Abstract

This paper shows that characteristic features of Purāṇic cosmology, such as alternating cosmic “continents” and “oceans” of successively doubling areas, can be traced to Vedic texts. The Rgveda speaks of seven regions of the universe, and Yajñavalkya, in Brhadāraṇyaka Upaniṣad, presents a cosmology that has all the essential features of the Purāṇic system. This discovery solves the old puzzle of the origin of Purāṇic astronomy.

Keywords: Ancient Indian astronomy, Purāṇic cosmology, Yajñavalkya

Introduction

The prehistory of Purāṇic astronomy is not well understood. Although it is known that the Purāṇas contain very old material, some modern historians of astronomy have believed that the cosmology presented there has no Vedic antecedents. In this paper, we show that this belief is wrong, and a system similar to Purāṇic cosmology is described in the Vedic tradition.
In the past few years a new understanding of the origins of Indian astronomy has emerged. In various publications,\textsuperscript{1} we have sketched a history of Indian astronomy from the earliest Vedic conceptions— as expressed in the astronomy of geometric altars— to the classical Siddhāntic astronomy. Meanwhile, the use of modern computer packages has made it possible to reexamine the astronomical references in the early texts.\textsuperscript{2} Although recent work showed that Purāṇic and Siddhāntic astronomies have several common points, the origins of Purāṇic astronomy remained unclear.

Here we present Yājñavalkya’s cosmology from Brhadāraṇyaka Upaniṣad (BU) 3.3.2 which has hitherto escaped scholarly attention. We show that this cosmology has all the basic features of the later Purāṇic cosmology and so it may be viewed as the original source.

The great Upaniṣadic sage Yājñavalkya is a major figure in the earliest Indian astronomy, that precedes Lagadha’s Vedāṅga Jyotiṣa. Elsewhere, we have noted that in the Śatapatha Brāhmaṇa, Yājñavalkya speaks of a 95-year intercalary cycle to harmonize the lunar and solar years,\textsuperscript{3} and he describes the non-uniform motion of the Sun.\textsuperscript{4} We showed that these were significant links in the early development of Vedic astronomy. The 19th century European Indologists tended to assign him to around 800 B.C., but a reexamination of the evidence suggests that he should be assigned to around 1800 B.C. However, the chronology of Yājñavalkya is not our concern here, so will not comment any further on it; this question is discussed at length elsewhere.\textsuperscript{5}

\textbf{Vedic and Purāṇic Cosmological Ideas}

In brief, the Vedas take the universe to be infinite in size. The universe is visualized in the image of the cosmic egg, Brāhmaṇda. Beyond our own universe lie other universes.

The Pañcaviṃśa Brāhmaṇa 16.8.6 states that the heavens are 1000 earth diameters away from the Earth. The Sun was taken to be halfway to the heavens, so this suggests a distance to the Sun to be about 500 earth diameters from the Earth.

Yajurveda, in the mystic hymn 17, dealing with the nature of the universe, counts numbers in powers of ten upto $10^{12}$. It has been suggested that this is an estimate of the size of the universe in yojanas.

The Purāṇas provide material which is believed to be close to the knowl-
edge of the Vedic times. Here we specifically consider Vāyu Purāṇa (VaP), Viṣṇu Purāṇa (ViP), and Matsya Purāṇa (MP). VaP and ViP are generally believed to be amongst the earliest Purāṇas and at least 1,500 years old.

The Purāṇas instruct through myth and this mythmaking can be seen in their approach to astronomy. For example, they speak of seven underground worlds below the orbital plane of the planets and of seven “continents” encircling the Earth. One has to take care to separate this imagery, that parallels the conception of the seven centres of the human’s psycho-somatic body, from the underlying cosmology of the physical universe of the Purāṇas, that is their primary concern in their jyotisa chapters. The idea of seven regions of the universe is present in the Rgveda 1.22.16-21 where the Sun’s stride is described as saptadhāman, or taking place in seven regions. The geography of concentric continents is a representation of the plane of the Earth’s rotation, with each new continent as the orbit of the next “planet”.

The different Purāṇas reproduce the same cosmological material. There are some minor differences in figures that may be a result of wrong copying by scribes who did not understand the material. In this paper, we mainly follow ViP.

ViP 2.8 describes the Sun to be 9,000 yojanas in length and to be connected by an axle that is $15.7 \times 10^6$ yojanas long to the Mānasā mountain and another axle 45,500 yojanas long connected to the pole star. The distance of 15.7 million yojanas between the Earth and the Sun is much greater than the distance of 0.46 million yojanas used by Āryabhaṭa in his Siddhānta. (But note that the yojana of the Purāṇas is different from the yojana of the Siddhāntas.) This greater distance is stated without a corresponding change in the diameter of the Sun. The size of the universe is described as 500 million yojanas.

In VaP 50, it is stated that the Sun covers 3.15 million yojanas in a muhūrta. This means that the distance covered in a day are 94.5 million yojanas. MP 124 gives the same figure. This is in agreement with the view that the Sun is 15.7 million yojanas away from the Earth. The specific speed given here, translates to 116.67 yojanas per half-nimeśa. We have argued that the speed of 2,202 yojanas in half-nimeśa mentioned by Sāyaṇa, may have emerged from the theory that light should travel at a speed that is able to illuminate the entire universe in one day.

The size of the universe is described in two different ways, through the “island-continents” and through heavenly bodies.
The planetary model in the Purāṇas is different from that in the Siddhāntas. Here the Moon as well as the planets are in orbits higher than the Sun. Originally, this supposition for the Moon may have represented the fact that it goes higher than the Sun in its orbit. Given that the Moon’s inclination is 5° to the ecliptic, its declination can be 28.5° compared to the Sun’s maximum declination of ±23.5°. This “higher” position must have been, at some stage, represented literally by a higher orbit. To make sense with the observational reality, it became necessary for the Moon is taken to be twice as large as the Sun. A point of note is that this model effectively assumes that all the heavenly bodies go around the Sun.

The distances of the planetary orbits beyond the Sun are as follows:

Table 1: From Earth to Pole-star

| Interval I                             | yojanas   |
|----------------------------------------|-----------|
| Earth to Sun                           | 15,700,000|
| Sun to Moon                            | 100,000   |
| Moon to Asterisms                      | 100,000   |
| Asterisms to Mercury                   | 200,000   |
| Mercury to Venus                       | 200,000   |
| Venus to Mars                          | 200,000   |
| Mars to Jupiter                        | 200,000   |
| Jupiter to Saturn                      | 200,000   |
| Saturn to Ursa Major                   | 100,000   |
| Ursa Major to Pole-star                | 100,000   |
| **Sub-total**                          | **17,100,000** |

Further spheres are postulated beyond the pole-star. These are the Maharloka, the Janaloka, the Tapoloka, and the Satyaloka. Their distances are as follows:
Table 2: From Pole-star to Satyaloka

| Interval II                  | yojanas   |
|-----------------------------|-----------|
| Pole-star to Maharloka      | 10,000,000|
| Maharloka to Janaloka       | 20,000,000|
| Janaloka to Tapoloka        | 40,000,000|
| Tapoloka to Satyaloka       | 120,000,000|
| Grand Total                 | 207,100,000|

Since the last figure is the distance from the Earth, the total diameter of the universe is 414.2 million yojanas, not including the dimensions of the various heavenly bodies and lokas. The inclusion of these may be expected to bring this calculation in line with the figure of roughly 500 million yojanas. Or, it is more likely, that the universe is taken to be egg-like in shape, as suggested by the name of Brahmāṇḍa, the world-egg.

Beyond the universe lies the limitless Pradhāna, that has within it countless other universes. These other universes were visualized to be independent world-eggs.

The geography of the Purāṇas describes a central continent, Jambu, surrounded by alternating bands of ocean and land. The seven island-continents of Jambu, Plakṣa, Śālmalā, Kuśa, Kraunca, Śāka, and Puṣkara are encompassed, successively, by seven oceans; and each ocean and continent is, respectively, of twice the extent of that which precedes it.

It is important to realize that the continents are imaginary regions and they should not be confused with the continents on the Earth. Only certain part of the innermost continent, Jambu, that deal with India have parallels with real geography.

Although, in earlier work we explored the non-orthodox interpretation that the doubling of the dimensions applied to the “oceans” as well as “continents”, we return to the orthodox view here, where the increase in dimension by a factor of two is only across the seven “continents.” At the end of the seven island-continents is a region that is twice the preceding region. Further on, is the Lokāloka mountain, 10,000 yojanas in breadth, that marks the end of our universe. The Lokāloka mountain can be compared to the shell of the world-egg.

Assume that the radius of Jambu is \( J_r \) yojana, then the radius of the universe is:
\[ U_r = J_r(1+1+2+2^2+2^2+2^3+2^3+2^4+2^4+2^5+2^5+2^6+2^6)+10,000 \] (1)

Or,

\[ U_r = 254J_r + 10,000 \text{ yojanas} \] (2)

If \( U_r \) is roughly 250 million yojanas, then \( J_r \) should be about 1,000,000 yojanas.

**The Orbit of the Sun**

Since the Sun’s axle is taken to have dimensions of \( 15.7 \times 10^6 \) yojanas, let’s see where exactly it will fit into the island-continent scheme. This is clear when we see that:

\[ 15.7 \times 10^6 \approx J_r(1 + 1 + 2 + 2 + 4 + 4) \] (3)

In other words, the orbit of the Sun will be somewhat beyond the Śālmala continent. Since the total radius of the Universe is roughly \( 254J_r \), it means that beyond the roughly 14\( J_r \) orbit of the Sun, there is present an approximately 16-fold expansion.

**Yājñavalkya in Bṛhadāraṇyaka U.**

Given the background of the Purānic system, we are ready to examine the statement by Yājñavalkya in Bṛhadāraṇyaka Upaniṣad (BU) 3.3.2. He says:

\[ dvātrimśatam vai devarathāhnyānyayam lokastaṁ samantam prthivi dvistāvatparyeti tāṁ samantam prthivi dvistāvatsamudraḥ paryeti \]

Thirty-two times the space traversed by the Sun’s chariot in a day makes this plane (loka); around it, covering twice the area, is the world (prthivī); around the world, covering twice the area, is the ocean. (4)

This describes a system where beyond the Sun’s orbit there is an expansion by a factor of 32; further beyond that there is doubling of the area in
the dimensions of the “Earth” and a further doubling in the dimensions of
the ocean beyond. In other words, there is a total expansion by a factor of
128 beyond the Sun’s circuit.

Notice that it is essentially the Purānic system in a simplified form. Like
the Purānic system, the land-mass and ocean alternate, increasing by a factor
of 2 for each land-mass, although there is explicit mention in this passage of
just one such region. A second region is the ocean just beyond the Earth and
other similar regions are suggested by the Rgvedic reference. Yājñavalkya,
collapses several steps by considering 32 times the space traversed by the
Sun, multiplied by another factor of 4, to be the Earth’s plane. This system
retains the idea of alternating land and water.

### Expansion by Factor of 32

Assuming that the seven continent-ocean scheme is meant by the \textit{saptadhāman}
of the Rgveda, Yājñavalkya, must use it in defining the plane that is 32 times
the space traversed by the Sun’s orbit. Since beyond this space lie just one
continent with the corresponding ocean (of double the area), the last contin-
ent must be Puṣkara. Since these two last regions have a combined size of
$128J_r$, this plane must be at a distance of $126J_r$ from the centre of Jambu.

Let the orbit of the Sun be at a distance of $S_r$ from the centre of Jambu.
Since (4) does not make it absolutely clear whether the phrase “space tra-
versed ... in a day” simply defines the circuit of the Sun, or whether one
should multiply this circuit by $2\pi$, we consider both these possibilities sepa-
rately.

In the first case, $32S_r = 126J_r$, which means that $S_r \approx 4J_r$. Or the circuit
of the Sun is just beyond the second continent Plakṣa. In the second case,
$2\pi \times 32S_r = 126J_r$. Or $S_r \approx 0.627J_r$. In this latter case, only a part of the
Jambu continent is the Earth, and most of it represents the atmosphere.

If one were to assume that Yājñavalkya knew that $J_r$ was approximately
1,000,000 yojanas, the radius of the Sun’s orbit will then be 4,000,000 yojanas
or 626,000 yojanas, respectively. It is noteworthy, that the Siddhāntas use a
figure which is not too different from the latter one.
Conclusions

The model of the universe described by Yājñavalkya in Brhadāranyaka Upaniṣad (BU) 3.3.2 appears to be the prototype that led to the full-fledged Purānic system. The two systems share essential features of area doubling and alternating land and water masses.

There are some difference of details, however. The Purānic system seems an expansion of the Sun’s circuit by a factor of 16. On the other hand, in Yājñavalkya’s system the expansion is by a combined ratio of 128.

If it is assumed that Yājñavalkya knew the dimensions of the continent and ocean scheme, the size of the orbit, in one of the interpretations, comes out to be 626,000 yojanas, which is only slightly larger than the number used in the Siddhāntas. This suggests that Yājñavalkya’s scheme was the model from which both the mature Siddhāntic and Purānic systems emerged.

Even if Yājñavalkya did not use the same dimensions as the later Purānic astronomy, the structural similarity of the two systems is striking.

We find that Yājñavalkya’s scheme moved the Sun closer to the Earth, compared to the earliest Vedic scheme where the Sun was right at the centre of the cosmos. It is interesting, nevertheless, that Yājñavalkya projects the Sun’s circuit, through his multiplication factor of 32, to this middle point. The mature Purānic system involves an increase in the size of the Sun’s orbit, compared to Yājñavalkya’s scheme.

Yājñavalkya’s description of the nature of the cosmos solves a long-standing puzzle regarding the origin of the Purānic system. We now know that this latter system is deeply connected to early Vedic ideas.

Notes

1. This work may be found collectively in S. Kak, “Birth and early development of Indian astronomy,” In Astronomy Across Cultures: The History of Non-Western Astronomy. H. Selin (ed.). Kluwer Academic, Boston, 2000, pp. 303-340;
   S. Kak, The Astronomical Code of the Rgveda. Munshiram Manoharlal, Delhi, 2000.
2. B.N. Narahari Achar, “Enigma of the five-year yuga of Vedanga Jyotisa,” Indian Journal of History of Science, 33, 1998, pp. 101-109.
B.N. Narahari Achar, “On the astronomical basis of the date of Satapatha Brahmana,” Indian Journal of History of Science, 35, 2000, pp. 1-19.

3. S. Kak, “The astronomy of the Śatapatha Brāhmaṇa,” Indian Journal of History of Science, 28, 1993, pp. 15-34.

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4. S. Kak, “The Sun’s orbit in the Brāhmaṇas,” Indian Journal of History of Science, 33, 1998, pp. 175-191.

5. Note 1.

6. H.H. Wilson (tr.), The Vishnu Purana. Trubner & Co, London, 1865 (Garland Publishing, New York, 1981); The Matsya Puranam. The Panini Office, Prayag, 1916 (AMS, New York, 1974);

R.P. Tripathi (tr.), The Vāyu Purāṇa. Hindi Sahitya Sammelan, Prayag, 1987.

7. G. de Santillana, and H. von Dechend, Hamlet’s Mill: An Essay on Myth and the Frame of Time. Gambit, Boston, 1969.

8. See Note 1.

9. S. Kak, “Speed of light and Purāṇic cosmology.” In Computing Science in Ancient India, T.R.N. Rao and S. Kak (eds.). Munshiram Manoharlal, Delhi, 2000.