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Elements Of Physics Reflected In Ancient Indian Knowledge

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The Vedas, being the earliest record of human civilization deal with various aspects of human life. they carry a comprehensive and coherent account of the life, ethos, thoughts and beliefs of Indian society. They are the manuscripts of the human experience of life and nature, The ancient Indian theories are rich in quality, quantity and variety. Thus, the philosophical speculations of India are considered as they relate to the Vedas. Although the Vedic accounts are established mythologically, they have great scientific value. The philosophical theories of later ages also hold the scientific temperament. To understand the physical environment was a great challenge for all early civilizations. Speculation of the material world, of properties or behaviour of matter, of motion, light, sound, electricity etc., came to be recognized as Physics in recent era. But it does not mean that the ancient world was quite barren of all kinds of thought. The promulgation of light, the ocean current, the change of seasons, the motion of matter, stars and planets etc., obey the laws of nature which can be best explained by scientific theories. But nobody can deny the ancient theories that delve into the question of the nature of matter and its behaviour and so on. Although modern science has revealed many facts with scientifically approved data, they also stop at a certain point beyond which they fail to answer many intellectual queries, and then there is no other way for them but to bow down to Indian religious and philosophical interpretations for getting an appropriate answer. So, it is said that where science ends there starts philosophy. Vedic or philosophical interpretations and scientific investigations are nothing but the two sides of the same coin. Though the mode of expression and the languages are different, the concept is almost similar.

Elements of physics in ancient India

Various experiments have been made and different theories have been propounded by modern scientists to explain every facet of the Universe. But the ancient Indian thinkers were very progressive in this respect as they have hypothesized various accounts in this line many centuries ago.

Physics is a branch of science that deals with matter and energy in space and time. This component of science began at the very moment of the creation of the material world. Ancient Indian texts are pregnant with such types of speculations which can be termed as the manifestation of the ancient Indian form of modern physics. In the Vedic speculation, philosophical interpretation and also in the scientific description some prominent components are specified as the basic elements of the Universe. According to modern science, air, water and heat are the three basic elements as these are produced initially at the beginning of the Universe. But in the Vedic literature' and philosophy generally, five prime components are mentioned, viz., earth, air, fire, water and ether. The five elements of the global earth as proposed by Aristotle appear to be direct derivations of the Taittiriya Upanisad¹. Though the nomenclature of the elements like earth, air etc., varies in the two different trends of expressions (i.e....., in the Vedas and the science), the importance of these elements is the same in both of them. The deity of Pṛithivī of the Rgveda and the *mahābhūtas*, Kṣiti of philosophy represents the earth, Vāyu represents air or atmosphere, Agni symbolizes the essential fire, Varuna stands for the total hydrosphere, Apah represents water, Indra signifies the geometric field, Rudra represents the abrupt change in the natural phenomena and so on. Thus, every deity that is glorified in the Vedas and the *mahābhūtas* revealed in the philosophy are the natural energies that bind the Universe together. Pṛithivī, Jala or spa and vāyu stand for the three states-solid, liquid and gaseous of matter into which science classifies matter, and Tejas stands for energy in the form of heat and light. There are instances in the Vedas which describe three forms of energy. Here the (Tejas) energy is said to be of three forms (tisro dyavah). In scientific language Indra, that represents the geometric field that can bring out earthquakes, Agni stands for geothermal field, i.e. (heat energy), Varuna for universal law of gravitation Marutas for wind energy and so on. Thus, various forces that oversee the Universe are electric, magnetic, gravitational and nuclear forces. The Rveda suggests the parabolic shape of space and also mentions the concept of gravity (the form of the geomagnetic field)

One important point to be mentioned here is that, in the Vedic passages ākāśa forms a subtle matter This Vedic concept of an all-pervading subtle energy has proved to be a subtle form of matter that is homogeneously distributed in space. The *Taittiriya Upanisad* also reveals the same fact. In 1965 two French Scientists Arno Penzias and Robert Wilson established that the whole space is surcharged with cosmic background radiation which is isotropic in all directions and this is a relic of the Big Bang times. It is a generally accepted notion that the Universe is classified into seven varieties in its finally finished form. They are Pṛthivī (solid), jala (liquid), vāyu (gaseous form), agni (energy in the form of heat and light), ākāśa (all-pervasive subtle energy relic of big-Big bang dik (space) and kāla (time), One Rgvedic mantra designates these seven classified states as sapta *ardhagarbhaḥ*. Here the term sapta directly refers to seven. Again, *ardhagarbhaḥ* means half-nature

womb, half-cooked that exactly tallies the scientific concept of the atomic state is described by the term 'nascent', the unstable or half-born state. Thus, the similarity between the atomic state of science and the *sapta ardha garbha* of Veda becomes at once palpable. The description of the atom and its part in the creation of the Universe is vividly described in the *Nyāya, Vaiśeṣika*, Jaina and Bauddha philosophy.

In Vedic literature, the cosmic nucleus (*Hiranyagarbha* or golden egg) is considered to be the source of all matter and energy (the material world). The Vedic philosophers called the Universe *Brahmanḍa* meaning the infinite cosmic egg. The whole Universe was in a concentrated form which is mentioned as a point or *bindu*. The process of creation of the Universe starts with the explosion of that bindu or point or cosmic egg. According to modern 'Big Bang' theory creation started from the Big Bang, i.e., the Great Explosion. The Indra-Vṛtta collision" mentioned in the Vedas can be termed as the mythical presentation of the explosion that brought about the creation. Vitta of Veda modern may be said to be synonymous with that of the black hole of science. In science, these black holes are isolated coffers of energy that are completely cut off from the rest of the Universe and that chug any energy that endeavours to reach this sphere of influence. These are called in Veda the Sambara's forts or the Vitta. Vitta's representation of great inertia also aligns with Newton's mechanics. According to Newton's law inertia opposes motion. If the applied force is stronger then the inertia will be broken and the motion will start. When Indra threw his Vajra on Vitta inertia was broken and motion in the form of creation started. In the Vedic and post-Vedic literature, the creation stories are generally related to water and cosmic nucleus. If the term halma or *hiranya* is interpreted as 'bright' and 'reddish yellow' and the word water as 'water- vapour' (water in its gaseous state), then the account of golden-egg (*Hiranyagarbha*) can be said to adhere to the notion of a hot, radiant nebula' which is the starting point of modern cosmological theories. Moreover, the modern theory of evolution forwarded by Darwin goes in favour of the water theory of creation given in the Vedas." In the Ṛgveda, Visvakarmā is glorified as the designer of this Universe. He has designed this Universe by blasting and smelting." References to cosmic dust as the building material of the Universe are found in certain hymns of the Ṛgveda which is similar to the modern scientific theories, A Supernova can be illustrated as a big cloud of cosmic dust that consists of many small particles with a great density and the outbreak of the Supernova makes the process of creation free. The Rgvedic hymn also points out this fact.

The theory of Purāṇas also corresponds to modern theory. The philosophy of the Purnas revolves around the three main principles of existence, i.e. creation preservation and dissolution which in turn give the notion of the cosmic cycle. This is quite similar to Einstein's theory of mass transforming into energy and vice versa. This mass-energy transformation principle is the outcome of Einstein's special theory of relativity. The description of the cyclic Universe is found in the de passages and in the philosophical interpretations too. Almost all philosophical schools knowledge the idea of a cyclic Universe. In the Rgvedic mantra," the Universe is described allegorically as a chariot which rests on a relating wheel where seven constituents are attached. This revolving wheel signifies the ever-changing phase of the Universe. It further implies that the final form of the Universe consists of seven components, which represent the finally developed forms of matter into which

the Universe can be classified. Thus the notion of a cyclic Universe presented by this hymn or by puranic or philosophical deliberations articulates Einstein's principle of equivalence of mass energy transformation.

The Vaiśeṣika theories of atoms, atomic combination, atomic reaction, chemical action, classification of metals as fiery substances, kinetic discussion of activity etc., prove the realistic and scientific outlook of this system. Therefore, Kaṇāda's system is recognized as the first systematic exposition of the ancient tradition of physics. The very idea of classifying the whole Universe into six (or seven in the latter tradition of *Vaiśeṣika*) types of categories or physical realities (*padārthas*) and claiming that nothing remains out of these categories," then proclaiming that all of these six categories are existent, knowable and nameable is thoroughly scientific in its approach. The *Vaiśeṣika* theory of atoms is undoubtedly a starting point in the history of physical concepts for explaining the universe in a causal framework. According to this school, atoms are the basic particles of all matters of the Universe. The *Vaiśeṣikasūtra* states that which is existent and has no cause is eternal. According to *Vaiśeṣika*, the concept that atoms are not eternal is erroneous." The Nyāya system also acknowledges that these atoms are without parts, which means they cannot be further subdivided. Again, they are neither produced nor destroyed, i.e., eternal, since destruction involves the separation of parts. The eternality and indestructibility of atoms are highly emphasized in the *Vaiśeṣikasūtra* and the indivisibility of atoms is again and again mentioned in the *Nyāyasūtra*. These fundamental entities combine to form substances. They (atoms) are invisible though the final substance formed by the juxtaposition of many such atoms is visible. In the *Nyāya - Vaiśeṣika* atomism, atoms first combine in pairs and then group into trios and so on. Of the things which we perceive among them, *tryanuka* is the smallest one. Thus, which makes up the dyad is called an atom and it does not have any further parts. This minute part (dyad) forms a member (*avayava*) of the smallest visible substance called *truti*. From truth or *tryanuka*, *caturanuka* is formed and from *caturanuka* larger one is produced and from still larger one is formed. This process can be shown in the following way Atoms unite- basic unit/molecule with two, three or n number of units where $n > 1$. This essentially means a group of 'n' atoms fall together to form one unit (n-1). Following the above process of combination, the atoms, the indivisible particles of matter move eternally in infinite space intrude on one another and come together to form physical objects. Kaṇāda's *Vaiśeṣika* philosophy is a modified form of Gautama's Nyāya philosophy. Kanada for the first time became able to distinguish between the physical changes that merely alter the substance's state and the chemical processes that result in new substances which were merely hinted at in the Nyaya philosophy of Gautama. The intrinsic properties exhibited by the different substances are a result of the collocation process of the basic particles (i.e., *paramānu*), which is a point energy with zero mass and dimension. Therefore, the dyad will have a finite mass and size and hence the spatial arrangement also becomes an important qualifier of the properties of the ultimate substance to be formed. This is comparable to the point of view of current physics regarding the basic particles like electrons, protons, bosons etc., which also intercombine in different combinations to form all the known matters. The nomenclature may differ in science and Nyaya- Vaiśeṣika but the basic idea of the composition of the Universe is the same. In science, any substance comprising of two or more primary particle types requires a chemical reaction to generate it, i.e., the conjunction and break up of pre-existing molecules. The same is the case with the Vaiśeṣika system. Again, in science, the molecules are stated as emerging from combinations among the fundamental entities. The

Vaiśeṣikasūtra also says so. Regarding forces, the notion of both science and the *Nyāya-Vaiśeṣika* is all the same. Both of them acknowledge that forces are necessary to bring about the grouping and break up of molecules. But unlike science, in the *Nyāya-Vaiśeṣika*, this force is implemented by God. The *Nyāya-Vaiśeṣika* speaks of the force of *adr̥ṣṭa*, guided by God as being responsible for the movement and motion of the atoms.

Having laid out the basic physics, Kaṇāda further goes on to explore the nature of physical changes that occur in the basic particles that constitute matter. For this, he provides an understanding of the states of matter that constitute the Universe in terms of their particles. Like science, Kanada says that solids occupy space and presume form due to the accretion of the constituent particles, i.e., atoms. Kanada for the first time gives a scientific explanation of the Vedic cosmogony where the Universe is said to have been transformed from a liquid state to a solid state. A reasonably clear understanding of liquid state and its transformation to gaseous or solid states, i.e., vaporization, melting and freezing is noticed in the *Vaiśeṣika* philosophy." Here he points out that the chemical reaction is produced through the application of heat. He further asserts that the fluid's particles possess energy. This causes them to possess the property of fluidity. The heat-bearing rays provide the particles with energy to form a gas. The heated particles of air impact the vapour and with this energy, it blends with it. Udayana also points out that solar heat is the source of all stores of heat required for chemical change in the world. Further, the *Vaiśeṣika* system holds that a kind of chemical reaction or physical transformation may occur in the *bhūta* atomic combination. The *Naiyayikas* also support this view and say that transformation of colour etc., may take place in atomic compounds. According to the *Vaiśeṣika* system, a basic substance, produced by primary atomic unification may however suffer qualitative changes under the influence of heat in its course of existence, which is technically known as *pakajotpatti*. The doctrine of atomic reaction by heat is variously described by the *Vaiśeṣika* as *pilupāka* and by the *Nyāya* as *pitharapaka*. Modern science also applies heat as a cause of chemical reactions. Prakastapada in his commentary on *Vaiśeṣikasūtra* has listed several properties as different factors which cause various types of motions in five material substances." According to the *Nyāya-Vaiśeṣika* system motion is present in all forms of matter except *ākāśa* as it is non-atomic. A variety of physical motions such as *prayatna* (motion caused by effort), *gurutva* (motion caused through weight), *dravatvā* (motion caused through flowing of liquids), *adr̥ṣṭa* (motion caused through unseen factors) are mentioned in the *Vaiśeṣikasūtra*. Moreover, motions caused through contact with matter are also mentioned in the same text, viz. *nodana* (motion caused through pressure), *abhighatal* motion produced out of impact), *sthitisthapakata* (motion caused by elasticity), *vega* (motion caused through velocity or momentum). The theory of motion is one of the important speculations in ancient India without which modern physics also cannot be established. In the *Mīmāṃsā* philosophy, Śābaraswāmi has made some statements about wave motion. He said that sound is a wave motion in the air. According to him, the particles of air are subject to a vibratory motion, a sort of *parispanda*, in the production of sound. The nature and properties of light and its interactions with material bodies are described by Gautama in his *Nyāyasūtra*. Here the physical nature of light and its impact on visual organs is described vividly. Thus, it can be said that the theory of atomism and the formation of substance prophesized by the *Nyāya-Vaiśeṣika* system may easily be compared to the exploration of modern-day physics. Though modern-day science has the liberty of bringing most of its fascinating questions to the laboratories and tests, it is still not possible to bring every aspect of the formation of the Universe to

such premises. But Kanada and Gautam have quite correctly, perfectly and boldly propounded all the theories many years ago without having such facilities. In Sāṅkhya and Yoga philosophy also the essence of physics is found. Energy, in modern science, interacts differently which helps in forming quarks, electrons, etc. These tiny particles combine to form protons, neutrons, nuclei, atoms and subsequently compounds or matters. The Sāṅkhya and Yoga metaphysics also portray the precipitation of energy, in the form of three *guṇas* up to the twenty-three categories. These twenty-three categories have been treated as the raw materials of the Universe in the Samkhya-Yoga philosophy. That means the Sāṅkhya and Yoga emphasize on the recognition of the energy principle and its conservation in the conception. of matter. Again, in the philosophical interpretation, the dissolution of the Universe has also been discussed broadly. While delineating the dissolution of the Universe it is said that the five *mahābhūtas* merge into the five *tanmātras*, *tanmatras* and eleven *indriyas* into the *ahamkāra*, *ahamkāra* into the *mahat* and ultimately *mahat* into *Prākṛti*. Thus, the disbanding of the Universe ends in *Prākṛti*, leaving no trace of the phenomenal Universe. This state is truly identical to the zero existence of the space-time continuum, i.e., zero *dik-kāla* of modern science. This is identical to the 'point of singularity' or 'big bang' as described in scientific theories. Moreover, the concept of *Prākṛiti* and its three *guṇas* represents respectively the intelligent stuff, the dynamic principle, and the inertia or the restrictive principle inherent in matter. The *Mīmāṃsakas* also believe in the existence of permanent *dravyas* or substances which are the basic substrata of changing modes of the Universe. According to them, the substance alone endures while its changing modes may take many forms. Both *Prabhakara* and *Kumārila* attached great importance to the nature of reality and classified the worldly objects that form the basic structure of the Universe into different categories. The *Bhatta* school recognizes nine categories of substances and the *Prabhakara* school eight categories. According to the *Mīmāṃsakas*, the material world is composed of atoms or the minute particles of earth, water, fire and air by the moral law of *karma*. That means the *Mīmāṃsakas* also believe in the atomic theory like the *Nyāya-Vaiśeṣika*. The *Prabhakar's*, like the *Nyaya-Vaiśeṣika*, hold that the *paramānus* or the primary atoms forming the material world are imperceptible and are smaller than the triads which are of the dimension of the motes in a sun-beam. In their view, earth, water, fire and air are perceptible only in their non-atomic state. The *Bhattas*, on the other hand, do not accept these primary atoms as minute elements on the ground that they are not perceived by anyone. According to them, the minute elements of matter are of the dimension of the motes in a sun-beam." In a word, the atoms, accepted by the *Bhatta-Mīmāṃsakas* correspond to the triads of the *Nyāya-Vaiśeṣikas* and the *Prabhakaras*. Thus, the deliberation of physics is echoed in the theories of ancient Indian philosophical schools. The Jain and Buddhist metaphysical standpoints on the nature of matter are also noteworthy in this connection. Six fundamental entities according to the Jainas constitute the Universe. Although all six entities are eternal, they continuously undergo countless changes (known as *paryāya*) As mentioned in the *Amyogadvara* Sorra the universal criterion of reality is *dravya* (substance) the particular characteristics of reality are the *jiva dravya* and the *ajivadravya*, i.e., the conscious substance and the non-conscious substance. The word *dravya* is defined in the Jaina philosophy as that which possesses qualities (*guṇas*) as well as modes (*paryāyas*). "A substance is real and reality consists of three factors, i.e., permanence, origination and decay." There are six substances in the Universe. The whole Universe in Jainism has been divided into two main categories-*jiva* (the conscious) and

ajiva (the unconscious), which comprise six substances (dravyas). *Ajiva* consists of five substances, viz. *ākāśa* (space), *dharma*, medium of motion), *adharmā* (medium of rest), *kāla* (time), and *puḍgala* (matter). Besides *puḍgala*, the other five are formless substances.

1. Dharmastikaya - the principle of motion
2. Adharmastikaya - the principle of rest
3. Akasaarikāya-space
4. Kāla dravya-time
5. Jivastikāya-soul
6. Pudgalastikāya-matter

In Jaina philosophy, whatever modifications are to be found in the Universe, they are to be explained in terms of the combined cooperation of the *ajiva* (living substance) and *puḍgala*. The Jaina philosophy also propounds atomism. According to Jainism, what is perceived is only a gross form of matter, which can further be analysed into ultimate components known as atoms.

The atomic theory of Jaina philosophy is based on the *puḍgala* which generally means matter. It has two parts to combine, *gala* to dissociate. So *puḍgala* means that substance which undergoes modifications by combination and dissociations." It is of two types: an or atoms and *Skandha* or molecules," The Jaina philosophers hold that the gross Universe is a structure made up of atoms. Atoms are eternal as regards their substance and each exists by occupying one space point. The atoms are indivisible" and all the atoms are qualitatively similar, each possessing one kind of taste, smell and colour and two kinds of touch, viz. hot or cold and rough or smooth. Ultimately all the atoms belong to the same class of *puḍgala*. The qualities of atoms are subject to change. The atoms combine to produce the world of objects because they are subject to the power of movement and stability provided by the space in which they exist. This causes them to be attracted towards each other and thus combinations are born. One atom attracts another atom and through this process of attraction, an aggregate (*Śkandha*) comes into existence. An aggregate (*Śkandha*), whether binary, tertiary or of a higher order, possesses the following physical characteristics-(1) sound, (2) atomic linking or mutual attraction and repulsion of atoms (3) dimensions, small or great (4) figure (5) divisibility (6) opacity and casting of shadow and (7) radiant heat and light." According to Jaina school, the changes in the physical Universe are due to atomic aggregation and disintegration. To the Buddhists, matter is to be comprehended through their forms (*rūpa*) and qualities such as sound, odour, taste etc., which are responsible for the substance-hood of matter. The Vaibhāṣika and Sautrāntika schools too adopted the atomic theory. Both of these schools not only admit the reality of substance but also that all external objects are the result of a combination of primary atomic units." According to the Vaibhāṣika, matter is a collocation of the substratum of colour, taste, odour and touch. Atoms are the minuet units of the *rūpa* *Skandha* (collocation of material elements). The unit which possesses the four-fold substratum of *rūpa*, *rasa*, *gandha* and *sparśa* is called *paramānu* which is the smallest form of *rūpa*. It is super sensuous and indivisible, inaudible, and intangible. But it is subject to incessant change. It is

changing every moment due to its constant change in combination. The Vaibhāṣika admitted that an atom had six sides. But the Sautrāntika seem to have regarded the aggregate of seven atoms at the smallest compound (am)." The Sarvastivadins talk about eight types of atoms. The four fundamental types are of earth (solid), water (fluid), fire (hot), and air (moving). The types of secondary atoms are of colour, odour, taste and touch. Sautrāntika holds that atoms are not particles of matter but a dynamic force or energy. A hard atom means repulsion, a watery atom means attraction or cohesion, a fiery atom means the energy of heat, and an airy atom means kinetic energy. Thus, the so-called atoms or ultimate particles are only energies," which constitute the material world. In this way, like the Nyaya-Vaiśeṣika and Jainas, Buddhism also acknowledges that the material world is a designed combination of the ultimate material particle known as an atom.

The atomic theory of Rutherford in the nineteenth century explored many facts about atomic bindings, atomic structure and their motion and so on with his gold-foil experiment which was very beautifully described by our philosophers many centuries ago. The only difference is that the old theories (Vedic, post-Vedic or philosophical theories) were established without any factual findings and modern theories have been promulgated with all experiments and specific data. Thus, the exploration of physics ensued long ago in India when there was no facility for scientific experiments.

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