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Indian Traditional Astronomy Knowledge System and Related Debates

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Abstract:

Science versus traditional knowledge is considered to be comparatively unfavorable in front of modern knowledge because traditional knowledge is more the result of imagination, contemplation and idealistic approach away from modern technology and experimental criterion. However, many times, due to the complexities in the acquisition and discovery of modern scientific knowledge, difficulties have to be faced in achieving the final goal. Therefore, we also have to resort to the study of traditional knowledge, civilizations, religious texts, philosophy, etc., in search of preliminary facts for a deep study of a subject, so that the modern scientist can easily do research work. That is, this traditional knowledge approach also serves as the primary source for the modern science field. By adopting this approach, this article will historically analyze 'Astronomy', a branch of the Indian traditional knowledge system, which has given India a unique identity at the global level and has also provided a source of indigenous knowledge for the modern Indian space programme. However, skeptics have been expressed by the Western world on the relevance of a strong tradition of astronomy propounded by Vedic sages and theorists.

Keywords: Astronomy, Vedic Knowledge, Space, Indian Tradition.

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Introduction:

Traditional knowledge or local knowledge is a record of human achievement in comprehending the complexities of life and survival in often unfriendly environments. (Malhotra, 2014) Similar to other traditional knowledge and civilizations, rich in knowledge from sages, saints and *Acharyas*, Indian civilization has also been ahead in the study of celestial/astronomical objects, mainly Stars and Planets, due to which the study of astronomy was born in India. By extension, from the *Vedic* age to the present period, India has made optimum progress in the field of astronomy and its associated space, although the two have a difference of more than four thousand years in the beginning of the field of study, but to improve human life and the aim of helping progress continues to be a beacon of astronomical ideas and knowledge since the *Vedic* age. However, even before the *Vedic* period, evidence of astronomy has been found in the Harappan civilization of India, such as the evidence of observational astronomy at Dholavira in Kutch district of Gujarat. (Basu, 2012)

Astronomy is the branch of science in which the observation and analysis of the Earth's atmosphere and its external activities, events, and interpretation are done. Simply put, the factors affecting humans directly - rain, seasons, clouds, storms, along with indirectly the center of attraction is the study of the sun, moon, various planets-satellites, meteorites, etc. At the early stage of astronomy in India, the center of study was for religious rituals, *yagya*, astrology, but which laid the foundation of scientific reasoning, discovery and new theory in the later period. This scientific knowledge included information on rainfall patterns, increase in agricultural yields, study of climate, identification of seasons, motion of planetary stars, calculation of time and calendar etc. Similarly, the foundation of the space program in independent India was also laid with the vision that the various problems faced by the citizens of the country such as agricultural yield and rainfall estimation, farmer literacy, poverty, information dissemination etc. can be made better. The only difference was that contemporary knowledge was based on modern technology and equipment and ancient knowledge built on open-eyed observation, observatories and non-modern (traditional) equipment. However, it is also not fair to say clarity because some traditional astronomical instruments were also used from the fifth century and earlier such as *Gola*, *Bhagan*, *Chakra*, *Dhanu*. We can say that in the traditional knowledge era, it was difficult to calculate the

planets and constellations and estimate the speed, but still today with the same knowledge stream, the celestial bodies in India have religious and social importance like the use of *Panchang.* (Subbarayappa & Sarma, 1985, p.20) Because the extent of Indian traditional knowledge is equivalent to contemporary issues such as the study of the Sun and its effects, the Moon (satellites), solar eclipses, lunar eclipses, day and night, motion and shape of the planet, stars, meteorites, the predominance of gas and existence of life and gravity, so its importance is also inevitable for the present.

Roots of Indian Traditional Astronomy Knowledge:

Evidence of astrology and astronomy is found directly or indirectly in *Vedas, Brahmanas, Aranyakas, Upanishads, Puranas and Mahabharata*, the main basis of *Sanatani*knowledge system. In the astronomical knowledge of *Vedic* literature, the universe was conceived as three distinct parts: the Earth, the Sky (space) and the Heaven (*diaus*). (Subbarayappa & Sarma, 1985, p.20) That is, this oldest view of the heavens and the celestial bodies shows that just as a child passing through infancy, adolescence, youth and adulthood, always looking at the sky and the celestial bodies with his inquisitive mind, questions what it is, how much Why is it distant, round, bright, hot, rising-setting, dark-light, etc.? In the same way, we can say that our saints, sages and shastris were also as curious about the universe as human beings even today want to know the unlimited information and facts of the universe. But we can understand the expansion journey of these facts, discoveries and principles of Indian astronomy by dividing it into several eras of history according to convenience. (Gopu,2019a) However, in general Indian astronomy is divided into two era Pre-*siddhantic (Vedic)* and *Siddhantic* Era (Post-*Vedic*):

1.*Vedic* Era (before fifth century BCE)
2. Eighteen *Siddhanta* Era (fifth century BC to fifth century AD)
3. Classical Age/Classical Theoretical (*Siddhantic*) Era (fifth century AD to Seventeenth century AD)

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1. Vedic Era (before fifth century BCE)

Vedas are considered to be one of the oldest literary evidence of any living civilization and culture, in which the description of the physical and spiritual world is found. It is a compilation of four *Vedas* - *Rigveda, Yajurveda, Samaveda and Atharvaveda* respectively. The *Rigveda* mentionsthirty-four lights, which are clearly referred to as the Sun, the Moon, the five planets and twenty-seven constellations. However, nowhere in these sources the names of all the planets together are indicative or listed. (Kak, 2002) but the first clear reference to the planets by name is found in the epic, the *Mahabharata.* (David, 1994) From the astronomical point of view before the *Mahabharata,* there is no definite, comprehensive and detailed mention of the planets in the above *Vedic* texts and the scale of accuracy was not fixed, but there was a satisfied understanding towards them. Because the astronomical knowledge of the *Vedic* sages was directly linked to religious rituals, in which the study of heavenly bodies as deities became a sacred duty. (Das,1936)

The first separate written appendix to the ancient astronomical knowledge of the Indians is *Vedanga Jyotish* (1400-1200 BCE) which is part of the *Vedas* about the celestial bodies. (Sule&Vahia, 2020) This is because *Vedanga* has originated to present clarity and understanding of *Vedas* in front of the world, *Rig-Jyotish* of *Rigveda, Yajush-Jyotish* of *Yajurveda* and *Atharvan Jyotish* of*Atharvada*are accepted as representative texts of *Jyotish Vedanga.*(Ranjan, 2018) But a dilemma is still alive among the scholars, due to their uncertainty about their definite time period and the name of the creator, hence *Vedas, Vedanga Jyotish, Surya Siddhanta*is known as *'Apaurusheya'.* (Hariprasad, 2018) Nevertheless, *Vedanga Jyotish* is helpful in providing a sense of behavioral and practical knowledge of the astrological part of the *Vedas.* Which was composed by *Acharya Lagadha,* but it is said that not the entire compilation, but some parts have been composed.

The *Yajurveda's Yajusha* astrology is considered important to astronomy, designating twelve tropical months, and six seasons: *Madhu* and *Madhava* - the spring season, *Sukra*and*Shuchi* - the summer season, *Nabha* and *Nabhasya*- the rainy season, *Isa* and *Urja* - autumn season, *Hemant* (winter) describes the season of *Sahas* and *Sahasya- Hemant* (winter), *Tapas* and *Tapasya* - the season of *Shishir* (cold). (Kak, 2002) Also a lunar year of 354 days and a solar

year of 365 days (360 in *Rigveda*) have been declared in *Yajurveda.*(Dutta & Sriram) Where the knowledge of twenty-seven constellations is also obtained, which were the axis of study in the *Vedic* period, in which the names of all the constellations from 0 degrees to 360 degrees- *Bharani, Krittika, Rohini, Magashira, Adra, Punarvasu, Pushya, Ashlesha, Magha, Poorvaphalguni* etc. done as. (Bhujle&Vahia, 2006) Similarly, knowledge of solstices and equinoxes, eclipses of the Sun and the Moon, the calculation of time, the traveling position of the earth is obtained from the astrological scriptures of this period, which include *Vedas, Brahmanas(Satapatha Brahmana),Upanishads (Chandogya Upanishad), Vedanta* (astrology), *Puranas* and the *Mahabharata* (interaction between *Shanti Parva* and *Bhishma Parva*) of Ved Vyas is included, the only difference is that the language has been revised from time to time in the form of simplicity, theory improvement and advancement. For example, in the *Chandogya Upanishad*, astronomy is best described as constellation science.

2. Eighteen Siddhanta Era (fifth century BC to fifthcentury AD)

This period is also known as the period before Aryabhatta or the period between Aryabhata from *Vedanga Jyotish* period.This 1000 year period is generally called the dark age of Indian astronomy because at present no written literary document or work is directly available. (Das,1936, p.199) That is, apart from the *Surya Siddhanta*, now all the principle material has disappeared and in subsequent centuries it has also been revised and updated from time to time. However, fortunately, *Varahamihira* wrote a treatise called *Pancha Siddhantika*, in which there is a comparative study of five of these eighteen principles existing in this period - *Pitamah, Vasistha, Surya, Romaka* and *PaulissaSiddhanta*. (Gopu, 2019b) These 18 principles are as follows: *Surya, Paitamah, Vyasa, Vashishta, Atri, Parashara, Kashyapa, Narada, Garga, Marichi, Manu, Angira, Lomasa, Paulisa, Chyavana, Yavana, Bhrigu, Saunaka.* (Rao, 2002, p.6) And this period has also had a mixed identity i.e., the influence of Greek astronomy on Indian traditional astronomy, for example the theory of sage *Vashishta* is considered to be a mixture of Greek and Indian knowledge. (ÕHASHI, 1994) The reason for this was also Alexander's invasion of India in 326 BC, after which communication between India and Greece was established through Arabia and there was an east-west transmission of knowledge. But today a lot of research work is also being done on this period, due to which this period is being called the Greatest era.

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3. Classical Era / Classical Theoretical (Siddhantic) Era (fifth century AD to Seventeenth century AD)

This era was called the golden age of Indian mathematics and astronomy. The reason for this is the use of trigonometric methods and epicyclic models to calculate the positions of the planets (Bharati,2018, p.19) as well as the uniqueness of this period was that India's astronomy developed in its own way in classical principles, which established itself as an independent subject, keeping itself free from foreign influence. (ÕHASHI, 1994) This can be gauged from the fact that from the sixth century AD until the time of Kepler's laws, Indian astronomers were probably the only ones in the world who could calculate eclipses with any degree of accuracy. (Kochar, 2010) Which includes Aryabhata-I (476-550 A.D), Varahamihira (505-587 A.D), Brahmagupta (598-668 A.D), Bhaskaracharya-l (600-680 A.D) Bhaskaracharya-ll (1114-1185 A.D) etc.

Aryabhata I: Aryabhatiya (499 AD)

Aryabhata was a fifth-century mathematician and astronomer as well as rich in astrology. At the age of twenty-three, he wrote the book *Aryabhatiya*(499 AD) divided into four sections. In the first two volumes, in thirty-three verses that can cover a total of three pages, the principles of mathematics and the principles of astronomy in seventy-five verses in five pages and the instruments for this have also been described.(*आचार्य*, 2006) Along with this, his book is considered compiled as a math-based astrology book. The summary of some important information propounded by Aryabhata related to Astronomy is as follows: (Dutta, 2006; Vahia&Subbarayappa, 2014; Shukla, K.S & Sharma, K.V, 1976)

- In ancient times, the earth was considered to be the center of the universe (Geocentrism), but according to Aryabhata, the sun is the center of the universe (Heliocentrism) and the earth also revolves around the sun.
- The brightness and light on the Earth and the Moon are not their own creation, but its source is the Sun.
- The shape of the earth is round and the time of sunrise and sunset changes due to line differences at different places.

- In ancient times, the earth was considered to be stationary, but according to Aryabhata, the earth rotates on its axis from west to east, resulting in a process like day and night.
- Aryabhatta, while declaring the situation of eclipse due to *Rahu-Ketu* prevalent in India as wrong, said that the cause of lunar eclipse and solar eclipse is dependent on the movement of the earth, moon and the reach of sunlight.

Varahamihira: Panchasiddhantika (575 AD)

Aryabhata's disciple, Ujjain-born Varahamihira (505 AD) was a mathematician, astronomer and astrologer, one of the *Navaratnas* (Gems) in the court of Vikramaditya Chandragupta-II. Varahamihira composed three important texts, the *Brihajjataka*, the *Brihatsamhita* and the *Panchasiddhantika*. In which *Panchasiddhantika* is considered to be the most precious because on the basis of this book the knowledge of the five principles of the Eighteen Siddhant era is obtained, as well as the interaction of foreign connections and access to knowledge in the major civilizations of that time. These include: *PaulisaSiddhanta* and *RomkaSiddhanta* (close to the Greek origin), *VasishthaSiddhanta* (a mixture of Indo-Roman-Greek), *Suryasiddhanta* (The Sun at the center of the mysteries of the Universe) and *Pitamahsiddhanta* (Pure Indian principle). (Das, 1930; Neugebauer & Pingree, 1970, pp. 9–14) We consider Varahamihira's contribution directly and indirectly to astronomy because he put the understanding of the activities related to natural life (Akash, Bhumi, Patala) in front of humans i.e., earthquake, vegetation, behavior of birds, underground water, knowledge of geography. Along with this, the gravitational force of the earth was also mentioned and the knowledge of horoscopes *(Janmakundli)* was special in all his works.

Brahmagupta: BrahmasphutaSiddhanta (628 AD)

Born in Rajasthan, Brahmagupta composed the *'BrahmasphutSiddhanta'*, which describes mathematics and astrology.His contribution to Astronomy also brought more accuracy and breadth to the earlier knowledge on the soil of India. For example, told the world how to accurately measure the time of solar eclipse and lunar eclipse and estimated the circumference of the earth. Also, the credit of explaining zero goes to Brahmagupta, he said, Adding or subtracting zero to a number does not change that number. A different context has been in Aryabhata and Brahmagupta, that is, on some issues both are seen opposite, first

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where Aryabhata opposed the *Rahu Ketu* story on lunar eclipse and solar eclipse, the same Brahmagupta has supported. Second, Aryabhata said that the earth is moving on its own axis, the same Brahmagupta considers the earth to be stationary.

Bhaskaracharyall: Siddhant Shiromani (1150 AD)

Bhaskaracharya was a famous mathematician and astronomer of the observatory located in Ujjain. This observatory was considered the leading center of mathematics and astronomy in ancient India. He wrote an enormous treatise known as *'Siddhanta Shiromani'* that is divided into four sections: Lilavati,*Bijaganita, Goladhyaya*and*Graha Ganita Adhyaya*.The most important part is Lilavati which introduces us to the knowledge of astronomy on the basis of dialogue, this dialogue is between Bhaskaracharya and his daughter Lilavati, in which Lilavati wants to know the answers of many questions from her father which are as follows (Soni,2020, C.12):

- Accurate knowledge of Gravity: Question asked by Lilavati- Father, who is carrying the weight of the earth? His answer was that at first it is a false belief that the Earth rests on *Sheshnag,* Turtle or Elephant, but Earth and all other planets remain in the sky without any support due to their gravitational force.
- How the Earth is Round: The shape of the earth was the subject of Lilavati's following query. If the earth appears flat, how can we then interpret it as being spherical? Bhaskaracharya responded that when we make the shape of a big circle and look at its hundredth part, it will appear flat but it is round. The same rule applies to the shape of the earth because the size of the earth is quite enormous in front of a general circle and the portion of the earth, we can see with our eyes appears flat to us but is actually spherical.
- Bhaskaracharya was determined with accuracy how long it takes for the earth to orbit the sun.

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Indian Traditional Astronomy and Western Notion:

When studying the Indian astronomical tradition in depth, then another doubtable dimension starts from the western world and that is Indian knowledge indigenous or is it the essence of foreign civilization and how antiquity is Indian Astronomy knowledge? There Indian Astronomy was one of the first subjects which attracted the attention of Western scholars after the existence of Sanskrit literature became known to them in the last quarter of the eighteenth century. (Tilak, 1925, p 2) And from the eighteenth century to the twentieth century and even in contemporary times, the debate and controversy about the greatness of Indian knowledge continues. In which American historians like David Pingree (twentieth Century) take a pessimistic view of India's astronomy i.e., Indian astronomy is rife with Greek wisdom, and we owe it a debt of gratitude for helping to preserve and keep the early Greek Astronomy tradition alive. (Pingree, 1976; 1978) Furthermore, Western astronomers do not consider the classical theoretical era, called the Golden Age of Indian astronomy, to be purely Indian. While several conceptions and hypotheses are said to have been inspired by Aryabhata, the Western knowledge branch, in contrast, gives the first credit to Greek astronomy. For example, *Anaxogoras* (510–428 BCE) first reported that the Moon shines due to reflected sunlight, and *Philolaus* (480–405 BCE) reported that the Earth rotates on its axis. Simultaneously Aryabhata proposed the heliocentric model which was originally advanced by the Greek astronomer Aristarchus (310–230 BC). (Miller, 2013) But, the Indian understanding of the Sun is the oldest, according to which if we analyze the *Aitareya Brahmana* (1000 BCE) instead of Aryabhata first, the Sun never really sets or rises. In realization, a number of European astronomers, such as Le Gentile, J. S. Bailly, Laplace, Playfair, William Jones, Colebrooke, and Max Muller, have been favorable and optimistic about Indian astronomy. J. Bentley, Whitney, Kate, Pingri, and others, on the contrary, are against the originality of Indian knowledge. (Tilak, 1925; Ghosh, 2014; Burgess, 2011)

But when we make a comparative study of Indian *Siddhantas* knowledge and European modern knowledge, a different characteristic emerges in both the scientific societies, which enlightens the relation of society and religious belief with science of that period. Indian astronomers could independently prove the legitimacy of their work and were not restricted and constrained by religion because the origin of astronomy in India was outgrowth of

astrology. In European society, every aspect of human existence was regulated and controlled by the Pope and the Church. In the essence of astronomy, the discovery of new facts and theories by European astronomers turned him against the Church, and he was also punished, thereby discouraging his work. For instance, Copernicus proposed the Sun as the universe's center in 1543, refuting the traditional notions held by Aristotle and Ptolemy that the Earth was the center of the universe. But due to religious convictions and his work defying God's logic, Copernicus was not permitted to publish his work. Furthermore, Galileo and Bruno, the scientists who supported and substantiated the work of Copernicus, were sentenced to imprisonment and burned alive (1660 AD) respectively for violating the church and religious beliefs. (Soni, 2020, C.2; Leveillee, 2011)

Indian Astronomy and Indian Space Knowledge:

The Indian government and the Indian Space Science Organization have incorporated ancient astronomical knowledge into the country's space programme in recognition of its significance. That is, in response to a question posed in the Lok Sabha in 2012 about the "Contribution of Ancient Astronomers," Union Minister of State Shri V. Narayanasamy said that the ancient Indian astronomers Aryabhata,Varahamihira, Brahmagupta, Bhaskara-1, and Bhaskara-2 still make contributions to our knowledge of the celestial mechanics concepts used in contemporary astronomy and space programmes because of their original theories. Also, in order to recognize and make aware of the importance of their work, in 1975, the first scientific satellite was named Aryabhata, in 1979 the Earth satellite was named Bhaskar-1 and the next satellite was named Bhaskar-2. In 2004, the observatory in Nainital was named Aryabhata Research Institute of Observational Science by the government and the International Astronomical Union also named a crater on the Moon as Aryabhata.

Former ISRO Chairman Dr. G. Madhavan Nair (2003-2009) stated that we can correlate the contemporary Indian space programme to the 7000-year-old *Vedic* knowledge of Indian astronomy. This is because we are currently discovering space information through modern technology and supercomputers. But We can describe that knowledge from the principles and concepts of ancient scientists *(Saints, Acharyas).* They had clarified scientific knowledge about stars, constellations, eclipses, and planets using the world's natural sensors—human eyes. Just as we get the knowledge of advanced mathematics and basic astronomy from the

Shulba Sutra, similarly the motion of the planets was considered to be elliptical rather than circular until Aryabhata's knowledge rendering, but the motion of the planets is circular. This benefits modern space activities as this knowledge is essential for precise operation and movement of artificial satellites. (Nair, 2015) For example, on August 7, 2022, the launch of India's first Small Satellite Launch Vehicle (SSLV D1) from Srihari Kota Space Center was successful, but the two satellites involved in the mission, EOS 02 and *Azadi* Sat, could not be established in the exact orbit. Because SSLV-D1 placed the satellites into a 356 km x 76 km elliptical orbit instead of a 356 km circular orbit and mission failed. The moon and Mars are now within our reach, and Indian traditional knowledge provides additional information about them.

The concern of fast rising space debris and management is today creating new challenges for the international space community. Yet, the *Shanti Mantra* of *Yajurveda* (36/17) - The Purification of the Environment - forewarns us in advance and states that pollution should not be present in the sky, space, soil, water, or plants because they all provide peace. The treatise of the *Vedic* sage Bharadwaja, *'Yantra Sarvasva'*, describes in depth the types and sizes of the planes. With the use of this work, we can gain that fundamental understanding of how to use aircraft to move from one planet to another, which will help modern scientists in his quest for space travel. And it will also be more helpful for ISRO's first human spaceflight mission *'Gaganyaan'* (Sanskrit Term). The ISRO's Aditya -L1 mission, which would be focused on close observation and research of the Sun, could benefit from the ancient *Surya Siddhanta*, which is still present as India's indigenous knowledge.

Conclusion:

In conclusion, was the basic structure of man's astronomical discoveries a logical outcome of science or tradition many thousands of years ago? Because in contemporary times man is endowed with more tools and scientific techniques, in the Vedic period these resources were fewer, but the knowledge of that time will nonetheless be regarded as being as scientific as that of today. Because the basis of ancient knowledge was also archaic tools, such as the *Gola* - for precise position of planets, *Shanku* - for study of direction, *Ghati* - for measurement of time etc. which have kept astronomical mysteries before us. And at present this knowledge

provides an ideal blueprint for 'Space Science', the latest branch of astronomy. The expanding research area of both then and still is primarily to remove the hurdles related to human life and after providing the best possible way of living, the new discovery form, the evidence of life on other planets and finding the option of settlement. For instance, Mars is presently a significant exploration hotspot in the pursuit for life, so astronomy and space science are deeply associated.

Indian astronomical knowledge has been called completely astrology by the western world, where it is nothing but imagination and fiction. But this is just an attempt by the western world to make Indian traditional knowledge irrelevant and to reach a secondary status. Away from irrationality, Indian traditional knowledge has integrated revisionist and pragmatic features, such as Aryabhata's revising of *Rahu-Ketu*'s narrative on lunar eclipses and solar eclipses. Nor was there religious rigidness against astronomy like western society.

The astronomical discoveries for the prediction of human destiny on the basis of constellations in the *Vedic* period, from its transition period - the eighteenth principle period to the amalgamation of mathematical and astronomical in *Siddhantic* era, show the potential and glorious history of Indian astronomy, but an dilemma still persists over the actual birthplace of astronomy. Bailly considered that astronomy had its origins in India and had been transmitted to the Chaldeans in Babylon and to the Greeks afterwards. (Kak, 2013) Even so, this discussion can never end because all civilizations consider their grandeur and achievement superior to those of every other civilization. But it is entirely inappropriate for one civilization to hold a monopoly on astronomy and related knowledge. All the civilizations related to astronomy, in which Indian, Babylonian, Greece, Arabia and China are prominent, provide the best knowledge only. (Mohan, 2015)

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