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An Introductory Outline of Knowledge Production in Pre-colonial India

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Abstract

In the introduction we seek to discuss the features of knowledge production in pre-modern India by taking astronomy as a case of illustration. It is an effort in the perspective of historical epistemology that inquires into the premises, inferential logic, proof, concept of truth, and method of confirmation of knowledge. It is an examination of the link of the concept of objectivity, rationality, and methodology at distinct stages of the production of knowledge as indicated by the tradition of *vyākhyā* and *bhāṣya*. What the introduction seeks to highlight is the progress of methodological pre-occupation in knowledge production of Pre-colonial India, which starts from the axiomatic approach to the insistence of confirmation through the production proof over the centuries.

Key words: Historical epistemology, Knowledge production, Methodology, Textualisation and epistemic properties

1. Introduction

Systematised knowledge production of specialised knowledge in India goes back to the age of the *Vedāṅga* texts (c.700 BC) which witnessed constitution of fields of knowledge around linguistics and astronomy as the earliest main components of the formal knowledge system of traditional India. Astronomy, mathematics, grammar, philosophy, theatre, architecture, healthcare and agriculture are examples of deep rooted and pervasive fields of knowledge in traditional India. Each system of knowledge had a splendid course of exponential growth across the centuries till the British occupation of the subcontinent, thanks to the tradition of both the household based and institutional facilitation of learning. It is a matter of wide recognition today that traditional Indian knowledge systems had contributed significantly to the growth of the world scholarship in the past.

2. Traditional Indian Knowledge

In a natural condition the human brain is genetically imbued with the capacity of unconscious experiential learning, memorising, and reproducing from time immemorial. Over the years human faculty of reflexivity grew up tremendously enabling formal constitution of knowledge through conscious analytical reasoning, comparison, rethinking and improving the knowledge. Subsequently, knowledge itself became an object of analysis, which led to its critical examination, validation, expansion, and reconstitution, possible only in a formal textual tradition.

According to the textual evidence knowledge production in ancient India was an individualistic meditative enterprise (*tapas*), improved upon through dialectics (*tarka*), hermeneutics (*mīmāṃsā*), interpretation (*vyākhyā*), commentary (*bhāṣya*), compilation

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(*saṃhitā*) and analytical comprehension (*saṅgraha*). Although every *vyākhya* or *bhāṣya* was apparently an interpretative commentary of a previous text, in reality it was addition of fresh knowledge, sometimes even strikingly original. Although often stated as part of the original proposition, most of the elaborations and expansions made in the *vyākhyā*-s, *bhāṣya*-s, *saṃhitā*-s and *saṅgraha*-s were fresh. Each of them proved to be a corrective exercise, of course in varying degrees from text to text, and each analytical comprehension an integrative function upon the extant corpus of knowledge. Any of the taxa like *vyākhyā* or *bhāṣya* or *saṃhitā* or *saṅgraha* of disparate ages and regions in traditional India would vouch for this fundamental feature of knowledge production and transmission. All these textual forms of knowledge were part of the practice of storing knowledge for learners as well as practitioners. Needless to say that knowledge production in the Indian sub-continent was not confined to the brāhmaṇas and their texts in Sanskrit. There is a commendable body of evidence for the persistent tradition of knowledge production by the sramaṇas and their texts in Pāli.

Production and practice of knowledge was an innate feature of all kinds of people, except perhaps those belonging to the *dāsa-bhṛtaka* category deprived of natural autonomy, which suffered servitude under subjection and immobility. Artisans and craftsmen had been generating and improving knowledge in their hereditary trades, although no written texts enshrining it have survived to the present. As knowledge embedded in the practice and orally transmitted by its users across generations, it might not have been turned into texts at any point of time. Surviving artefacts and their traditional makers constitute the proof.

3. Textual Domination

Autonomous ethnic groups living in the forests and along the fringes had their orally transmitted practical knowledge with inseparable links to subsistence and survival. Nevertheless, the innate faculty of knowledge production was not active in all people, for many of them had existed as subsumed and controlled by one kind of institution or the other, depriving them of their natural autonomy. Artisans and craftsmen who had a relative autonomy in the domain of skilled practices could produce and preserve knowledge essential for their arts and crafts. Having incorporated to the caste system, their practices were subjected to upper-caste impositions enforced through textual appropriation. *Vāstu* texts best exemplify this through the mixing up caste based social norms with architectural prescriptions. Multiple forms of knowledge got preserved as part of orality during all periods, but all of them never had equal acceptance, for the properties of authority, authenticity and credibility were neither ontological nor epistemological but ideological as determined by the social system's power relations. This Marxist, modernist interpretation is criticised and substituted by the postmodern deconstructionist perception of Solipsistic Cartesianism (Lyotard, 1984). Only those who could wield control were able to generate knowledge and dictate it for others to blindly follow. In a band the authority was the *śaman*; in the tribe, the headman; in the slave society, the master; in the feudal society, the lord and so on. It is indeed, a complex situation that precludes a detailed recounting of the process as empirically given. In stratified and structured societies of specialisation the sections that could own and control decided what should prevail as knowledge of authority, authenticity and credibility.

Always the powerful and the dominant in the society decided what to be recognised as knowledge. In the case of the society of caste based differentiation and hierarchy of the Indian sub-continent, the power relations structured by the dominance of the upper castes (*trivarṇika*-s),

competitively decided knowledge by using their command over material and cultural resources. This accounted for the privileging of the brāhmaṇical against the śramaṇic or the precedence of the former over the latter or the obliteration of the multiple forms of knowledge and practices among the lower castes and various ethnic groups. Elaborate textualisation of knowledge and its preservation as part of orality with strategies ensuring continuity and error-free recollection made the brāhmaṇical texts different from the śramaṇic knowledge that had resorted to literacy.

Knowledge being symbolic of status and ranking was contested primarily between the brāhmaṇa-s and śramaṇa-s over a long period, which involved the use of all intellectual means of debate (*tarka*), rituals methods of enhancing royal status (*yajña*, *hiraṇyagarbha* and *tulābhāra*), genealogical strategy of the divinisation of royalty (the puranic process and *praśasti*-s), political means of appointing scholars as royal preceptors and creation of noble status (*sāmanta*) in the social hierarchy of power relations. At some point the śramaṇa-s secured dominance over the brāhmaṇa-s with some precedence of the Pāli texts of knowledge over the Sanskrit texts, but lost it for good in a couple of centuries and the latter established their dominance all over the sub-continent with an undeniable status of intellectual authority attributed to Sanskrit texts. Sramaṇa-s themselves took to learning Sanskrit not only to debate with the knowledge texts thereof but also to acquire cultural legitimacy and status.

4. Processes of Syncretism

Nevertheless, there was always a process of absorption and extraction of knowledge from the non-brāhmaṇical other namely the śramaṇic and the parallel streams of 'the knowledge – practice combine' of the lower strata. Caraka and Suśruta in their texts acknowledge as to how they produced knowledge by learning and analysing 'the knowledge – practice combine' of the people of the forest and the lower castes.[1] Textualisation or the constitution of the *saṃhitā* was the result of the process of extraction or absorption. It was mostly a one-way process, for the caste based social differentiation and distancing precluded dissemination of the textualised brāhmaṇical knowledge.

Also, there was institutionalised prevention of the flow of formal knowledge from above as borne out by the prescriptions in the *Dharmaśāstra*. Indeed there was dissemination from above (*abhisaṅkramaṇa*) and below (*pratisaṅkramaṇa*), primarily of ideological elements that the latter had to accept invariably, for they were integral to the process of domination. In the process the brāhmaṇical knowledge seldom went into the hands of people belonging to the other *varṇa*-s. However, the textualised or the processed form of knowledge in the custody of the *śramaṇa*-s did percolate to the practices of the lower castes to a great extent as the ethnographic survival of the scholarship of Sanskrit the repository of textualised knowledge systems and practices based on scholarly texts in astronomy, architecture and healthcare among the lower castes indicates. At any rate absorption from below was perceptibly far more than dissemination from above.

5. Epistemic Differences

What one observes as the major epistemic difference between the textually ordained knowledge of the upper caste exclusiveness and 'the knowledge – practice combine' of the lower

[1]The verse from *Caraka saṃhitā Sūtrasthānam*, Chapter I, *Dīrghamjīvitiyam*, 121.
oṣadhīr nāmarūpābhyām jānate hy'ajapā vane |
avipāścaiva gopāśca ye cānye vanavāsinah || 1.1.121 ||
Shepherds and other pastoral groups (*ajapa*-s and *gopa*-s) of the forest areas are well versed in the knowledge of herbs.

castes is that the former is a self-consciously realist academic product while the latter, an unconscious cultural practice. The former constitutes a concrete body of knowledge in the form of the text that is amenable to open interventions leading to additions to as well as the improvement of the knowledge whereas the latter is an abstract and closed practice undergoing changes as the culturally given. This is not to say that there is nothing culturally given about the former. Knowledge is purely objective in no society, for in all societies it is rendered plausible as the discursively tempered and manipulated, under the inescapable structure of power relations (Foucault, 1972).

Historical epistemology of both the śramaṇic and brāhmaṇical forms of knowledge would show that they were culturally given too in the sense that the *Piṭaka* and *Nikāya* categories of the śramaṇic knowledge and the Vedic, Itihāsic, Śāstraic, Purāṇic categories of the brāhmaṇical knowledge had their pressures and impositions of the changing material base and the entailing social power relations in time and space (Kosambi, 1958 & 1962). For instance, the knowledge produced and preserved by the śramaṇa-s was primarily of a didactic kind with a pragmatic dimension due to the obvious factors related to their worldview of differing degrees of austerity. Healthcare, a prominent field wherein they generated knowledge was driven by the purpose of *dhamma* according to which treatment (*cikitsā*) of illness (*vāti*) was an important means to resolve the sorrow (*āti*) of the devoted people (*upāsaka*-s). It was more ontological in nature. However, for the purpose of debate they did produce knowledge based on epistemic principles of objectivity, proof, veracity and concept of truth. The logic of mathematics was central to all forms of Traditional Indian knowledge with hermeneutic primacy.

Even the most extensively approved brāhmaṇical fields of knowledge, namely mathematics (*gaṇitam*) and linguistics (*vyākaraṇam*) owed their origins to the Vedic rituals, the former as part of efforts to ensure precision in the ritual architecture and the latter as part of efforts to ensure error free preservation and interpretation of ritual texts. It was the beliefs around the Vedic sacrificial ritual that necessitated knowledge in astronomy, the seeds of which are present in the *Ṛgveda* itself. The belief that the conduct of sacrificial rituals would go futile in case of the incidence of an eclipse during their performance was the primary compulsion for acquiring knowledge and competency to predict the occurrence of eclipse. Being elaborate, long-lasting, and expensive in terms of goods, services and rewards, the Vedic sacrificial rituals once commenced should have their successful completion was quite important. Losing a sacrifice on the incidence of an eclipse was ignominious to the priest who officiated and the king who patronised its performance. Therefore, ability to predict the eclipse was a crucial need for both the priest and the king. Mathematics began to grow as the fundamental tool of astronomy that had ritual pressure in producing predictive knowledge about planetary positions and movements.

6. Epistemic Properties

That there was politico-ritual imposition on scholars would not mean that it precluded adherence to epistemological principles such as rationality, objectivity, verifiability, proof and notion of truth in their enterprise of knowledge production (Matilal, 1971). An inquiry into the aspects of historical epistemology such as premises, inferential logic, proof, concept of truth, and method of confirmation of knowledge is feasible here for visualising the development of methodological pre-occupation in terms of the concept of objectivity, rationality, and methodology at distinct stages of the formulation of knowledge (Renn, 1996, p. 4; Hacking, 1999; Daston, 1994). An important epistemic property of the traditional Indian astronomical knowledge

is its theoretical situation beyond the empirically given and articulation of the premises and conclusions in the language of mathematics. The integrated nature of production of knowledge, essentially addressed to the extant corpus, necessitating every scholar to be thorough with the master texts, was another significant epistemic feature that ensured linearity about the intellectual progress through fresh contributions. Long term direct observation as guided by the extant knowledge, regular and systematic recording and reckoning by means of mathematical tools had been the features of heuristics related to contemporary knowledge production. Mathematics was the object of understanding, tool of analysis, field of hermeneutics, subject of discovery and medium of articulation. However, insistence on production of proofs as an epistemic property began only at a later stage.

It is true that initially these properties were not explicit and theorems were stated without proof. Strong traditions were often resorted to for accepting certain statements of precursors sustainable as *pramāṇa* or a rule of thumb. A *pramāṇa* is an all inclusive abstraction stated in verse (*śloka*), almost like a formula or an equation, but with a prescriptive tone. It is statement of observational results but often without disclosing the cognitive strategies followed to arrive at them. Sometimes a precursor's statement was adopted and sustained as *pramāṇa* for the reason that he had stated it affirmatively. This initial attitude apart, it began to be routine for a *vyākhyā* or *bhāṣya* to delve seriously into an earlier claim, made as a *pramāṇa* by a precursor and to try and make explicit the basic premises of the claim and to develop on the inferences thereof. This is not to mean that constitution of evidence was insisted upon as an epistemic law in those days. Their primary intellectual concern was bringing out more precision to results in the studies, which were given as statements as if axiomatic (*pramāṇa*). Every previous text of authority was interpreted, reinterpreted, commented upon and comprehended by succeeding scholars from time to time. *Āryabhaṭīyam*, the most widely cited text of authority in time and space, had acquired empirical base and proof for its theoretical propositions only during the successive ages through scholarly interpretations and elaborations (Shukla and Sarma, 1976). However, something culturally significant about the tradition of reinterpretation in Indian astronomy is the retention of Āryabhaṭa's authority as the highest in spite of corrections, additions and improvements on his findings by others through independent perception. In the perspective of historical epistemology, when the previous claims are explained in the light of new perceptions, variations occur even at the level of the basic structure as a result of historical changes. In fact, this text was subjected to the greatest number of reinterpretations and additions, of which probably the first known case that improved Āryabhaṭa's results was by Haridattan who is said to have added graded tables of the sines of arcs of anomaly and of conjugation at intervals of 3° 45' to know the correct planetary positions. Similarly Nārāyaṇa Paṇḍita's *Gaṇita Kaumudī* and an algebraic treatise called *Bījagaṇitāvataṃsa* are said to have added a methodological discussion of mathematical operation to Āryabhaṭa's theory of planetary positions.

There is a perceptible epistemic shift in traditional Indian knowledge production in general and Kerala astronomy in particular since the time of Mādhava who made lasting contributions to mathematical astronomy by developing on the inferential items in *Āryabhaṭīyam*. Inferences drawn from Mādhava were subjected to scrutiny and correction by Parameśvaran, his pupil in the light of the results of his long sustained observations. He seems to have done direct astronomical observations for fifty-five years, systematically recorded the results, and wrote a treatise on *Dṛggaṇita*, a mathematical model of astronomy, an example *par excellence* for the

epistemic tradition (Sarma, 1990). His mastery over the extant knowledge and sizeable contribution to it in the form of new theorems are embodied by the *bhāṣya*-s he wrote on *Mahābhāskarīya*, *Āryabhaṭīya* and *Līlāvatī* of Bhāskara II (ibid.). The mean value theorem propounded by him is considered to be quite crucial and essential subsequently in proving the fundamental theorem of calculus. Similarly, his mean value type formula for inverse interpolation of the sine function, a one-point iterative technique for calculating the sine of a given angle, and a more efficient approximation that works using a two-point iterative algorithm, is now understood essentially the same as the modern secant method (Dreyer, 1989). He is said to be the first mathematician to provide the radius of a circle with an inscribed cyclic quadrilateral.

Likewise Nīlakaṇṭha Somayāji in his *Tantrasaṅgraha* carried the process further producing more clarity in pre-existing theories, particularly expansion of the sine cosine series of Mādhava. He is acclaimed for expanding the methods and theories of Mādhava, particularly by elaborating his derivation, improving proofs for his series of the arctangent trigonometric function, and other infinite series. *Tantrasaṅgraha* is in 432 *śloka*-s in Sanskrit and in 8 chapters, generally on the epicyclic and eccentric models of planetary motion, but specifically dealing with the motions and longitudes of the planets, various problems related with the sun's position on the celestial sphere, including the relationships of its expressions in the three systems of coordinates, namely ecliptic, equatorial and horizontal coordinates, the lunar and the solar eclipses, the deviation of the longitudes of the sun and the moon, the rising and setting of the moon and planets, and a graphical representation of the size of the sun-shine part of the moon.

Nīlakaṇṭha's study is a clear indication of how new knowledge is created lineally by developing on the results of the previous studies. He is an example worth citing in the context of epistemic universals about knowledge production in traditional Indian, such as rationality, analytical comprehension of the extant knowledge, new tools of observations, methodological modifications, systematic recording of observational results, mustering of inductive mathematical proofs for previous theorems, hermeneutic additions and scholarly integration. *Tantrasaṅgraha* embodies these epistemic distinctions, which one of its contemporary *bhāṣya*-s, namely *Yukti-dīpika*, is said to have highlighted (Narasimhan,1998). His *Graha-parīkṣā-krama* is a methodological manual of observations in astronomy and the use of observational tools. *Siddhānta-darpaṇa* is Nīlakaṇṭha's another significant work often noted for the interest he exhibited in methodological instructions. Nīlakaṇṭha's *Āryabhaṭīya-bhāṣya*, his masterpiece provides a heliocentric model of the solar system and many results on calculus. Nīlakaṇṭha attributes the series to Mādhava, although it is not possible to ascertain whether Mādhava discovered all the series. It has been shown that Mādhava's discoveries include the Taylor series for the sine, cosine, tangent and arctangent functions, the second-order Taylor series approximations of the sine and cosine functions and the third-order Taylor series approximation of the sine function, the power series of π (usually attributed to Leibniz), the solution of transcendental equations by iteration, and the approximation of transcendental numbers by continued fractions. Mādhava is said to have correctly computed the value of π to 9 decimal places and 13 decimal places, and produced sine and cosine tables to 9 decimal places of accuracy. He also extended some results found in earlier works, including those of Bhāskara (Rajaraja Varma, 1896; Ramasubrahmanian, Srinivas and Sriram, 1994, pp. 784-709). He is said to have significantly improved Āryabhaṭa's model for Mercury and Venus. Nīlakaṇṭha's equation of the centre for these planets remained the most accurate until the time of Johannes Kepler in the 17th

century. It was C.M. Whish, a civil servant of East India Company, who brought to the attention of the western scholarship the existence of *Tantrasaṅgraha* through a paper published in 1835. The other *grantha*-s mentioned by C. Whish in his paper were *Yukti-bhāṣā* of Jyeṣṭadeva, *Karaṇa-paddhati* of Puthumana Somayaji and *Sadratnamālā* of Sankara Varman (Wish, 1835, pp. 509-523).

Insistence of the production of proof as a primary epistemic requirement is best manifest perhaps for the first time in the work of Jyeṣṭadeva. It is interesting to note that proofs for Mādhava's series expanded by Nīlakaṇṭha into sine, cosine and inverse tangent series were given only after a century by Jyeṣṭadeva in his *Yuktibhāṣā*, a Malayalam text. In spite of the constitution of the three crucial power series heading towards the invention of calculus, a comprehensive theory of differentiation or integration was not achieved by him. The fundamental theorem of calculus facilitating higher trigonometric functions was developed by Leibniz and Newton almost a couple of centuries later. However, there exists a running thread of the same epistemological control across the cognitive exercises involving empirical scrutiny, rational analysis and theorisation in Jyeṣṭadeva's constitution of proofs for the power series and in Leibniz's or Newton's formulation of the fundamental theorem of calculus enabling higher trigonometric applications. Jyeṣṭadeva's *Yuktibhāṣā* which is in a way his *bhāṣya* of *Tantrasaṅgraha* embodies mathematical proofs of the theorems of Mādhava and Nīlakaṇṭha. Nīlakaṇṭha's methodological rationality is best highlighted and pursued further by Jyeṣṭadeva who has given many rational approximations based on continued fractions, which scholars have not made out as yet. What has been shown totally new is a convergent infinite process capable of attributing the value of π to arbitrary accuracy. Jyeṣṭadeva shows that several such processes were known to the astronomers of Kerala. *Yuktibhāṣā* gives two methods for the calculation of the circumference: The first gives an algebraic recursion relation involving a sqare-root that converges to the exact value, and the second starts as a way to avoid sqare-roots in the calculation. What turns out as a matter of epistemic significance in *Yuktibhāṣā* is the onset of the practice of providing proofs rather than just statements of results (Raju, 2001, pp.325-61). Another significance of the text is its use of the regional language (Malayalam) instead of Sanskrit and replacement of the poetic *genre* with prose. In short, it goes quite evident that the basic epistemic concept called objectivity was the cognitive motor in traditional Indian knowledge production and it progressively persisted as the central string of control across every *vyākhyā* or *bhāṣya*.

7. Overseas Transmission

Circulation and progressive accretion of knowledge across regions in India had always gone beyond the sub-continent to Persia and the Arab world in the west and to China and the larger Asia in the east, thanks to the long distance itinerant traders. Long distance trade hardly meant mere exchange of material goods. It inevitably involved exchange of cultures to which transaction of knowledge was integral. Production of new knowledge in a region was often catalysed by elements drawn from the knowledge of another region. Cultural transactions during the 15th and 16th centuries that marked extensive and frequent overseas voyages by merchants and missionaries were of an unprecedented dimension. Often regional sharing carried knowledge forward to higher phases, the accomplishment of which would normally be within a larger geographical entity with a knowledge-language of intra-regional use for sustained scholarly enterprises, unless socio-economic and politico-cultural changes become totally unsuitable.

It is evident now that mathematical astronomy in 16th century Kerala with a few

centuries of persistent efforts and systematic progress was fast heading towards the fundamental theorisation of calculus (Rajagopal and Venkataraman, 1949, pp.1-13; Rajagopal and Iyer, 1952, pp.65-74; Joseph, 1994; 2009a and 2009b). But culmination of the theorisation did not happen in the region not due any traumatic changes in its socio-economic and politico-cultural spheres leading to an unfavourable environment. Nevertheless, the growth of garden land economy, influence of market, increased monetisation, transmutation of agrarian rent into cash, urban growth, political instability, social tension and a greater dominance of the cult of devotion were characteristics of the time. Knowledge production was advancing in various fields. In mathematical astronomy Achyuta Piṣāroṭi, Sankara Varma, and Melppathur Nārāyana Bhaṭṭatiri were eminent names. More *gurūkula*-s were coming up imparting scholarship increasingly in the regional language, as indicated by the work of Jyeṣṭadeva. However, it appears that there was the conspicuous absence of a scholar of Jyeṣṭadeva's calibre during the period, precluding the possibility of evolving a comprehensive theory of calculus.

A very significant factor was the unprecedented possibility of overseas transmission of the knowledge from the Kerala region to the Persian world and Europe through maritime traders and Jesuit missionaries (Mallayya and Joseph, 2009b). Moreover, Europe after Renaissance was witnessing a phenomenal techno-economic, socio-cultural and politico-intellectual development providing an ideal environment for the production of new knowledge, thanks to the primacy of reason, critical intelligence and curiosity of the age. The situation of Kerala was just the opposite, characterised by a preponderance of the cult of devotion to gamic gods and the entailing irrational beliefs. In fact, there was a marked shift from astronomy to astrology, āyurveda, epic studies, and theatrical literature quite explicable in relation to contemporary social compulsions on the one side and the declining critical intelligence of the scholarly generation on the other. Viewing from the perspective of historical epistemology, the process was that of an uncritical return to the axiomatic and the traditionally given, from the threshold of proof construction shown by Jyeṣṭadeva. Actually what Europe developed subsequently was a linear advancement of the same epistemic tradition with additions enabling improvement of knowledge as well as cognitive means to go further. Jyeṣṭadeva's formula showing a passage to infinity, which facilitates calculation of areas under parabolas, is an essential constituent of the theory of calculus (Joseph, 2009a). It is the same formula that contemporary European scholars like Pierre Fermat, Blaise Pascal and John Wallis also had used. The planetary model of Nīlakaṇṭha and the planetary model of Tycho Brahe are one and the same. Similarly, it is said that Wallis's results on continued fractions are identical to those of Bhāskara II (Dennis and Joseph, 2004). That there exists no linearity but instead an epistemic rupture about the progress of mathematics between India and Europe is a matter taken for granted under the influence of the long sustained belief about the East as the opposite of the West in all respects. The West had built up this contrast through the historical process of representing the East on the basis of unfounded ideas, imaginary notions and prejudices, which subsequently gave rise to the myriad of discursive strategies of Eurocentrism for distinguishing the West from the East in every aspect of culture (Foucault, 1972; Said, 1977). Between the East and West, there was no paradigm shift in terms of epistemic meanings, measures and parameters regarding the production of astronomical knowledge in the 17th century. Their mathematical approach through the development of infinite series for understanding and reckoning planetary positions and movements were epistemologically the same.

8. Observations

Scholars were engaged in addressing intellectual issues in the domain of knowledge of their choice, a process that inevitably transcended the region and Sanskrit, the language of specialised traditional scholarship, facilitated their sub-continental convergence. It becomes clear that intellectual perception comes into being out of interaction with the community of scholars and their scholarship on the one side and under socio-cultural compulsions. The traditional Indian intellectual culture, disrupted and alienated by colonialism, is inaccessible today not solely because it is all in Sanskrit but mainly because we do not know its knowledge-language that is ontological and culturally contingent. It is a language of historically contingent cultural constructs that are not mere words or tropes but established traditional practices. Thanks to the studies by a few dedicated modern scholars, we realise that there existed a single cognitive thread of epistemic control in the production of knowledge. The long protracted and persistent *vyākhyā /bhāṣya* tradition demonstrates a clear linearity about the progress of methodological pre-occupation in knowledge production of Pre-colonial India from the axiomatic through proof creation to the scientific over centuries. There was no rupture in the process although the next higher phases were manifested not in regions across India but in Europe. What emerges is the universality of epistemic properties that make deeper knowledge distinct irrespective of its geography. Any inquiry into the methodological ideas of knowledge production in pre-colonial India starting with mathematical astronomy and proceeding to other areas discovers this epistemological unity.

9. About the Articles

The articles in this Special Issue are specialised engagements in the select branches of knowledge outlined in the above paragraphs and the overt or covert demonstration of their embedded methodological aspects that we have briefly discussed as part of our introduction. These articles deal with knowledge produced at disparate periods between the early historic and the late medieval or early modern. Sharada Srinivasan's article explores the trajectory of knowledge production in the realm of metallurgy from the Bronze Age to the Iron Age. She attempts to show how archaeometallurgical researches aided by inscriptional and literary sources juxtaposed to ethnoarchaeological survivals in the continuing artisanal technologies can provide insights into the antiquity of knowledge production, through her case studies of high-tin bronzes from Iron Age Tamil Nadu, zinc smelting evidence at Zawar, Rajasthan, gold working in the Nilgiris, and the high-tin bronze mirror craft of Aranmula, Kerala. She also seeks to explore the interplay between functional and cultural imperatives through which one may explain the preferential emergence of certain technologies with respect to debates on knowledge production.

M.S. Valiathan's article seeks to study Caraka's views on knowledge with reference to Āyurveda. He shows how Caraka conceived Āyurvedic knowledge as having no beginnings since there was never a time when the flow of life and intellect did not exist or a time when the knowers of āyurveda did not exist. According to Caraka, knowledge dealt with the eternal characteristics of life endowed by nature, which included health and disease, happiness and sorrow, their material substrates and many inter-relations. Valiathan's article informs that to Caraka substances and their inherent properties such as heavy and light, cold and hot and the law of generality and particularity which determine the union and disunion of substances are also eternal. Based on the views of Caraka, Valiathan argues that the knowledge of Āyurveda did not arise out of nothing or from a moment of creation, for it is the sum total of timeless concepts and traditions

crystallized as a treatise or a system. What his article underlines as an enduring lesson is Caraka's willingness to draw upon the philosophical perspective of the *Vaiśeṣika, Nyāya* and *Sānkhya* thinkers and adapt them so as to suit his own intellectual conception of āyurveda.

There is an attempt to trace the history of Āyurveda in the article by Raghava Varier from the antiquity of the healing and health care tradition. He argues that the making of Āyurvedic knowledge was a long process involving the contributions of several generations of practitioners over centuries. Varier shows that different healthcare traditions in the past had a long course of interactive co-existence involving mutual borrowing of experiences, techniques and approaches. They involved those of the tribal peoples, brāhmaṇas and śramaṇas. As regards the methodology of knowledge production embedded in both the traditions, he rightly points out many years of experiential learning through constant observation, careful examination and scrupulous verification as central. According to him none of the traditions was in isolation. He maintains that it was with the *saṃhitā*-s that Āyurveda became an explicitly coded and systematised form of knowledge.

In a joint article, Venugopal and Darsan Sankar seek to examine the epistemic properties and methodological aspects of Āyurvedic knowledge at the instance of the allusions in the text. The authors argue that the knowledge in Āyurveda is based mainly on four types of theories (*siddhānta*) viz., *śarvatantra siddhānta* (the theory universal to all *śāstrās*), *pratitantra siddhānta* (the theory particular to Ayurveda), *adhikaraṇa siddhānta* (the theory relating to each topic) and 4) *abhyupagama siddhānta* (the untested theory). These *siddhānta*-s were debated among practitioners and novices of various schools of thought on the basis of entrenched logical procedures (*vādāmarga*) followed to justify propositions. They show that the Āyurvedic knowledge was formulated on the basis of certain specific criteria of theoretical rationality known as *tantra-yukti.* Āyurveda is a holistic knowledge, the whole of which cannot be comprehended just by knowing the parts.

Divakaran's article starts with the premise that the principle and results of mathematics are universal and immutable. However, he observes that there are significant variations in the practice of mathematics from culture to culture. The article seeks to inquire into the roots of the broad universals across the culturally contingent variations. He illustrates extensively and argues that the oral and nominal mode of communication accounts for the variation. The Indian approach to geometry as distinguished from the Hellenic, the evolution of the idea of proof in India, and the explosion of new mathematical ideas in Kerala during 15th and 16th centuries and a review of cross-cultural influences are other topics discussed in the article.

In the joint article by Balachandra Rao, Rupa K. and Padmaja Venugopal, they seek to analyse the phenomenon of heliacal rising and setting of stars in general and of Canopus in particular in the light of the theories in Indian astronomy. They argue that it is the circumpolarity for different latitudes during different periods, usually in intervals of thousands of years, which makes the star *Agastya* (Canopus) significantly distinct. The article seeks to explain how the star, *circumpolar* for an extreme North Indian latitude, attained some status after two thousand years for a lesser North Indian latitude. It has been argued that the course of *circumpolarity* of Canopus moves southwards reducing the terrestrial latitude successively until it reaches a southern limit. According to the authors the star reverses its course moving northward until it reaches the northern limit of terrestrial latitude.

Rajendran in his article on the inferential episteme termed '*anumāna*' points out an

unfortunate grey spot in the Indian intellectual tradition, i.e. the relative lack of methodological discussions in the otherwise impressive theoretical treatises. However, it is evident that knowledge in various spheres like astronomy, mathematics, engineering, metallurgy, medicine, jurisprudence, aesthetics and *yoga* was formulated through a rigorous procedure of logic relating to deduction. Raghuramaraju's article deals with the issue further, by shifting the focus from the site of knowledge production to the site of organisation. Organising, according to Raghuramaraju, requires a different methodological preoccupation. It involves a methodological strategy to assemble the diverse elements in the different texts as exemplified by the work of Bādarāyana in the organisation of the *Vedānta sūtra-s*. Raghuramaraju argues that there is a difference in the case of Nāgārjuna who, in the process of organization of the sayings of the Buddha, provided them with a philosophical foundation. Embarking on the acknowledgment of studies on knowledge production in pre-modern India, he begins by tracing a trajectory from the present, neutralised or frozen.

Sundar Sarukkai's article maintains that in the history of science, there are two significant questions relating to the transmission and circulation of ideas and knowledge across different cultures. One is the question relating to the claim of greater antiquity of science in the Indian and Chinese civilizations. The other is the question concerning the cross-cultural transmission of the Indian and Chinese science to Europe before the onset of 'modern science.' Sarukkai, focusing on the use of translation and the theoretical assumptions therein, enquires into the relation between translation and transmission. He rightly argues that the framework of translation studies has a great relevance to the discussion of the cross-cultural transmission of knowledge, for it brings to the fore serious methodological issues in the process of the production of science.

In an article R. Champakalakshmi seeks to explore the beginnings and growth of knowledge production in the Tamil language, literature and culture. Starting with the poetics and the grammatical exegesis of the heroic poetry in *Tolkāppiyam* that laid the foundation of specialised knowledge tradition in Tamil, she discusses the production and transmission of knowledge in Grammar, Mathematics and its ancillary Astronomy through the *gurukula* system. Referring to the subsequent period of 4th-6th centuries AD, representing a new socio-economic formation and the spread of the Buddhist and Jain religions in the region, she examines the specialised knowledge content in the *Patineṇkī; kkaṇakku*, a series of 18 didactic works on contemporary ethics, morality and social norms.

The article by Y. Subbarayalu examines the historical context and features of the earliest available grammatical text of old Tamil literature, popularly known as the Sangam literature (dated anterior to the fifth century AD) – the *Tolkāppiyam.* His essay discusses the importance of the later commentaries in making sense of the laconic and terse aphorisms of this treatise, and also the importance of this grammar as a historical chronicle of socio-cultural value.

Mundoli Narayanan brings out the fact that most traditional Indian performance forms are characterised by distinct modes of embodied knowledge. Taking the case of Kathakali, the traditional performance art from Kerala, he shows how with the degree of systematization present in their performative practices enhances its intensity and problematizes the inherent mind-body hierarchies. According to him the performative practice of Kathakali, involving a repetitive training regimen, inscribes in the young student a comprehensive language and aesthetic of performance. He argues that a distinctive 'body mind' and a 'body memory' relationship is established, almost entirely precluding the intervention of the 'conscious mind.' Narayanan

observes that the formal embodied knowledge is expected to be informally enriched in performance by a greater awareness of the aesthetic, emotive, thematic and other significant aspects of performance, as the student acquires life experience and matures both as a person and as a practitioner.

Naresh Keerthi's article seeks to study the musical meta-genre known as the *prabandha* that has much variety in number, description and details as per the musicological sources of the early and late medieval times. The author considers here a specific sub-category – the *śrīraṅga Prabandha*, studies its genealogy through the musicological literature, and uses it as an example to understand the life trajectory of the concept of a *prabandha*. By studying the structural, textual and musical content of the song in comparison with the musicological prescription, he exemplifies and draws attention to the methodological problems in studying the history of something as transitory as a performed genre – be it musical, theatrical or otherwise.

R.V. Achari's article examines the *Vāstuśāstra*, a term occurring in several Sanskrit texts of early India to mean *Vāstuvidyā* or architecture, against the historical context of the text's transformation into a set of Sanskrit lyrics with the prescriptions based on mythical beliefs of a society of *varṇa/jāti* discriminations. He argues that in the process of filling the text with bizarre beliefs, the architectural knowledge and skill developed and continuously improved by the community of artisans and craftsmen got sidelined. Critical of the present practice of using the terms *Vāstuvidyā*, *Vāstuśāstra* and *Taccuśāstra* interchangeably, Achari underlines the importance in epistemologically distinguishing *Vāstuvidyā* from *Vāstuśāstra* , a text of mere factoids.

To conclude, the articles address the character of knowledge in the fields such as ancient metallurgy, healthcare, mathematics, logic, philosophy, grammar, architecture, intellectual history, histrionics and musicology. They are illustrative of the fact that the pre-modern Indian knowledge in such fields was generated through determinate logical ways and means (*tantra-yukti*-s) ensuring intellectual depth, authenticity, and credibility. Interestingly these strategies confirming the veracity of knowledge are what modern methodology embodies. In that sense the systematised knowledge of pre-modern India represents antecedents of scientific thinking that signifies 'science,' derived from the Latin word *'scientia'* denoting profound knowledge, until Newton's Principia set the example of science with an epistemic distinction.

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