

# The Nature of Light in Indian Epistemology

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## ABSTRACT

Indian epistemology is of interest to the physicist for its framework of reality includes observers in a fundamental manner. The nature of light in this epistemology is presented with a background on the principal ideas related to space, time and matter. In the Indian physics tradition of Vaiśeshika, observables arise as a consequence of motion of which two kinds, intrinsic and extrinsic, are postulated. The atom in itself is not observable for it is taken to be an abstraction with a potential to acquire various attributes based on multiplied arrangements and vibrations. Other Indian approaches to epistemology privilege the subject over matter. In contrast to Western approaches where it is an epiphenomenon, consciousness is taken to have a real existence.

**Keywords:** Light, Indian epistemology, Vedānta

## 1. INTRODUCTION

According to the well-known biography of Schrödinger by Moore, Indian philosophical ideas of Vedānta helped Schrödinger discover the idea of a state function that is a sum of all possibilities. Moore adds that in their development of quantum theory “Schrödinger and Heisenberg and their followers created a universe based on superimposed inseparable waves of probability amplitudes. This new view would be entirely consistent with the Vedāntic concept of All in One.”<sup>1,2</sup>

The parallels or analogies between Vedānta and quantum theory have motivated many scientists to examine Indian scientific ideas. But in spite of this interest the understanding of these ideas remains woefully inadequate. In India itself, there is almost no study of Indian science and for a variety of complex political and social reasons the knowledge of Sanskrit, the language in which Indian science is written, is fast disappearing among the elite.

Indian epistemology approaches reality differently from Western science and while some have classified it as “idealism,” it is apart from Western idealism in many ways. It is unlike standard scientific epistemology in that it accepts consciousness as an independent category different from matter. It provides an interesting resolution to the seemingly insoluble problem of interaction between the causally closed worlds of matter with the world of consciousness. It accepts the possibility of obtaining knowledge by non-empirical means. In most general terms, Indian epistemology differs from Western epistemology in that it includes sentient agency within the universe.

Light in Indian thought has outer and inner aspects. The outer light is generated by atoms of light while the inner light is a consequence of consciousness. The intuition associated with the inner light is called *jyotisha* (from the Sanskrit  *jyoti*, light). The two lights are taken to be connected. These ideas can only be *understood* by considering the underlying cosmology in which the world of objects and things and world of ideas and experience are different at the phenomenal level but identical at a deeper level.<sup>3</sup>

The writings of Schrödinger provide the best articulation of Indian ideas by a scientist although he did it in a haphazard way in different essays. He notes that the absence of sentient observers in the scientific world picture means that it is not a complete picture and that the scientific enterprise by its very nature can only speak of things. Posing the problem of the split between objects and subjects in *Mind and Matter*, Schrödinger stated that the solution could only be based on Indian ideas:<sup>4</sup>

It is the same elements that go to compose my mind and the world. This situation is the same for every mind and its world, in spite of the unfathomable abundance of “cross-references” between them. The world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the physical sciences, for this barrier does not exist.

The reason why our sentient, percipient and thinking ego is met nowhere within our scientific world picture can easily be indicated in seven words: because it is itself that world picture. It is identical with the whole and therefore cannot be contained in it as a part of it. But, of course, here we knock against the arithmetical paradox; there appears to be a great multitude of these conscious egos, the world is however only one...

There is obviously only one alternative, namely the unification of minds or consciousnesses. Their multiplicity is only apparent, in truth there is only one mind. This is the doctrine of the Upanishads.

While this may sound attractive philosophy (at least to some), the question arises if it has any relevance to the workings of science. Indeed the reason why few people have rushed to study it is the belief that while it makes for a comforting position it solves no real problems.

In this paper, I argue that one can go beyond Schrödinger's writings and show that consciousness (that lies behind subjective experience) manifests itself in everyday world leaving a trace that is open to scientific examination. In principle, the *apparent* influence of consciousness on matter (I use the term apparent because at a deeper level the consciousness-matter divide does not exist) should be measurable in all transformations including evolution of life forms. Indeed, arguments have been made that the rise of complex organic molecules cannot be explained on probability consideration alone.<sup>5</sup> The case can also be made that evolved forms are already present as potential within natural law and "natural selection" is a restatement of the fact that pure probabilities do not account for the outcomes of the *random* evolutionary process. But these views are generally consigned to philosophy since outcomes in the evolutionary chain cannot be associated with specific probability values with any degree of unanimity.

I argue for consideration of anomalous events that are a part of social history as evidence of the workings of universal consciousness. Although these events may be seen as coincidences, their sheer improbability strains credulity. Of these the most astonishing is the speed of light that is correctly given in a medieval text.<sup>6</sup> Less spectacular, but equally impressive, are ancient Indian estimates of the age of the universe in a cycle of expansion and contraction and the distance to the sun. If one were to see these coincidences to be similar to the random process of creativity and scientific discovery (as recounted, for example, by Hadamard<sup>7</sup> and discussed further elsewhere<sup>8,9</sup>), then the question of the epistemology behind the process of creativity becomes relevant. Archetypal creative impulse is also woven in the fabric of dreams as in the anecdotal accounts of Elias Howe for the sewing machine in 1845 and Kekulé's for the structure of benzene in 1862.

In certain philosophical schools of the West (as in Plato's theory of Forms or Kant's transcendental idealism), ideas are taken to be part of the structure of the mind or even to exist independent of the mind. But these schools are not taken seriously in the narratives of science. Modern science privileges empiricism, that is knowledge based on observations by the senses together with logical inference and abstraction, as the only true source of knowledge. It cannot provide explanations for unusual coincidences like the one related to the speed of light. Neither can it provide explanations for agency and intentionality in psychology or the performance of savants.<sup>10</sup>

Indian ideas on the nature of knowledge are complex and traditional texts present these ideas from a variety of perspectives. This paper is an introduction to these ideas with emphasis on nature of light and physical reality. It begins with the broad philosophical question of ways of knowing. In the next section, an outline of the Vaiśeshika system of Indian physics is provided. The subsequent section presents the atomic view of light. Next, we analyze anomalous statements on speed of light and the distance to the sun. The paper also addresses the question of interaction between consciousness and matter.

## 2. REALITY AND WAYS OF KNOWING

Traditionally, there were six main schools of philosophy in India, each of which had its own approach to epistemology together with accepted means of cognition. There is agreement in these schools that as consciousness cannot be reduced to material phenomena, phenomenal reality has two aspects: one of material phenomena and the other of consciousness. Reality is dual at a phenomenal level but unitary at a deeper, transcendent level.

This transcendent reality can only be approached through a variety of unique and complementary perspectives. Like the room in space with its six different walls in which each window provides a different view, Indian philosophy has six *darśanas* (visions or "schools").

Each school accepts a variety of means of cognition. In the Vaiśeṣhika sense perception and inference are valid means, whereas in the Sāṅkhya verbal testimony or scriptural authorities are additional means, and the Nyāya accepts comparison also as a means of valid cognition. The idea is that the knowledge furnished by one means must not be attainable by any other means, it should not be reducible to another, and it should not be contradicted by another means of cognition.

Indian epistemology acknowledges error of cognition. The final test of such theories is the application to everyday experience. Since false theories and cognitions can affect one's understanding of reality and one's response to it, a kind of a relative truth may be ascribed to them.

The Sanskrit term for epistemology is *prāmāṇyavāda* (literally being established by proof). It deals with *prameya* or the object of cognition, *pramā* or *pramiti* which is the cognition itself, and *pramātri* or the subject that cognizes. A distinction is made between knowledge as *jñāna*, which is experience, and representation of it as *vijñāna* that can only approximate true knowledge. Self-knowledge comes through intuition which stands outside the subject-object dichotomy. Understanding proceeds in a paradoxical manner by the contemplation of the self through the self or, in Sanskrit, the ātman through the ātman.

The Vaiśeṣhika system of Kanāda is a conceptual representation of space and the gross visible matter taken to be constructed out of the varying motions of *anu*, its most fundamental particle. In the Nyāya, or logic, that is closely tied to the Vaiśeṣhika, minds are not empty slates; the very constitution of the mind provides some knowledge of the nature of the world. The four *pramānas* through which correct knowledge is acquired are direct perception, inference, analogy, and verbal testimony.<sup>11,12</sup>

Gotama, the early teacher of the Nyāya, lists four factors involved in direct perception as being the senses (*indriyas*), their objects (*artha*), the contact of the senses and the objects (*sannikarsha*), and the cognition produced by this contact (*jñāna*). *Manas*, or mind, mediates between the self and the senses. When the *manas* is in contact with one sensory organ, it cannot be so with another. It is therefore atomic in dimension. It is because of the nature of the mind that our experiences are essentially linear, although quick succession of impressions may give the appearance of simultaneity.

A later Nyāya philosopher recognizes four kinds of perception: sense perception, mental perception, self-consciousness, and yogic perception. Self-consciousness is a perception of the self through its states of pleasure and pain. In yogic perception, one is able to comprehend the universe in fullness and harmony.

The Sāṅkhya system describes evolution at cosmic and individual levels. It views reality as being constituted of *purusha*, consciousness that is all-pervasive, motionless, unchangeable, without desire who at the individual level is the *sākshin*, the witness, and *prakriti*, which is the phenomenal world. Prakriti is composed of three different strands (*gunas* or characteristics) of *sattva*, *rajas*, and *tamas*, which are transparency, activity, and inactivity, respectively.

Evolution begins by *purusha* and *prakriti* creating *mahat* (Nature in its dynamic aspect). From *mahat* evolves *buddhi* (intelligence) and *manas* (mind). *Buddhi* and *manas* in the large scale are Nature's intelligence and mind. From *buddhi* come individualized ego consciousness (*ahamkāra*) and the five *tanmātras* (subtle elements) of sound, touch, sight, taste, smell. From the *manas* evolve the five senses (hearing, touching, seeing, tasting, smelling), the five organs of action (with which to speak, grasp, move, procreate, evacuate), and the five gross elements (ether, air, fire, water, earth).

The evolution in Sāṅkhya is an ecological process determined completely by Nature. It differs from modern evolution theory in that it presupposes a cosmic intelligence and further beyond a universal consciousness. In reality, modern evolution also assigns intelligence to Nature in its drive to select certain forms over others as well as in the evolution of intelligence itself.

### 3. THE VAIŚEṢHIKA SYSTEM

The Vaiśeṣhika system has categories not only for space-time-matter but also for attributes related to perception of matter. It starts with six categories (*padārthas*) that are nameable and knowable. Nothing beyond these six fundamentals is necessary, because they are sufficient to describe everything in the universe from concrete matter to the abstract atom.

The six categories are: *dravya* (substance), *guna* (quality), *karma* (motion), *sāmānya* (universal), *viśeṣha* (particularity), and *samavāya* (inherence). The first three of these have objective existence and the last three are a product of intellectual discrimination. Universals (*sāmānya*) are recurrent generic properties in substances, qualities, and motions. Particularities (*viśeṣha*) reside exclusively in the eternal, non-composite substances, that is, in the individual atoms, souls, and minds, and in the unitary substances ether, space, and time. Inherence (*sāmānya*) is the relationship between entities that exist at the same time. It is the binding amongst categories that makes it possible for us to synthesize our experience. In later descriptions of the system a seventh category of “non-existence” is added.

Of the six categories, the basic one is that of substance and the other five categories are the ones that the mind associates with the substance. Thus observers belong to the system in an integral fashion. If there were no sentient beings in the universe then there would be no need for these categories.

There are nine classes of substances (*dravya*), some of which are non-atomic, some atomic, and others all-pervasive. The non-atomic ground is provided by the three substances of ether (*ākāśa*), space (*dik*), and time (*kāla*), which are unitary and indestructible; a further four, earth (*prithvī*), water (*āpas*), fire (*tejas*), and air (*vāyu*) are atomic composed of indivisible, and indestructible atoms (*anu*); self (*ātman*), which is the eighth, is omnipresent and eternal; and, lastly, the ninth, is the mind (*manas*), which is also eternal but of atomic dimensions, that is, infinitely small.

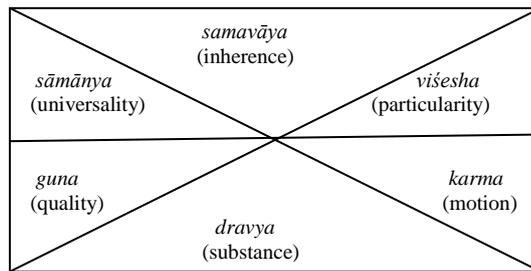


Figure 1. The six categories of Vaiśeṣhika

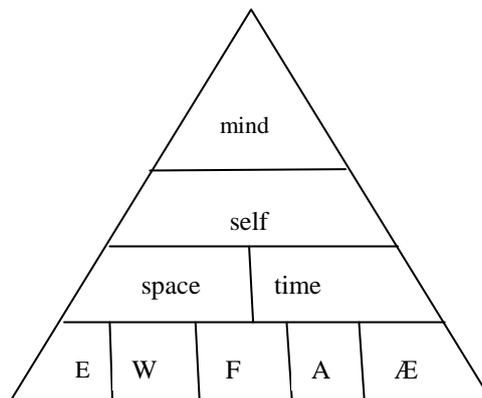


Figure 2. The nine dravyas (substances):  
E: earth; W: water; F: fire; A: air; Æ: ether

It is postulated that distinguishing characteristics and motion are essential for the classification of matter. Space and time are identified through motion of matter or the sun.

Of the substances, four (earth, water, fire, and air) are material (that is consisting of atoms) and capable of motion whereas five others (time, space, ether, ātman, and mind) are non-material and, therefore, no motion may be associated with them. It is significant that ātman is listed before mind, suggesting that it is the medium through which mind's apprehensions are received. The atoms of earth, water, fire and air are different and this difference arises out of the different ways the fundamental atom of materiality combines with itself in different arrangements.

The examination of the various parts of the Vaiśeṣhika system reveals that its observables arise through the effect of motion in a consistent manner. As is true of other systems, this system leads to its own paradoxes. Yet, it offers a comprehensive and scientific view of the universe beginning with gross visible matter all the way up to the subtle invisible mind.<sup>13</sup>

The atom is indivisible because it is a state for which no measurement can be attributed. What cannot be measured cannot be further divided and it cannot be spoken of as having parts. The motion the atom possesses is non-observable and it may be viewed as an abstraction in a conventional sense. Space and time are the two lenses through which matter is observed and they form the matrix of universe.

The distinction between intrinsic (*karma*) and extrinsic (*kārya*) motions arises from the fact that intrinsic motion is uniform in all directions.

When the universe ceases to be at the end of the cosmic cycle, matter is not annihilated; rather, it reaches a quiescent state where its atoms have no extrinsic motion and so become invisible, which appears very similar to the conception of the state of the giant atom at the beginning of cycle of creation. The lack of motion represents a cessation of time, because time is a measure of change.

In the epistemology of the Vaiśeṣhika system, it becomes possible to obtain knowledge due to the agency of ātman or self. In Figure 2, the atomic substances exist within the matrix of eternal substances.

#### 4. ATOMS AND LIGHT

Atoms possess incessant vibratory motion. Heat and light rays consist of very small particles of high velocity. As material particles, their velocity is finite. This is also due to the fact that motion is contingent upon time as one of the dravyas.<sup>10</sup> Particles of heat and light can be endowed with different characteristics and heat and light can be of different kinds. The atoms of light and heat belong to the tejas category; there are four other kinds of atoms with attributes.

There is no difference between the atom of a barley seed and paddy seed, for both these are constructed out of the atoms of earth. Under the impact of heat particles, atoms exhibit new characteristics.

A *bhūta*-atom evolves out of integration from the corresponding *tanmātra*, which is its potential form, indicating a primacy of the abstract over the material. Although atoms are unitary objects their combinations generate various *tanmātras*. Combinations of rudiment-matter (*bhūtādi*) lead to more specific forms. Atoms vibrate when acted upon by energy.

The atom's potentiality manifests in distinct attributes based on state of conjunction and motion. It is this potentiality that leads to diverse complex atoms with different attributes. These attributes may be viewed as being created by the matrix of space, time and number. Light has a special place in this view as it is both an elementary constituent of matter as well as the medium that shines the inner space of the mind. The atom of light cannot be described fully.

Although the Vaiśeṣhika is an atomic theory, it is so only as an idealization and its measurable attributes are in a continuous spectrum as they are generated within the womb of an infinite space-time matrix.

In the Kashmir school of Śaivism, both outer and inner realities (consciousness) are characterized by vibration (*spanda*) and it is this vibration that makes self-referral possible. The ultimate movement takes place not in space and time but inside consciousness.

## 5. ANOMALOUS EVENTS

This section presents anomalous events as evidence of the workings of consciousness in the large although one could also explain them as coincidences. The difficulty with the latter explanation is that the probability of choosing numbers mentioned here is extremely small. These cases are different from speculations in ancient texts (somewhat like science fiction) describing airplanes, space travel, embryo transplantation, weapons that can destroy the world and so on that have come to pass<sup>14</sup> because they are general ideas which do not involve specific numbers. The figure of 8.64 billion years for the universe cycle in Indian cosmology, which is not too different from the currently accepted value of the time since the big bang, is widely known. Here I speak of two other numbers that are not well known.

*Speed of Light.* The mention of the 14th century knowledge of the speed of light in India is an example of spontaneous discovery in the manner discussed by Hadamard in his book. The speed is found in the well-known commentary on the Rigveda by the medieval scholar Sāyana (1315-1387), prime minister in the court of the Vijayanagar Empire. It associates the speed of 2,202 yojanas in half a nimesha with the sun (or sunlight). The time measure of nimesha is well attested in Indian astronomical and encyclopedic texts as being equal to 16/75 seconds.<sup>15</sup> The yojana is variously defined by different writers. It was defined in two different ways by leading astronomers of the time. Likewise, it seems to have been used in two different ways for terrestrial applications.

According to the Arthaśāstra, the famed third century BC book on polity and economics, a yojana is 8,000 dhanus (bow). For a long time Western scholars took a dhanus to be equal to six feet or 1.83 meters,<sup>16</sup> and with this Sāyana's number is  $3.02 \times 10^8$  meters per second which corresponds closely to the correct value of the speed of light. More recently, it has been suggested based on dimensions of ancient monuments that the standard value for the ancient dhanus is 1.904 meters, which makes the value of speed about 4 percent higher. I have discussed the question of units related to speed elsewhere.<sup>17</sup>

There is no way this speed could have been measured in medieval India. Until just over 200 years ago it was not even known in the Western tradition that light had finite speed. In 1676, Rømer calculated this speed in terms of the speed of earth's rotation around the sun, and his value was about 26% less than the modern value. Sāyana could not have obtained this figure from the West or anywhere else and, therefore, it can only be seen as an inspired guess.

*Distance to the sun.* Until modern times, the solar system was taken to be much smaller than its currently accepted value. Pappus of Alexandria writing in the 4<sup>th</sup> century took the distance to the sun to be about 490 earth radii. At the beginning of modern Western astronomy, Tycho Brahe took the distance between the earth and the sun to be  $8 \times 10^6$  kms and Kepler took it to be about  $24 \times 10^6$  kms.

In the Indian Purānas, the earliest of which predates fifth century, the sun is associated with two "axles": the first one is  $15.7 \times 10^6$  yojanas long and the second one is 45,500 yojanas long<sup>18</sup> (section 2.8 of the Vishnu Purāna). One can presume that the longer axle represents the distance to the earth and the shorter axle represents the deviation from the circular path. Speaking of this astronomical reference, we cannot prove that it is from the earliest layer of the text, but there is general scholarly consensus that the text is at least 1,500 years old.

One of the variant definitions of yojana, which was prevalent in Kashmir (a region where many Purānas were written), is given by Stein<sup>19</sup> (footnote to verse 393) where he takes it to be about 6 miles (Stein: "The direct distance by road from Srinagar to Vijebror is about thirty miles. This corresponds exactly to five yojanas."<sup>20</sup>). If this yojana was meant (6 miles or 9.6 km), then the distance to the sun is about  $150.72 \times 10^6$  kms. Given that the distance between the two cities is an approximate value, the distance to the sun can be taken to be identical to the modern value of  $149.598 \times 10^6$  kms.

One might complain that we are picking a value of yojana that was only used regionally. This criticism is valid, but we are not trying to find a scientific basis to the choice of the distance to the sun. Rather, we are showing that the choices presented by intuition, without any firm basis in physical theory, can be surprisingly accurate. Accepting the validity of such a way of knowledge is against the mainstream program of science and current schoolbook theories of mind.

It is indeed possible that even before modern telescopic astronomy, which did not exist in India, a reasonable estimate of the distance to the sun could be made based on durations of lunar and solar eclipses. But there is no evidence that such calculations were made by astronomers.

There are other anomalous precise numbers in the ancient texts that include the size of the earth in the accounts of Eratosthenes, Āryabhata, and al-Bīrūnī. The apocryphal account of Eratosthenes's measurement of the size indirectly by measuring the shift in the shadow of the sun at noon between Syene and Alexandria is not credible since the distance between the two cities was not known accurately and the shift in the angle of the shadow could not have been measured with the accuracy that the calculation of the earth's diameter demands.

In the traditional explanation of the workings of mind, habits picked up in childhood and in school are the impediments that prevent one from being connected to one's intuition. Real creativity requires challenging dogma as well as one's own certitudes. One sees unexpected connections, which is an element of creativity, in extraordinary states of mind. Looking within can reveal unexpected knowledge about the universe for we are a part of the universe.

## 6. INTERACTION BETWEEN THE WORLDS OF CONSCIOUSNESS AND MATTER

The Indian view of consciousness -- that it is a unity and the feeling of sentient beings as being separated from others is a misapprehension -- was endorsed by Schrödinger in his influential book *What is Life?*<sup>21</sup> Indian tradition accepts that consciousness influences nature by the process of observation (*drishti* in Sanskrit). This is very similar to the quantum mechanical view of the influence of observation on a physical process by the quantum Zeno effect.<sup>22</sup> But the difference between quantum theory and Indian ideas is that although one speaks of observations in quantum theory there is no place in its ontology for observers. Schrödinger was aware of this limitation of quantum theory and he argued that sense-categories like the *tanmātras* of the Sāṅkhya system of creation at the individual or the cosmic level were essential to understand reality.

In traditional art Śiva (representing individual and universal consciousness) is shown as lifeless next to the vibrant Goddess (who represents Nature). Abstract representations of the cosmos show Śiva as a dot (of immateriality) within the (geometric) framework of the material world. Much of Indian mythology is an exposition of Indian epistemology in a coded language.

If evolution of machines is driven by human intelligence, the case could be made that biological evolution is driven by Nature's intelligence which is an embodiment of consciousness.

One can also assert that biological forms, and by extension machine forms, are latent in the physical law, just as the excited states of the electron orbits are latent in the physics of the hydrogen atom even though these states may not be occupied. Furthermore, ideas can be given the same footing as biological forms or machines although they need appropriate biological structure to be articulated.

The bridging of the worlds of consciousness and matter does not occur at the level of matter or mind. In Indian epistemology, consciousness itself is a transcendent category that goes beyond both matter and mind.

## 7. CONCLUSIONS

Indian epistemology has some parallels with Western idealism that accepts independent existence of ideas and forms. But it is different from idealism in the sense that the self has access to much more than what the individual obtains through the sense organs. The conception of the self at the individual level (*ātman*) or in its totality (*brahman*) together with the counter-intuitive notion of equality between the two selves makes it possible to see how large scale correlations can exist and how a person can obtain surprising insights through intuition. Naturally, such insights can only be rationalized within the framework of the individual's knowledge. Although ordinarily consciousness and matter are two distinct categories, consciousness can influence the evolution of matter through observation.

A study of the categories of Indian physics does not yield any special insights on light that are useful for the understanding of the nature of the photon. But it presents a cosmology of the material universe that illuminates anomalous findings that are part of scientific discovery. Consciousness cannot disrupt natural law related to matter but it can guide its evolution by making certain outcomes more likely than others. The universe is closed on itself at the level of consciousness and there are instances of anomalous experience and coincidences at the personal level and such

coincidences also occur in the scientific world. Coincidences in Indian scientific texts that support these ideas include the age of the universe, the distance to the sun, the speed of light, and other numbers. There are also instances of impressive qualitative scientific speculations in the literature.

Indian epistemology could be considered to be falsified if no evidence is found for large correlations in the world. There are many who will dismiss anomalous numbers described in this paper as coincidences. Perhaps there would be greater acceptance if new carefully devised scientific tests are proposed to determine large correlations in the laboratory and in terrestrial and astronomical processes. The likelihood that such tests are devised will remain small unless Indian epistemology becomes a part of the scientific conversation.

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