

**SAW Three-day Meeting:
How do writings in the astral sciences document mathematical
practices and the practitioners?**

**Three one-day meetings,
organised in the context of the SAW Seminar**

“History of Science/History of text”

January 15, 2015; February 5, 2015; February 19, 2015

Organised by:

Karine Chemla (SPHERE & SAW project),

Matthieu Husson (SYRTE and SAW project),

**Richard Kremer (Dartmouth College and researcher invited by the SAW
project),**

and the SAW team

**Venue: Paris Diderot University, Condorcet Building
4 rue Elsa Morante 75013 Paris or 10 rue Alice Domon et Léonie Duquet
75013 Paris, <http://sawerc.hypotheses.org/practical-information>**

Room 646 A

9.30 am — 5.30 pm

I. Rationale

II. Programme

I. Rationale

In connection with the 3-month SAW workshop on “Mathematical Practices in relation to the Astral Sciences”, the “History of Science/History of Text,” seminar will focus during these three days on written sources related to the astral sciences. The purpose is to understand how these sources document mathematical practices in these contexts, and their practitioners. The (not mutually exclusive) themes will be the following:

- *Paper technology, clay technology, palm leaf, bamboo, silk, wood, copper technology in the astral sciences.* How did practitioners of the astral sciences use supports for writing or other types of support in their activities? Do our sources document how writing supports were used to carry out computations or other operations, to develop reasoning, to make instruments? Do they document other uses of these supports, or how other supports were used?

- *Three-dimensional objects.* What can sources allow us to restore about the three-dimensional objects practitioners used to carry out their activities? We think in particular about spheres used to draw on them, or armillary spheres, used in relation to activities in the astral sciences.

- *Sources as documents.* How, more generally, can sources attest to activities in the astral sciences? Can we identify traces in manuscripts documenting what actors did with them? Or, how can the way a writing refers to other parts in it, or to other writings, allow us to describe authors’ as well as readers/users’ activities with it? Can we identify trajectories of use of a given document, or of a set of documents?

The days will be very informal. Each speaker will be given two hours with at least half of the time devoted to discussion. The purpose is to prepare the publication of a collection of essays in a scientific journal.

II. Programme

January 15, 2015

9.30am-11.30am

Sebastian Falk (Dept. of History and Philosophy of Science, Cambridge)

Amateur astronomers learning with tables: the case of the Equatorie of the Planetis

Abstract: Peterhouse, Cambridge MS 75.I, known as the *Equatorie of the Planetis*, is a rich testament to medieval mathematical practices.¹ Its controversial attribution to the poet Geoffrey Chaucer by its first editor, Derek de Solla Price, has meant that much of the scholarship

¹ The manuscript is now fully digitised and freely accessible online at <http://cudl.lib.cam.ac.uk/collections/peterhouse>

on the manuscript has focused on the authorship question, but it has far more to tell us about the ways that astronomers designed and used instruments, compiled tables, and carried out calculations.

The manuscript, dated *c.* 1393, consists of three sets of astronomical tables, written in two hands. In some ways these overlap, but in others they are very different. They are followed by a treatise explaining how to make a planetary *equatorium* (according to a design unique to this manuscript), and how to use it with the foregoing tables.

Close reading of the manuscript's physical features reveals much about the ways it was used. For example, the tables of mean motions were computed to a striking degree of precision. Yet one can observe that the compiler added an extra column of data to one table, writing in smaller figures after it had been rubricated. This seems to have been done in order to reduce apparent errors of rounding in the final column, but such tiny errors were invisible on the instrument for which the tables were supposedly compiled.

Why did the compiler make such amendments to his tables? And why do discrepancies (for example radices for inconsistent locations and dates) appear among the tables? I will discuss a number of mistakes in the tables, some of which were corrected, and make some suggestions for what this tells us about the author's (changing) expertise.

Fascination with the manuscript began when Price discovered, half-buried in the manuscript's binding, a reference to "Chaucer". Yet Chaucer is not the only astronomer cited by the author. Two marginal annotations refer to Profatius and Arzachel, apparently as the sources of planetary parameters whose use the author wished to justify. Elsewhere, marginalia appear in a simple cipher. Why did the author make such marginal additions to his treatise and tables?

Half of the tables are in the same hand as the treatise; the remainder have been annotated by that hand. This suggests that the author of the treatise also compiled the tables (though cross-references between folios within the manuscript indicate that it may originally have been ordered differently). In places the author has explicitly noted that a table was for use with "the *equatorium*", presumably the one described in the treatise. Such notes can allow us to reconstruct the process of compilation, as well as the uses that the author made of his tables.

I believe that the evidence mentioned above suggests that this compilation was produced by an astronomer still in the process of learning his art, and of finding uses for it, whether mathematical or astrological. If so, it has much to tell us about the ways and situations in which astronomy was studied in the medieval period. It even forces us to reconsider the authorship argument. Looking at the evidence on both sides of that argument with this fresh perspective may shed new light on the question of whether this manuscript is indeed, as Price supposed, the final part of the *Treatise on the Astrolabe*.

11.45 am-1 pm/ 2.15pm-3 pm

Matthieu Husson (CNRS-SYRTE, Observatoire de Paris and SAW project)

John of Murs' eclipse computation in the Escorial O II 10

Abstract: The Manuscript Escorial O II 10 contains a set of commonly used astronomical treatises in the context of the faculty of arts in Paris at the end of the 13th and beginning of the 14th centuries. Its main interest lies in the autograph notes that John of Murs, an important 14th century astronomer, made in the margins of this manuscript throughout most of his intellectual career concerning a wide range of scientific and non-scientific topics. Among those notes,

two sets related to the observation of two successive solar eclipses (1333 and 1337) will be examined. Two directions of analysis will be explored. First, we will examine how these notes inform us about John of Murs' interrelated astronomical and mathematical practices in these eclipses observations. This will lead us to an awareness of some more editorial choices made by John of Murs in these notes, the meaning of which will be pondered.

3.15 pm -5.15 pm

Richard Kremer (Darmouth College and researcher invited by the SAW project)

Dialing, geometry and proof in early 16th-century Europe: Stabius's paper instruments

Abstract: In a number of recent papers, Jim Bennett has described dialing as an important craft component of 16th-century cosmography. Combining the skills of engravers, printers, cartographers, cosmographers, instrument-makers, astrologers and mathematicians, dialers created geometrical tools to solve practical problems like time-telling, surveying, navigating, laying out fortifications, or measuring volumes of casks. Dialers, Bennett argues, transmitted their innovations as "constructive techniques", not as demonstrations or explanations. In this paper, I will examine the constructive techniques in a set of four paper instruments designed by Johann Stabius, historian and mathematician at the court of Emperor Maximilian I, and printed as broadsides in 1512-15. I will consider examples of other contemporary dialers experimenting with constructive techniques and will ask whether these techniques alone, without appeal to geometrical proof, enabled innovative instrument designs to emerge.

February 5, 2015

9.30 am-11.30 am

Daniel Morgan (ERC-SAW, SPHERE)

Sphere Confusion: The Textual Reconstruction of First-millennium hun Instruments

Abstract: Ancient and modern alike, scholars of China treat the appearance of the “sphere instrument” (*hun yi* 渾儀) in the Han (206 BCE – 220 CE) as a revolution in practice. Inspired by work on astronomical instrumentation in other traditions, I have come to realize that Chinese intellectuals were alone in their sphere fever, which begs the question of why. As nothing survives the first millennium by way of professional instrumentation, we must turn to texts to answer questions of construction, availability, use, and competition. Approaching the topic through Li Chunfeng’s 李淳風 (602-670) instrument catalog, we find first of all that there is rampant terminological ambiguity between what we might call armillary spheres and celestial globes used variously for observation, demonstration, and calculation, and that descriptions of “observation” often involve looking *at* the instrument rather than *through* it. When it comes to observational armillary spheres proper, we find that they were actually quite limited in number and accessibility. Working from instrumentation literature and observational records, furthermore, we look at issues of graduation, construction, alignment, and observational practice to assess matters of precision, accuracy, and popularity, concluding that practitioners’ obsession with the “sphere instrument” had less to do with its observational application than we may have assumed.

11.45 am -1 pm/2.15 pm -3.00pm

Sho Hirose (ERC-SAW, SPHERE)

What were the functions of the armillary sphere in Paramesvara’s Goladīpikā?

Abstract: Armillary spheres had been part of the Sanskrit astronomical tradition and almost every comprehensive text on astronomy would mention them and sometimes give instructions for their construction. *Goladīpikā* ("Illumination of the sphere") is a text in two versions which deal with structures of the armillary sphere and various topics in astronomy related to them. The purpose of this presentation is to see how the armillary sphere was used as a tool for instruction and reasoning.

3.15 pm-5 pm

Nathan Sidoli (Waseda University, Tokyo, and researcher invited by the SAW project)

The use of physical devices to do computation. Selections from Ptolemy's *Analemma*, and Heron's *Dioptra* 35.

Abstract: In this communication we examine a documentation concerning two different instruments used in the hellenistic world to make, among other things, astronomical computations. After a brief contextualisation of this documentation, the focus will be first on the aspects of the sources which describe the instruments and the way they describe it, and second on the way the operations with the instruments are described as well as their mathematical and astronomical meaning.

February 19, 2015

9.30 am-11.30 am

Li Liang (Beijing Institute for the History of Natural Science and researcher invited by the SAW project)

Procedural table as a tool: The calculations in Chinese calendric astronomy

Abstract: This presentation will discuss a kind of unique table used in pre-modern China. Several samples will be introduced to show how it arranges the calendric calculations and lists each step of them in order to normalize the calculations. The users can pick up data from the appropriate numerical tables and fill them in this kind of procedural table to make the calculations mechanized. This method becomes a useful tool in Chinese calendric astronomy which makes the calculation and the using of numerical tables more normalized and also reduces the chance of errors.

11.45 am-1.pm / 2.15pm-3 pm

Mathieu Ossendrijver (Berlin Humboldt University, Topoi, and researcher invited by the SAW project)

Astronomical tables of the spread sheet type

Abstract: Among the various types of astronomical tables which can be found in the ACT documentation some can be described roughly to be of a “spread sheet type”. In these tables, values are computed from columns to columns according to a fixed algorithm. They raise many interesting questions including questions of accuracy, methods of rounding/truncating, selection of quantities to be tabulated versus to be left out of a table, selection of those parameters that must be modelled accurately vs those that can deviate more strongly from empirical behaviour etc. We will present these tables in the context of the ACT documentation and discuss how they can be examined so as to give historians clues concerning the type of mathematical practices of which they are the outcome.

3.15 pm-5.15 pm

Matthias Hayek (CRCAO, Université Paris Diderot)

Rotating Disks and Straight Rulers: Paper Instruments in Japanese Early Modern Divination Manuals

Abstract: Divination in China and Japan can be performed using a wide array of devices. Among them, chronomantic techniques from the Tang period onwards have used three-dimensional boards, and topo/domomantic techniques have employed various kinds of measuring tools. In 18th century Japan, the latest avatars of such techniques were transmitted through printed manuals to a broader and broader audience. In these manuals, we can find elements, which seem to be two dimensional, paper renditions of said devices. In this presentation, I will focus on two types of such items: multilayered circular tables used to determine auspicious directions, and graduated rulers for ‘measuring’ the auspiciousness of objects.