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A Scientific Tour among the Mathematical Instruments in the Collection of the Bibliothèque nationale de France

Fransız Milli Kütüphanesi Koleksiyonundaki Matematiksel Aletler Arasında Bilimsel bir Gezi

Anthony Turner, *Mathematical Instruments in the Collections of the Bibliothèque Nationale de France*, in collaboration, for instruments from Islamic lands, with Silke Ackermann, Taha Yasin Arslan. Turnhout: BNF ÉDITIONS; London: BREPOLS, 2018. 336 pages, over 260 illustrations in colour, Bibliography. ISBN: 978-2-7177-2763-0 (BnF), ISBN 978-2-503-56805-8 (Brepols).

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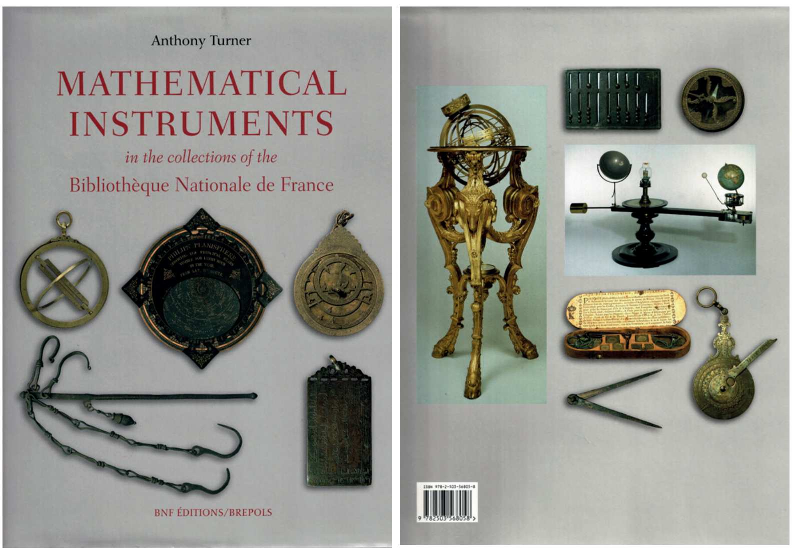
Scientific instruments constitute essential resources in the study of the history of science, not only because they shed light on their design and construction, production, practical employment and functions, but also they stimulate us in thinking about their role towards scientific progress. In recent decades, the scientific instruments in museum libraries and various collections have become a treasure trove for historians of science and their research with increasing interest in material culture withinin history of science.[1] However, museums and libraries can only offer a select part of their collection for permanent public display. Therefore such complete catalogue with detailed information about all items in the collection is a invaluable source.

Anthony Turner, the author of the catalogue in review, specialises in the social history of ideas of the *Ancien Régime* and the history of scientific instruments, clocks, watches, sundials and precision technology. This richly illustrated volume offers a detailed description of a hundred thirty-eight objects in total, held in the collections of the Bibliothèque nationale de France, especially those kept in the *Département des Cartes et Plans, the Départment des Monnaies, Médailles et Antiques,* and the *Bibliothèque de l'Arsenal*. The book draws attention to the well known and displayed items as well as to instruments unknown to scholars, students and public.



1 For a discussion on the significance of scientific instruments in the history of science studies, see Albert Van Helden, and Thomas L. Hankins, "Introduction: Instruments in the History of Science," *Osiris* 9 (1994): 1-6; Jim Bennett, "Presidential Address: Knowing and Doing in the Sixteenth Century: What Were Instruments For?," *The British Journal for the History of Science* 36, 2 (2003): 129-50; Liba Taub, "Introduction: Reengaging with Instruments," *Isis* 102, 4 (2011): 689-696.

Instantly the reader might get the impression that the catalogue is devoted primarily to mathematical instruments because of the author's choice of title. However, the use of the term '*mathematical instruments*' does not only represent a class of instruments for drawing and calculation in the narrow sense, but also the measurement instruments and their close connection with the *mathematical art*.[2] As such the book includes detailed descriptions of the astronomical instruments including astrolabes, celestial spheres, cosmographic instruments, celestial planispheres, sun-dials, and nocturnals, alongside a linear rule, a bead-frame abacus, dividers, and balances.

The volume opens with a preface, an introduction and a chapter on mathematical instruments kept in libraries. The catalogue is divided into eleven sections, supplemented with a bibliography. The chapter on 'Mathematical Instruments in Libraries' emphasises the process of putting books and instruments at the disposal of knowledge within European libraries. The sections of the Catalogue are arranged in accordance with categories of the BnF's collection: *Astrolabes, celestial spheres, cosmographic instruments, celestial planispheres, sun-dials&nocturnals, compasses, calendars, varia, balances, clocks, and missing instruments.* Each instrument is documented with a full entry detailing *signature, inscription*, *date*, *materials*, *dimensions*, *descriptions*, *commentary*, *provenance*, *maker*, *exhibition*, *inventory number*, and *references*. Turner points out that items of the collection are arranged in a chronological order in established dating. Silke Ackermann and Taha Yasin Arslan have collaborated with the author for instruments from Islamic lands.

The first section of the catalogue includes five Islamic and four European astrolabes. The Islamic planispheric astrolabe, entitled multiple plate astrolabe, made by Ahmad ibn Khalaf dated late ninth or early tenth century is the oldest item among the astrolabes in the BnF collection. This is followed by the universal single plate astrolabe (1218-19 CE) crafted by Muḥammad ibn Fattūḥ al-Khamāi'rī. This instrument differs from the former in that it can be used for any latitude. The third item is a Persian planispheric astrolabe by Muḥammad Mahdī al-Khādim al-Yazdī (*c.*1659/60 CE). This elaborated instrument differs from the previous two with its technical details and aesthetic quality. According to Turner, the anonymous French multiple plate astrolabe from the early fifteenth century seems to bear the influence of Fusoris' workshop, but is distinct for its size and the arrangement of the scales on the back. Two European astrolabes follow: one was made by Georg Hartmann (1489-1564) in 1526 in Nuremberg, which was an important city trading not only between Italy and the East, but also between northern and southern Europe. The town also was abounded with workshops for metalwork and other crafts in the fifteenth and sixteenth centuries. These three European

2 For a more detailed discussion of this issue see Jim Bennett, "Early Modern Mathematical Instruments," *Isis* 102, 4 (2011): 697-705; Deborah Jean Warner, "What is a Scientific Instrument, When Did It Become One, and Why?," *The British Journal for the History of Science* 23, 1 (1990): 83-93.

astrolabes are followed again by an anonymous Islamic multiple plate astrolabe dated to a period between 16th to 18th centuries. The eighth item of this section is a *rete* made by François Chassignet (*fl.* 1622) at Rome in 1622. Turner comments that this *rete* should have later additions. This section is concluded with an Islamic astrolabe-quadrant made for Tunis and acquired in the same city before 1875. Turner's preference in following a chronological order allows for a comparison of the characteristics of the instruments produced in different milieus and also informs about their circulation, with rich commentaries and provenance data for each instrument. However, an arrangement according to their place of origin could have been useful to follow the scientific views and activities within the same cultures.

On the other hand, full descriptions, commentaries and provenance information provide hints to researchers for studying the extant instruments, especially for those who want to read the instruments as a text in itself. In this context Islamic astrolabes are provided with excellent descriptions. All engraved features on Islamic astrolabes are shown in tables with their Arabic original rendering, transliteration and English translation. However, while the star names engraved on the *rete* of the Islamic multiple plate astrolabe are shown in tables in the indicated form, a similar table is not provided for the star names inscribed on the European rete. These tables would have been convenient for cross reference.

The second section introduces the *celestial spheres,* which are representations of the sky. It includes two Islamic globes; five French armillary spheres including the Ptolemaic geocentric models (4 specimens) and a Copernican model; a French armillary planetarium; and a navisphere. The first two items are given under the title of the *solid sphere* are two Islamic celestial globes. The first celestial globe (*c.* 1080 CE), attributed to Ibrāhīm ibn Sa'id al-Sahlī al-Wazzān, is introduced with a comprehensive discussion on its production date. The second piece is another Islamic globe (1573/74 CE), made by Muḥammad ibn Muḥammad al-Hāshimī. Then the catalogue continues with the detailed descriptions and illustrations of the 18th century Ptolemaic and Copernican armillary spheres produced by French globe-makers. This testifies that Ptolemaic armillary spheres were still produced even after the heliocentric model of the universe became widely recognized. For instance, two items, the Geared Ptolemaic Armillary Sphere and the Geared Copernican Armillary Sphere, both completed by 1724 is of great interest because the same person(s) produced them as a companion and/or comparative pair. This is reminiscent of an Ottoman treatise on the construction and usage of the Ptolemaic and Copernican armillary spheres. This treatise was translated by Aleko-zâde Yorgaki Petropulos (*fl.* 1872) from French to Turkish for perusal in Ottoman schools in AH 1266 (1849/50 CE). We do not know much about Petropulos' life except for the information that he was a translator attached to the Sublime Porte and the Seraskerat (Ministry of War) in AH 1246 (1830/31CE).[3] This treatise is known as *Tercüme-i*

3 Yorgaki Petropulos, *Risale-i Mukaddime-i Küre*, Istanbul University Rare Books Library, TY 6549, AH

Küre-i Müşebbeke Aleti (lit. the translation of the instrument armillary sphere) or *Küre-i Sema Aleti* (lit. instrument of the celestial sphere), or *Risale-i Mukaddime-i Küre* (lit. introductory treatise on the [celestial] sphere), and does not include any image of Ptolemaic and Copernican armillary spheres. Thus, Turner's catalogue provides a good starting point for analysing the construction of Ptolemaic and Copernican armillary spheres described in the Ottoman treatise, relying on the commentaries and detailed descriptions of both armillary spheres.

Another interesting item of the second section is a mid-18th century French armillary planetarium. It differs from the other armillary spheres with planetary rings for Saturn, Jupiter, Mars, the Earth-Moon system, Venus and Mercury. Each of them is marked with its mean distance from the Sun and the period of its orbit, which are recorded in the list. The section closes with a late 19th century French navisphere which is the globe illustrating various constellations to be used in navigation. This piece represents the original model of Comte de Magnac's (1836-1857) instrument and is signed by the first maker. Turner offers abundant information on the instrument, including a brief history of the process of obtaining the patent of the navisphere.

The third section entitled 'Cosmographic instruments' introduces a broad range of European instruments from the different periods. The first item, an astronomical volvelle is a paper instrument printed by François Belprey in 1653, Its description is written in collaboration with Richard L. Kremer. An extensive description is given under the title 'planetary and stellar planisphere'. The author provides not only the photographs of the present instrument but also an illustration from a publication. The other rare objects are related to eclipses. One of them is entitled 'planisphere showing solar and lunar eclipses or eclipsareon, and calendar' dated 1681; the other two are called the 'world time and eclipse indicator' and were signed by Louis Joseph Aubert in 1811; and the last one is an 'eclipse indicator' produced in 1890. The '*eclipse calculator*' signed by Ernst Friedrich Moritz Schotte (1829-1895) and P. Möhring was probably produced for demonstration in schools because it explains the formation of the eclipse rather than how to predict it. In the 20th century, an Ottoman translator Ali Allahyar published the *Sema Aleti İzahnâmesi* (lit. prospectus of the Celestial Instrument)[4] to introduce an eclipse indicator, which is provided in Turner's catalogue (No. 26).

In reviewing this comprehensive catalogue, we encounter another fascinating yet anonymous instrument which is the armillary planetarium dated 1856. It represents not only Mercury, Venus, Mars, Jupiter, Saturn, but also Neptun, Uranus and minor planets/asteroids as telescopic planets. Another instrument consisting of a cardboard plaque intended to be placed against a wall that was signed by Tresmechini and dated c.1880 is the 'Comographic

1266, 29 folios. This treatise is currently being studied by Solmaz Ceren Özdemir, a graduate student at the Department of the History of Science, Istanbul University.

4 Ali Allahyar, *Sema Aleti İzahnâmesi* ([İstanbul]: [Maarif-i Umumiye Nezâreti Telif ve Tercüme Dairesi], 1334 R [1918]), 52-56.

apparatus'. It has a large central diagram surrounded by explanations of the basic celestial phenomena, such as the origin of day and night, lunar phases, lunar and solar eclipses. This section ends with 'astronomical models for teaching' from the first quarter of the 20th century.

The fourth section introduces twenty-five celestial planispheres from the period between 1808 and 1995. The large part of the collection consists of celestial planispheres made in France, and a small number of English planispheres produced in Germany. Material used in these objects are printed paper or lithograph on card, carton, canvas or pasteboard.

The fifth section dealing with sun-dials and nocturnals presents seven items. The first piece is a plane vertical sun-dial representing an analogue instrument with two dials, which is made of marble, from the late second/early first century BCE. The second sample, a portable vertical dial, was made in AH 559 (1163/64 CE) by Abī al-Farāj 'Īsā, an apprentice of al-Qasam Ḥamiyyat. The inscriptions on the instrument are shown in the tables. The third item under the title 'a time-finder for day and night' is an early 17th-century European instrument. Each part of the instrument is given in full description, and the stars marked on it are listed. The *magnetic azimuth dial* made by Stephan (Etienne) Migon in 1652 is an unfinished diagram because the hour lines and the compass directions have not been marked. The following object is a 17th-century cylinder dial for latitude 37°. The sixth piece in this section is a 18th century *double dial* of which Turner gives a detailed description and an extended commentary. He points out that this instrument incorporates a map which is rare among the sundials. This section closes with a universal equinoctial ring dial from the early 18th century. This instrument is composed of three rings and its engravings are partly in Latin and partly in Arabic script. Thus it was argued that this sample fell into Ottoman hands. This commentary provides a good starting point for further research since the use of the universal equinoctial ring dial among the Ottomans is not well-known. Kandilli Observatory and Earthquake Research Institute, Istanbul, has three universal equinoctial ring dials in its collection. Two of them are engraved in Arabic: One of them (inventory no. 70) made by Ömer Baki in AH 1249 (1833/34 CE); the another (inventory no. 72) is undated and it's maker is unknown. The third object is a European universal equinoctial ring dial (inventory no. 235). It consists of the latitude of some cities such as Strasbourg (49°), La Rochette (46°), Copenhague (56°).[5]

The sixth section is devoted to *compasses* and introduces five items from the ninth century: Two Chinese, one Islamic and one of European origin. These are described in detail under the titles 'Chinese geomantic compass', 'qibla compass', and 'Paris direction indicator'.

5 Currently I am working on these instruments as part of a project entitled *Osmanlı Astronomi Tarihinde Dâ'ire-i Mu'addil'in Yeri, Yapısı ve Kullanım Alanları Üzerine Karşılaştırmalı Bir Araştırma* (A Comparative Research on the Construction, Usage and Place of Dâ'ire-i Mu'addil in the History of Ottoman Astronomy), and funded by the Scientific Research Projects Coordination Unit of Istanbul University (Project Nr. 36171).

The seventh section deals with *calendars.* Among them is the *mécaneclipse* dated 1768 to predict solar and lunar eclipses. It was made by Jean Baptiste Fortin (1740-1817). Turner points out that Fortin's catalogue of 1770 mentions that this instrument was designed as based on the calculations of Philippe de la Hire and Nicolas-Louis de la Caille. In the Ottoman setting, early interest in eclipse prediction devices are dated 17th century. The first sample is a calendar known as the *Rûznâma-i Şeyh Vefâ*, which was replicated by İbrahim Şehidi bin Hüseyin Dede in AH 1086 (1675-76 CE). This copy contains a paper instrument with two moving circles (volvelle) which enables the user to perform calculations relating to the phase of the Moon, lunar mansions and eclipses (both solar and lunar).[6] In early 18th century, the Ottoman ambassador Yirmisekiz Mehmet Çelebi (d.1732) was fascinated by an eclipsarium he had observed during his visit (1720-21) to the Paris Observatory. His son, the ambassador Mehmed Said Effendi (d. 1761) had purchased an eclipse calculator "De La Hire – Bion" in Paris and let translated its manual into Turkish in 1748. [7]

In the eighth section, the reader finds eighteen diverse instruments, including a fragment of an Egyptian cubit, a portable Roman bead-frame abacus, a set square, a plumb line weight, dividers, callipers, a talismanic plate, an Ottoman (probably Egyptian) dial instrument, the cast of a talismanic mirror-back with zodiacal and planetary symbols, the fragment of linear rule, a compass rose and double hour scale, a circular arithmetical table, an universal time-finder. The items range from c.1550 BCE to the ninth century. Accompanying tables which show all the engraved features on Islamic instruments are provided. However, Turner points out that some instruments were unavailable for close inspection and some descriptions could be only be made based on one preliminary inspection and photographs.

The ninth section includes thirty-seven balances from Roman times to the 19th century: The Roman steelyard and its parts; scale-pans for a balance dated 19th century, a balance-set for money changing dated from the 17th to the 19th century. In this section, items are not presented chronologically. The author's decision is entirely appropriate in this regard, because this kind of classification allows the reader to follow the historical development of objects.

In the tenth section, the reader is given information on both decorative arts and European clocks. The section opens with a German drum dated by 1544. The French floor-standing pedestal clock (No. 128), dated *c.* 1720, is presented with an in-depth description of each part of this clock, and detailed information on makers, owners, and locations.

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6 Sheïkh Vefa, *Rouzname-i Sheïkh Vafa*, replicated by Ibrahim Shahidi ibn Khoudaï Dede (Bibliothèque nationale de France, supplément turc 537, AH 1086 [1676CE]): fol. 6r. Currently I am working on this astronomical volvelle as part of a project entitled *Paper Instruments in the History of Ottoman Astronomy*, and funded by the Scientific Instrument Society (SIS).

7 Feza Günergun, "The Ottoman Ambassador's Curiosity Coffer: Eclipse Prediction with De La Hire's "Machine" Crafted by Bion of Paris," in *Science between Europe and Asia*, eds. Feza Günergun and Dhruv Raina (Dordrecht Heidelberg London New York: Springer, 2011), 77-101.

Anthony Turner has also addressed the question of the six missing instruments of the BnF collection in the final section. He collated the information on the details of these instruments from library inventories, and the catalogues of the 1875 and 1912 exhibitions. The catalogue ends with an extensive bibliography.

To sum up, theoretical methodology which suggest the reading of scientific instruments as texts, has been realised with the compilation of this catalogue. Although, Turner, in his introduction, points out the limitation of this catalogue owing to its descriptive character, the catalogue contains not only detailed descriptions of the objects kept in the collection of the BnF, but it also provides abundant information on their makers, patrons, and owners. All the information is based on excellent references and extensive bibliography. Therefore the catalogue not only provides the available literature of the subject matter but serves as a precious guide to those who want to research the historical scientific instruments. Thus the *Mathematical Instruments in the Collection of Bibliothèque Nationale de France* is much more than a catalogue. This catalogue offers valuable insight and tools for those studying scientific instruments and is highly recommended to all who are interested in their history.