Lecture 13

Feb. 22, 2016

The literal meaning of the Sanskrit word, Siddhanta is simply settled opinion or doctrine, dogma, axiom, received or admitted truth; any fixed or established or canonical text-book on any subject" (< siddha, adj. mfn.- accomplished, fulfilled; that has attained the highest object, thoroughly skilled or versed in). [[1]](https://en.wikipedia.org/wiki/Siddhanta#cite_note-1) (from Wikipedia)

Siddhantic Astronomy however has come to mean “mathematical astronomy” of India in the classical period (the Gupta Age,

Traditionally, Hindu religion tends to classify all knowledge into two broad kinds:

1. Laukika, or this worldly. Traditionally, astrology/astronomy, mathematics, medicine are seen as this-worldly or laukika. Laukika knowledge refers to matters of fact which are obtained by ordinary means of sensory perception and logic. This knowledge is relatively temporary – can be wrong or right
2. Alaukika vidya, or divine knowledge which requires spiritual training and is not accessible through senses and unaided human reason. This is divine knowledge, and because it is divine, cannot be wrong, and cannot be challenged by laukika knowledge.

This division is important for understanding the history of astronomy in India for this reason: Cosmological speculations appear in both the laukika (secular) and alaukika (divine) literature. In other words, the two domains are not clearly separated: sacred books, especially the Puranas contain detailed descriptions of the creation and the structure of the universe; as do the secular, this-worldly writings.

 So essentially, Indian cosmology has two main sources:

1. The Puranas, which have the status of divine knowledge, or vidya. Pandits and learned brahmins considered these works as sacred as the shruti, or the Vedic revelations.
2. The Siddhantas in the laukika or secular spheres. The word “Siddhantic” here means mathematical astronomy developed by India’s best known mathematicians including all the familiar names from Aryabhata and Varhamihira. Mathematicians.

History of Indian astronomy can be understood as a story of tension between the two models. Because the Puranic model of the cosmos had divine authority, we will find Siddhantic astronomy making compromises with the Puranic model time and again. We will see that even when Siddhantic astronomers knew the true cause of eclipses, they would still not openly question the role of Rahu and Ketu of the Puranic model. In fact, the compromise continues till today: Navagraha is still worshipped, and educated people drop everything when their astrologers tell them it is rahu-kaalam.

Before we get into details of the two models, remember:

* Both of them are strictly geo-centric. There is no hint of helio-centrism in Aryabhata or any other Siddhanta.
* The earth in the center of the universe is a flat disc in the Puranic model, while Siddhantas accept a spherical earth at the center of the universe.

The Puranic Model of the universe

The Puranas: Puranas form part of the Hindu sacred texts that are categorized as ‘smiriti”, literally what is remembered, as opposed to “shruti” that is heard, i.e. divine revelation “heard” by rishis. Even though smritis is considered less authoritative than shruti, Puranas acquired the status of the “fifth Veda” in the medieval period and are considered as authoritative as the shruti.

When were the Puranas composed? Two phases, first around the time of Mahabharata and then later in the Gupta period, 4-6 ce. In medieval times, the Bhakti themes began to dominate, and all the popular gods and goddesses – especially Brahma, Vishnu and Shiva and their wives Sarasvati, Lakshmi, Parvati –make an appearance.

All Puranas deal with five themes:

Creation of the universe (sarga); dissolution of the universe (pratisarga); yugas, or the ages of the universe; vansha, or genealogies of kings and dynasties, and finally vansha charita, stories about the deeds of gods and kings.

The Puranic picture of the universe:

* The earth is a flat disc, 500 million yojanas in diameter . A yojana is around 10 km). so the earth is 5 billion km in diameter.
* In the center of this disc stands the month Meru, or Sumeru, 84,000 yojanas tall
* The surface of the earth is covered by concentric rings of seven continents divided by seven oceans.
* The sun, moon, constellations and planets are carried around Meru which makes them appear to rise and set.
* The pole star is directly above the summit of Meru, upon which is the city of Gods.
* The moon is higher than the sun; the five visible planets are higher than the constellations.
* The phases of the moon, as well as the solar and lunar eclipses are explained by a demon Rahu.

Time in the Puranas: Puranas talk of immense cycles of time. This time scale, however fantastic, is important to know because the Siddhantas continued to use it.

* The universe is created and destroyed in a Kalpa, day and night of Brahma, 4,320 million years or 4.32 billion years.
* There is a shorter period called mahayuga, which is “only” 4, 320,000 years long.
* Mahayugas are divided into four smaller units in a 4:3:2:1 ratio in which the world decays from good to bad. The last the worst age is called kaliyuga, which lasts 432, 000 years.
* There are 71 mahayugas in a period called manvantara; 14 manvantaras and some extra years make up one kalpa.
* The current Kaliyuga is supposed to have started on Friday, Feb. 18, 3102 BCE.

Siddhantic Astronomy

The Greek Influence:

After Alexander, we find evidence of Greek astronomy/astrology on India. The major evidence comes from a text called Yavanjataka by someone named Sphujidhvaja .

It is a versification of an earlier translation into Sanskrit of a Greek text, thought to have been written around 120 BCE in [Alexandria](https://en.wikipedia.org/wiki/Alexandria).

What was transmitted through Yavanajatka?

* Spherical earth,
* geocentric model,
* planets (only sun and the moon in Vedanga Jyotish )
* epicycles but no equants. So it is not Ptolemaic. Evidence unearthed by Pingree leads us to believe that it was the work of Hipparchus that was introduced into India.
* first known mention in India of the 12 zodiac signs
* division of the zodiac into 360 degrees. ( we still express muhurta and half-muhurts sexagesmically.) no sign of this before yavanjataka.

These new concepts were combined with Puranic ideas of time led to Brahma or Paita-maha-siddhanta, which is the basis of all later Siddhantas. The existence of mount Meru was also retained.

The original source of various pakshas is a treatise called the Brhama-Siddhanta, also called Paitamaha Siddhanta (Pitamaha is another name for Brahma). This text survives only as a fragment and has become absorbed into one of the Puranas (Vishnu-dharamottara-purana). The date for this text is somewhere around the time of Aryabhatta, as he had access to it and quotes from it.

Since this is the model for all other Siddhantas, let us look at what it says:

It is framed as a dialogue between Brahma and a sage by the name of Bhrigu who seeks instruction on how to calculate time.

Brahma Siddhanta accepts the Puranic time scale described above. This is fundamental to the rest of the calculations:

All celestial objects – the seven planets, including the sun and the moon, the apsidal points (see the footnote below) [[1]](#footnote-1) and ascending nodes of their orbits, and the fixed stars – are considered to complete integer number of revolutions around the Earth in one kalpa.

All of them are supposed to start from a conjunction at the zero point of celestial longitude and latitude, or the beginning of the ecliptic (see footnote below)[[2]](#footnote-2)

This time frame is kept in the later siddantas, which assume that the present age is the kaliyuga of the 28th mahayuga of the seventh manvantara of the kalpa. The present Kaliyuga is supposed to have begun on with the Mahabharata, which is dated precisely to Friday, 18 February, 3102 BCE!! ( How did this date become established? No one really knows. But the accepted view is that astronomers in the first millennium CE retrodicted an approximate conjunction of planets around then. That became the handy starting point from which to calculate time. )

Not long after the Brahma siddhanta, siddhantic astronomy branched into different schools, or pakshas, the most notable of them are Arya pakasha (associated with Aryabhatta) and the Brahma Paksha (associated with Brahmagupta) and Saura Paksha.

These pakshas are distinguished from one another mostly by the values of the parameters they use for the division of time and the cycles of the heavens. All the pakshas, however, share the time scale of the original Pitamaha Siddhanta, which as we have seen, adopts the Puranic time scale of kalpas and yugas.

Let us look at the major pakshas:

1. Arya Paksha: is named after Aryabhatta (born 476 ce)

This paksha allots 1008 instead of 1000 mahayugas to a kalpa. He divides a kalpa into equal mahayugas.

In his well-known work called the Aryabhatiya, a kaliyuga is one-fourth of a mahayuga instead of one-tenth and there is a conjunction of planets at the start of the ecliptic at the beginning and the end of each Kaliyuga. While this is a big change, Aryabhatta claims that he is true to the astronomy of the Pitamaha Siddhanta.

The other major astronomers in this tradition are :

Varahamihira (500 CE) famous for *Panchsiddhantika,*

Bhaskara I (early 7th century) who composed two texts called Maha-Bhaskariya and Laghu-Bhaskariya.

Lalla (probably 8th c) also followed the Arya P though he reverted to the more traditional division of mahayuga.

1. **Brahma paksha:**

Main proponent is Brahmagupta (598 CE) who writes a work which in English means “the corrected Siddhant of Brhama” He is critical of AB for violating the smritis and making all yugas equal. He says they are not.

 Well-known in this paksha are:

 Sripati

 Bhaskara II in the mid-12th c.

 Aryabhatta II in the late 10-11th c.

1. **Saura paksha**

This school follows Surya Siddhanta instead of Brhama or Pitamaha S. It combines the tradition time divisions of the Brhama Paksha with planetary conjunctions taken from Arya Paksha. Claims that it is the word of the sun god Surya and therefore has to be correct.

**What were they trying to accomplish??**

1. **Computation of times, locations and appearances of future and past celestial phenomena, i.e predictive astronomy**
2. **To explain the computations in geometrical forms**
3. **Teach mathematics.**

**So did the Siddhantic astronomy manage to falsify and reject the Puranic view of the cosmos?**

Not really.

While some crucial aspects of the Puranic cosmology were challenged, many compromises were simultaneously made.

Challenges:

1. The flat earth is rejected. Here is Aryabhatta:
“the globe of the earth made up of earth, water, fire and air, in the middle of a cage of the constellations formed of circles, surrounded by the orbits of the planets, in the center of the heavens is everywhere circular. In the same way that the bulb of a kadamba flower is entirely covered by blossoms, so is the globe of the earth covered by all beings born of earth and water.”
2. That the moon is farther away than the sun. Here is Brahmagupta: “if the moon were above the sun, how would its power of increase and decrease in brightness be calculated by the position of the moon?”
3. Lalla challenged the idea of eclipses being caused by a demon. He asked: “if your opinion is that a demon invariably devours the moon or the sun by means of magic, how it that the eclipse ever be found by calculation? “

Compromises:

1. Aryabhatta retains the Meru, while reducing its size to one yojna and accepting the Puranic idea that it is shiny and covered with jewels.
2. Brahmagupta challenged AB because he was defying the smritis. He defended the puranic idea of rahu and ketu causing eclipses because it was divine knowledge and defying it would make Brahmins’ rituals useless. (see the full quote from Alberuni in the lecture on Islamic science).
3. Saura paksha invoked god surya to claim its superiority.

The compromises continued into the modern era when Copernican astronomy was introduced:

Tried to reconcile Copernicus with Siddhantas (which are not helio-centric and then claimed that all this is OK for calculations, but the heavens are actually as described by the Puranas.

challenges

The flat earth is openly challenged.

Here is Aryabhatta: “ the globe of the earth … is in the middle of the cage of

1. Apsis means: *Astronomy.*either of two points in an eccentric orbit, one **(higherapsis)**farthest from the center of attraction, the other **(lower apsis)**nearest to the center of attraction. [↑](#footnote-ref-1)
2. Ecliptic: *noun*

ASTRONOMY

a great circle on the celestial sphere representing the sun's apparent path during the year, so called because lunar and solar eclipses can only occur when the moon crosses it.

*noun*

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