

## **Seminar SAW: Mathematical practices in the context of the astral sciences**

**2014-2015 (suite)**

**organised by:** Karine Chemla, Matthieu Husson, Agathe Keller, Christine Proust and the SAW group

**Paris Diderot University, Condorcet Building**

**9:30 am to 5:30 pm**

Details: <http://sawerc.hypotheses.org/seminars/seminar-saw-2013-2014-mathematical-practices-in-the-context-of-the-astral-sciences>

### **Part I: Presentation**

### **Part II: Programme**

### **Part I: Presentation**

Astral sciences require a very rich set of mathematical practices, computational and geometrical, which were probably instrumental in exploring astral phenomena and structuring the tasks actors strove to carry out. The general aim of the seminar is to describe mathematical practices and bodies of knowledge that can be identified in the context of these activities in the ancient world, and more specifically, even though not exclusively, in Mesopotamia, ancient China and the Indian subcontinent. We shall focus our attention on the *variety* that these practices and bodies of knowledge evidence. Our aim is to understand what accounts for such variety and to situate these practices and bodies of knowledge in their social and intellectual contexts. It is also to capture which ones among our mathematical sources specifically attest to contacts with activities in the astral sciences. To address these issues, we intend to bring together historians of mathematics and historians of the astral sciences. We

will also need to combine anthropological approaches with epistemological, historical and archaeological approaches.

Several questions look already promising in this perspective: Some are in continuity with the research carried out in the first phase of the SAW project, devoted to mathematical practices in the context of administrative and economic activities. Others are new, in relation to the subjects addressed in the second phase of the SAW project. We present briefly a sample of those issues under three main rubrics, even though the division is artificial and throughout the seminar the three main topics distinguished will be dealt with in relation to each other.

### *Mathematical practices and mathematical cultures*

- In the last two years, we have identified some features that proved to be quite fruitful to capture the specificity of a mathematical practice, and we have already begun to work on them. We shall explore how fruitful they can be for the new task we set ourselves. They include: the shaping of measuring units, numbers and measurement values; the ways of handling them in computations or other mathematical tasks; the management of approximation; issues of precision and, more generally, epistemological factors.
- Some new questions appear promising in the context of astral sciences. The concept of angle, and the other concepts shaped when that of angle was not used, will be the object of a new and specific effort: we shall wonder how these concepts are related to units that were at the same time, distance units, units allowing practitioners to identify a direction, or time units. Attention will also be paid to concepts of cycle, circle, disc, circumference, round, in their diagrammatic or material representation, as well as in the arithmetical management they required, such as the use of congruences.

### *Astral sciences questions*

- The issues on which we will focus in this respect include: the shaping of space and time, and of their relationships (in particular the issue of whether they were constructed in a single way, or in multiple ways depending on the questions addressed); the tools and instruments shaped to locate an object, and describe its motion in relation to the position of an observer; more broadly, the various ways astral phenomena were conceptualized in the different contexts, and how these conceptualizations related to the type of mathematical approach to astral phenomena adopted.
- These questions will be addressed broadly. Mathematical astronomy is a key part of the astral sciences, but only a part of it. Astrology and various divination techniques, time keeping and calendar shaping are also important parts relevant to our project. We expect that each of these activities put into play specific types of mathematical practices. More generally, we will also consider the very definition of the astral sciences, their delimitation, the internal dependencies between their various parts, the relation between the astral sciences and other contemporary disciplines or domain of inquiry (e.g., natural sciences, music, and medicine). Such a clarification will help us contextualize the mathematical practices of astral sciences.

### *Sources as texts and objects*

- Mathematical practices in the context of astral sciences involved the shaping of types of artifacts with which practitioners carried out their activities: theoretical treatises, instruction texts, numerical tables, astronomical instruments. We suggest that these sources must be understood as texts and objects. We shall focus systematically on this dimension, since we share the conviction that it is quite fruitful to interpret these artifacts as well as the activities carried out in relation to them. It is also powerful in order to identify the milieus in which they were produced and used.
- This type of inquiry will also require shedding light on the history of the modern and critical editions of these types of sources, and bringing a critical awareness to critical editions of the past. This appears as a key task in order to shape new standards in this respect.

These are only some of the questions to be explored during the seminar. We also hope that focusing on the astral sciences will bring to light new interesting features of mathematical practice that are worth considering for the project of describing mathematical cultures in their variety.

## Part II: Programme

**October 17, 2014**

**Room 366 A**

**General mathematical practices in the astral sciences and their relation to/contrast with mathematical sources 2**

*"Diagrams"*

The aim here is to explore the various kinds of diagrams used in the astral sciences and the specific uses of these diagrams, both in theoretical and practical contexts. Complex astronomical instruments can also be addressed here.

**John Wee** (University of Chicago)

*A Choice of Microcosms: Dodekatemoria Models and the Calendar Text System*

**Abstract:** This lecture builds on my presentation at the ICHSTM 2013 (Manchester), where I explained the construction of *hypsomata* drawings on cuneiform tablets published in E. Weidner's 1967 book *Gestirn-Darstellungen auf babylonischen Tontafeln* (hence, *GDBT*). The *GDBT* tablets assumed a schematic Babylonian year of 360 days that could be mapped exactly onto the sun's ecliptic of  $360^\circ$ , as well as a "micro-zodiac of 12" whereby a month or zodiacal sun-sign was divided into twelve equal parts. W. Hübner's 2005 article on the "Dodekatemoron" in classical sources, however, identified at least four different mathematical methods by which *dodekatemoria* were calculated. While Hübner's *Methods C and D* yield a "micro-zodiac of 12," *Methods A and B* actually result in a "micro-zodiac of 13" that scholars have largely ignored. The "micro-zodiac of 12" was attractive, since its twelve micro-zodiac divisions were a fitting microcosm of the twelve zodiacal signs, and since calculations involving 12 (rather than 13) were simpler to perform. I demonstrate, however, that the

“micro-zodiac of 13” was instrumental in synchronizing sun, moon, and virtual moon in the Calendar Text System. Echoing the meaning of reciprocals in cuneiform commentaries, the virtual moon was reciprocal to the real moon and a signifier of therapeutic ingredients. In an obvious break from the medical zodiacology of the *GDBT* tablets, the same ingredients prescribed by the sun’s twelve micro-zodiacal signs in the *GDBT* tablets became associated instead with the virtual moon’s thirteen micro-zodiacal signs in the Calendar Text System.

**Sho Hirose** (SAW ERC Project, SPHERE)

*Instructions for drawing on the ground in some Sanskrit sources*

**Abstract:** There are hardly any diagrams preserved in Sanskrit astronomical manuscripts, but the texts tell us that it was a common practice to draw diagrams on the ground. For example: traces of gnomon shadows and auxiliary lines added to them for calculation; the positions of the sun, moon and earth (or its shadow) in an eclipse; orbits of planets and epicycles. I shall look into their roles in education, observation, and presumably, geometrical reasoning.

**Matthias Hayek** (CRCAO, Université Paris Diderot)

*Cosmograms, Temporalities, and Computations in premodern Japan*

**Abstract:** Many divination techniques, from the West as well as from the East, use temporal parameters as their ‘primary values’. Such techniques may be referred to as forms of ‘chronomancy’. In the ‘Sinicized world’, we find several of such techniques that, while pertaining to different ‘local’ categories (calendar, *Yijing*, astrology etc.), show signs of structural and procedural likeness.

In this paper, I would like to look at three different techniques used in Early Modern Japan (17<sup>th</sup>-19<sup>th</sup> century): divination by the eight trigrams (hakke uranai 八卦占い), a kind of horoscopy and “calendar astrology”; “Plum-blossom changes in the mind” (Baika shin’eki, Ch. Meihua xinyi 梅花心易), a form of *Yijing*-based arithmology; and a “fate calculation” technique (*sanmei* or *kanmei*, Ch. *suanming*, *kanming* 算命, 看命) based on twelve “stars.

Although they belong to different categories, they all involve similar algorithms, based on modular arithmetic. What is more, from at least the seventeenth century, these techniques offer similar ways to project tables and circular diagrams onto the practitioner’s left phalanx bones and thus turn the hand into a kind of computing device.

By looking at both the similarities and the differences between these techniques, my goal here is to shed light on the operative processes involved and to try to understand the nature of relations between data, parameters, signs, and results.

**Matthieu Husson** (SAW ERC Project- SYRTE-Observatoire de Paris)

*Emmanuel Poulle’s distinction between geometrical equatory and mathematical equatory in Les instruments de la théorie des planètes selon Ptolémée : équations et horlogerie planétaire du XIIIe au XVIe siècle*

**Abstract:** Emmanuel Poulle built his monumental study of the Latin tradition of equatories on a distinction between two types of instruments: the geometrical equatory, which follows closely the Ptolemaic geometrical model in order to produce numerical planetary positions, and the mathematical equatory, more closely linked to tabular procedures to obtain numerical planetary positions. We will present this distinction, its explicit motivations and its historiographical use by Emmanuel

Poulle. On this ground we will open the discussion in order to see if and how the distinction can be adapted to other traditions of astral sciences instruments in any relevant way for the study of mathematical practices in relation to astral sciences to which the second phase of the SAW project is devoted.

**November 14, 2014**

**Room 483 A**

**General mathematical practices in the astral sciences 3**

*“Astral sciences and other disciplines”*

How do the issue of mathematical bodies of knowledge/practices allow us to approach the relationship between astral sciences and other “disciplines,” such as music, natural philosophy, medicine, rituals...? This is the topic to which this session of the seminar is devoted.

**Caterina Guenzi** (CEIAS, EHESS)

*The tree of jyotiṣa and its branches. Ritual and therapeutic uses of astral sciences in contemporary India*

**Abstract:** This talk will aim at exploring how far astral sciences (*jyotiḥśāstra*) can be said to be “astral”. In doing this, I will first show that *jyotiḥśāstra* is an epistemologically heteroclitic scholarly tradition that includes different kinds of knowledge, more or less related to astral bodies and to mathematical sciences. Secondly, I will show that even when dealing with astral bodies, astral sciences deal with much complex entities such as *graha*, that are not only planets, but also Hindu gods and demons. Thirdly, on the basis of the fieldwork I conducted among astrologers in Banaras, I will discuss the practical uses of astral sciences in Hindu daily life and focus on the relationship between astrology, medicine and ritual.

**Cristian Tolsa** (Universidad de Barcelona)

*Ptolemy's bridge between mathematical astronomy and Platonic philosophy*

**Abstract:** The Canobic inscription, a supposedly early work of Claudius Ptolemy preserved in the manuscript tradition of the *Almagest*, represents one of the very few examples in the Graeco-roman world of a genuine effort to match empirical scientific knowledge with Platonic philosophy, specifically the harmonic principles contained in the world-soul of the *Timaeus*. A crucial, understudied passage in the middle of the work embodies the bridge between mathematical astronomy and philosophy.

**Samuel Gessner** (Universidade de Lisboa)

*Astral sciences and the making of planetary clocks – a comparison of mechanical translations of planetary theory*

**Abstract:** Tba

**Howard L. Goodman**

*Dynamic Domains of Activity in Early Chinese Harmonometrics and Their Astral Crossovers and Caesuras*

**Abstract:** Other papers associated with the SAW conference have looked at Li Chun-feng's historiography—its structure and use of precedents. This has shown us espe-

cially how the seventh century saw harmonics (or harmonometrics) through a lens of a historiography of science. Li Chunfeng emphasized the bridging power of number and how number theory and specific values could cross into calendro-astronomy. His rhetoric used accounts of past debates and catalogs of recovered instruments in the context of archeo-harmonics. I wish to turn a bit in another direction, away from harmonometrics seen through seventh-century historiography, and add concretion to the activities themselves by presenting a set of historical incidents from other sources, spanning roughly Western Han through the fifth century AD. The goal is to show that harmonometrics was in fact a known and supported form of institutional and private inquiry that contained the same sort of debate, agonistic confrontation, use of historical/textual precedent, and programs of empirical tests and data as did calendro-astronomy. In addition, the sources bring out networks of practitioners. I comment on what I see as motivations for harmonometric practices, such as establishing an absolute pitch, a resulting pursuit of modal bitonality and transposition in music, the complete shift to aerophones to accomplish required research, the influence of numeric patterns and specific numbers in calendro-astronomy, and how Li Chunfeng's archeometrological take on Xun Xu produced a new embedment for the standard rule—namely, instead of the span of the palm, or other body parts (“embodiment”), the standard-rule became historically fixed and named for the legendary “Zhou,” its antique, even antiquarian, “body”.

**December 19, 2014**

**Room 483 A**

**Astral sciences in context 2:**

“Astrology and horoscope related computation”

By looking at this theme we want to explore a specific aspect of mathematical practices in the context of astral sciences: what kinds of computation, what kinds of use of instruments and tables, what kinds of procedure can we find in the context of astrological activities or the making of horoscopes? We would also like to link these questions with an exploration of the milieus in which astrology, astronomy and mathematics were practiced. Can we find clues about different kinds of astrologies that might have been practiced in different milieus or for different purposes (maybe a physician does not use the same kind of astrology than a priest, or someone planning military campaign)? How does this relate to the kind of documents we are studying and the kind of mathematical practices to which they testify? In the end, we might also want to question, refine or specify the commonly received view that astrology is one of the main goals of mathematical astronomy in the ancient world.

**Hermann Hunger** (Austrian Academy of Sciences)

*Numerical schemes in Babylonian astrology*

**Abstract:** In ancient Babylonia astrology, in the sense of looking for information about the future from looking at the sky, uses mainly omina. These contain no computations; only distances in space and time are sometimes considered and expressed in numbers. There are a few relatively late astrological texts which do use computation. First, the so-called horoscopes have to be mentioned. The astronomical data listed in them must have been computed, but these computations are not part of the horoscope texts themselves. Then, we have texts which divide the zodiacal signs of 30° into 12

equal parts so that each part is  $2\frac{1}{2}^\circ$  (“micro-zodiac”). This subdivision is used for astrological purposes and for a simple scheme to establish “rising times” of ecliptic arcs depending on the length of daylight. Finally, there are texts related to medicine which connect the choice of treatments and of drugs to positions of celestial bodies or to the calendar by means of a mathematical scheme.

**Anne Tihon** (Université Catholique de Louvain)

*An astronomical syntax, based on Hipparchus: the Papyrus Fouad inv 267 A.*

**Abstract:** The papyrus Fouad 267 A, discovered by Jean-Luc Fournet in the collection preserved at IFAO in Cairo, contains a long fragment of a particularly interesting astronomical treatise. The anonymous author gives an example "to calculate a birth" on the night of 8 to 9 November AD 130. The fragment is confined to the calculation of the longitude of the sun. This is calculated with the help of a "syntax" based on Hipparchus, from which the text mentions an otherwise unknown observation, that of the Summer Solstice of 158 BC June 26. What is unique in this text is calculation in parallel of three different longitudes: the sidereal longitude (based on the sidereal year of  $365\frac{1}{4} + 1/102$  days), the ‘mean’ longitude (based on the year  $365\frac{1}{4}$  days) and the tropical longitude (based on the tropical year  $365\frac{1}{4} - 1/309$  days). The author refers to Hipparchus, and mentions the precession of the equinoxes: one can see from the calculations that this is estimated as  $1^\circ$  in 78 years approximately. The author uses chronological periods similar to those of Ptolemy (periods of 25 Egyptian years, single years, Egyptian months, Egyptian day, hours), but also large periods of 30,000 and 7,000 years, unique in the history of Greek astronomy. The calculations presume a model with an excentric identical to that of Ptolemy. The rest of the text considers the conversion of times according to a table of oblique ascensions somewhat different from that of the *Handy Tables* of Ptolemy, and also the calculation of the declination of the sun. The *Syntax* to which the text refers is a complex and refined work of astronomy, at a level comparable to that of Ptolemy, and remarkable for the precision of its parameters and the complexity of the combinations of numbers employed.

**Kenneth Zysk** (University of Copenhagen)

*Numerical Physiognomy in Ancient India*

**Abstract:** As early as the *Gārgīyājyotiṣa* in first century BCE, numerical physiognomy was an integral part of the literature pertaining to the human marks (*puruṣa-strīlakṣaṇa*). Its principal purpose appears to have been as an aid in the memory of the different parts of the body and their characteristics and is another example of the Indian penchant for counting and enumeration (*saṃkhyā*). An upper limit of 100 was placed on the parts, so that over the course of time, different ways of counting the individual parts emerged to arrive at the ideal number.

At first, there were two systems of enumeration: a non-fixed and a fixed number of body parts. The former seems to have come first, since as early as the epic *Rāmāyaṇa*, a non-fixed number of parts is enumerated as a means to distinguish the king Rāma from his brother, Lakṣmaṇa. Here the non-fixed number of parts occurs in random order, with the numbers 3 and 4 predominating, e.g., 3 fixed, 3 pendulous, ..., 4 lines, ... 14 in equal 2, ..., 5 smooth, ..., 10 lotus like. Another version occurs in Garga, where fewer parts occur, but the individual parts are listed, thus providing a more comprehensive version.

The system of fixed number of parts is much more regular in all versions from Garga onwards, all of which revolve around the numbers 31, 32, and 33 in 7 characteristic categories. The number 33 is the earliest and most prominent, followed by 31. An early Buddhist version of a fixed number of body parts records 32 marks of the Buddha. However, the method of enumeration in the Buddhist and Brahmanic sources are entirely different.

This paper, therefore, will explore the presentation of numerical physiognomy from its first recorded account in the epic, through the early *Jyotiṣa* texts and the later *Purāṇas* with an eye towards understanding the ways in which the different parts of the body were counted to come up with an ideal number of 100.

### **Alain Arrault (EFEO)**

*Calendars, hemerological calculations, manuals of calendar annotations in China*

**Abstract:** The hemerological dimension of the Chinese calendar is undoubtedly the one that prevails over his astronomical and liturgical aspects. There are indeed hundreds of activities, which can be roughly grouped into ten categories, which tell daily what is auspicious to do and what is not. Methods to determine "the quality of days" are most often based on "spirits" (*shensha*), which are annual, monthly or daily, and specific to the calendar. Numbering in the dozens, the placement of these spirits and determination of the resulting activities is a real headache, some overlapping with others, some obviously in contradiction with each other, etc. However, it seems that very early manuals were developed to make the task of the calenderist easier, but at the same time it is his choice that was restricted.