

On the time measurement units and measuring instruments of Samanta Chandrasekhar, the great naked eye Astronomer

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Abstract . Mahamahopadhyaya Shri. Chandrasekhar Singh Harichandan Mohapatra Samanta popularly known as Pathani Samanta was born in the then princely state of Odisha, Khandapadagad in 24th December 1835 (*Pausa Krusna Astami tithi*)[1]. He was a great naked eye astronomer mankind has ever seen [2]. *Sidhanta Darpan*, written by him is a masterpiece in astronomy and still being used in the state *Odisha* and especially in the rituals of *Jagannath Dham, Puri*. In this communication only time measurement units and measuring instruments used by him for local time calculation is discussed. In *Sidhanta Darpan* (Pratham Prakash, Sloka 25-30) different smaller units of time is given and it is worth noting that the smallest unit of time i.e. 'Truti' used by *Samanta* is $\sim 4.9382E-6$ s, which is of the order of μ s. In subsequent verses (slokas) largest unit of time known to him is described and it is $\sim 3.11 \times 10E14$ years. Again, it is interesting to note that one day of *Brahma* (referred in mythologies as the creator of everything) is $8.64E9$ years as per the calculations of *Samanta* and he has a bold prediction that out of the current holy day of present *Brahma*, $1.97E9$ years has been elapsed. Modern calculation and prediction is of the view that $\sim 1.38 E10$ years from Big Bang (creation of universe) has been passed till date [3,4]. Again, *Samanta* is of the view that this *Brahma* will live for all total $3.11E14$ years. The two values are not very far from each other. In this communication different time measuring low cost instruments like *Chapa Yantra*, *Golardha Yantra*, *Chakra Yantra Swayambaha Yantra* etc. are discussed in detail in this communication.

Key words: unit, Big Bang, yantra

1. Introduction

Mahamahopadhyaya Shri. Chandrasekhar Singh Harichandan Mohapatra was born in the then princely state of *Odisha*, *Khandapadagad* in 24th December 1835 (*Pausa Krusna Astami tithi*)[1]. *Samanta* popularly known as *Pathani Samanta*. He was a great naked eye astronomer mankind has ever seen after Tycho Brahe [2]. He was last luminary among the great scholars of Indian

scientific tradition to mention a few, *Aryabhata, Barahamihir, Bhaskaracharya, Brahmagupta, Ganesh, Sudhakar Dwivedi, Satananda, Kamalakar Bhatta, Kutanacharya, Ellacharya, Bapudev Sastri and Madhab Mishra*. They had their own *Siddhants*. Besides those many more might have contributed significantly to astronomy whose names were not recorded in the history, since their *Siddhantas* were not published. *Sidhanta Darpan*, written by him is a masterpiece in astronomy and still being used in the state *Odisha* and especially in the rituals of *Jagannath Dham, Puri*. The work was completed and published in the year 1899 by *Bidyaratna Press* [5] due to the effort of Prof. J. C. Ray. After this it was published in different languages by different publishers [1,5, 6].

2. Contents of *Sidhanta Darpan*:

Sidhanta Darpan is a voluminous work contains many chapters. *Siddhanta Darpana* contains 24 chapters with 2506 slokas, out of which 2290 verses composed by Samanta and 216 citations from earlier authors [7-9]. It contains 55 tables, each tables contains more than 50 numbers sometimes given up to five places in sexagesimal system [7]. All this shows his amazing computational skill and ability to carry out enormous calculations using large numbers without any aid.

Summary of contents of *Siddhanta Darpan* [8-10]

Chapter No.	Name of the section	Contents	No. of slokas
1	Madhyamadhikara	Description of time	55
2		Description of Bhagana etc.	25
3		Mean planet position	77
4		Various corrections	57
5	Spastadhikara	True planet position	221
6		Finer corrections	161
7	Triprasnadhikara	Gnomos etc.	95
8		Lunar eclipse	87
9		Solar eclipse	78
10		Parilekha description	137
11		Transit of planets	111

Chapter No.	Name of the section	Contents	No. of slokas
12		Alignments of planets	93
13		Rising and setting of planets	85
14		Phases of Moon	68
15		Description of Mahapata	71
16	Goladhikara	A set of question on Sun and Earth	80
17		Description of earth	160
18		Description of earth (contd.)	176
19		The celestial sphere	124
20		Description of instruments	112
21		Some deeper questions	251
22		Kaladhikara	Description of year etc.
23	Prayer to Purusottam(Lord Jagannath of Puri)		56
24	Conclusion		154
25	Additions	Transit of Venus	5

3. Time measuring units used in *Sidhanta Darpan*

In chapter 1 (*Pratham Prakash*) *Samanta* has illustrated time measuring units for astronomical calculations and other work. In verses (Slokas) 25-52 it is written in detail which is shown in the table given below.

SI No.	Samanta's Unit for measuring time	Modern units equivalent to that unit
1	1 <i>truti</i>	4.938E-6 s
2	1 <i>laba</i>	4.938E-4 s
3	1 <i>nimisa</i>	1.48 E-2 s
4	1 <i>kāsthā</i>	0.266 s

5	1 <i>guru varna</i>	0.4 s
6	1 <i>prāna</i>	4 s
7	1 <i>kalā</i>	8 s
8	1 <i>bighati/pala</i>	24 s
9	1 <i>khyāna</i>	240 s or 4 min
10	1 <i>danda/ghati</i>	1440 s or 24 min
11	1 <i>muhurta</i>	2880 s or 48 min
12	1 <i>day or naxatra dina</i>	86400 s
13	1 <i>divya/asura dina</i>	360 years
14	1 <i>mahā yuga/chatur yuga</i>	4.32E6 years
15	1 <i>manwantar</i>	3.0672E8 years
17	1 day of <i>Brahmā</i>	8.64 E9 years
18	The life span of this <i>Brahmā</i>	3.11 E 14 years

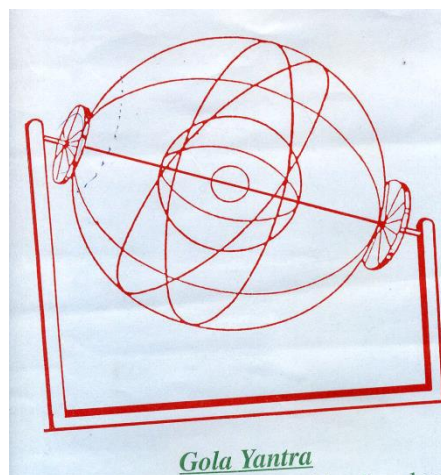
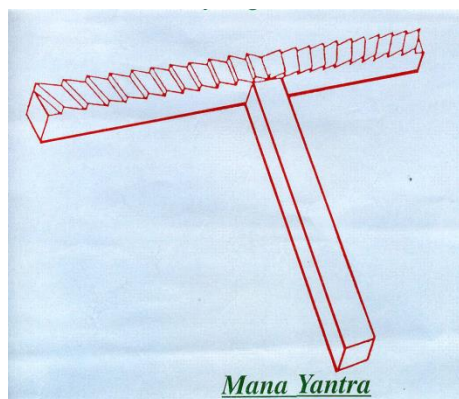
The smallest unit of time i.e. ‘*Truti*’ used by *Samanta* is $\sim 4.9382E-6$ s, which is $\sim \mu\text{s}$. In subsequent slokas (Verses) largest unit of time known to him is described and it is $\sim 3.11 \times 10E14$ years. Again, it is interesting to note that one day of *Brahma* (referred in mythologies as the creator of everything) is $8.64E9$ years as per the calculations of *Samanta* and he has a bold prediction that out of the current holy day of present *Brahma*, $1.97E9$ years has been elapsed. Modern calculation and prediction is of the view that $\sim 1.38E10$ years from Big Bang (creation of universe) has been passed till date [3,4]. The two values are not very far from each other. Again, *Samanta* is of the view that this *Brahma* will live for all total $3.11E14$ years.

4. Time measuring instruments given in *Sidhanta Darpan* [4]

In chapter 20 (*Vinsa Prakash*) different time measuring instruments used by *Samanta* is given [1]. The extends from verse (*sloka*) 52-109.

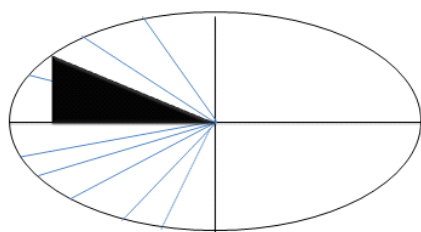
***Mānayantra*:** It is a T-shaped instrument made of two sticks, one standing vertical to the other. Former one got holes or marks in each unit. The observer can determine the height and distance of a distant object simultaneously by observing the object inside those holes taking two readings from different positions. This is the instrument which made *Samanta* popular among the

common people of *Odisha* since its working principle is very simple based on rudimentary geometry.

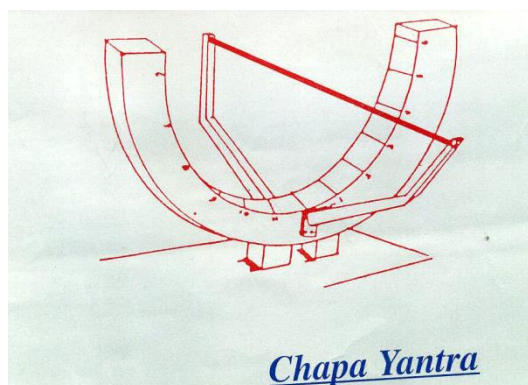


Golayantra: It is a replica of earth surrounded by the sky. In other words it represents a globe surrounded by the celestial sphere. As we know the globe is used to locate a place on the earth through imaginary latitude and longitude lines on it. Similarly imaginary lines are drawn across celestial sphere to determine position, motion and their respective rising and setting times of heavenly bodies throughout the year.

Suryaghadi: It was fabricated by *Samanta Chandra Sekhar* and its model version was installed by Prof. Jogesh Chandra Roy in Ravenshaw College (now Ravenshaw University). Although it is later replaced by different people it has been showing correct local time even now and attract people of different parts of globe.

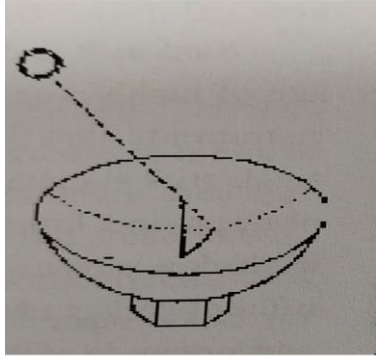


Suryaghadi

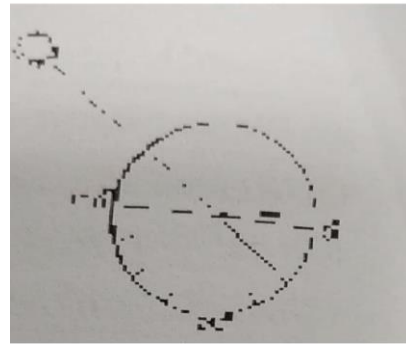


Chapayantra: It gives informations on time, date and month.

Golardha Yantra: It was designed by *Samanta* by using the lower part of the circular water pot and a stick of length equivalent to the radius of the pot inserted vertically upward at its center. This shows equally accurate time as the other sundials.



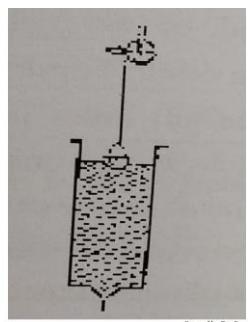
Golardhayantra



Chakrayantra

Chakrayantra: It is also a Sundial fabricated by *Samanta* following the similar principle of parallel axis to axis of rotation of earth and plane parallel to the equatorial plane.

Swayambahayantra: It is an instrument consisting of a container filled with water and an indicator plate connecting with a pot floating on the water. Continuous evacuation of water with a constant rate indicates constant time interval in the indicator plate. *Samanta* was keeping this instrument all the time with him, since it can work in both day and night time independent of sky conditions (whether cloudy or clear, sunny or night).



Swayambahayantra

5. Conclusion

Samanta used to use time measuring units $\sim \mu\text{s}$. He has also developed low cost instruments to observe the motion of celestial objects with accuracy. Since, he was a naked eye astronomer from his accurate measurement of position and velocity of different celestial bodies one may expect that he was well versed in physical laws. He was a Sanskrit scholar and do not know English at all. So, all his discoveries and inventions did not influenced by western research. His work has still do have significance and relevance. The copies of *Sidhanta Darpan* distributed in England (700 copies), France (300 copies), Germany (1000copies) shows how popular it is even today.

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