

Special Section:

Matter And Energy According To The Jain Scriptures

by Duli Chandra Jain

English translation of the article,

'JAIN DARSHAN MEN PUDGAL DRAVYA AUR PARMANU SIDDHAANTA',
published in Shri Chandabai Abhinandan Granth, 1954.

This article is being presented without any editing or updates except for the following excerpt from the Preface to 'Cosmology Old and New' by Prof. G. R. Jain.

“As has been remarked by Fermor, Asia had not been scientifically asleep during the whole of several millennia before the introduction of modern sciences into India by the Europeans. Researches by oriental scholars into the old Sanskrit and Pali texts are gradually bringing to light the valuable gems of the cultural heritage of India. The Jains and the Buddhists made discoveries of immense value. In fact Dr. N. R. Dhar has attributed the intellectual stagnation in India after the 12th century to the decline of Buddhism under whose aegis science had considerably developed. About the contributions of Jain thinkers in the field of physics, biology and mathematics very little is known to the intelligent public for want of proper literature on the subject. The present (text) is a humble attempt to put before the English-knowing public the contributions of Jains in the domain of cosmology and atomic physics. It is not an attempt to seek in ancient texts the substance of modern theories, as some are likely to think, nor is there any attempt to bring by forced, distant and misleading analogies the ancient discoveries in line with modern science.”

Secrets of the universe and philosophy:

From prehistoric times, the universe has been a puzzle for man. It seems that man, the most advanced and cogitative animal of the universe, must have observed the first rays of the sun and moon with feelings of awe, wonder and mystery. That is why, in Vedas, ancient sages and scholarly monks are found to pray to the glorious elements of nature, such as the sun, the moon, the ocean and lightning. Eventually, the concept of the Creator originated in the mind of man as also the curiosity about the fundamental elements of the universe. The hypothesis of the five elements of earth, water, fire, air and space of Indian philosophers, the theory of earth, water, fire and air of the Greek thinkers, and the concept of six fundamental entities of the universe, namely, soul, matter (including energy), principle of motion, principle of rest, space and time of Jain philosophers constitute attempts to answer this question. Ancient thinkers like Kanad (k;d) and Democritus

attempted to decipher the intrinsic composition of matter as well and proposed their atomic theories. The Jain philosophers also have made significant contribution in this respect. The German scholar, Dr. Schubring remarked,¹ “He who has a thorough knowledge of the structure of the world cannot but admire the inward logic and harmony of Jain ideas. Hand in hand with the refined cosmological ideas go the standards of astronomy and mathematics. A history of Indian astronomy is not conceivable without the famous SOORYA PRAJNAPTI.”

The principles enunciated by the Jain thinkers are remarkable from the fact that they were put forth thousands of years ago. Modern scholars trace the origin of the atomic theory with Kanad and Greek philosophers. However, if the western scholars had a chance to study the Jain literature, they would have traced the origin of the atomic theory to Bhagwaan Parshvanath who lived around 850 B.C., many years before Kanad.

Fundamental entities of the universe in Jainism:

According to Jainism, the universe has six fundamental entities (DRAVYAs):²

(1) Soul (JEEV), (2) matter and energy (PUDGAL), (3) principle of motion (DHARM), (4) principle of rest (ADHARM), (5) space (AAKAASH) and (6) time (KAAL). These six fundamental entities are indestructible, eternal and intrinsically invariable (DHARVA). This is the implication of the definition of entity - existence is the quintessence of entity.³ Existence implies permanence with respect to intrinsic attributes, while origination and annihilation with regard to modifications. Annihilation implies destruction of the present form and origination entails the inception of a new form. In these processes, the innate characteristics of the substance such as existence and the quality of being substantial remain invariable. This is the aspect of permanence. For example, a piece of coal burns and turns into ashes. In this process, the lump of coal is depleted and powdered ashes are formed. These constitute annihilation and origination, respectively. However, the element carbon remains permanent.

¹ Cosmology Old & New by Prof. G. R. Jain, published by Bharatiya Jnanpith, New Delhi, 1975, page vii.

² AJEEVAKAAYA DHARMAADHARMAAKAASHAPUDGALAAH [5-1];
DRAVYAANI [5-2]; JEEVAASHCHA [5-3]; KAALASHCHA [5-39].

Acharya Umaswati's TATTVAARTH SUTRA

³ SADDRAVYALAKSHANAM [5-29]; UTPAADAVYAYADHRAUYAYUKTAM SAT [5-30].

Acharya Umaswati's TATTVAARTH SUTRA

The above concept of entity in Jain philosophy precludes the need for creation and Creator. The entities of the universe are eternal and permanent from the point of view of intrinsic attributes. Thus they cannot be created out of a void. Only transient forms can be created or destroyed. All entities are eternal. Their quantities remain constant. One entity cannot be changed into another. The entities are formless except for matter and energy (PUDGAL).⁴ When matter⁵ interacts with matter, or when soul and matter interact with one another, transformations of states take place. This principle of permanence of the Jain philosophy can be related to the law of indestructibility of matter of modern science as defined in the eighteenth century by the famous scientist Lavoisier in the following words: Nothing can be created and in every process there is just as much substance (quantity of matter) present before and after the process has taken place. There is only a change or modification of matter.

Matter and energy in the universe:

According to Jain philosophy, matter (including energy) is one of the six entities of the universe. Matter has form; it is perceptible by our senses. All that is observed through the senses of touch, taste, smell, sight and hearing is matter. Acharya Pujoyapad⁶ defines matter as the entity that has form and qualities such as shape and color. Form can be defined as aggregation of color, taste, smell and touch. In plain words, an entity that possesses touch, taste, smell and color is called matter. Touch is of eight kinds: smooth, rough, soft, hard, hot, cold, light and heavy. There are five kinds of taste: sweet, sour, bitter, astringent and acidic. Two kinds of smell are pleasant and unpleasant. There are five kinds of color: black, red, yellow, white and blue.

A thing that exhibits even one of the above attributes, definitely has the other three attributes as well. Some attributes are tangible (evident) while others are intangible (obscure). In certain instances, we may not be able to detect some of these attributes with our senses. For example, infrared rays, which are essentially heat rays, are invisible to human eyes but owls and cats can see with the help of these rays. Further,

⁴ NITYAAVASTHITAANYAROOPAANI [5-4]; ROOPINAAH PUDGALAAH [5-5].

Acharya Umaswati's TATTVAARTH SUTRA

⁵.In this context, the word 'matter' is implied to include energy

⁶ ROOPAM MOORTIH ROOPAADISAMSTHAANAPARINAAMO, ROOPAMESHAAMASTEETI
ROOPINAH MOORTIMANTAH. SARVAARTH SIDDHI, Chapter 5

photographs can be taken with infrared rays. Similarly, we cannot detect the smell of fire but it can be detected with a tele-olfactory cell. This device is more sensitive than our nose and it can detect fire from a distance of 100 yards. It is also employed to transmit fragrance over long distances and in automatic fire control. This fact shows that some of the attributes of matter are obscure to our senses but they do exist.

Concept of five colors:

The Jain scriptures describe five colors while there are seven colors in the solar spectrum. Further, there are a variety of natural and pigmentary colors. This apparent paradox can be addressed by pointing out that in this context, color does not refer to the solar spectrum. It refers to a fundamental attribute of matter that produces the impression of colors such as black, blue and yellow on the retina of our eyes and the resulting sensation in our brains. The Optical Society of America defines color as,⁷ “Color is the general term for all sensations, arising from the activity of retina and its attached nervous mechanisms. It may be exemplified by the enumeration of characteristic instances such as red, yellow, blue, black and white.”

The concept of five kinds of color can be explained on the basis of the following scientific observation. When the temperature of an object is raised gradually, at first, it emits mostly infrared (dark) heat rays. Then as the temperature rises, it emits mostly red rays and then yellow rays. At higher temperatures, its radiation turns white and then blue. This is known as blackbody spectrum. Professors M. N. Saha and B. N. Shrivastava write,⁸ “Some of the stars shine with a bluish-white light, which indicates that their temperatures must be very high.” This fact indicates that the five colors are the natural attributes of matter that are emitted by any piece of matter at different temperatures. The Jain thinkers have also mentioned that colors are infinite in number. These correspond to the infinite wavelengths in the blackbody spectrum. These facts bring out an aspect of agreement between Jainism and modern science.

Atomic theory in Jainism:

The Jain scriptures state that all matter is composed of elementary particles (PARAMAANU). These elementary particles are extremely fine and

⁷ Cosmology Old and New by Prof G. R. Jain, page 129.

⁸ Treatise On Heat, page 341.

indivisible. These can be considered to be fundamental units of matter. The characteristics of an elementary particle are as follows:⁹

1. All matter is made up of elementary particles, which are the ultimate units of matter.
2. An elementary particle is eternal, indestructible and extremely tiny. It cannot be seen by us.
3. An elementary particle has one taste, one smell, one color and two kinds of touch (either smooth or rough, and either hot or cold).
4. The existence of an elementary particle can be ascertained by its aggregates (SKANDH) - pieces of matter.

In general, aggregates of matter have four kinds of touch: smooth or rough, hot or cold, hard or soft, and light or heavy. The questions of hard or soft and of light or heavy do not arise in the case of an elementary particle. Thus it has only two kinds of touch.

The processes of formation of atoms and aggregates:

Jain thinkers have advanced the following consistent and logical processes regarding the formation of elementary particles (ultimate particles, PARAMAANU) and aggregates (molecules, SKANDH).¹⁰

1. Aggregates are formed through processes of disintegration, integration, and combination of disintegration and integration. Disintegration implies breaking up of aggregates and integration entails combining of aggregates. The third process entails break up of some aggregate(s) into fragments and coalescing of the resulting fragments.
2. Elementary particles are produced through disintegration only.
3. The integration occurs on account of smooth and rough attributes. Aggregates with smooth touch can combine with those having rough attributes. Further, smooth aggregates can bind with other smooth aggregates. Similarly, rough aggregates can bind with other rough aggregates.

⁹ KAARANAMEV TADANTYAH, SOOKSHMO NITYO BHAVETMARAMAANU
EIKARASAGANDHAVARNO DWISPARSHAH KAARYALINGASHCHA .

Swami Akalankadev in TATTVAARTH RAAJVAARTIK, 5-25.

¹⁰ BHEDASANGHAATEVYAH UTPADYANTE [5-26]; BHEDAADANU [5-27];
SNIGDHAROOKSHVAD BANDHAH [5-33]; NA JAGHANYA GUNAANAAM [5-34];
GUNASAAMYE SADRISHAANAAM [5-35]; DVADHIKAADHIGUNAANAAM TU [5-36];
BANDHEADHIKAU PAARINAAMIKAU CHA [5-37].

4. Elementary particles having only one unit of smooth attribute or one unit of rough attribute do not enter into association. This implies that elementary particles in the lowest energy state do not bind.
5. Moreover, elementary particles or aggregates that have equal units of smooth or rough attributes, that is, those that are in the same energy state do not enter into integration.
6. Only those elementary particles that differ in smooth or rough attributes by two units bind to each other. For example, a particle having 4 units of smooth attribute can combine with one that has 6 units of smooth or rough attributes.
7. In the process of integration, the resulting aggregate acquires the smooth (or rough) attribute of the fragment that has a majority of the units of smooth (or rough) attributes. For example, if a fragment having 15 units of smooth attribute combines with another fragment having 13 units of rough attribute, the resulting aggregate is smooth. In scientific experiments, it is observed that if an atom gains an extra electron (which carries a negative charge), the resulting ion is negatively charged. Similarly, if an atom loses an electron, the resulting ion acquires a positive charge.

Evidently, it is not possible to affirm that these rules can withstand the scrutiny of laboratory experiments. Nevertheless, the fact that Jain thinkers advanced the theory of formation of particles and their aggregates is momentous.

Classification of matter:

The Jain acharyas have extended a pretty scientific classification of matter (including energy). The two main classes of matter are: elementary particles (PARAMAANU) described above and aggregates (SKANDH) that are agglomerates of elementary particles. Aggregates have been subdivided into the following six categories:¹¹

¹¹ ATISTHOOLASTHOOLA AH STHOOLA AH STHOOLASOOKSHMAASHCHA
 SOOKSHMASTHOOLAASHCHA |
 SOOKSHMA ATISOOKSHMA ITI DHARAADAYO BHAVANTI SHADBHEDA AH ||
 BHOOPARVATAADYA BHANITA ATI STHOOLASTHOOLA ITI SKANDHA AH |
 STHOOLA ITI VIJNEYA AH SARPIRJALATAILAADHYA AH ||
 CHHAAYAATAPAADHYA AH STHOOLETARASKANDHA ITI VIJAANEEHI |
 SOOKSHMASTHOOLA ITI BHANITA AH
 SKANDHAASHCHATURAKSHAVISHAYAASHCHA ||
 SOOKSHMA BHAVANTI SKANDHAPRAAYOGYA AH KARMAVARGANASYA PUNAH |
 TADVIPAREETA SKANDHA ATISOOKSHMA ITI PRAROOPAYANTI ||

1. Extremely gross (STHOOL STHOOL) - solids such as metals, rocks and wood.
2. Gross (STHOOL) - liquids such as water and oil.
3. Mildly gross (STHOOL SOOKSHMA) - light energy, shadow and heat.
4. Slightly gross (SOOKSHMA STHOOL) - gaseous substances such as hydrogen, oxygen and chlorine. Further, invisible forms of energy such as sound energy belong to this category.
5. Slight (SOOKSHMA) - aggregates of matter related to our thought-activity. They are known as material karmas (KAARMAANA VARGANA). These are affected by our thoughts and feelings. In turn, these aggregates of matter influence worldly souls and other aggregates of matter.
6. Extremely slight (SOOKSHMA SOOKSHMA) - extremely fine aggregates of matter such as electrons, protons and neutrons.

Note that light energy has been placed before gases, although the density of gases is considerably higher than that of radiation. It seems that the criterion of classification is visual perception and not density. Light energy can be seen while gases cannot be seen with our eyes. The things that can be detected with the eyes have been classified as mildly gross while the things that cannot be seen with the eyes, slightly gross.

In the above classification of matter, energy has been included with matter. The word 'PUDGAL' includes both, matter and energy. Thus according to Jain concepts, energy is also material. It too has the attributes of touch, taste, smell and color. Light is a form of material because it has color. And as stated above, a thing that manifests even one of the four attributes, necessarily has the remaining attributes as well. Thus light has touch, taste and smell as well although these attributes of light cannot be detected by our senses. Earlier, the scientists did not accept that energy is material. However, according to the theory of relativity and the theory of electronic structure of matter, it has been established that an electron, which is a universal constituent of matter, manifests a dual aspect - matter and energy. The relationship between matter and energy is given by

$$\text{Energy} = \text{mass} \times (\text{speed of light})^2.$$

Max Born in his celebrated work 'Restless Universe' states, "According to this theory (theory of relativity), mass and energy are essentially the same.

Forms of energy:

Jain philosophers have stated that images, shadows and sound as well are forms of matter.¹² Some thinkers consider a shadow (darkness) as absence of light but the Jain philosophers have indicated that shadows are caused by obstruction of light in conformable processes in which light is blocked.¹³ In general, darkness is considered as an antithesis of light and the cause of objects to become invisible. As stated earlier, science does not consider darkness as an opposite of light because the infrared radiation is present in darkness as well. These infrared rays enable the owls and cats to see in darkness. Further, special kinds of photographic plates are sensitive to them. Thus darkness is not absence of radiation. It is merely absence of visible light.

Images:

The Jain scriptures have stated that images and shadows are also forms of matter. In scientific work, there are two kinds of images formed by mirrors and lenses - real images and virtual images. Both are formed by light rays reflected and/or refracted by mirrors and/or lenses. These processes indicate that real and virtual images are forms of energy. It is energy that manifests in the form of images as well as shadows. When a detector is placed suitably near dark bands of an interference pattern, it is observed that electrons are emitted, indicating that a dark band is not devoid of energy. Thus certain shadows as well constitute forms of energy.

In Jain scriptures, the process of formation of shadows and images has been adequately described. Shadows are formed when an opaque object obstructs the rays of light. Thus it is darkness. As explained above, it is not absence of radiation but a form of energy. A different kind of obstruction entails the interposing of mirrors and lenses in the path of light rays to form real or virtual images. Real images are formed by the actual intersection of rays, and are mostly inverted and enlarged/diminished. In Jain scriptures, these images have been described as being formed by virtue of aberration of attributes such as colors and size (VARNAADI VIKAAAR PARINAT). Virtual images are not formed by the actual intersection of rays and so Jain scriptures describe them as

¹² SADDO BANDHO SUHUMMO THOOLU SANTHAAN BHEDATAM CHHAAYA I
UJJODA DAVASAYYA PUGGALADAVVASS PAJJAAYA II

Muni Nemi Chandra Siddhanti Dev in DRAVYASAMGRAH

¹³ TAMO DRISHTIPRATIBANDHAKAARANAM PRAKASHAVIRODHI I

Acharya Pujapad in SARVAARTH SIDDHI

apparitions (MAATRAATMIKA CHHAAYA).¹⁴ These highly sophisticated concepts presented in the Jain literature about images and shadows are remarkable.

The Jain philosophers have classified radiation into two categories: heat (AATAP) - the radiation emitted by hot objects such as fire and sun, and light (UDYOT) - the cool radiation emitted by fireflies and the moon.¹⁵ In the former, much of the energy is emitted in the form of heat rays, and, in the latter, most of the energy is emitted in the form of light. This classification shows the incisive discernment of ancient thinkers.

Sound and its classification:

Jainism considers that sound is material - a form of PUDGAL. Vaisheshik philosophy asserts that sound is an attribute of space. However, modern scientific experiments demonstrate that sound is material and it is not an attribute of space. Jainism says that sound is produced when aggregates of matter interact with each other.¹⁶

In Jain literature, sound has been classified as follows:¹⁷

Linguistic (BHAASHAATMAK) and non-linguistic (ABHAASHAATMAK). Linguistic sound has been further divided into articulate (AKSHARAATMAK) and inarticulate (ANAKSHARAATMAK). Similarly, non-linguistic sound has been classified as natural (VAISRASIK) such as the sound of thunder, and functional (PRAAYOGIK), the sound made by effort, such as the sound produced by musical instruments. The sound produced by musical instruments has been classified into the following four categories:¹⁸

¹⁴ CHHAAYA PRAKASHAAVARANANIMITTA | SAADWEDHA |
VARNAADIVIKARAPARINATA | PRATIBIMBAMAATRAATMIKA CHETI |
Acharya Pujapad in SARVAARTH SIDDHI

¹⁵ AATAP AADITYAADI NIMITTA USHNAKASHALAKSHNAH |
UDYOTASHCHANDRAMANIKHADYOTAADIPRABHAVAH PRAKASHAH |
Acharya Pujapad in SARVAARTH SIDDHI

¹⁶ SHABDASKANDHAPRABHAVAH SKANDHAH PARAMAANUSANGHASANDHAATAH |
SPASHTESHU TESHU JAAYATE SHABD UTPAADAKO NIYATAH ||
Acharya Kundkand in PANCHAASTIKAAYASAAR

¹⁷ SHABDO DWEDHA BHAASHAALAKSHANAVIPAREETATVAAT |
BHAASHAATMAK UBHAYATHA AKSHAREEKRITETAR VIKALPAT |
ABHAASHAATMAKO DWEDHA PRAYOG VISRASAANIMITTATVAAT |
TATTRAVAISRASIKO BALAAHAKAADIPRABHAVAH |
PRAYOGASHCHATURDHA TAT VITAT DHANASAUSHIRABHEDAAT |
Swami Aklankadev in TATTVAARTH RAAJVAARTIK

¹⁸ CHARMATANANANIITTAH PUSHKARABHEREEDARDURAADIPRABHAVASTATAH |
TANTREEKRITAVEENAASUGHOSHAADISAMUDBHAVO VITATAH |
TAALAGHANTALAALANAADYABHIGHAATAJO GHANAH |
VANSHASHANKHAADINIMITTAH SAUSHIRAH |
Acharya Pujapad in SARVAARTH SIDDHI

1. Sound produced by vibrations of membranes (TAT) such as drums.
2. Sound produced by vibrations of strings (VITAT) such as piano and violin.
3. Sound produced by reed instruments (GHAN) such as harmonium and xylophone. The sound produced by bells and plates is also included in this category.
4. Sound produced by vibrations of air columns (SAUSHIR) such as organ pipes or a conch.

Modern science has classified sound into two categories: noise and musical sound. Noise is included in natural (VAISRASIK) sound. Musical sound is generated in four processes: vibrations of strings, vibrations of membranes, vibrations of rods, plates and reeds, and vibrations of air columns. These correspond to the four classes of musical sounds described in Jain literature. The Jain theory of sound asserts that sound is produced by modifications of material media. This seems to be the result of scientific insight of Jain thinkers.

Some observations on the classification of matter:

It seems that extremely slight (SOOKSHMA SOOKSHMA) aggregates (SKANDH) of matter include particles such as electrons, protons and neutrons. These are aggregates and not the ultimate particles (PARAMAANU) defined in Jain scriptures for only aggregates can function independently. Elementary particles cannot function independently according to Jain concepts. It appears that negatrons (negatively charged protons) as well belong to this category of aggregates. Max Born in his book 'Restless Universe' writes, "Perhaps negative protons (negatrons) also exist, no one has succeeded in finding them yet. And perhaps there are regions in the universe where they are in excess. There positive electrons (positrons) circulate round negative nuclei. Matter of that kind, would not differ from our matter."

This fact implies that it is possible that the particle negatron is formed by a combination of electrons and positrons. Similarly, a proton may be a combination of positrons and electrons. Further, a neutron may be a combination of equal numbers of positrons and electrons. Such concepts have been presented by Max Born in the book 'Restless Universe'.

Certain special features of the Jain theory of matter:

The most important feature of the Jain theory of matter is that unlike other Indian schools of thought, according to the Jain thinkers, all different types of matter and energy are essentially identical in nature. All matter is made up of elementary particles that possess either the

smooth or the rough attribute of touch. The Jain philosophers have affirmed that all different types of matter such as earth, water, air, fire, gold and mercury, are mere modifications of matter composed of identical basic constituents.

Acharya Umaswati, who lived around the first century A.D., has stated in TATVAARTH SUTRA that all aggregates of matter are formed through the breakup of larger aggregates or through a combination of smaller aggregates, and that these processes occur because of the smooth and rough attributes.¹⁹ This means that all substances in the universe, such as lead, gold and sulfur, which we see or detect through our senses, are made up of particles possessing smooth and rough attributes. Further, their constituent particles are similar and therefore all matter is identical in nature. Prior to the advent of the theory of electronic structure, scientists believed that different elements were made up of different kinds of matter. However, the theory of electronic structure has led to the conclusion that atoms of all elements are made up of protons, neutrons and electrons. Thus all matter is similar in nature. This principle agrees with the Jain concept of matter.

It appears that the Jain thinkers considered that the Sanskrit words for smooth (SNIGDH) and rough (ROOKSH) were equivalent to the positive and negative charges of electricity. In the sixth century A.D., Acharya Pujyapad wrote in SARVAARTH SIDDHI, that lightning and thunder are caused by virtue of the smooth and rough attributes of matter.²⁰ Modern science believes that lightning and thunder are caused through electrical discharge. Thus it seems that the words SNIGDH and ROOKSH mean positive and negative charges, respectively.

Many scientists believe that of all the elementary particles protons, neutrons, electrons and positrons, only electrons and positrons are indivisible. Max Born has written, "The existence of the first four (electron, positron, proton, neutron) is firmly established, two light ones (the electron and the positron) and the two heavy ones (proton and neutron). These are too many for it is likely that the combination of a proton and an electron will give a neutron, and a combination of a neutron and positron will give a proton. Either neutron or proton must be

¹⁹ BHEDASANGHAATEBHYAH UTPADYANTE [5-26] |
SNIGDHAROOKSHATVAAD BANDHAH [5-33]

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²⁰ SNIGDHAROOKSHAGUNANIMITTO VIDYUDULKAAJALADHAARAGNEENDRA-
DHANURAADIVISHAYAH (VAISRASIKAH SHABDAH) |

Acharya Pujyapad in SARVAARTH SIDDHI

composite.”²¹ According to the Jain concept even electrons and positrons are composite formed from smooth and rough aggregates of ultimate particles. It means that the electron is composed of both smooth and rough kinds of aggregates, and similarly, the positron is also composed of both smooth and rough aggregates. There is an excess of two absolute units of smooth attribute in a positron, while there is an excess of two absolute units of rough attribute in an electron. For example, when an aggregate having x units of rough attribute combines with another aggregate having $x + 2$ units of rough attribute, the resulting aggregate has $2x + 2$ units of rough attribute. When an aggregate having $x - 1$ units of smooth attribute combines with another aggregate having $x + 1$ units of smooth attribute, the resulting aggregate has $2x$ units of smooth attribute. When an aggregate having $2x + 2$ units of rough attribute combines with an aggregate having $2x$ units of smooth attribute, the resulting aggregate (such as an electron) has 2 units of rough attribute. A proton is formed in a similar process.

The above examples illustrate that two aggregates that differ in smooth or rough attributes by two absolute units only can unite. Further, the resulting aggregate acquires the attributes of the original aggregate with larger units of smooth or rough attributes. Thus the combination of aggregates with dissimilar attributes results in aggregates possessing only two absolute units of smooth or rough attributes. This fact shows that electrons, protons and positrons possess two absolute units of rough or smooth attribute. The fact that the magnitude of negative charge on an electron is equal to that of the positive charge on a proton or a positron, in spite of the fact that their masses are different, supports this concept of Jainism.

There are two views in the Jain scriptures regarding the combination of aggregates with dissimilar kinds of touch - smooth and rough. According to one belief, two aggregates possessing equal units of smooth and rough attributes do not bind to each other. The absolute numbers of smooth and rough attributes must differ by two for combination to take place. According to the second view, two aggregates having equal absolute units of smooth and rough attributes can combine. The formation of neutron and neutrino can be explained on the basis of the second belief.

One more concept of Jain philosophers is worthy of consideration. Acharya Nemi Chandra Siddhant Chakravarty writes:²² In aggregates of

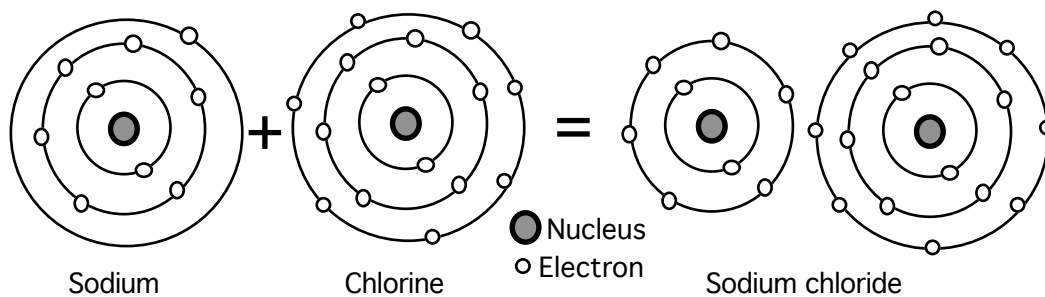
²¹ Restless Universe, page 266.

²² POGGALADAVVAMHIANOOSAMKHEJJADEEHAVANTI CHALIDAAHU |

matter (solids, liquids and gases), particles are in incessant motion. This concept points to the electronic theory of matter of modern science. This activity of particles (electrons and nuclei) has been divided into two classes:²³ Spontaneous activity (VISRASA KRIYA), which takes place without any external agent, and induced activity (PRAYOG NIMITTA KRIYA), which is engendered by external means. The former includes the motion of electrons around the nuclei of atoms and the random motion of molecules of gases.

In the context of formation of aggregates, it should be pointed out that aggregates are formed through three processes: breakup (BHED), combination (SANGHAAT) and breakup-cum-combination (BHED-SANGHAAT). Breakup can be interpreted as certain particles leaving one aggregate and combining with another aggregate. Combination can be considered to be a sharing of some particles between two aggregates. The third process involves partial transfer of some particles from one aggregate to another aggregate followed by sharing of the transferred particles between the two. In each case, a new aggregate is formed.

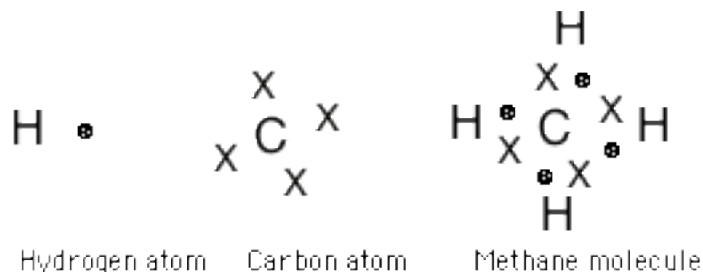
In chemistry, there are three kinds of bonds for formation of molecules from atoms: ionic, covalent and coordinate covalent. In ionic bond, some



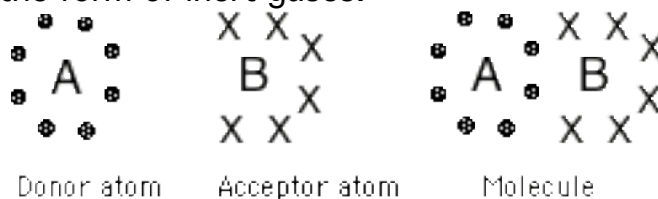
electron(s) from the outermost orbital shell of one atom are transferred to the outermost orbital shell of another atom. Thus a molecule is formed. For example, consider the atoms of sodium and chlorine shown in the figure below. The electron from the outermost orbital shell of sodium is transferred to the outermost orbital shell of chlorine that has seven electrons. Thus the resulting outermost shell of sodium assumes a stable structure like that of the inert gas neon, and the resulting outermost shell of chlorine assumes a stable structure similar to that of the inert gas argon. A molecule of sodium chloride (common salt) is formed in this process.

²³ PUDGALAANAAMAPI DWIVIDHA KRIYA | VISRASA PRAYOGANIMITTA CHA |
Swami Aklankadev in TATTVAARTH RAAJVAARTIK

In a covalent bond, electrons from the outermost shell of one kind of atom combine with the electrons of the outermost shell of another atom. Thus the outer electronic shells of all atoms assume the configuration of inert gases. As shown in the figure below, the four electrons from the four hydrogen atoms combine with the four electrons on the outermost shell of carbon to form a molecule of methane gas. Each hydrogen atom shares two electrons, thus assuming the electronic structure of the inert gas helium, while the carbon atom with the eight electrons on the outermost shell assumes a structure similar to that of neon.



In a coordinate covalent bond, electrons from the outermost shell of one atom are transferred. These electrons are shared by both atoms. For example, two electrons belonging to atom A (in the figure below) are shared by both atoms A and B. Thus the electronic structure of both atoms assumes the form of inert gases.



Thus the three types of bonds, ionic, covalent and coordinate covalent can be compared with breakup (BHED), combination (SANGHAAT) and breakup-cum-combination (BHED-SANGHAAT), respectively.

Breakup (BHED) has one more aspect - the disintegration of aggregates. Jain scriptures state: (BHED) entails disintegration of aggregates on account of intrinsic or extrinsic causes.²⁴ This fact can be compared to the phenomenon of radioactivity. This process is related to the internal structure of atom and thus it is intrinsic. The emission of alpha particles from a nucleus of uranium and other elements is an appropriate illustration of BHED.

According to Jainism, matter (PUDGAL) possesses infinite energy. This fact has been mentioned in many scriptures. An extremely fast ultimate

²⁴ SANGHAATAANAAM DWITAYA NIMITTAVASHAADDVIDAARANAM BHEDAH I

particle (PARAMAANU) can traverse the entire universe (a distance of about 3.2×10^{22} km) in the shortest interval of time (SAMAYA). This is an example of the infinite energy of matter. According to modern science, one gram of matter is equivalent to 9×10^{20} ergs of energy. This amount of energy can be obtained by burning 3000 tons of coal. The formula of mass-energy equivalence has been given above.

The Jain scriptures state that the entity that undergoes the processes of disintegration (GALAN) and combination (POORAN) is matter (PUDGAL).²⁵ This fact implies that one aggregate can combine with another aggregate due to the smooth and rough attributes and a new aggregate is formed. This process is POORAN. On the other hand, a section of an aggregate can part with a larger aggregate. This process is called GALAN. In the past, scientists believed that one element cannot be transformed into another element. However, it has been observed that in the phenomenon of radioactivity, when three alpha particles are emitted from an nucleus of uranium, it turns into a nucleus of radium, and when a nucleus of radium emits five alpha particles, it turns into a nucleus of lead. These are instances of the process of GALAN. When an alpha particle enters the nucleus of nitrogen, a nucleus of oxygen is formed. This is an example of the process of POORAN. Similar processes occur in lithium and beryllium as well.

Transformation and accommodation of matter:

The Jain theory about intrinsic transformation and accommodation of matter can be considered from a scientific viewpoint. The region of space that has souls, matter and energy, principle of motion and principle of rest and time has innumerable iotas (PRADESH, absolute units). It is stated that one elementary particle of matter occupies one iota of space. There are infinite elementary particles of matter and energy in the universe. How can so many elementary particles of matter be contained in the innumerable iotas of space? Acharya Pujoyapad has written: On account of intrinsic transformations and capacity of accommodation, particles and even aggregates can be accommodated in a single iota of space.²⁶ This same concept has been presented in Muni Nemi Chandra

²⁵ POORAYANTI GALANTI ITI PUDGALAAH | POORANAGALANAANVARTHA-
SAMJNAYATVAATA PUDGALAAH | Swami Aklankadev in TATTVAARTH RAAJVAARTIK
CHHABIH SANTHAANAM BAHUBIH DEHEHIM POORADI GALADITTI POGGALO |

DHAVALA

²⁶ SOOKSHAMPARINAAMA AVAGAAHANASHAKTIYOGAAT |
PARAMAANVAADAYO HI SOOKSHAMABHAAVENAPARINATA
EIKAIKASMINNAPYA AKAASHAPRADESHEANANTA- ANANNTA AVATISHTHANTE,
AHAVAGAAHANASHAKTISHCHAISHAAMAVYAAHATAASTI |

Siddhanti Dev:²⁷ The iota of space in which a single elementary particle of matter is accommodated can contain untold number of particles of matter. How is this possible? The explanation of this fact is that although an elementary particle matter is indivisible, matter can undergo intrinsic transformations and it possesses the capacity of accommodation. The region of space occupied by some particles of matter can accommodate many more particles and aggregates. For example, in a room having a number of electric lamps can accommodate the light energy of many more lamps. An indivisible elementary particle can contract and thereby its density can increase. This process can be seen from a scientific viewpoint. An atom consists of a nucleus, which is composed of protons and neutrons, and orbital electrons. The volume of the nucleus is considerably smaller than the volume of the atom, while the density of the nucleus is far greater than the density of atom. When electrons are removed from the atom, the stripped atom occupies an extremely small volume. Astronomical research has established that some stars in the universe are two hundred times denser than any material on earth. E. S. Eddington has written that a ton of nuclear matter can fit in our pocket. Recently, a star has been discovered whose density is 620 tons per cubic inch. Evidently this star is composed of stripped atoms that have no orbital shells. This is an intrinsic transformation of matter.

It is evident that many of the Jain concepts of matter and energy can be explained on the basis of modern science. According to the ancient Jain thinkers, the origin of these concepts is exceptional knowledge. However, one can also consider the Jain concepts of matter and energy to be consequences of philosophical investigation and exchange of ideas. Regardless, they are invaluable, and, it seems that many of the Jain concepts of matter and energy conform to scientific observations.

* * * * *

Rational Perception

TASMAADEKASMINNAPI PRADESHE ANANTAANANTANAAMAVASTHAANAM NA
VIRUDHYATE | Acharya Pujapad in SARVAARTH SIDDHI

²⁷ JAAVADIYAM AAYAASAM AVIBHAAGEEPUGGALAANU BATTHADHAM |
TAM KHU PADESAM JAANE SAVVANUTTHAANADAAN RIHAM | DRAVYASAMGRAH

Isaac Newton said of himself near the end of his life, "I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all un- discovered before me."