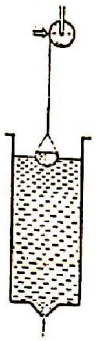
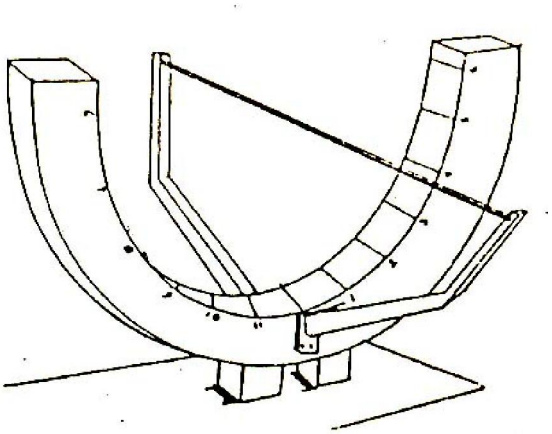
The Legacy of Samanta Chandrasekhara

Nikunja Bihari Sahu



Swayambaha Yantra

One of the greatest original astronomers of all time, Samanta Chandrasekhara extended and enriched the scope of Indian astronomy by virtue of his practical observations of the night sky. His full name is Mahamahopadhyaya Samanta Chandrasekhara Sinha Harichandan Mohapatra. However, in Orissa he is popularly known as Pathani Samanta, a nick-name given by his parents on account of their first two children having died in infancy. India has, over the years, produced many outstanding scholars in Astronomy such as Aryabhatta-1 of Kusumapura (476 A.D.), Varahamihira of Ujjaini (503 A.D.), Brahmagupta of Bhillamala or Bhinmal in Rajasthan (598 A.D.) and Bhaskara-II of Bijayapura or Bijapur in Karnataka (1114 A.D.). Samanta Chandrasekhara is said to be the last link in this long chain of classical astronomers that our country has produced.



Chapa Yantra

Early Days

Although the exact date of birth of Samanta Chandrasekhara is debatable and shrouded in mystery, he is believed to have been born on 13th December, 1835 in a royal family of the princely state of Khandaparagarh presently in the district of Nayagarh. Struck with poverty, child Chandrasekhara had little scope of having any formal school education or access to the breath-taking developments of science which was sweeping the whole western world at that time. There was no teacher who could instruct him into depth and he was quite ignorant of any language other than Sanskrit and his mother-tongue Odia. Only a paltry collection of books in his family library written on palm leaves in Sanskrit in purely classical style was the sole source of information for him. He has to content himself within the hills and jungles of his native place with only the stars as his guide.

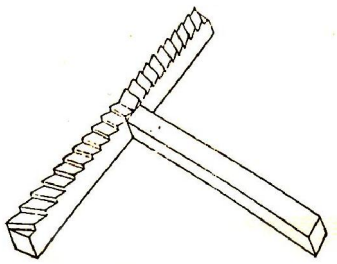
Need for Accuracy

It is said that at the age of 10, one of his uncles initiated him to astronomy and showed him few stars in the sky. This aroused his curiosity for the stars that persisted as a lifetime passion. At

the age of 15, he noticed that the position of stars was not in accordance with the rules prescribed in the famous astronomical texts or Siddhantas followed at that time. Again and again, he measured with a graduated rod the relative distance of heavenly bodies anticipating an agreement between the observation and calculation, but every time his hopes were dashed to the ground. He was not sure whether the rules were fundamentally wrong or his observations lack the accuracy as demanded by the merit of such task. Only correct measurement was necessary to settle this doubt which inherently requires efficient instruments. As there was no instrument maker at that time to supply him with the requisite tools to carry out such precise measurements, he had to develop his own set of instruments out of whatever materials he found, such as bamboo and wood. Sometimes, he used shell of the fruit Bottle gourd, an iron bowl as the raw material. Needless to say, the clear and blue canopy of the sky seen from his place was his observatory that offered him endless scope for astronomical pursuit.

Tools

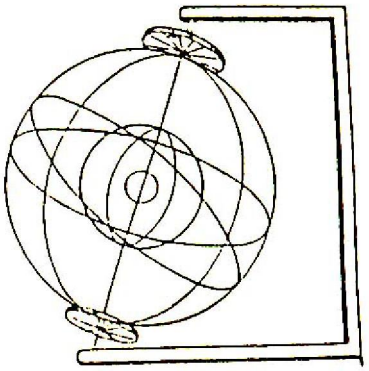
His instruments can be broadly classified into three categories, i.e. instruments for measuring Time, Versatile instruments and Armillary Sphere. In the context of the highly sophisticated instruments in use these days for astronomical measurements (capable of millionths part of a degree in accuracy), it will be interesting to have an idea of the instruments he was actually using. Instruments for measuring time include sun-dials like Chapa Yantra, Chakra Yantra, Golardha Yantra, and of course, a Water clock called Swayambaha Yantra. Chakra Yantra which measures time for an entire day consists of a graduated disc with a staff fixed at the centre. Chapa Yantra, basically a semi-circular dial with a pointer aligned at the Pole-star, measures time for half of a day. Golardha Yantra is a hemi-spherical sun-dial.



Mana Yantra

The instruments which were for versatile use primarily include a stick called Shanku and a 'T' shaped instrument called Mana Yantra. Shanku, or Gnomon as it is popularly known, consists of a stick of measured height fixed vertically on a leveled ground. By measuring its shadow length cast by the Sun at different times, it was possible to determine the directions of a place, the Local Time, the Latitude of the observer, the Altitude, the Zenith Distance and the Declination of the Sun and its position along the Zodiac belt. However, his most favourite instrument was the Mana Yantra which readily measures angles in the sky as well as on the ground. It consists of a wooden staff to which is attached a cross-piece in the form of a 'T'. The cross-piece is notched into stairs and pierced with holes to indicate the angle subtended by the distant object at the free end of the staff. With this instrument in hand , he is said to have measured the height of the Saptasajya hill with a fair degree of accuracy once upon a request made by the then British Commissioner of Cuttack Mr. Cooks. With Mana Yantra, he also measured the height of the Mahendragiri hill of Manjusha in Parikuda upon a request made by the king of Manjusha and his value was verified by the then Madras Government. Both Shanku and Mana Yantra can also be used to determine the height and distance of a hill, tree, lamp-post or cloud. Of course, for such a task (where both the Height and Distance of the object are unknown), separate

measurements from two different distances have to be taken.



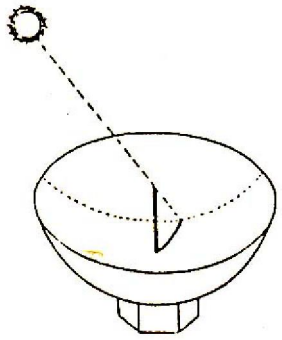
Gola Yantra

Armillary Sphere or Gola Yantra was a very common device prevalent among classical Indian astronomers and is basically a three-dimensional model of the celestial sphere. It was used as a demonstration kit for showing to students various great circles used in astronomy as well as for measuring the Latitude and Longitude of planets. In this mode, it was able to show the direct and retrograde motion of the planets along the zodiac circle.

Landmark Contribution

Samanta Chandrasekhara, at the first hand, attempted to improve the existing calendar system that regulates the daily rituals of the Hindu society. This was very important, as the native Hindu almanac computed from the rules given by the old Siddhantas were falling into serious errors and no two almanacs agreed in their computations. Samanta Chandrasekhara has, therefore, painstakingly re-determined the elements of the old Siddhantas aided by his practical observations. The ephemeris computed from his elements proved to be more accurate than any other almanacs available at that time, and hence, provided a standard source of reference in the otherwise chaotic situation prevailing at that time. Not surprisingly, his calendar system was accepted in many learned circles including the temple authorities of Puri for performing various day-to-day rituals of the deity.

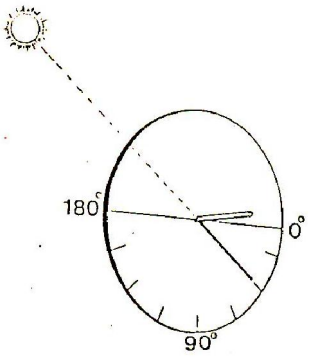
He has prescribed several corrections to be applied to the mean motion of the planets so as to precisely determine their positions in the sky. The ephemeride computed from his elements were in close agreement with the Nautical Almanac followed in Europe at that time. While the Bengali almanac may be in error by as much as 4^0, the corresponding error in Siddhanta Darpana was restricted to only half a degree.



Golardha Yantra

Chandrasekhara has discovered some original corrections to be applied to the mean motion of the Moon to account for its three important anomalies, i.e. Evection, Variation and Annual Equation. Although some of these anomalies were known to independent observers at various tomes, Chandrasekhara was the only Indian astronomer who has detected and measured all these three values.

Another important contribution of Chandrasekhara was the improvement of the values of Parallax for the Sun and the Moon which were so important for the calculation and prediction of eclipses. To determine the parallax of the Sun and the Moon, their respective distances from the Earth have to be expressed in terms of Earth radii. Chandrasekhara has suggested an innovative experiment with a coin so as to determine the ratio of the Distance to the Diameter for the Sun and the Moon. A table comparing the values for the Horizontal Parallax as determined by various observers of that time is appended below:



Chakra Yantra

Parallax of Objects	Old Siddhantas	Chandrasekhara	Modern Value
Sun	3' 56"	22"	8.9"
Moon	52'42"	56'28"	57'03"
Difference of Parallax for the Sun and the Moon	48'46"	56'6"	56'51"

Siddhanta Darpana

Armed with the devices, Chandrasekhara spent nights after nights in the all absorbing game of star gazing. At the age of twenty-three, Chandrasekhara started to record his observations systematically and compiled these findings in a masterpiece treatise written in Sanskrit on palm leaves called Siddhanta Darpana which he completed at the age of only thirty four. But it took 30 years to get published in Devnagari script from Kolkata. It contains 2500 number of slokas of which 2284 are compiled by himself and the rest are due to other scholars. This book contains numerous instances of astronomical methods of determining the position and motion of planets, mathematical treatment of spherical astronomy, instrumentation techniques, improvements over earlier measurements, theories and models.

Acclaims and Accolades

For his landmark achievements in the field of astronomy, he was conferred the title Mahamohopadhyaya in 1893 by the British Government in a special convocation ceremony held at Cuttack. He was compared with Tycho Brahe, the Danish astronomer for his striking similarity in life and works.

His treatise Siddhanta Darpana earned him wide acclaim abroad. His work was highly appreciated by the prestigious British journal Nature (Vol. 59, March 1899) and the American journal Knowledge (Vol. XXII, Jan-Dec, 1899). According to the journal Knowledge, "Of all the numerous works in astronomy published within the last few years, this is by far the most extra-ordinary and in some respects the most instructive …….. and is a complete system of astronomy founded upon by naked eye observations only…… The work is of importance and interest to us Westerns also. It demonstrates the degree of accuracy which was possible in astronomical observation before the invention of telescope, and it enables us to watch, as it were, one of the astronomers of hoary, forgotten antiquity actually at his work before us today." The journal Nature writes, "We should imagine him to be greater than Tycho, for without the same assistance, without the encouragement of the kings and the applause of his followers, he has advanced his favourite science quite as effectively as did the Danish astronomer…….. The effect is to leave us at every page with a higher opinion of the author labouriously recording his observations on a palm leaf, and unselfishly devoting his life to the services of his country-men who do not appreciate the nobility of his effort and the entirety of his devotion."

Samanta Chandrasekhar is clearly the pride of our State. He symbolizes how best human talent can rise within various earthly constraints, and hence, his life and works will continue to be a source of inspiration for the young for years to come.

Nikunja Bihari Sahu, Education Officer, Regional Science Centre, Bhubaneswar -751013.