitational force is still very small and other forces determine the motion. As the aggregates grow in size the gravitational force increases and the effect of electromagnetic force diminishes because the number of *parmanus* having positive and negative charge in the aggregate is likely to be of the same order canceling the effect of each other. Thus the motion of large particles and objects is governed mainly by gravitational force.

4 Conclusions

It appears that spatial, spectral and temporal **energy states** are major difference between the two smallest size “**matters**” known so far: fermions and *parmanus* in science and Jainism respectively. The *paramanu* of Jain philosophy is the smallest indivisible fraction, quantum, of energy. The Jain *paramanu*, the real energy quanta, is far too smaller than the quantum of energy, photon, assumed by science. Science has discovered particles like quark but it still remains a mystery what makes the quark. The journey of science has been from gross to fine and it has gone to the level of quark. Jain philosophy starts from the ultimate particle *paramanu* and proceeds up to the gross form of matter. Jain philosophy says that the fundamental constituent of nature is energy and *paramanu* is its ultimate unit. *Paramanu* makes up *vargana* and *vargana* make up photon and the gross particles like quark, electron, etc. Jain philosophy presents the subtler form of matter which science has not discovered so far. The story of matter from quark and electron onward is known to science. Jain philosophy also offers some plausible explanation to puzzling questions like what is the nature of matter

other than the ordinary matter postulated by science. Thus Jain philosophy and science together reveal more complete picture of the physical reality.

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