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NEWS

Workshop on the History of Numerical Tables, 22-23 March 2010, Paris*

Numerical tables are a significant yet often overlooked source for the history of mathematics. They contain valuable information about the computational techniques and relations they embody. They also throw light on scientific practices, assumptions, and aspirations of those who compiled them. It has been argued that the prominence given to mathematical tables in the Sanskrit exact sciences was linked to Islamic influences,[1] in particular to the *Zîj* texts containing mathematical tables and accompanying explanatory discussion intended for practical astronomical use. From the twelfth century onwards, numerical tables in Sanskrit (*koṣṭhakas*) rose in popularity, becoming an important part of Indian astronomy. Astronomers working in the Sanskrit tradition also developed their own innovations for data-storage and retrieval. Dozens of such texts testifying to cross cultural influences were produced between the late fifteenth and late eighteenth centuries.

Although catalogues of tables in worldwide collections have been produced,[2] very few table texts have been published, still less were studied in any depth. All the tables contain mathematically interesting features. Some tables are notoriously difficult to unravel. Retrieving parameter values and the mathematical processes and techniques that had gone into their construction involves the use of elaborate numerical and statistical methods as well as other ad-hoc techniques, including symmetry, approximation procedures, and interpolation methods.

Tables, then, are a rich source for evaluating the various computational trends in the Indian exact sciences. They provide a vital complement to our knowledge gained from non-tabular formats. Extensive studies will help document the relationship between tables and theoretical texts, such as *siddhântas* and *karaṇas*. Furthermore, tables reveal a sense of those elements from astronomy and mathematics that were esteemed and prioritized by everyday working

* **Agathe Keller**, CNRS-Paris VII University, France, kellera@univ-paris-diderot.fr and **Clemency Montelle**, University of Canterbury, New Zealand, C.Montelle@math.canterbury.ac.nz

practitioners. They may also offer evidence concerning the interaction between astronomical observation and the computational procedures and underlying parameters used by astronomers.

Furthermore, the tabular format gives us an insight into how *koṣṭhakas* were regarded and used by different groups: those that conceived and computed them, those that copied them, and those that used them. The close study of data layout, language, and paleographical details may be significant in this context. The tabular format can also shed light on the pre-history of *koṣṭhakas* in Sanskrit writings. Broadly speaking, these investigations will contribute in a critical way to our understanding of the growth and eventual dominance of tables and computational mathematics in the Sanskrit exact sciences up to the modern period.

With these aims, a workshop entitled "Tables et Astronomie"[3] was organized on 22-23 March 2010 at the Université Paris-Diderot in Paris. This is part of an international multidisciplinary four-year project "*Histoire des tables numériques*" (The History of Numerical Tables, 2010-2013), which is lead by Dominique Tournès (Univ. Saint-Denis, La Réunion) and funded by the Agence Nationale de la Recherche (ANR) of France.[4] Seven papers were presented at the workshop, of which the following three dealt specifically with Sanskrit sources.

Agathe Keller (Sphere, CNRS and Denis Diderot University, France), in the paper entitled "A Short Introduction to the History of Numerical Tables in India", gave a broad account of the history of numerical tables in India. In Indian tradition, a certain number of textual passages were labelled as "tables" by historians, such as the verses of the *paribhâṣâ* section of the *Lîlâvatî* by John Taylor (and others after him), the list of sine differences given by Āryabhaṭa, or the list of *ahargaṇa*s given by Bhâskara I at the end of his commentary on the *gaṇitapâda* of the *Āryabhaṭīya*. She argued whether the arithmetical and algebraic algorithms could be used in temporary tabular dispositions that involve a vocabulary related to the table format. Using examples from Úridhâra's *Pâṭîgaṇita* and its anonymous commentary on square root extractions and computations on fractions, Keller pointed to the vocabulary that described the dynamic of tabular computations. *Koṣṭhakas* give both the data-list and the tabular format and whether it should be understood as the meeting point of these two separate trends of earlier mathematical texts? The lively discussion following Keller's presentation explored those traits and features particular to the tabular genre. Dominic Tournès suggested that one could consider any list of numbers

(insisting on the double inclusion) as a numerical table, while Clemency Montelle argued that a numerical table distinguished itself as a genre by the use of alignment. Agathe Keller wondered whether intricate numerical relations expressed in versified-prose should be included also in the tabular format.

Setsuro Ikeyama (Kyoto Sangyo University, Kyoto, Japan), "Introducing an edition, translation, and explanation of Gaṇeśa's *Pâtasâraṇî*, an astronomical astrological table", described the contents of the *Pâtasâraṇî*, a small treatise for calculating occurrences of an astrological phenomenon called *pâta*, which was composed in the early 16th century by Gaṇeśa, the author of the *Tithicintâmaṇi*[5] and *Grahalâghava*. The *Pâtasâraṇî* consists of a set of tables and accompanying verses with commentaries. Ikeyama used six manuscripts of this text, containing the commentaries by Viúvanâtha, Dinakara, and Divâkara. He is in the process of editing these texts, translating them into English, and analysing the tables that come with them. The verses appear as algorithmic rules which use the accompanying tables to solve a given problem. Ikeyama compares and explores the procedures described in the text with the tabulated values.

Clemency Montelle (University of Canterbury, New Zealand) made a presentation on "The *Karaṇakesarî*: Mathematical tables for computing eclipse phenomena". She gave an overview of the *Karaṇakesarî* of Bhâskara (fl. 1681), a set of astronomical tables for computing the circumstances and details of lunar and solar eclipses. These tables were composed in Saudâmikâ, a locality probably in Gujarat, and their epoch is Śaka 1603 (1681 AD). While most eclipse tables are part of larger astronomical works, this is a rare (if not the only) instance of a set of tables devoted exclusively to this topic.[6] The tables contain elongations, apparent lunar and solar diameters, measures of the shadow cone, half-durations, "deflection", and parallax, as well as other relevant astronomical parameters. There exists a short accompanying text to supplement the tables. This is divided into two *adhikâras*: a *candraparva* in thirteen verses, and a *sûryaparva* in seven verses. Through careful analysis of the structure of the tables, Montelle explored their conception, some underlying parameter values, suggested original methods of computation, as well as various mathematical features particular to the table format itself.

While these three papers dealt with numerical tables in India, the following four papers were devoted to the tables from other parts of the world.

Nathan Sidoli (School of International Liberal Studies, Waseda University, Tokyo), gave an overview of "Ptolemy's use of tables to model motion".

Steven Wepster (Mathematisch Instituut, Universiteit Utrecht), discussed "18th century Lunar Tables: Theory meets Application".

David Aubin (Institut de mathématiques de Jussieu, UMR 7586, université Pierre-et-Marie-Curie Paris 6), gave an idea of the system of 19th century astronomical calculations based on Greenwich archives under the title "Ou ce que les archives de Greenwich nous apprennent sur le calcul des tables astronomiques au 19e siècle".

Marie-José Durand-Richard (Sphere, CNRS et Université Denis Diderot), discussed "La prédiction des marées en France et en Angleterre au 19e siècle: analyse comparée"

This workshop is the first in a series of upcoming studies and colloquia dedicated to tables in Sanskrit sources. Another workshop on this theme is being planned in France in December 2010. All interested parties are welcome to submit a description of their research on this theme for consideration to Dr A. Keller and Dr C. Montelle. The workshop will be fully subsidized.

Notes and References

1. Plofker (2009) pp. 274-277, Pingree (1981) pp. 41-46.
2. See, e.g., Pingree (1968) and (1973).
3. http://www.sphere.univ-paris-diderot.fr/spip.php?article220
4. http://www.rehseis.cnrs.fr/spip.php?rubrique148
5. Ikeyama & Plofker (2001).
6. Pingree (1981) 46.

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