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From Paramāṇu to quarks: A comparative inquiry into Vaiśeṣika philosophy and modern atomic science

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Abstract

The question of what constitutes the ultimate building block of matter has fascinated philosophers and scientists across civilizations. Ancient Indian philosophy addressed this question through the Vaiśeṣika doctrine of Paramāṇuvāda, while modern science approached it through the development of atomic theory based on experimentation and observation. Although these two traditions emerged in entirely different intellectual environments, both sought to explain the composition and transformation of the physical universe. Vaiśeṣika philosophy describes paramāṇu as the smallest eternal unit of matter that combines to produce all material substances. Modern atomic theory, on the other hand, has progressed from Dalton's concept of the indivisible atom to the contemporary understanding that atoms consist of subatomic particles and that even protons possess an internal structure composed of quarks bound together by gluons. This study compares these two perspectives by examining their concepts of matter, methods of inquiry, philosophical foundations, and scientific significance. The paper argues that while Vaiśeṣika presents a metaphysical explanation of the material world, modern atomic theory offers an experimentally verified model that continues to evolve with scientific discoveries. Such a comparative examination not only highlights the originality of ancient Indian philosophical thought but also demonstrates the continuing relevance of classical ideas in discussions concerning the nature of matter.

Keyword: Vaiśeṣika, Paramāṇuvāda, Kaṇāda, atomic theory, dalton, proton, quarks, modern physics

Introduction

The search for the fundamental nature of matter has remained one of the oldest intellectual pursuits in human history. Across different civilizations, philosophers and scientists attempted to determine whether material objects could be divided indefinitely or whether there existed an ultimate indivisible unit underlying all physical reality. This universal curiosity gave rise to different theories, each shaped by its own cultural, philosophical, and scientific context.

Among the Indian philosophical traditions, the Vaiśeṣika school, founded by the sage Kaṇāda, presents one of the earliest systematic explanations of the material universe through its doctrine of Paramāṇuvāda. According to this theory, all physical substances originate from eternal and indivisible paramāṇus. These minute particles combine in various ways to produce the diversity observed in the material world. The Vaiśeṣika philosophers developed this theory through logical reasoning and metaphysical analysis, integrating it with broader concepts such as causation, time, motion, and cosmic order.

Modern atomic theory developed through an entirely different intellectual process. Beginning with John Dalton's atomic hypothesis in the early nineteenth century, scientific understanding of matter expanded through continuous experimental investigation. Subsequent discoveries by J. J. Thomson, Ernest Rutherford, Niels Bohr, James Chadwick, and later developments in quantum mechanics transformed the concept of the atom from an indivisible particle into a highly complex structure containing electrons, protons, and neutrons. Contemporary particle physics has advanced this understanding even further by demonstrating that protons and neutrons themselves are composite particles made of quarks held together by gluons through the strong nuclear force. Consequently, the modern concept of the fundamental particle continues to evolve with ongoing experimental research.

Despite their different methodologies, both Vaiśeṣika philosophy and modern science share a common objective: to explain the basic constituents of the physical universe and the processes

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through which material diversity arises. The present study explores these two intellectual traditions through a comparative analysis, highlighting their points of convergence as well as their philosophical and scientific distinctions. Such a comparison contributes not only to the history of ideas but also to a broader dialogue between classical philosophical thought and contemporary scientific inquiry.

Methodology

The present study adopts a qualitative and comparative research methodology. Primary Sanskrit sources, particularly the Vaiśeṣika Sūtra and other classical philosophical texts, have been examined to understand the doctrine of Paramāṇuvāda. These textual interpretations are compared with the historical development of modern atomic theory as presented in scientific literature. The study combines textual analysis, conceptual comparison, and historical interpretation to identify both similarities and differences between the two systems. Rather than attempting to establish direct historical influence, the research analyses how each tradition independently explains the structure and behaviour of matter within its own intellectual framework.

Research Questions

1. How is the concept of the ultimate particle explained in Vaiśeṣika philosophy and modern atomic theory?
2. What are the principal similarities and differences between Paramāṇuvāda and contemporary atomic science?
3. How do the philosophical assumptions of Vaiśeṣika differ from the empirical approach of modern science?
4. What significance does the comparison between these two traditions hold for contemporary interdisciplinary research?

Vaiśeṣika's Paramāṇuvāda

The Vaiśeṣika system, occupies a distinctive position among the six orthodox schools of Indian philosophy because of its systematic explanation of the physical universe. One of its most remarkable contributions is the doctrine of Paramāṇuvāda, which explains the origin and composition of material substances through the concept of the paramāṇu, the smallest unit of matter. Rather than relying on experimentation, Kaṇāda developed this theory through logical reasoning, observation of natural phenomena, and philosophical inquiry. His objective was not merely to describe the physical world but also to explain the principles governing creation, transformation, and dissolution. According to Vaiśeṣika philosophy, every material object is ultimately composed of extremely subtle particles known as paramāṇus.¹ These particles are imperceptible to the senses and cannot be divided into smaller units.² They exist eternally and remain unchanged despite the continuous creation and destruction of material objects. The visible changes that occur in the world do not affect the essential nature of the paramāṇu, which persists throughout cosmic cycles. Vaiśeṣika further explains that paramāṇus belonging to the same element combine to form a dvyaṇuka (binary aggregate). Additional combinations produce larger structures such as tryaṇuka and progressively more complex material bodies. Thus, the diversity observed in nature results from different arrangements and combinations of these eternal particles

rather than from the creation of new matter. An important feature of this theory is that paramāṇus are regarded as inherently inactive. Motion and combination do not arise spontaneously but begin under the influence of adṛṣṭa (the unseen cosmic principle) or Īśvara according to Vaiśeṣika and Nyāya interpretations. Once motion begins, atoms combine according to definite principles, giving rise to the physical universe.

Unlike the atom of modern science, the Vaiśeṣika paramāṇu is not merely a physical entity. It possesses philosophical significance and functions within a broader metaphysical framework that includes concepts such as karma, causation, time (kāla), space (dik), and cosmic order. Consequently, Paramāṇuvāda serves both as a theory of matter and as an explanation of the orderly functioning of the universe.

The principal characteristics of the Vaiśeṣika paramāṇu may be summarised as follows:

- a) It is the smallest indivisible unit of matter.
- b) It is eternal and cannot be created or destroyed.
- c) It remains imperceptible to ordinary sensory perception.
- d) Different combinations of paramāṇus produce the diversity of material objects.
- e) Its activity is initiated by an external cosmic principle rather than by inherent motion.
- f) It forms an integral part of the metaphysical explanation of reality.

Although formulated more than two millennia ago, Paramāṇuvāda represents one of the earliest systematic attempts to explain the material universe in terms of fundamental particles. Its logical structure demonstrates the remarkable analytical ability of ancient Indian philosophers and continues to attract scholarly interest in comparative studies involving philosophy and modern science.

Development of Modern Atomic Theory

Modern atomic theory emerged through centuries of scientific investigation and continuous experimental refinement. Unlike ancient philosophical speculation, the modern understanding of matter has been shaped by observation, laboratory experiments, and mathematical analysis. As scientific instruments became increasingly sophisticated, earlier ideas regarding the indivisibility of the atom were repeatedly revised, leading to the contemporary picture of matter at the subatomic level. The modern scientific study of atoms began with John Dalton in the early nineteenth century. Dalton proposed that all matter consists of extremely small particles called atoms and that atoms of the same element possess identical properties and masses. He also suggested that atoms combine in fixed numerical ratios to form chemical compounds and that chemical reactions involve only the rearrangement of these atoms. Although Dalton considered atoms indivisible, his theory provided the foundation of modern chemistry.

A major revision occurred in 1897, when J. J. Thomson discovered the electron through cathode-ray experiments. This discovery demonstrated that atoms contained smaller negatively charged particles and therefore could no longer be regarded as indivisible. Thomson proposed the Plum Pudding Model, in which electrons were embedded within a positively charged sphere. Although this model was later replaced, it established that atoms possess an internal structure.

Further progress came through Ernest Rutherford's gold foil experiment in 1911. Rutherford showed that most of the atom consists of empty space and that nearly all of its mass is

¹ Tasmād anārabdha eva paramāṇuḥ, Tarkabhāṣā, Prameyanirūpaṇam.

² Paramaḥ sarvavacaramako'ṇuḥ, Śabdakalpādruma.

concentrated in a tiny, positively charged nucleus. This discovery fundamentally changed scientific understanding of atomic structure and laid the foundation for nuclear physics.

Building upon Rutherford's work, Niels Bohr introduced his atomic model in 1913. He proposed that electrons revolve around the nucleus in fixed energy levels and that they absorb or emit energy when moving between these levels. Bohr's model successfully explained the spectral lines of hydrogen and represented a major advance in atomic theory.

Another important milestone was achieved in 1932, when James Chadwick discovered the neutron. The identification of this electrically neutral particle completed the basic picture of the atomic nucleus and explained differences in atomic mass among isotopes of the same element.

Subsequent developments in quantum mechanics transformed the classical view of the atom. Scientists such as Schrödinger, Heisenberg, and Dirac demonstrated that electrons do not move in fixed circular paths. Instead, they occupy probability distributions known as atomic orbitals, where only the likelihood of finding an electron can be calculated. This quantum mechanical model remains the accepted description of atomic behaviour.

Modern particle physics has advanced even beyond the traditional atomic model. Today, scientists recognise that protons and neutrons are not fundamental particles. They are composite particles made of quarks, which are held together by gluons through the strong nuclear force. High-energy scattering experiments conducted in particle accelerators have confirmed this internal structure. Consequently, the proton itself is no longer regarded as indivisible. Although quarks cannot normally exist independently because of the phenomenon known as colour confinement, their existence has been firmly established through experimental evidence. This represents one of the most significant developments in contemporary physics and illustrates that scientific knowledge continues to evolve as new discoveries emerge.

Thus, the history of modern atomic theory reflects a continuous process of refinement. What began as Dalton's indivisible atom has gradually developed into the present understanding of atoms as highly complex systems composed of nuclei, electrons, and even smaller elementary constituents. This evolving nature of scientific knowledge distinguishes modern atomic theory from earlier philosophical models while simultaneously demonstrating humanity's enduring quest to understand the fundamental structure of matter.

Similarities between Vaiśeṣika's Paramāṇuvāda and Modern Atomic Theory

a) Search for the Fundamental Unit of Matter

Both Vaiśeṣika philosophy and modern atomic science seek to explain the physical universe by identifying its smallest constituent. Vaiśeṣika introduces the concept of the paramāṇu as the ultimate material particle, whereas modern science initially regarded the atom as the smallest unit of matter before discovering its internal structure. Despite differences in interpretation, both traditions recognise that visible objects are composed of extremely minute entities.

b) Formation of Complex Objects through Combination

According to Vaiśeṣika, material substances arise from successive combinations of paramāṇus, beginning with binary aggregates (dvyanuka) and developing into larger structures. Modern chemistry similarly explains that atoms combine through chemical bonding to produce molecules, compounds,

and all observable forms of matter. In both systems, complexity emerges from the organisation of simpler units.

c) Imperceptibility of Fundamental Particles

Neither the paramāṇu nor the atom can be observed directly with the unaided human eye. Vaiśeṣika philosophers described paramāṇus as supersensible entities understood through logical inference, while modern science investigates atoms and subatomic particles using advanced experimental techniques such as electron microscopy and particle accelerators. Thus, both acknowledge that the fundamental constituent of matter lie beyond ordinary sensory perception.

d) Explanation of Material Diversity

Both theories explain the diversity of the physical world through differences in the arrangement and interaction of fundamental particles. Vaiśeṣika attributes the variety of substances to different combinations of eternal paramāṇus, whereas modern science explains diversity through variations in atomic number, electron configuration, molecular bonding, and subatomic interactions.

e) Rational Inquiry into Nature

Although their methodologies differ, both systems represent systematic attempts to understand nature through rational investigation. Vaiśeṣika employs philosophical analysis and logical reasoning, whereas modern science relies on experimentation and empirical verification. In both cases, the objective is to establish an ordered explanation of the material universe rather than relying solely on mythological accounts.

Differences between Vaiśeṣika's Paramāṇuvāda and Modern Atomic Theory

a) Nature of the Fundamental Particle

Vaiśeṣika philosophy considers the paramāṇu to be eternal, indivisible, and incapable of further decomposition. Modern science, however, has demonstrated that atoms are divisible into electrons, protons, and neutrons. Furthermore, contemporary particle physics has established that protons and neutrons themselves consist of quarks bound together by gluons. Therefore, unlike the Vaiśeṣika paramāṇu, the modern atom is not regarded as the ultimate indivisible unit of matter.

b) Method of Investigation

The doctrine of Paramāṇuvāda was developed primarily through philosophical reflection, logical analysis, and metaphysical reasoning. Modern atomic theory, in contrast, is founded upon systematic experimentation, precise measurement, mathematical formulation, and repeated verification through scientific observation. Consequently, the epistemological foundations of the two systems differ substantially.

c) Concept of Motion

Vaiśeṣika maintains that paramāṇus are inherently motionless and begin to interact only through the influence of adṛṣṭa or divine agency. Modern science explains atomic and subatomic motion through natural forces such as electromagnetism, gravitation, the strong nuclear force, and the weak nuclear force, without invoking metaphysical principles.

d) Scope and Purpose

The primary objective of Vaiśeṣika philosophy is philosophical and metaphysical. It seeks to explain not only

matter but also causation, cosmic order, karma, and liberation. Modern atomic theory has a more limited scientific purpose, focusing on the physical properties and behaviour of matter. Its applications extend to chemistry, medicine, electronics, nuclear energy, and modern technology rather than spiritual inquiry.

e) Evolution of Knowledge

The concept of the paramāṇu has remained essentially unchanged within the classical Vaiśeṣika tradition. Modern atomic theory, however, has undergone continuous revision as new discoveries have emerged. Scientific understanding has progressed from Dalton's indivisible atom to Thomson's electron, Rutherford's nucleus, Bohr's atomic model, quantum mechanics, and finally to the Standard Model of particle physics, which explains the internal structure of protons and neutrons in terms of quarks and gluons.

Conclusion

The comparative study of Vaiśeṣika's Paramāṇuvāda and the Atomic Theory of Modern Science demonstrates that both traditions represent significant intellectual efforts to explain the fundamental nature of matter, despite originating in different historical and cultural settings. The Vaiśeṣika system, developed through philosophical reasoning, presents the paramāṇu as the smallest, eternal, and indivisible constituent of the material universe. In contrast, modern atomic theory has evolved through continuous scientific investigation, revealing that atoms possess an intricate internal structure composed of electrons, protons, and neutrons. Contemporary particle physics has further shown that even protons and neutrons are composite particles consisting of quarks bound together by gluons, indicating that scientific understanding of matter continues to develop with new experimental discoveries.

Although the conceptual foundations of these two systems differ considerably, they share a common objective of identifying the basic constituents from which the material world is formed. Vaiśeṣika explains the diversity of the universe through the combination of eternal paramāṇus within a broader metaphysical framework involving causation, karma, and cosmic order. Modern science, on the other hand, interprets the same diversity through experimentally verified interactions among atoms and subatomic particles governed by the fundamental forces of nature.

This comparison demonstrates that ancient Indian philosophy anticipated the idea that complex material objects arise from minute constituents, even though its methods and conclusions differ from those of contemporary science. At the same time, the rapid progress of modern physics illustrates that scientific theories remain open to revision as new evidence becomes available. The transition from Dalton's indivisible atom to the discovery of quarks clearly reflects the dynamic and self-correcting character of scientific inquiry.

Rather than viewing these traditions as competing explanations, they may be understood as complementary approaches that address the question of matter from different perspectives. Vaiśeṣika contributes profound philosophical insights into the nature of existence and causation, while modern atomic theory provides experimentally validated explanations of physical reality with extensive technological applications. A dialogue between these two knowledge systems enriches our understanding of both the history of ideas and the continuing human quest to discover the ultimate structure of the universe. Such interdisciplinary studies

encourage a deeper appreciation of India's philosophical heritage while simultaneously recognising the remarkable achievements of modern scientific research.

References

1. Keśavamiśra M. Tarkabhāṣā. Kavirāja G, editor. Varanasi: Chowkhamba Sanskrit Series Office.
2. Deb R. Śabdakālpadrumaḥ. Delhi: Motilal Banarsidass.
3. Kaṇāda. Vaiśeṣika Sūtra. Chakrabarty D, editor. New Delhi: D.K. Printworld; 2002.
4. Gangopadhyaya MK. Indian atomism: history and sources. Calcutta: K.P. Bagchi & Company; 1980.
5. Deussen P. Outlines of Indian philosophy. Delhi: Ess Publications; 1976.
6. Landau LD, Kitaigorodsky AI. Physics for everyone. Moscow: Raduga Publishers; 1978.
7. Mishra AK. Atomism of Nyaya-Vaisesika vs Jainism-a scientific appraisal. Indian J Hist Sci. 2006;41(1):57-78.