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NEWS

Conference on Indian Astronomy and Mathematics in Ancient India: A Report*

An International Conference on 'Astronomy and Mathematics in Ancient India' was organized on 24th April 2009, at the University of Brussels by the Centre Altaïr for History of Science (Secretary: Dr Jean Michel Delire, http: altair.ulb.ac.be) and the Belgian Association of Indology (Secretary: Dr. Christopher Vielle), in collaboration with the Fonds National de la Recherche Scientifique, the Wiener-Anspach Foundation, the Commission for the History of Ancient and Medieval Astronomy and the AMOS firm (Liège). The following papers were presented:

R. Mercier (Cambridge University) presented a paper on "The Reality of Indian Astronomy" dealing with dispute about its antiquity in general, and the age of certain texts in particular. Roger Billard results ought to have settled the main features of the history, but however it was disputed in some quarters, not least by David Pingree. This paper reviews Billard's approach, and demonstrates the strength of his claims. All of his results are recomputed, and revised where appropriate.

Billard's work discussed the parameters of the Indian canons such as that of Āryabhaṭa (ca 500 AD) and analysing whether the works were based on observations made by him, or merely inherited from Greek sources. This question has been discussed in detail.

J.M. Delire (Universite de Bruxelles) focussed on "The Indian Accomplishments in Trigonometry : the Construction of Sine Tables". From the *Pauliśasiddhānta* (as summarized by Varāhamihira-VIth century) onwards, the Indian astronomers used sine tables for arcs as a multiple of 3°45′. Contrary to the *Pauliśasiddhānta,* Āryabhaṭa gave a table of sine differences computed it with the help of a recursive formula that he did not explain, nor did his commentator Bhāskara (629). To find a proof (*upapatti*) of the accuracy of this formula, one

*Reported by Dr J.M. Delire, http: altair.ulb.ac.be

had to wait until the 14th-16th centuries, when Kerala astronomers devised numerous *upapattis* for trigonometrical results. In particular, Nīlakaṇṭha (1444-1545AD) and Jyeṣṭhadeva (c. 1500-1610) established the *Āryabhaṭīya*'s formula for sines and cosines of non tabulated arcs on interpolation method which amounts to the first terms of corresponding series of Taylor (1685-1731AD).

P.S. Filliozat of Institute De France, Paris, spoke on "Mathematics and Scholastics in Medieval India, the example of the *Haricarita* by Parameśvara Bhaṭṭa". Parmeśvara Bhaṭṭa's *Haricarita* is to be read at two levels. At the first level and in conformity with the title it is a devotional *vaiṣṇava* poem, summarizing the tenth *skandha of Bhāgavata–purāṇa*. At the second level it is an astronomical work. In the initial words of each stanza one recognizes the 248 *vākyas* of Vararūci, a popular text in Kerala. These *vākyas* are groups of syllables denoting numbers by the *kaṭapayādi* convention and providing a complete cycle of the fluctuations of Moon's longitude from its mean value in a period of 248 days. This is a basic material to determine the daily position of the Moon. Such a text with a double destination is an exercise of great literary virtuosity. The paper introduces the reader to the astronomical contents of the text and to its method of composition, its poetical value and religious significance.

S.R. Sarma (formerly Professor of Sanskrit at Aligarh Muslim University) discussed about Indian Astronomical Instruments in Belgium. Astronomical and time-measuring instruments constitute an important source for the reconstruction of the history of astronomy of any culture. Finding no documentation on the extant Indian instruments, after an exploration of museums and private collections about twenty years ago some 450 specimens in India, Europe and the US were located. In this connection, the speaker had the opportunity of studying ten instruments in different private and public collections in Belgium in February 1996. In this lecture, these specimens, their history and importance have been described. Special attention is paid to two instruments, for these are the earliest known extant specimens of their kind, viz. a Sanskrit astrolabe made in 1605 AD in Gujarat and a *Dhruvabhrama-yantra* crafted in 1785 AD in Rajasthan.

Ch. Minkowski of Oxford University delivered a lecture on "Sanskrit Astronomers and the Mughals". In the sixteenth and seventeenth centuries, learned Brāhmins were present at the Mughal court, in a variety of roles. Some came from Benaras only as visitors, representing the world of Sanskritic learning; others were attached to Mughal courtiers such as Rahim Khān Khānān, Asaf Khān, and Todar

Mal; still others served as scribal service personnel in Akbar and Dārā Shikoh's translation projects. This paper focuses especially on the scientists who were appointed as 'resident' astronomers or astrologers, and who composed works in Sanskrit. Figures discussed include Nīlakaṇṭha, author of the *Tājikanīlakaṇṭhī* and his borther Rāmā, author of the *Muhūrtacintāmaṇi*, as well as Nityānanda, who translated the Persian mss. *Zīj i Sājahāni* into Sanskrit as the *Siddhāntasindhu*, and later wrote the *Sarvasiddhāntarāja*, which argued for the incorporation of some astronomical techniques, models and parameters from the *yavanas* or *romakas*.

K. Ramasubramanian (Indian Institute of Technology, Mumbai) traced "Evolution of Planetary Models : Āryabhaṭa to Nīlakaṇṭha". Though at least from the time of Āryabhaṭa (499 AD), the Indian astronomers have been employing precise analytical expressions for finding the longitudes and latitudes of the planets, there was an error in the application of '*manda-saṃskāra*' (equation of centre' correction) for the interior planets. Nīlakaṇṭha (c. 1500 AD) seems to be the first savant in the history of astronomy to have clearly derived speculative or cosmological argument based on the correct application of equation of centre correction for Mercury and Venus. Besides tracing the development of planetary models in the Indian tradition the author also the transmission hypothesis that has been critically analysed proposed and maintained by the indologists for over a century and a half.

F. Patte (Universite Paris Descartes) discussed about Rhythms and Algorithms, the Indian Mathematical Genius. Reading Indian prosody treatises, like Piṅgala's *Chandaḥsūtra* or Kedāra's *Vṛtta-ratnākara*, or music treatises, like Śārṅgdeva's *Saṅgītaratnākara*, one comes across certain the art of algorithms which appears to have been developed to a large extent by Indian mathematicians. In chapter VI of Kedāra's *Vṛtta-ratnākara*, one finds how to combine long and short syllables in a meter of a fixed length. In *Saṅgītaratnākara*, chapter IV, one finds how to combine four elementary units of time in a given measure. All these issues fall in the mathematical field of combinatorics.

For example, there are nineteen possibilities to combine *druta*, *laghu*, *guru* and *pluta* in a musical sequence made up of six *drutas*. The comprehensive enumeration of these combinations is called *prastāra*.

It is found that the algorithims used by the Indian paṇdits to establish the *prastāras* are an ingenious construction which allows many further mathematical developments : counting, using recursive formulae (*sarkhyā*), finding the pattern of a combination by knowing its order in the *prastāra* (*naṣṭa*), or, conversely, finding the order of a given combination (*uddiṣṭa*).

K. Mahesh & R.V. Pai (also from Indian Institute of Technology, Mumbai) presented a paper on "Turning an Algebraic Expression into an Infinite Series". Turning a finite expression into an infinite series is indeed one of the brilliant accomplishments of the human intellect. Generally Newton is considered to be the pioneer who opened up the gate to enter into this bizarre arena that seems to have given an impetus to the advancement of science and technology. However, if one were to historically track the foremost amongst the mathematicians who worked in this area, it turns out that the contribution of Kerala mathematicians between fourteenth and sixteenth centuries are indeed remarkable. During the presentation, this was illustrated considering a typical example from the work *Kriyākramakarī*, an elaborate commentary on *Līlāvatī* of *Bhāskarācārya* by Śankara Variyar (c. 1534 AD).

Two Indian astronomical instruments were displayed by Prof. S.R. Sarma (recorded presented through the --- of the owner) attracted lot of attention. The participants had rare opportunity of viewing the origined instruments.