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'Instruments between East and West'

Abstracts

ANCIENT ASTRONOMICAL INSTRUMENTS IN PAKISTAN

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Lahore has been celebrated as a centre of production of astronomical instruments since the sixteenth century. During the reign of Mughal emperor Humāyūn, Allāhdād set up his workshop here, and produced astrolabes. Allāhdād's descendants made exquisite astrolabes and seamless celestial globes until the eighteenth century. Instrument production at Lahore was revived in the nineteenth century by Bulhomal who, together with his associates, produced astrolabes and several other kinds of instruments bearing inscriptions in Persian, Sanskrit, and even in English. Perhaps the last great instrument produced by this group is a large astrolabe now in the Lahore Museum; it was designed by Lalah Bulhomal, a Hindu, and fabricated by Pīr Bakhsh, a Muslim.

Examples of these Lahore astronomical instruments can be found today in nearly every major collection in the world. Most were studied by Dr. S. R. Sarma, but he did not have the opportunity to study the instruments held in various museums in Pakistan. In order to fill this gap and raise awareness of this important heritage of astronomical instrumentation in Islamic culture, the author has begun a comprehensive survey of such instruments in Pakistan and is implementing a national inventory of medieval instruments. The author also designs and makes sundials and astrolabes for display and didactic purposes.

This paper will provide an overview of astronomical instruments in Pakistan museums, highlighting some of the most important artifacts. It will conclude with an account of the astrolabes designed by the author.

Keywords: Astronomical instruments, Astrolabe, Allahdad family, Pakistan.

Mubashir Ul-Haq Abbasi serves as Assistant Professor in the Institute of Space Technology, Islamabad, Pakistan. An electrical engineer and amateur astronomer, he established the first "Radio Astronomy Lab" in Pakistan. An author of three books, delivers lectures, holds workshops, designs and fabricates astrolabes to popularize astronomy.

OUR ANCESTORS TAUGHT THE WORLD: UNPUBLISHED INSTRUMENTS FROM THE CAIRO MUSEUM

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This poster will present several unpublished scientific instruments from the collection of the Museum of Islamic Art in Cairo, such as a rare Ottoman astrolabe and a compass of Shah Abass from the Safavid period.

I aim to discuss these instruments along four axes:

- a description giving the story behind each object;
- an assessment of how the object worked in the past, and how to reuse it today;
- an analysis of how these instruments may reveal Islamic influences on the West;
- a comparison of the materials used and their relevance to several schools in Islamic art.

I hope that this small project will offer a passage between the past and the present.

Keywords: Ottoman period, astrolabes, sundials, engineering tools.

Mohamed abd el-Salam is curator in the Textiles Department and assistant supervisor at the Museum of Islamic Art in Cairo with responsibility for the museum's collection of scientific instruments. He is also a lecturer in the Faculty of Archaeology at Helwan University, where he is a PhD candidate working on a dissertation on 'Islamic Chinese Arts and Chinese Influences on Japanese and Koran Art (between the 16th - 19th centuries CE).'

RECONSTRUCTING THE MOROCCAN SULTAN'S COLLECTION OF EUROPEAN SCIENTIFIC INSTRUMENTS (19th century)

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Mawlay Muḥammad ibn 'Abd al-Raḥman, also known as Muḥammad IV, was the Sultan of Morocco from 1859 to 1873. Even before ascending the throne, he attempted to open and modernise his country, which until then had remained completely rooted in its own traditions and outside the mainstream of new scientific ideas. As a passionate lover of astronomy and mathematics, he was interested in modern European developments in these areas, and purchased many expensive instruments in London and Paris. The first part of this talk will be an attempt to reconstruct his collection of instruments, as described by foreign diplomats or travellers, or documented by Arabic translations of operating manuals. The second part will deal with a copy of the famous mechanical calculator, the "arithmomètre de Thomas," given to his son Hasan I in 1873. A Moroccan scientist translated the instruction booklet from French into Arabic complete with personal comments, giving an interesting insight into Moroccan expectations of such an innovation.

Keywords: Morocco, England, France, astronomy, arithmomètre.

Pierre Ageron teaches pure mathematics and history of mathematics at the University of Caen since 1988. His research interests lie in mutual awareness between Western Europe and Islamic countries in the modern era, including French Orientalist scholarship as well as dissemination and appropriation of modern scientific knowledge in Morocco and the Ottoman Empire. Most of his sources are hitherto unstudied Arabic manuscripts.

EASTERN AND WESTERN INSTRUMENTS IN OSMAN EFENDI'S *GIFT OF THE CONVERT* (1779)

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Osman Efendi bin 'Abdūlmennān (1713-1784) was a German convert to Islam who worked as an official Ottoman interpreter at Belgrade fortress. He also translated several books from German into Turkish or Arabic. For example, Osman translated a geography book we believe to be an early edition of Johann Hübner's school text (and not, as previously believed, Varenus' *Geographia Generalis*). In this talk, we will address Osman's masterpiece: the *Gift of the Convert to Rekindle the Extinguished Flame* (1779), a long treatise in Arabic about Euclidean geometry, Galilean dynamics, and their applications to military techniques. Ten manuscript copies are extant throughout the former Ottoman Empire; part of the manuscript was translated into Turkish by Gelenbevi İsmail Efendi. The treatise is essentially a careful compilation of three European books that we have identified: one by Bélidor (more precisely, its German translation by Bion), one by Wolff, and one by Blondel. A fascinating feature is that some traditional typically Islamic material is also incorporated into it, and this hybrid character appears especially clear when geometrical and surveying instruments are mentioned or described in the treatise. We will list all of them and provide details about some examples. Among modern Western instruments are the plane table (*al-ṭabla*), the magnetic compass (*al-bûsula*) and the universal instrument for firing of bombs (*al-âla al-kulliyya yumkin bihâ ramî al-khumbara*); among traditional Islamic instruments are the sine quadrant (*al-rub' al-mujayyab*) and the aerial leveling instrument (*al-kûniyâ al-hawâ'iyya*).

Keywords: Translation, circulation, geometry, surveying, military techniques, Ottoman Empire.

Pierre Ageron teaches pure mathematics and history of mathematics at the University of Caen since 1988. His research interests lie in mutual awareness between Western Europe and Islamic countries in the modern era, including French Orientalist scholarship as well as dissemination and appropriation of modern scientific knowledge in Morocco and the Ottoman Empire. Most of his sources are hitherto unstudied Arabic manuscripts.

Mahdi Abdeljaouad is a retired professor at University of Tunis. His interests include history of mathematics and mathematics education. He is particularly active in the history of mathematics teaching in the Islamic Mediterranean countries.

THE MATHEMATICAL COMPASS BETWEEN EAST AND WEST

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In studying the history of scientific instruments, one particular mathematical instrument stands out: the compass. In the history of mathematics, the story begins with the Greek mathematicians' construction "the compass-and-straightedge," but additionally, in the Islamic world, a special form of compass was invented: the perfect compass, which was an important breakthrough in solving some problems of ancient mathematics. The Greek collapsible compass was only useful for drawing an undetermined circle, while the perfect compass was designed to draw conic sections, enabling solutions to additional mathematical problems.

Abū Sahl al-Qūhī, a mathematician of the 10th century, invented the perfect compass. He was the first of a number of Muslim mathematicians interested in the subject, exemplified by a number of mathematical works including the treatises of great scholars including al-Sijzī, Hibat Allāh al-Usturlābī al-Baghdādī, al-Abharī and Ibn Yūnus. The story of "the perfect compass" continues in Western Europe after the Renaissance, and includes work of Leonardo da Vinci and before him, Benvenuto della Volpaia and Antonio da Sangallo; however, it is unclear whether the Italian developments were independent of Islamic tradition, and this question remains controversial. A complete survey has resulted in the discovery of some mathematical similarities between these two traditions, despite the lack of historical evidence for such transmission.

Keywords: History of Mathematics, Mathematical Compass, Perfect Compass, Islamic Civilization, Renaissance.

Hassan Amini has a PhD in the History and Philosophy of Science from the Iranian Institute of Philosophy (2014) with a dissertation on "The Status of the Spherical Trigonometry in the History of Geometry" (Supervisor: Dr. Hossein Masoumi Hamedani). Amini has a MA in the History of Science from Tehran University (2008). The title of his MA thesis is "Al-Risāla al-Muʿīnīyya of Khwādja Naṣīr al-Dīn al-Ṭūsī: A Critical Edition and Study". His current research focuses on the history and philosophy of mathematics.

ELIMINATING THE NECESSITY OF USING OBSERVATIONAL INSTRUMENTS IN TIMEKEEPING

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Muḥammad ibn Katib Sīnān al-Qunawī al-Muwaqqit is one of the pioneers of timekeeping in 16th century Turkey. He continued the timekeeping tradition established by the Mamluk astronomers between the 13th and 15th centuries. He started the Turcification movement on timekeeping by translating into and compiling in Turkish for the first time. His main goal was to improve the practicality of timekeeping applications, on both instruments and tables. His most extensive work, *Mīzān al-Kawākib*, is an exceptional example for practical use of tables for timekeeping. *Mīzān al-Kawākib* consists of tables prepared not for the Sun's, but for the stars' positions, and it contains more than 240,000 numerical values, and is the first extensive work of its kind, comprising an introduction on how to use the main tables, a star catalogue for some 500 stars and tables for timekeeping for four functions. As he revealed in the introduction, Muḥammad ibn Katib Sīnān compiled these tables with the intention of eliminating the necessity of using instruments to determine the time at night and he discovered a method to do so. Unfortunately, his approach, albeit progressive, did not make a lasting impact on Ottoman timekeeping. Nonetheless, the idea of determining time without any instruments involved is quite ingenious. The aim of this presentation is to introduce Muḥammad ibn Katib Sīnān's progressive idea and to discuss the efficiency of his method and making observations without instruments.

Keywords: Ottoman astronomy, tables for timekeeping, muwaqqit, Muḥammad ibn Katib Sīnān, astronomical instruments.

Taha Yasin Arslan is a research assistant in the Department of the History of Science, Istanbul Medeniyet University. He studied pre-16th century Mamluk and Ottoman timekeeping in his PhD (Istanbul University, Department of the History of Science, 2015). As a scholarship student of TÜBİTAK (Ankara) he made researches at Oxford University in 2015. His main interests are timekeeping and instrumentation in the Mamluk and the Ottoman-eras.

DESCRIBING THE THEORY OF THE EARTH'S ROTATION BY USING FOUR KINDS OF ASTROLABES

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Al-Sijzi, the Iranian astronomer, believed that the Earth rotated around its axis and he constructed his astrolabes in accordance with this belief. Al-Biruni attempted to describe the four types of astrolabes invented by Al-Sijzi. In most astrolabes (i.e., planispheric astrolabes), the coordinate system depends on the stationary observer and the positions of the stars, which are spinning around the Earth, and are measured relative to the various coordinates. In the astrolabes made by Al-Sijzi, the stars are considered to have a fixed position in space, and the horizon of the observer rotates relative to the fixed points. This idea was originally proposed for constructing scaphoid astrolabes; however, other kinds of astrolabes (i.e., Mstry astrolabes, Marychy astrolabes, and cruciate astrolabes) were also based on this idea. In this paper, based on information in Biruni's *Al-Estiab*, the structure of these four types of astrolabes is compared to flat instruments, and their operating principles are described based on the theory of the Earth's rotation.

Keywords: Astrolabe, Al-Sijzi, al-Biruni.

Asadollah Safaei holds his MSc in astrophysics. He is the head of Kashan University Observatory, Iran. His research interests are ancient astronomical instruments and their construction. He authored several publications (in Persian) on this topic.

A HISTORY OF GNOMONICS IN IRAN

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Gnomonics is a branch of astronomy dealing with time telling using the shadow of a gnomon, a piece projecting from the surface of the dial and in sunlight, casting a shadow onto an hour grid. Gnomonics is the theory and practice of making and using sundials and noon markers, and it has roots in prehistoric periods, and in many ancient cultures such as Egypt, Greece, China, India and Iran. Several ancient sundials from the Ottoman period still exist in Turkey and Syria, and sundials remain important even today in our more technological period. In recent decades there has been renewed interest in sundials, because they are closely related to astronomy, mathematics (especially trigonometry) and artistic creativity, and they are very useful didactic mathematical instruments.

In this paper, I will provide an account of the history of gnomonics in pre-Islamic Iran and during the Islamic era. Some historical references will be introduced and an account of the scientists and their works in this field will be presented, and illustrated with photos of ancient and modern sundials and noon markers existing in Iran. We may also organize a sundial workshop for the interested audience.

Keywords: Gnomonics, sundial, noon marker.

Mohammad Bagheri has received his PhD in history of mathematics from the University of Utrecht (Holland) in 2006. He is engaged in the history of mathematics and astronomy in the Islamic civilization. He is the chief-editor of the Persian journal *Miras-e Elmi* (Scientific heritage). At present he is the Secretary of the Commission for the History of Science and Technology in Islamic Societies. He is a member of several scientific societies and advisory board of several scientific journals in the field of history of science.

SCIENTIFIC INSTRUMENTS THAT WERE USED AND CURRENTLY IN EXHIBITION IN ANKARA UNIVERSITY PHYSICS DEPARTMENT

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The Physics Department of Ankara University's Faculty of Science was founded in 1943. Hence, this department has an important position in Turkey's science history because it is one of the first physics departments and its history is important for the science politics of the Turkish Republic. There are many scientific instruments used from the 1950's to the 1990's which are presently on exhibition in the department. The poster will present these scientific instruments and show their importance for the scientific research in Turkey. Information on their history and importance in the history of science will be presented.

Keywords: Physics Department, Ankara University, scientific instruments.

Vural Bařaran is a graduate of Ankara University Faculty of Science's Physics Department. He completed his master's thesis in the Department of Philosophy, Chair for the History of Science, Ankara University. His master's thesis was on the Ottoman texts on ballistics. Currently he is pursuing his PhD thesis focusing on the mathematical knowledge included in the 18th century Ottoman texts on ballistics. His areas of interest are history of physics, philosophy of science, philosophy of Nature, Kant, Althusser.

ALVA MASON, PHILADELPHIA INSTRUMENT MAKER, 1825-1860

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The first instrument that inspired the author to collect and study scientific instruments, an inclined plane with a brass plaque signed ALVA MASON PHILA., was purchased in 1984. No other examples of signed Mason instruments were located. Brothers David, Alva and William Mason were born each two years apart in Connecticut in the 1780's and moved to Philadelphia by 1811, where they were engaged in wood and brass engraving. William and Alva were partners from 1816, first in brass engraving, then in 1825 as Philosophical Instrument Makers. By 1827 William had left the business, and Alva continued until 1860. Three of his signed instruments are illustrated in an 1830 book on Natural Philosophy, and in 1837 he published a broadsheet with instruments and prices. In 1991, the author discovered and purchased another signed Mason instrument, a double cylinder air pump. A third example was discovered in 2011 while watching an historical cooking TV series, A Taste of History. A background photograph incorrectly described as Joseph Priestley's instruments showed an Atwood machine that looked similar to Mason's version in the 1830 book. The series producer was contacted, who said the photograph came from the Smithsonian digital archives. This led to the primary source as an amateur 19th century photographer at Dickinson College in Carlisle, Pennsylvania. Special Collections at Dickinson was contacted, and said that they had an Atwood machine in the archives, and upon inspection, it has the signed brass A. Mason label. This talk will describe the three known surviving Mason instruments and give a short history of Alva Mason.

Keywords: Alva Mason, Philadelphia, philosophical instruments, Atwood, vacuum pump, inclined plane.

Steve Beare collects 19th century scientific instruments and books on science and technology and is also interested in the history of bookbindings. He is writing a book on a 19th century New Jersey bookbinder's tool cutter and his catalogue of 2500 designs for stamps. He is a retired research chemist and lives in Wilmington, Delaware.

PRODUCTION AND CIRCULATION OF TEACHING INSTRUMENTS DURING THE TWENTIETH-CENTURY: THE EXAMPLE OF THE FULLY-AUTOMATIZED CLOUD CHAMBER BY THE OFFICINE GALILEO IN FLORENCE

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The framework for this presentation is a project aimed at retracing the transition of the cloud chamber from a research to a teaching paradigm, and which was developed at the Europa-Universität in Flensburg and supported by the Humboldt Foundation. As an instrument for research, the cloud chamber, was introduced by CTR Wilson in 1911, and then studied by Wolfgang Engels in 2006, according to the replication method. Starting from this study, the presentation will relate the original apparatus to a second one produced, for teaching purposes, by the Italian Company “Officine Galileo” in 1949.

The Italian model, designed by the physicist Carlo Ballario was built according to a modification to his original instruments introduced by Wilson in 1933, and projecting the use of a plastic membrane. Moreover, relying on a consistent electrical component, the instrument is fully automatized thanks to a single button for activating the magnetic field inside the chamber, deactivating the electric one, powering the illumination, launching the expansion, and restoring the apparatus. In the presentation, I will:

- retrace the transformation leading from the original Wilson instrument to the Italian model;
- contextualize the production of the Italian apparatus within the partnership between Ballario and the Officine Galileo and give insights on the circulation of the instruments within the Italian schools;
- summarize the challenging aspects which arose from working with the model at the Fondazione Scienza e Tecnica in Florence;
- relate the experimental practise with this, and other educational devices, to the practise with the historical Wilson cloud chamber.

Keywords: Teaching instruments, particle physics, cloud chamber, Officine Galileo.

Eugenio Bertozzi has been a Humboldt Research Fellow at the Europa-Universität in Flensburg with a project on the cloud chambers as instruments for teaching. Presently he is a scholar-in-residence at the Deutsches Museum in Munich with a project on the procedures of visualization in particle physics experiments.

TAQI AL-DIN AND TYCHO BRAHE: A COMPARATIVE STUDY OF THEIR OBSERVATIONAL INSTRUMENTS

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At the dawn of modern astronomy, Taqi al-Din Muhammad ibn Ma'ruf al-Râsid (1526-1585) and Tycho Brahe (1546-1601) each played an important role in the design of astronomical instruments. Upon the order of Sultan Murad III (r. 1574-1595) Taqi al-Din built an observatory in 1579 on a hill overlooking the city. The observatory, however, was destroyed by the orders of the same Sultan on 22 January 1580 for numerous socio-political reasons linked to bad omens (the outbreak of Black Death and some military defeats), and rivalries between Ottoman high officials. Taqi al-Din wrote a treatise in Turkish titled *Alât al-Rasadiyya li Zîc al-Shahinshahiyya* in which he described the instruments of the Observatory and gave some hints about his observational methods. The nine instruments and the tool he described are the following: 1- Armillary sphere (*Zat al-halak*), 2- Mural quadrant (*Lebna*), 3- An instrument for measuring the horizontal coordinates (*Zat al-semt va'l irtifâ*), 4- Torquetum (*Zat al-shu'batayn*), 5- Ruler quadrant (*Rub'-ı mistara*) or wooden quadrant (*Rub'-ı daffa*), 6- Diopter (*Zat al-sukhatayn*), 7- Tool with a rope (*Zat al-avtar*), 8- Sextant (*Mushabbaha bi'l-manatik*), 9- Astronomical clock (*Bangâm al-rasadi*) and additionally an Indian compass (*Syndî pargal*). The present paper aims to introduce and compare the instruments designed and used by Taqi al-Din and Tycho Brahe in the observatories in Istanbul and on Hven Island.

Keywords: Taqi al-Din, Tycho Brahe, Istanbul Observatory, Ottoman Empire.

Atilla Bir is an emeritus professor of electrical engineering. Beside lecturing and researching in system and control engineering in Istanbul Technical University, he wrote popular articles on the hydraulic devices designed by medieval Islamic mechanics, published the *Kitab al-Hiyal* of Banu Musa bin Shakir (9th c.), and prepared technical accounts of Taqi al-Din's (16th c.) works. Among his other research interests are quadrants, sundials, mechanical clocks, Turkish reflex bows and norias of Anatolia.

Mustafa Kaçar is professor of History of Science at Fatih Sultan Mehmet Vakıf University. He holds a PhD from Istanbul University with a thesis on the history of the Imperial Engineering School (Mühendishane) in Istanbul. He collaborated with Professor Atilla Bir in publishing the works of Takiyüddin (16th c.) and Ahmed Ziya Akbulut (early 20th c.) on astronomical instruments.

KĀSHĀNĪ'S ṬABAQ AL-MANĀTIQ: THE MOST ADVANCED EQUATORIUM EVER DESIGNED IN THE MIDDLE AGES AND EARLY MODERN TIMES

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An equatorium is an astronomical instrument designed for determining a planet's coordinates in the sky at any given time with no need for numerical computation, and which can be used to assist astronomers mainly when great accuracy was not required. Three different groups of equatoria were built in the middle ages and early modern period: mechanical, geometrical, and mathematical. We neither know for sure who the first inventor of the equatorium was nor when it was invented; however, the earliest treatises on this instrument were written by three Andalusian astronomers: Ibn al-Samḥ, al-Zarqālluh, and Abū-l-Ṣalt. Later, Hebrew and Latin authors improved the instrument and wrote a great deal on the subject. As far as we know, the only extant Arabic manuscript on an equatorium in the eastern part of the Islamic world is that of Kāshānī (15th A.D.). His instrument has been widely considered as the highly advanced equatorium not only compared with Andalusian but also compared with Hebrew and Latin equatoria which were described and built after the time of Kāshānī. In this presentation, I will review the history of equatoria and compare the construction and use of Kāshānī's equatorium with its ancestors and predecessors. A paper model of Kashani's equatorium will be used to show how it works and how accurately it calculates planetary positions.

Keywords: Kāshānī's Ṭabaq al-Manātiq, equatorium, Andalusian equatoria.

Hamid Bohloul received his BS degree in physics and his MA in the History of Islamic Exact Sciences. Now he is working on his Phd. He is deeply interested in the history of astronomy, especially on the pre-telescopic astronomical instruments. He is currently working on the construction and use of pre-telescopic astronomical and their social aspects.

SCOPING OUT TELESCOPES: THE SURPRISES OF A FAMILIAR INSTRUMENT

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A telescope serves as an easily recognizable scientific instrument, one with a readily understood purpose and construction. But not always. In Summer and Fall 2015, an intensive 3-month safari tracking down and optically measuring instruments in more than two dozen museums and private collections across Europe capped a decade of investigating the startling variety of early telescopes. In addition to describing our methods, we will present selected key findings, including: the surprising quality of the oldest securely dated telescope (Berlin, 1617), previously unstudied metal tubes in Kassel and Skokloster, clearing up ambiguities of the 'Marius' telescope in Munich, the surprising existence of very long Galilean telescopes, lenses chipped in surprising ways, and the finding of the only two known examples of 17th century Keplerian telescopes.

Keywords: Telescopes, materials, forms, users, testing.

Marvin Bolt and **Michael Korey** have identified and examined 17th- and 18th-century telescopes in museums throughout Europe over the past decade. Their research brings together technical, aesthetic, and social aspects of scientific instruments, and usually involves multiple collaborators, especially of late Huib Zuidervaart, Tiemen Cocquyt, Rolf Willach, and Rolf Riekher. Bolt and Korey's work has only been possible due to the many museum colleagues and private collectors who have shared their knowledge and facilitated access to the objects in their collections.

SOME UNUSUAL INSTRUMENTS OF A PROVINCIAL COLLECTION

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The Museo Civico di Modena (Italy) preserves a large number of very varied artistic works and technical artefacts. Among them, there is a very fine collection of 18th and 19th century physics and astronomy instruments. The peculiarity of this collection is that many of its instruments were made locally by very little known makers, who were sometime “artists,” who worked for the local university and had no ambitions to be involved in the national or international market. Therefore, their instruments are unusual, show a great originality and hardly reproduce the more or less standardised design which had been introduced by the most important French or English makers of the time. In my paper I will present some of these artefacts (mechanical model, hydraulic and electrical apparatus, etc.) as well as their history.

Keywords: Scientific instruments, local makers, provincial collection.

Paolo Brenni is specialised in the history of scientific instruments and of precision industry in the period from the beginning of the 18th century to mid-20th century. He works in Italy but he also collaborates with various European museums and scientific institutions. He is actually the president of the Scientific Instrument Society.

INSTRUMENTS OF KNOWLEDGE AND POWER IN COLONIAL CONTEXT: THE SCIENTIFIC INSTRUMENTS IN THE FRENCH OCCUPATION OF EGYPT, 1798-1801

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The Napoleonic expedition to Egypt was both a military campaign and a scientific venture, but its scientific instruments have yet to be studied. Even Ann Godlewska's excellent reference work hardly mentions – and only citing printed sources – a few instruments used in “The Napoleonic survey of Egypt” (*Cartographica*, 1988). Conversely, the proposed paper is based mainly on unpublished sources, either official archives or private correspondences.

The French “*Commission des sciences et des arts*” was supplied with the most portable and accurate instruments available at the time. A special emphasis was given to astronomy and topography – for the 1/100,000 topographical map of Egypt – but the scientists and engineers used many other instruments of mathematics, physics and chemistry, all provided by preeminent French instrument makers (Berthoud, Dumotiez, Fréminville, Lenoir, Mossy, Richer, Rochette...), as well as previously imported ones (Dollond, Nicholson, Saussure, Wedgwood). In addition, members of the expedition brought their own instruments. (extra Berthoud chronometers, Conté's barometer to determine altitudes...).

Scientific instrument makers (Lenoir's son) and specialised “artists” from the *Ecole polytechnique* also belonged to the Commission. After the looting of instruments during the first Cairo uprising (October 1798), the Mechanical Workshops (*Ateliers mécaniques*) set up under Conté provided the colony with new ones. They were made in three workshops respectively devoted to “astronomical instruments,” “geographical and topographical instruments,” and “precision machinery, geometrical instruments, horology and plate.” Even new devices were designed, made and tested in Cairo, such as an apparatus to measure milliseconds which was presented to the Egyptian Institute.

The paper will also emphasize the scarcity of Egyptian testimonies regarding French scientific instruments.

Keywords: Scientific instruments, French expedition to Egypt, Commission des sciences et des arts, Ateliers mécaniques du Caire, Napoleonic Survey of Egypt, Nicolas-Jacques Conté, Paul-Etienne-Marie Lenoir, Nicolas-Antoine Nouet.

Patrice Bret is a senior researcher on history of science and technology. He has edited 18th-century sources. Among his publications, many deal with French-Egyptian cultural exchanges, He is preparing an administrative and cultural dictionary of Egypt under the French occupation (*Le Nil, la République et le Croissant*), alongside a biography of Nicolas-Jacques Conté.

MUSIC AND "AN-ESTHETICS" IN THE EARLY MODERN SCIENCE: THE MONOCHORD AS SCIENTIFIC INSTRUMENT

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The monochords described by Ramos de Pareja, Zarlino and Mersenne, have been analysed in their writings, reconstructed as experimental objects, and contextualized in the historiography of the scientific instruments of the so-called "Scientific Revolution." Related to the concept of "consonance," each monochord preserved a physico-mathematical "truth" (natural harmonics, psychoacoustic thresholds, physical network variables) and, in turn, had practical functions as a pedagogic tool, for construction and tuning of musical instruments. This double function (scientific and aesthetic) is indissoluble, and therefore the historiographical classification that insists on ordering scientific instruments according to philosophical or practical nature, cannot be applied to the monochord. If "music" was a "science" in the 15th, 16th, and 17th centuries, the monochord is a "scientific instrument," and as such, its absence is surprising, and its inclusion is simultaneously both ignored and included in collections and museums of both musical and scientific instruments. The reconstructions presented –real and virtual– help to understand a coalescence of senses and rationality, but which ultimately entered the quantitative and formal domain of early modern science which chose research over aesthetics. The monochords of Ramos de Pareja, Zarlino and, particularly Mersenne, show us a path to early modern science going from Spanish rhetoric to Venetian Aristotelian logic (apodictic and dialectic) up to Mersenne's "an-aesthetics" experiences, passing the beauty of nature but being "hypnotized" by its mechanism.

Keywords: Music, science, harmony, monochord, proportion, aesthetics.

Carlos Calderón Urreiztieta, has his PhD from Pompeu Fabra University. He holds a master in the History of Science from the University of Barcelona. He completed his studies in Music and Architecture in the University Simón Bolívar, Caracas, Venezuela. As an active lecturer in "Palau" and "Liceu" of Barcelona, he is orientating his investigations to music, art and science and trying to communicate through multimedia presentations.

ITALIAN ASTRONOMICAL EXPEDITIONS TO THE WEST

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During the “golden era” of early Italian astrophysics (1860-1880), some scientific expeditions to Western countries were organized, in order to observe astronomical phenomena such as total solar eclipses and transits of Venus. Some Italian astronomers participated in the expeditions, as invitees or organizers, bringing with them instruments and apparatus needed for the observations. The talk will illustrate the context of those small scientific “migrations,” describing the staff, the equipment, the results, and the impact on the local culture. In fact, in addition to being visitors, sometimes the scientists inspired the establishment of local scientific institutions – as in the case of Calcutta Observatory. This is an interesting development in the perspective of a cooperation between East and West.

Keywords: Astronomy, scientific expeditions, observatories.

Ileana Chinnici is an astronomer at INAF-Palermo Astronomical Observatory, where she has been Curator of the Museum from 1996 to 2004. She is author of some books and many articles on history of astronomy published in national and international journals. Her main research topic is history of astronomy in the 19th century.

**PRESENTATION OF THE EXHIBITION: JANELLO TORRIANI, GENIO DEL
RINASCIMENTO (CREMONA 10TH SEPTEMBER 2016-29TH JANUARY 2017)**

Cristiano Zanetti

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Janello Torriani, also known as Juanelo Turriano (Cremona, Italy c.1500 – Toledo, Spain 1585) was a skilled blacksmith and a locksmith, a scientific instrument maker, a universally admired clockmaker and hydraulic engineer, court mathematician, and celebrated inventor. Born during the troubled time of the Italian Wars, Janello Torriani had an incredible professional trajectory that took him from Cremona to the imperial court of Charles V and also to that of King Philip II of Spain. Among his creations were the first known machine-tool to cut toothed wheels; inventive applications of gimbals; two revolutionary planetary clocks; and the first giant machine ever seen, the Toledo Device, a 300-metre-long complex structure that could elevate water over a slope of a 100 metres. Torriani also participated in the Gregorian reform of the calendar, contributing with a treatise and mathematical instruments for calculus. Further mathematical and mechanical endeavours included waterworks surveying, designing the casting of bells, celestial observations, and the production of automata and other curious creations, such as a combination lock and spring-driven portable mills, and astronomical instruments. My poster will be provided with an Oculus device for virtual reality to experience the highlights of the exhibition.

Keywords: Exhibition, renaissance, artisan, clockmaking, engineering, astronomy.

Cristiano Zanetti (PhD, European University Institute, 2012), the curator of the exhibition “Janello Torriani, genio del rinascimento” (Cremona, 10 Sept. 2016) was awarded with the 7th edition of the Garcia-Diego international prize in 2014. He has conducted research on Renaissance planetary horology and engineering while a post-doctoral fellow at The Medici Archive Project and at the Max Planck Institute für Wissenschaftsgeschichte.

A 16TH CENTURY OTTOMAN COMPENDIUM OF ASTRONOMICAL INSTRUMENTS: ADMIRAL SEYDI ALI REIS'S MIR'AT-I KÂINAT

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The Turkish admiral Seydi Ali Reis (d.1562) is the author of a number of treatises on astronomy, nautical astronomy and astronomical instruments, among them the *Mir'at-ı Kâinat* (*Mirror of the Universe*). Written in Turkish, it was compiled from various Arabic, Persian and Turkish sources. The book includes information about the construction and uses of five portable astronomical instruments: *usturlab* (astrolabe), *rub'-ı mukantar* (almucantar quadrant), *rub'-ı müceyyeb* (sine quadrant), *zatü'l-kürsi* (armillary sphere), and *dâire-i muaddil* (equatorial ring). The first three of these instruments were widely used by Ottoman astronomers and timekeepers in the 16th century. Many treatises were composed to explain their use. Two of the instruments, *zatü'l kürsi* and *dâire-i muaddil*, were less popular than the other three. Although these astronomical instruments could individually provide a solution for almost the same astronomical problems in different ways, Seydi Ali Reis preferred to compile a book encompassing all of them. Another important point is that the compilation of a book of this kind by a navigator is not usual among the Ottomans. Taking into account all of these issues, the present paper will try to answer the following questions: Why and for whom did Seydi Ali Reis compile this book? Why did he choose these instruments? How did these instruments relate to Ottoman nautical astronomy in the 16th century?

Keywords: Mir'at-ı Kâinat, Seydi Ali Reis, portable astronomical instruments, 16th century, Ottoman maritime history.

Gaye Danişan Polat is a graduate from the Department of Astronomy and Space Sciences, Istanbul University. She completed her master thesis (*Observatories and Astronomical Observations in Turkey, 1575-1997*) in 2009, and her PhD thesis (*Ottoman Nautical Astronomy and Astronomical Instruments in the 16th century*) in 2016. She currently pursues her research on the history of astronomical instruments.

THE YOUNG TURK AND HIS OPHTHALMOSCOPE

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Esat Neşet (Essad Néchat, Esat Işık Pasha, 1865-1936) was sent to Paris in 1889, following his graduation from the Military Medical Academy in Istanbul where he specialised in ophthalmology under Profs. Panas and Despagne. Esat was the only Turk among fellow residents, including Drs. Constantinos Tahinzis, Alexios Trantas, Ananias Gabrielidès, Panaghis Giannoulatos, all of whom were to hold key positions in Istanbul and Athens, and Lit.Dr. Nicolaki Vassiladès, also from the Turkish army.

Dr. Esat developed a simple reflecting ophthalmoscope consisting of a pair of plane and concave pierced mirrors mounted back-to-back on a sprung frame allowing for rotation and use in both ophthalmoscopy and sciascopy. The original 'Ophtalmoscope Essad' ordered from Maison L. Giroux Paris in 1893 has mirrors of 39 mm diameter with a central circular aperture of 5 mm set in a brass frame with foldable handle. A modified version has larger mirrors (44 mm) and a smaller sight-hole (3 mm).

On his return to Istanbul in 1894, Esat Işık was appointed professor at the Gülhane Military Hospital and the Imperial Children's Hospital. He received the Pasha title from Sultan Abdulhamid II, but sided with the constitutionalist movement leading to the Young Turk Revolution of 1908. Dr. Esat Işık was nominated Deputy Minister of Health in 1912, and undertook the reorganisation of the Red Crescent. Esat Pasha became an active member of the ruling Committee of Union of Progress during WWI. Unpatented and still in use, the Essad Ophthalmoscope remains the singular Ottoman contribution to the modern medical armamentarium.

Keywords: ophtalmoscope, Essad Néchat, Esat Işık Paşa, Ottoman Empire.

Şeref Etker, BSc, MD, Consultant Paediatric surgeon & urologist. Research interests: History of surgery and medicine in Turkey, 1850 to 1950.

INSTRUMENTS AND METHODS FOR RECOGNIZING THE PURITY OF A METAL PIECE AND AMOUNT OF EACH ELEMENT IN ALLOYS

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Innovating a method for recognizing the purity of a metal piece and the amount of each element in alloys was interesting for scientists from ancient Greece and the Islamic period until the European Renaissance. Archimedes (3th c. BCE), Razi (9th -10th c.), Khazini (12th c.) and Galilei (16th -17th c.) constructed complicated balances in an attempt to analyze these data, but the inaccuracy of these instruments led Menelaus (1th – 2th c.) and later Khayyam (11th – 12th c.) to devise mathematical methods for finding metal purity without using these balances; however, Menelaus did find that he needed an instrument for constructing metal pieces with equal volume.

Some scientists worked on methods and instruments for constructing metal pieces with equal volume, all of which al-Biruni (10th -11th c.) found unsatisfactory and he ultimately invented an instrument that could calculate the weight of metal pieces with equal volume without first having to construct them, which ultimately led to other more useful methods.

In this paper we will discuss the complex balances, followed by mathematical methods, efforts to construct metal pieces with equal volume, and finally al-Biruni's method for calculating the weight of metal pieces with equal volume without constructing them.

Keywords: Densitometry, alloy, Islamic period.

Abouzar Farzpourmachiani, holds a MA in History of science in Islam. He is the chief-editor of the Iranian newsletter for history of science.

ANCIENT MECHANICAL INSTRUMENTS AND THE MECHANICAL WORLD VIEW: GREEK, ISLAMIC AND MODERN SCIENCE

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In the first half of the twentieth century, Boris Hessen (1893-1936) and Henryk Grossmann (1881-1950) put forward a series of theses to show that the instrumentation of the sixteenth and seventeenth centuries could provide the mechanical philosophy which was one of the key elements of the Scientific Revolution.

Although mechanical instruments were not unknown among the ancient Greeks and scientists in the Islamic world, philosophers of those periods (400 B.C – 1700 A.C) never provided a mechanical world view to oppose the organic natural philosophy of Aristotle. Ptolemy's *Planetary Hypothesis* is the only known work which mentions cosmology and mechanical instruments side by side. As he states, his book is written to represent the configuration of the heavenly bodies on the basis of his observations and mathematical arguments presented in *Almagest*, but there is another purpose too.

The Arab translator preferred to keep the Greek word “μηχανικός” (= of or pertaining to machines) in an Arabic form, adding a suggested translation for it: “al-Ḥīyal” [literally: “ingenious devices”] was a term by which to call the technical methods, including geometry and mathematics, to build mechanical instruments. By mechanical instruments, Ptolemy probably means the instruments similar to Antikythera mechanism which was built in the first century BCE. Ptolemy shows that cosmology and mechanics could be two sides of the same coin. Nevertheless, neither Ptolemy, nor the Islamic writers of theoretical astronomy books developed this notion of a non-Aristotelian natural philosophy.

Keywords: mechanical instruments, mechanical philosophy, Greek science, Islamic science, modern science.

Amir Mohammad Gamini, is a faculty member of the Institute for the History of Science, University of Tehran. He holds a PhD in History and Philosophy of Science from the Iranian Institute of Philosophy, 2013 (Dissertation title: "Shīrāzī and his role in the science of hay'a", Supervisor: Dr. Hossein Masoumi Hamedani). His research interests are history of astronomy, ilm el-hay'a, science and religion.

NAVIGATIONAL INSTRUMENTS OF ESTONIAN SEAMEN, ca. 1860-1940

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Estonia has been a bridge between Russia and Europe for centuries. From the second half of the 19th century, Estonia started to become a “maritime nation,” and seafaring became more professional. As instrumentation evolved, navigational instruments used by the Estonian seamen also changed. This paper gives an overview of the instruments used in Estonia based on the collections of the Estonian Maritime Museum. Through the descriptions of the objects, we will explore some aspects of the Estonian maritime history, concentrating on wider processes.

Navigational instruments kept in the collections of the Estonian Maritime Museum date back to the beginning of 19th century, but most are from the beginning of the 20th century (mostly Western productions), and the Soviet period when Soviet instruments became prevalent on Estonian vessels. This paper concentrates mainly on navigational instruments used between 1860 and 1940. The 1860's mark the beginning of Estonian shipbuilding and cargo shipping, whereas 1940 marks the beginning of Soviet occupation during which many Estonian ships were nationalized or destroyed, and motor ships replaced the sailing ships that were widely used until 1940.

The aim of this paper is to analyse the usage of different types of instruments in comparison with the historical developments. The collection consists of sextants, octants, compasses, logs, sand glasses, chronometers, etc, which give a good overview of the instruments used in Estonia, and how the origin of navigational instruments changed through history. The statistics about the collection of navigational technology of the Estonian Maritime Museum will also be discussed.

Keywords: Navigation, instruments, Estonia, seamen, sextant, compass.

Feliks Gornischeff is researcher and curator at the Estonian Maritime Museum in Tallinn. His main tasks include scientific research based on the collections of the Estonian Maritime Museum, mainly the collections of nautical technology, naval weapon systems, ship models, boats and badges/insignia.

THE RISE OF THE SCIENTIFIC INSTRUMENTS' PRODUCTION IN RUSSIA: FROM THE TURNERIES OF PETER THE GREAT TO THE INSTRUMENTAL CHAMBER OF THE ACADEMY OF SCIENCES

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The pre-Petrine Russia did not produce any scientific instruments, though foreigners living in Moscow, as well as some educated nobles and diplomats bought them from Europe. The first bulk purchase of various scientific instruments occurred during the Great Embassy of Peter Ist in Europe (1697-98), when the first two instrument makers (a clockmaker and an optician) were hired. Since this time, three main factors have been influential in instrument making in Russia: the acquisition of instruments from abroad (including the arrival of diplomatic gifts such as the famous Gottorp Globe), the hiring of foreign masters, and the organization of local manufactures. The first Russian local manufactures were originally supervised and directed by foreign experts, then, with those experts' help, under the direction of locally trained specialists (including the famous Russian mechanic Andrej Nartov).

This paper will discuss all these processes with regard to the specific politico-administrative context of early 18th century Russia, in particular the dominant and determining role of the sovereign. This paper will also present the two main spaces where scientific instruments were produced. First, there were non-specialized workshops (wood turning workshops of Peter Ist, 1690s-1720s) where machine tools for the artistic processing of bone, wood and metal were manufactured. These workshops occasionally produced scientific instruments (solar and stellar clocks, drawing and nautical instruments, globes). Second, there was a specialized production system operating within the framework of the Academy of Sciences and serving the needs of the Academy (i.e. the Chamber for Instruments, 1725)

A collective portrait of the European masters who worked in these environments, and of their Russian disciples, will be presented. The typology of their production will also be discussed.

Keywords: Instrument making, turning workshops, Peter Ist, Chamber for Instruments, Academy of Sciences, Recruitment of European masters, 18th century, Russia, Great Embassy.

Dmitri Gouzevitch (PhD) is attached to the Centre d'Etudes des Mondes Russe, Caucasiens et Est-européens, EHESS, Paris. His research interests are the rise of the engineering as a profession in Russia (18th-19th c.) and in western Europe (technical training, professional organizations, production of knowledge and cognitive practices, the role played by technological transfer and cultural exchanges).

Irina Gouzevitch (PhD) is attached to the Centre Maurice Halbwachs, EHESS, Paris. Her research interests are the transfer, acculturation and circulation of scientific and technical knowledge in the 18th century (technical training, communication networks, professional mobility; identity questions; intercultural exchanges between Russia and Western Europe).

**ATOMIC AGE MODELS:
PROMOTING NATIONAL NUCLEAR PROGRAM AT THE CAR DEALER**

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In the spring of 1949, a three-week exhibition – *Atomåldern* ‘the Atomic Age’ – was opened by the Swedish Crown Prince in Osterman’s Marble Halls that usually displayed cars for sale in central Stockholm. The exhibition became a tremendous success with over fifty thousand paying visitors in three weeks! This exhibition followed similar exhibitions in the UK like the *Atomic Train* exhibition.

The exhibition dealt with the development of the understanding of the inner workings of the atom, but it also included various innovative ways of displaying the “mysterious world” of the atom. Films from Hiroshima and the Bikini Islands added to the fascination for the dramatic content. Since Sweden had just embarked on a national atomic energy program, it was also important to show that Sweden was in the forefront of atomic research, and two models from the Research Institute of the Royal Swedish Academy of Sciences were thus noted with pride in the newspapers as signs of Swedish scientific achievements and competitiveness. The two models on display from the Research Institute of the Royal Swedish Academy of Sciences were a 1:20 model of the new 225 cm-cyclotron intended for 30 MeV deuterons and a 1:20 model of the 1400 kV high voltage facility with a cascade generator and an accelerator tube used for light nuclei research. The paper will discuss the popular images of nuclear endeavours at the time and the use of models in exhibitions.

Keywords: Models, atomic energy, exhibition, promotion of science.

Karl Grandin holds a MSc in physics engineering and a PhD in history of science and ideas from Uppsala University. His research has mainly dealt with the history of modern physics. He has a lot of experience in international collaborations, especially dealing with scientific heritage and from digitizing projects.

MEASURING THE ALTITUDE WITH AN ALLA FRANCA INSTRUMENT: THE OTTOMAN ENGINEER FEYZI'S TREATISE ON THE SEXTANT

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The astrolabe and the quadrant were the instruments that Ottomans used to measure the solar altitude for setting time or finding latitude. Their crafting and use was a tradition inherited from medieval Islam. The modernisation of the military in the 18th century, besides introducing new technologies (shipbuilding, gun casting, fortification etc.) from Europe, had paved the way for procuring European treatises. The library of the Engineering School (*Mühendishane*) in Istanbul was well equipped with 400 treatises in French on sciences and military arts. Among the instruments sent in 1804 to the Engineering School by the Imperial Palace (*Enderun*) were two sextants produced in England. In 1805, an Ottoman engineer named Feyzi compiled a treatise on the operations that can be performed with the sextant. Titled *Muhâdarât-ı Feyzi* (Lectures of Feyzi), the treatise is among the earliest Ottoman/Turkish texts introducing the sextant. Although the connection between the treatise and the two sextants is not clear, one can argue that this instrument was valued and utilized primarily by engineers, bearing in mind that later manuals were mostly compiled by military officers or engineers. The timekeepers (*muvaqqits*) seem to have continued to employ the traditional wooden quadrant or the basic metal astrolabe to determine prayer times. The present paper aims to study the *Muhâdarât-ı Feyzi* in order to comprehend the introduction and use of the sextant among Ottoman engineers.

Keywords: Sextant, Ottoman Empire, Mühendishane, Feyzi the engineer, *Muhâdarât-ı Feyzi*.

Feza Günergun, Ch.E, holds a PhD in medical history from Istanbul University. She is the head of the Department of the History of Science, Istanbul University. Her research interests are the introduction and establishment of modern sciences in Turkey (18th-20th c.); Turkish translations of European science books; dissemination of modern sciences in Turkey; the role of journals in the diffusion and popularization of sciences.

Gaye Danişan Polat is a graduate from the Department of Astronomy and Space Sciences, Istanbul University. She completed her master thesis (*Observatories and Astronomical Observations in Turkey, 1575-1997*) in 2009, and her PhD thesis (*Ottoman Nautical Astronomy and Astronomical Instruments in the 16th century*) in 2016. She currently pursues her research on the history of astronomical instruments.

Atilla Polat is a graduate from the Department of Mathematics of the Middle East Technical University (METU, Ankara). He completed his master thesis on the 19th century Turkish mathematician Vidinli Hüseyin Tevfik Pasha in 2014. He is currently working on the mathematical treatise compiled by the 16th century Ottoman mathematician Matrakçı Nasuh for his PhD thesis. His research interests mainly focus the history of mathematics in the Ottoman Turkey.

FROM OUTER SPACE TO MUSEUM FLOOR

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Although the University of Groningen is currently setting up a campus in China, it does not have historic bonds with the Eastern world, apart from objects in the botanic and ethnologic collections, which fall outside the scope of the SIC. But East-West is just a matter of perspective; therefore, in my talk the city of Groningen will be East and the USA West, which is also hemispherically correct! After several years of hard work behind the scenes, the first Dutch satellite for space research was launched by NASA in 1974. After the launch, it became clear that the satellite was not in the right orbit to fulfil its designated tasks. Luckily, Dutch engineers, in the spirit of true explorers, thought of a device to overcome this. The mission turned out to be a great success, with several new discoveries.

In my talk I will discuss some technical properties of the satellite, what remains of it, the results of the project, and also the problems that come with curating an instrument like this (ownership, aesthetics). Many similar curatorial problems also apply to other instruments from 1970's onwards.

Keywords: Space research, curating, modern instruments.

Jan Waling Huisman has been a scientific instruments collections manager/curator for over 25 years. His interests are engineering, physics and education. After being involved in over 40 exhibitions he thought he'd seen it all, but still learns every day.

A GAZE ON SOUNDS – THE CHLADNI FIGURES OF OTHER SCIENTISTS

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One of the classical experiments first done in the late 18th century was developed by E.F. Chladni. The sound figures, later known as Chladni figures, were seminal to the research in the young field of physics called 'acoustics'. These experiments require no special instrument, only some plates of glass or metal, a violin bow and a little bit of sand or powder, used in an innovative way.

In my talk I will analyse the historical development of these acoustic experiments, replicating the experiments to shed light on the development of acoustics as a branch of physics. I will discuss the experiments of various scientists, the differences in their work and analyses of the results. I will show that the questions asked by the scientists, and their expectation of outcomes, varied not only over time, but were also a function of their individual research interests. Are their experiments identical, even when using the same apparatus? What are the similarities and differences?

Keywords: History of acoustics, historical experiments of Chladni figures.

Jasmin Janka has studied history of science at the University of Hamburg, Germany. Currently she works as a postgraduate on the Europa-Universität Flensburg in the Department of Physics and its Didactic and History. Her dissertation will be on the history of acoustics. Her other fields of research are the history of astronomy and epistemology of science.

THE INSTALLATION OF FIRST TEN ELECTRON MICROSCOPES IN MEDICINE AND FIRST OUTCOMES IN TURKEY

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The discovery of the electron microscopes (EM) goes back to 1920's. The first images in biology, bacteria and viruses, were taken in 1939; however, it is the development of ultramicrotome in 1949, which brings the EM into the realm of medical studies.

The first EM to be used in medical research in Turkey was installed in the Istanbul Pendik Veterinary Bacteriology Institute in 1953. The second EM was presented by The President of Germany, Theodor Heuss, to The President of Turkey, Celal Bayar, on the occasion of Bayar's visit to Germany. The EM was installed into Ankara University, The Faculty of Medicine, Histology and Embryology Department in a ceremony in 1959. The later six EMs were installed in the same departments in Istanbul, Hacettepe, Ege Universities. The ninth one was installed in the clinical department in the Ege University, Faculty of Medicine, Department of Dermatology in 1974. The tenth EM was the first accredited one, and was installed in Istanbul University, Faculty of Medicine in 1975.

In that period, the main contribution of EM was the imaging of ultrastructures of cell morphologies. The first papers using the EM in Pendik explored thrombocytic morphology in congenital thrombopathy. These were followed by the studies of kidney ultrastructure and immune cell analyses. Till 1956, the analysis remained at the level of general morphology, as the ultramicrotome was not available in Turkey. In 1965, EM analysis was used first time in a case study, Von Willebrand's Disease. In 1968, a sample of cervix cancer was investigated using EM.

Keywords: Electron Microscopy, Turkey, History in Medicine.

Rukiye Karabacak, is a molecular biology and genetics graduate from Bilkent University. Currently she is a PhD student at the Histology and Embryology Department. Her main interests are development and usage of high tech microscopes in life sciences.

Bizden Sabuncuoglu, MD, is a Full-time Professor in Histology and Embryology Department, Faculty of Medicine, Ankara University. Her research interests include histology of otolaryngology and nervous system.

SOME OBSERVATIONS ON THE SCIENTIFIC INSTRUMENT TRADE IN THE 19TH CENTURY OTTOMAN EMPIRE

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The Ottoman territory was a market for scientific instruments in the 19th century. Using European educational institutions for inspiration, the Ottoman State, missionaries, or, in the last decades of the century, some individual entrepreneurs founded many schools in the Empire, and those schools which included a science curriculum were the main buyers of these instruments. As well as institutions, individuals or businesses who obtained scientific instruments for non-pedagogical reasons (research, collection, etc.) might have been 'customers' for instruments; however, little information is presently available on the scientific instrument trade between the Ottoman Empire and Europe. Questions such as 'who were the producers and who were the customers?' 'how did the acquisition process function, including a description of provider, customer, and manner of delivery,' remain largely unanswered. My research will focus on physics instruments, and try to understand how trade networks between Ottoman buyers and European instrument makers/sellers were established. With the help of archival sources and secondary literature, I intend to make an initial analysis of the trade in the instruments of physics in the Ottoman Empire during the 19th century.

Keywords: Scientific Instrument trade, the Ottoman Empire, Europe.

Meltem Kocaman (PhD) is an assistant professor currently working at the Istanbul University, Department of the History of Science. Her main field is history of science and engineering in the Ottoman Empire in 19th and early 20th century. Topics of some of her researches are the history of physics, its education; reception of theory of relativity; the first electrical engineers in the Ottoman Empire and Republic of Turkey.

DENTAL GAPS, TRUE SOLAR MOTION, AND THE PARAMETERS OF ECCENTRICITY: TRACING PLANETARY THEORY IN THE GEOMETRY OF UNEVENLY TOOTHED WHEELS WITHIN RENAISSANCE CLOCKS

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Only few Renaissance astronomical clocks aimed to show the “true” (and not just the mean) motion of the planets as seen from an earthly observer – their slow and non-uniform “wandering” from West to East. These automata may justly be considered mathematical instruments for two reasons: they manifest a mechanical transposition of mathematical astronomy, and their conception and design required the mastery of practical geometry and trigonometry. This paper presents an analysis of new research on two such instruments, the subtle astronomical automata created for Landgraf Wilhelm IV in Marburg and Kassel around 1560.

In a collective effort, Wilhelm IV, his astronomers, his chief “artifex” Eberhard Baldewein, and the roughly dozen craftsmen working under him developed complex machines whose hands were able to move according to the longitudes tabulated for planetary motion. Passing from the abstract geometrical model described by Ptolemaic theory to a brass mechanism, however, led them to use eccentric axes, epicyclic gears, and cogwheels with uneven tothing (“dental gaps”).

We present research developed during the project “Deus ex Machina” aimed at deducing certain astronomical parameters implicit in Wilhelm’s mechanisms. The challenges encountered in measuring and interpreting various mechanical parts will be discussed. In particular, we explore the possibility of deriving parameters for the solar eccentricity in connection with Wilhelm’s own renowned program of astronomical observation. Could it be that a careful analysis of these machines (and the written sources once accompanying them) allows us to witness the birth of a new astronomical theory?

Keywords: Planetary theory, equatoria, automata, solar eccentricity, non-uniform gearing.

Michael Korey, after working as a university mathematician in the field of harmonic analysis, he became curator of mathematical and philosophical instruments in Dresden in 2002. His current research addresses early-modern optics (esp. the material history of the early telescope), 18th-century collections of Judaica, and the project ‘Deus ex machina’ on Renaissance planetary automata.

Samuel Gessner, after a degree in physics, received his PhD (Paris) in history of science. “Instruments in texts and in the practitioners’ hands” was his first post-doc project at CIUHCT (Lisbon) – in line with his focus on diverse mathematical cultures in early modern Europe. Since 2014, he has been working on early planetaria.

Karsten Gaulke, historian of astronomy, previously headed the Kepler Museum in Weil der Stadt, Germany, and has been director of the Astronomisch-Physikalisches Kabinett since 2004.

HUGO MASING'S SEISMOGRAPHS – FROM TARTU TO FIVE CONTINENTS

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The electromagnetic seismograph invented in 1902 by the Russian physicist Boris Golitsyn was improved in the 1920s by Johan Vilip, a professor at the University of Tartu. Hugo Masing, an instrument-maker residing in Tartu, produced the so-called Golitsyn-Vilip-type seismographs for various European countries but also for the United States, South America, China, Africa and New Zealand. The technical aspect of the seismograph has been studied and presented by professor emeritus of Tallinn Technological University, Enn Hendre. The aim of this presentation is to build on his work and investigate the marketing side of the workshop's business, from a historian's viewpoint.

Fortunately, the international correspondence of the Masing workshop has partially survived and the main aim of this presentation is to investigate questions such as: why were these seismographs favoured by so many seismological stations all over the world? What was special about the Golitsyn-Vilip seismographs? Which other products were available on the market? How (if at all) did Masing advertise its products and services?

Thus, having an understanding of how scientific instruments were marketed is a valuable part of our wider understanding of instrument dissemination. By analysing the marketing practices of a workshop located in an obscure university town in Eastern Europe, we can explore interesting and useful insights into these discussions.

Keywords: Seismology, seismograph, dissemination.

Janet Laidla is the Head of the Old Observatory at the University of Tartu Museum. She has studied history with interest in early modern historiography, history of culture and history of science. She has curated exhibitions on space exploration and solar eclipses.

STRANGE “UNIVERSAL” ASTROLABE IN A FRENCH SECONDARY SCHOOL

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A unique astrolabe, among more than 5000 objects, is described in the on-line catalogue of the French association ASEISTE (<http://www.aseiste.org>). The object is kept at the *Lycée Montesquieu*, a former Oratorian monastery, in *Le Mans* (France). Though at first incorrectly described as a “Rojas universal astrolabe” (that would have been great good fortune!), a direct examination showed that it is actually made of two parts belonging to two different instruments, both incomplete (no rete, nor alidade):

1) the mater and limb of a classical planispheric astrolabe:

- limb and back beautifully engraved, Gregorian calendar, months labeled in an old French style, double shadow square and unequal hours diagram;
- the front of the mater, very damaged, shows remains of a classical non-removable plate: marks of former almucantars, azimuth lines and unequal hours;

2) an independent “universal” or “catholic” plate, not fitting the mater excavation:

- whole plate finely engraved, the usual oblique ecliptic line is missing,
- surprisingly: on the back of this plate, a very rustic elevation sundial of a special type known as “Capuchin dial” has been later engraved, but not well executed.

A survey of the principles of planispheric and universal astrolabes, and “capuchin sundials” will be given. Nothing is known at present about the origin (namely latitude) of this object; however, we shall give some deductions and information from the careful examination of the remaining mater lines and of the capuchin dial. And why not imagine a possible story!

Keywords: Astrolabes, sundials.

Pierre Lauginie, a former lecturer and researcher in physics, he has developed an experimental approach to the history of science teaching, based on adaptations of historical experiments. Present interests are on history of instruments and measurement, and popularization of science.

SCIENTIFIC INSTRUMENTS IN THE GREEK SCHOOLS OF ISTANBUL

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Among the schools still in existence for the Orthodox citizens of Istanbul, the most famous is the Great School of Nation (Fener Rum Erkek Lisesi), founded in 1454, immediately after the Ottoman conquest, and operated almost continuously. The advent of Enlightenment ideas in the Greek community of Istanbul at the beginning of the 19th century caused a gradual curricular shift to science courses. Experimental physics was taught sporadically during the first half of the century, and later was introduced permanently in the curriculum, but not before 1850.

From 1865 to 1883, the physics laboratory of the School underwent unprecedented development, growing from nothing to a collection of more than 300 devices and instruments. The procurement of the instruments was done in four phases and was a result of donations (in stock or cash) and purchases of used instruments. The construction of an impressive building for the school and its permanent establishment there in 1883, really boosted the laboratory, as it not only had a specially designed room and shelving for instruments from each branch of physics, but was also accompanied by a wave of donations. Most of the instruments were constructed in France, as were most instruments in Greek schools of this era. In the first quarter of the 20th century the School purchased instruments from Max Kohl and later from CENCO, but these are outside the scope of this paper, which will discuss how the collection evolved during the 19th century, and some of the most spectacular instruments in it.

Keywords: Scientific instruments, Greek Schools, Istanbul, Great School of Nation.

Panagiotis Lazos works as physics teacher in secondary education. He has also a BSc on photography and a MSc in History and Philosophy of Science. He is a PhD student and the paper he will present in this symposium is a part of his PhD research. His main research interest lies in the recording of collections of scientific instruments of the 19th century in Greek schools and how they were used in the educational process.

George N. Vlahakis is assistant professor at the Hellenic Open University and fellow Researcher at the Institute for Historical Research/ NHRF. He is president of the Commission on Science and Literature DHST/IUHST.

MAKING VISIBLE THE INVISIBLE: TIMOLEON ARGYROPOULOS' DEVICE FOR STUDYING STANDING WAVES

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Timoleon Argyropoulos was one of the first professors of physics in the University of Athens and one of the key people involved in the development of the sciences in the independent Greek state during the 19th century. He had studied in Paris and had a particular interest in experimental research in fields such as electricity and waves. Many of his papers were published in international journals or were read at the Academy of Sciences in Paris. Among other accomplishments he was the first to use an X-ray machine in Greece for scientific purposes. Furthermore, he was a capable instrument maker and constructed a unique instrument for the study of standing waves. This instrument could also be used for educational purposes, as it could give a visual image of waves long before the advent of oscilloscopes.

In the present paper we aim to discuss this instrument and its international “career,” and to present our attempt to reconstruct it for the first time in almost 120 years.

Keywords: Timoleon Argyropoulos, University of Athens, 19th century.

Panagiotis Lazos works as physics teacher in secondary education. He has also a BSc on photography and a MSc in History and Philosophy of Science. He is a PhD student and the paper he will present in this symposium is a part of his PhD research. His main research interest lies in the recording of collections of scientific instruments of the 19th century in Greek schools and how they were used in the educational process.

George N. Vlahakis is assistant professor at the Hellenic Open University and fellow Researcher at the Institute for Historical Research/ NHRF. He is president of the Commission on Science and Literature DHST/IUHST.

**FROM SAMARKAND TO EUROPE,
THE LONG JOURNEY OF ULUGH BEG'S *ZIJ***

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The *Zij* established in 1437 in Samarkand by Ulugh Beg includes much astronomical data obtained using the monumental quadrant he had commissioned less than two decades earlier. After Ulugh Beg's assassination in 1449, one of the Samarkand astronomers took the *Zij* to Constantinople where eventually—once interactions developed in the 16th century between the Ottoman Empire and Western countries—copies were found and bought by European travellers.

We shall describe how the tables for fixed stars and those describing the motions of the Moon, Sun and planets observed at Samarkand observatory came to be known and much appreciated by Western astronomers in the late 17th century. We shall then show how the *Zij* came to interest Western historians of astronomy and explain how in the early 19th century it was the subject of a dispute between French historians of science, concerning the supposed superiority of Indian or "Arab" astronomy.

Keywords: Ulugh beg, Samarkand observatory, astronomical tables, *zij*.

Françoise Le Guet Tully is honorary astronomer. Her research projects concern the history of astronomical instruments and of institutional observatories. She also works on the archives of the astronomer/inventor Henri Chrétien and collaborates on the hypertelescope project, a joint R&D venture of Collège de France and Observatoire de la Côte d'Azur.

GEORG FRIEDRICH PARROT AND HIS LABORATORY IN EARLY 19TH-CENTURY TARTU

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In 1802, after long debates about its location and structure, the University of Tartu was opened for the three Baltic Sea provinces as a German-language university in the Russian Empire. It became an important centre of cultural exchange between Russia and Germany.

Georg Parrot's life and career had four distinct periods: youth and studies in France and Germany, early years in Livonia, activities as a professor at the University of Tartu, and activities in the Academy of Sciences in Saint Petersburg.

As a professor of physics at the University of Tartu (1802-1828), Parrot established a physics laboratory that was the best in Russia at the time. It had 450 pieces of experimental equipment and more than 60 of them were invented or improved by Parrot himself. Approximately 50 of the items have been preserved. Parrot divided physics into seven main fields: general properties of bodies, statics and mechanics of solids and fluids, simple substances and mixtures, thermal phenomena, light phenomena, optical phenomena, electrical phenomena and magnetic phenomena. Study instruments were categorised on the basis of these, but due to the differences between disciplines, and a multitude of experimental tools, the instruments concerning solids and fluids were considered separately. The eighth field was physics of the Earth — mountains and seas, volcanoes and auroras — nature's own laboratory, where the researcher's only sources are observations.

In St. Petersburg, Parrot started improving the physics laboratory of the Russian Academy of Sciences. While in Saint Petersburg, one must credit Parrot chiefly for demanding new equipment to study electromagnetism (although he doubted the relation between electricity and magnetism). The equipment allowed Heinrich Emil Lenz (1804-1865), his student, to reach fundamental conclusions in this field (Lenz's law).

The lists of instruments and preserved items allow us now investigate the spread of physical science ideas from West to East and from East to West.

Keywords: Physical instruments, spread of ideas.

Lea Leppik is research director of the University of Tartu Museum since 2002. Her main research interest is university history (first of all University of Tartu) in 19th and 20th century.

A USER'S GUIDE TO THE *MUSARṬAN* ASTROLABE: A NEWLY REDISCOVERED 15TH CENTURY MANUSCRIPT

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Combining Northern and Southern astrolabes was an innovation of Islamic scholars in the 9th or 10th century CE. The result was a group of astrolabes constructed on the basis of what is known in modern literature as “mixed north-south stereographic projections.” One of the best known astrolabes of this kind in the medieval Islamic world was the *Musarṭan* (crab-shaped) astrolabe. Invented by Muḥammad b. ‘Abd Allāh, known as Naṣṭūlus (flourished 890–930 C.E., Baghdad), no example of this type of astrolabe is known to be extant. In addition to the standard, medieval literature on astrolabe-making, which reveals the geometric-astronomical structure of the *Musarṭan* astrolabe, a group of treatises were written, specifically, on its applications. *Mukhtaṣar dar ma‘rifat-i uṣṭurlāb-i Musarṭan wa Muqawwas* is a treatise of this kind, written in Persian by a certain Pīr Muḥammad, known as Ḥakīm-i Tabrīzī (14th–15th century C.E., Tabrīz). In this presentation I intend to illuminate the structure and applications of the *Musarṭan* astrolabe on the basis of a critical edition and English translation of this text. Based on the text, I have developed a computer-based, reconstructed model of the instrument that was in the possession of the author. This will enable me to demonstrate graphically the applications of the astrolabe. Based on the evidence provided in the text, I then show how the author’s understanding of this instrument, his methodology in approaching the explanation of its structure, and the terminology he uses, differs from the literature that preceded him.

Keywords: *Musarṭan* astrolabe, stereographic projection, mixed projection, Naṣṭūlus, Pīr Muḥammad Ḥakīm-i Ṭabrīzī.

Pouyan Shahidi Marnani’s research focuses on the astronomical instruments and the overlapping areas between Islamic physics and cosmology. He is a graduate in Geodesy and Geomatics (Surveying) Engineering. He completed in 2011 his master’s thesis on a *Musarṭan* astrolabe and made critical editions al-Sijzī’s text and another Persian 15th c. text on this astrolabe. He published on the astrolabe collection of the Malek National Museum (Tehran). He studied and made research in the Institute of Islamic Studies, McGill University.

GALILEO'S TIME MEASURER

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In June 1637, Galileo Galilei sent a letter to Lorens Reael (Governor of the Dutch East Indies) explaining how to manufacture a timekeeper or “time measurer” as a solution to the longitude problem. A precise solution to this problem could offer safe, fast and efficient navigation. Galileo studied the properties of the pendulum for a long time and discovered a uniform period of vibration in their motion, a property called isochronism that could potentially turn them into reliable timekeepers.

In the Galileo Museum in Florence, there is a drawing on display (inv.2433) that was made by Galileo's pupil Vincenzo Viviani, and by Galileo's son, Vincenzo. The display claims that this drawing “reproduces the apparatus illustrated by Galileo” in the 1637 letter to Lorens Reael. After a meticulous study of the letter in question, there are problems comparing Galileo's description and Viviani's drawing. The instrument described by Galileo is not that of a simple pendulum, as one could expect, but has a considerable number of particularities and is very different from the one that figures in Viviani's drawing. This drawing may be inspired by Galileo's description but it is very far from being its reproduction.

What we propose here is to present Galileo's “time measurer,” its properties, and its precision in time measurement, to explain why the drawing does not correspond to Galileo's description, and finally to develop a hypothesis of where Galileo might have found the inspiration for creating this kind of “time measurer.”

Keywords: Galileo, time, timekeeper.

Meropi Morfouli's principal research interests lie in the field of Philosophy and History of Sciences and particularly in the notion of time in physics and astronomy. She's currently investigating in her Ph.D. thesis how the precision in time measurement intervenes in Newton's construction of the gravitational theory.

AN IRANIAN QUADRANT FOR FINDING QIBLA

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An important topic in the history of Islamic mathematics and astronomy is determining the direction of any particular city towards Mecca (qibla). Based on a directive in the Koran, Muslims face Mecca to pray at least five times a day. Finding qibla seemed an easy problem during the early years of Islam, but as Islam spread throughout the world, Muslim scholars started to try different ways for determining qibla.

As both mathematical methods as well as finding time to determine qibla, especially when the worshipper was on a trip, were not accessible to ordinary people, various instruments were devised to make it simpler. One of the common qibla indicators during the Islamic history was the quadrant, and mathematical functions could be simplified by applying quadrants for finding qibla.

In this paper, we first introduce some of the most important quadrants used by Islamic scholars, and also compare mathematical formulae. Also, an Iranian quadrant presented by Mohammad Bāqir Yazdī in 17th A.D. is analyzed in the second part of the paper.

Keywords: Qibla finding, qibla instruments, quadrants, analemma.

Razieh Musavi holds a BA in pure mathematics from K.N.T University (Iran) and a MA in the History of Islamic Science from University of Tehran. Her thesis was about an Islamic treatise on qibla finding. Her interest lies in working on qibla manuscripts and instruments.

TIME MEASURING INSTRUMENTS OF THE OBSERVATORY OF PARIS

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Based on instruments at the Observatory of Paris related to the measure of time, the virtual exhibition “La précision des mesures en astronomie” was developed in 2016 in the framework of the Chaire internationale Blaise Pascal. Some of the presented instruments were actually used by the astronomers of the Observatory and some others were donated or bought by the Observatory as historical exhibits. Among the latter, the virtual model of Dondi’s astrarium was constructed following Emmanuel Poulle’s analysis of the relevant 14th century manuscript.

In this paper we will present the instruments in the exhibition, among them various types of sundials (16th c. and later), a 16th c. nocturlabe, two Persian astrolabes (18th and 19th c.), pendulums, clocks, La Caille’s sextant, meridian telescopes, chronometers, and instruments for time signals.

Keywords: Observatory of Paris, astrarium, clocks, sundial, quadrant, meridian circle.

Efthymios Nicolaidis is director of the History, Philosophy and Didactics of Science and Technology Programme of the Institute of Historical Research, National Hellenic Research Foundation (www.hpdst.gr) and President of the International Union of the History and Philosophy of Science and Technology / Division of History of Science and Technology. His main publications are on the history of science in Byzantium, the Ottoman Empire and the Modern Greek State, the spreading of modern European science and the history of the relations science-religion.

FROM THE OTTOMAN EMPIRE TO CANADA: MIGRATING SCIENTIFIC INSTRUMENTS ACROSS CULTURES

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In 1980, the Canada Science and Technology Museum acquired a collection of over 130 mathematical instruments dating from the 12th to the 20th century. The collection includes a wide variety of standard rules, compasses, sundials, plumb bobs, levels and dividers, many of which were produced or used throughout the late Ottoman period. Some have fascinating markings and inscriptions. They were collected over a lifetime by George Petrovic, who was born in Yugoslavia and lived in Serbia and Montreal. Petrovic studied, practised, and taught architecture, held a doctorate in technical science, and was a member of the International Committee for Historical Metrology, in Basil, Switzerland. This talk, which aims to focus on this interesting case of the migration of scientific objects across time and cultures, will be in two parts - first, we shall describe the provenance and collecting history of these instruments, and how they came to Canada; second, we shall place some of the instruments in their original Ottoman context of making and use, placing them in the larger context of Ottoman science studies, and examining the changing scientific culture and its influence on the usage of scientific objects as a result of the encounter with European science.

Keywords: Ottoman Empire, Canada, provenance, mathematical instruments, metrology.

David Pantalony is curator of Physical Sciences and Medicine at Canada Science and Technology Museum. He obtained a PhD from the Institute for the History and Philosophy of Science and Technology at the University of Toronto. His main research interest is the history of scientific instruments.

Hasan Umut holds a BSc in Industrial Engineering from Boğaziçi University (Istanbul) and a MA in History from Istanbul Bilgi University. He is currently pursuing a PhD at McGill's Institute of Islamic Studies. His main research field is theoretical astronomy in the Ottoman Empire.

PHYSICS INSTRUMENTS AT THE ENRICO CAFFI MUSEUM OF NATURAL SCIENCES, BERGAMO

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The physics instruments currently preserved at the Enrico Caffi Museum of Natural Sciences in Bergamo date back to the late eighteenth century and originally came from the Physics Cabinet of the Paolo Sarpi Secondary School. The collection includes some pieces of great scientific, not to mention artistic and antiquarian, value as rare examples of the apparatus used to teach physics in the very early nineteenth century. The E. Caffi Museum has implemented a development programme for the instruments in order to make this highly valuable historic and scientific heritage accessible to the public in a permanent exhibition.

The project was curated by Laura Serra Perani, who was responsible for cataloguing the collection, and coordinating the technical and exhibition details with the Museum staff, with support from collaborators Giorgio Mirandola and Paolo Brenni. The exhibition would not have been possible without the contribution of local company Lovato Electric S.p.A. A significant part of the project was the restoration and preservation of some particularly important instruments from the collection, which was undertaken by the Science and Technology Foundation in Florence, under the curation of Paolo Brenni and Anna Giatti. The restored instruments include an air pump constructed by Giovanni Albrici in 1793, two Volta electric lighters from the early nineteenth century, an orrery constructed by Charles Rouy and acquired in 1812, a terrestrial globe made in Paris in 1774, two heliocentric armillary spheres dated 1753 and signed Désnos – Paris, an induction coil with rotary switch from the mid-nineteenth century, and an Aron electric meter dated 1890.

Keywords: Historic physics instruments, Natural Science Museum Enrico Caffi.

Laura Serra Perani graduated in physics from the University of Milan. She is currently working with the University of Bergamo, Faculty of Engineering. He has cataloged the collection of educational scientific instruments of the Physics Cabinet at Paolo Sarpi Secondary School. Her field of interest is the history of physics and scientific instruments.

TREATISES ON THE DESCRIPTION AND USE OF THE SECTOR (PERGÂR-I NISBE) IN MANUSCRIPT COLLECTIONS OF TURKEY

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The sector, called “Pergâr-ı Nisbe” in Ottoman Turkish, was one of the major mathematical instruments in use in Europe from the second half of the sixteenth century to the nineteenth century, and is an instrument based on the idea of the proportions between similar triangles, and thus has many practical applications in mathematics, geometry, surveying and military. There are many texts on the description and the use of the sector especially in French, English and German; however, until now there has been no study about the transfer of this instrument to Ottoman Turkey. We have determined two kind of sources for this paper: first, there are the instrument lists from the beginning of the nineteenth century at the engineering schools (*mühendishanes*) in Istanbul, in which we see nothing except the name of the instrument; second, there are the treatises on the description and the use of the sector written in Ottoman Turkish and held in different manuscript collections of Turkey. In this paper, we will mainly focus on these treatises in order to comprehend the introduction and use of this instrument among the Ottomans.

Keywords: Pergâr-ı nisbe, sector, compas de proportion, Ottoman Empire, mathematical instruments, Mühendishane.

Atilla Polat is a graduate from the Department of Mathematics of the Middle East Technical University (METU, Ankara). He completed his master thesis on the 19th century Turkish mathematician Vidinli Hüseyin Tevfik Pasha in 2014. He is currently working on the mathematical treatise compiled by the 16th century Ottoman mathematician Matrakçı Nasuh for his PhD thesis. His research interests focus mainly the history of mathematics in the Ottoman Turkey.

THE MAGIC LANTERN AS INTERCULTURAL AMBASSADOR BETWEEN CULTURES AND RELIGIONS: IMRICH EMANUEL ROTH AND THE FIRST DISSOLVING-VIEW SHOWS IN THE OTTOMAN EMPIRE 1845/1846

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An instrument of light, the magic lantern remained in the shadow of other physical and optical instruments for its first 150 years. The introduction of the highly luminous hydro-oxygen light in the second quarter of the nineteenth century transformed the lantern into a medium for public enlightenment and intercultural understanding. Very soon after the January 1843 introduction of dissolving views by Ludwig Döbler (1801-1864) in continental Europe, many other projection-enthusiasts followed. One of them was Imrich Emanuel Roth (1814-1885), the son of a Jewish restaurant owner in Kosice (Slovakia). Well educated in painting at the universities of Vienna, Munich, and Dusseldorf, Roth settled down in Budapest in 1840. Fascinated by the new medium of dissolving views, and certainly inspired by Döbler, he quickly understood the boundless attraction of the optical device. He viewed the magic lantern as high art and painted his own slides, which were regarded as the most sophisticated of his time. He travelled through Eastern Europe, Asia, and Africa with his equipment to give public and private dissolving-view shows. This paper follows his travels through newspaper articles, and personal letters. At the turn of the year 1845/46, Roth introduced dissolving views into the Ottoman Empire, even giving a show at the Dolmabahçe Palace in Constantinople. With the recommendation of the minister of foreign affairs, Reşid Pasha, he then introduced dissolving views at the Ottoman court of Alexandria – presentations which were viewed by the family of Viceroy Muhammad Ali Pasha, the founder of modern Egypt. The deep fascination for the art of projection at the Ottoman court opened the doors for future projectionists to give shows for wider audiences in the Ottoman Empire. This paper revives the forgotten story of how the magic lantern became an instrument that enriched cultural exchange between East and West.

Keywords: Magic lantern, dissolving views.

Bernd Scholze has developed a passionate interest in the *Laterna magica* over the past decade, searching for previously unknown primary sources, both written and instrumental. By night he studies the *laterna*; by day, he leads the German operation of a Stoke-on-Trent based pottery company.

A TREATISE ON THE CONSTRUCTION OF ASTRONOMICAL INSTRUMENTS BY MUNAJJIM ḤUSAYNĪ GĪLĀNĪ

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Munajjim Ḥusaynī Gīlānī was born in Lahijan city in the north of Iran and flourished during the 15th century AD. He wrote a treatise entitled *Tashrīḥ al-ālāt fī sha'n al-imtihānāt* (describing tools useful for experiments). The third chapter of this treatise explains how to build astronomical instruments. He also reported a solar eclipse that was observed in Istanbul in 887 AH (1481 AD). A comparative study was accomplished between his work and some other well-known books (written by Kashini and Nasir al-Din al-Tusi). In this research some new details of his life have been revealed. He lived in Istanbul, Edirne, Lahijan and Mazandaran (today a province in southern shore of Caspian Sea), and other cities.

Keywords: Astronomical instruments, Munajjim Ḥusaynī.

Morteza Somi is a master's student in the Institute for the History of Science, University of Tehran. His research interests are history of medieval astronomy and mathematics.

THE ARRIVAL AND INTRODUCTION OF THE TELESCOPE INTO IRAN BEFORE THE 19TH CENTURY

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The advent and introduction of modern astronomical instruments such as telescopes into Iran before the establishment of the first general modern college and schools in Iran, notably Dār al-Fonūn (the polytechnic college founded in Tehran in 1851) are among important issues in the history of science in Iran on which little research has been done.

In this paper I will introduce and analyze some texts and historical documents which discuss the telescope or have some figures of planets inspired by observing with telescopes in Iran during the advent of modern astronomy up to the establishment of Dār al-Fonūn. Drawing on these texts and documents, I will discuss the historical sequence of the treatises as well as their mutual effect on one another, and introduce some of the most influential scientific figures and their scientific-cultural roles within the history of science in Iran, particularly in modern times. Finally I will present new findings from my research on these scientific treatises and figures.

As we have found, shortly after Galileo, travelers from the West, introduced the telescope to Iranians and some of them made telescope in Iran. Thus the Iranian Safavid court was familiar with the telescope and it was used in Iran from Safavid to Qajar times for military or hunting purposes and sometimes in schools as a scientific instrument.

Keywords: Modern Astronomy, Telescope, Safavid, Qajar, Dar al- Fonun.

Seyyed Hadi Tabatabaei holds a MSc. in history of science His special interest is the introduction of modern astronomy to Iran, which was the topic he investigated in his M.Sc. thesis. He is fluent in Arabic, Persian, Turkish and English and has an interest in making sundials.

A MINGLING OF TRADITIONS: EUROPEAN PORTABLE SUN-DIALS AND ISLAMIC DIALLING DURING THE OTTOMAN PERIOD

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A preliminary presentation of the place of gnomonics in Arab-Islamic society is followed by a discussion of the appearance of European portable dials in Iran and in the Ottoman world; their possible influence on the development of the pocket-size, compass-dial qibla indicator (qiblanumâ), is considered.

Keywords: Sun-dials, Qibla.

Anthony Turner works on the development of scientific instruments from Antiquity to c. 1830, on the history of horology, and on the social history of ideas in the Early Modern period. He has recently completed a catalogue of instruments held in the Bibliothèque Nationale de France, and continues to compile a bio-bibliography of French instrument-makers in collaboration with Denis Beaudouin and Paolo Brenni.

**THE SMALL PLANE TABLE:
AN INVENTION BY AN OTTOMAN MILITARY OFFICER**

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One of the earliest mentions to the plane table dates back to 1551 and is found in Abel Foullon's *Usage and Description de l'Holomètre*. Its common use began in Europe in late 16th century. By providing a solid and plane surface to users, plane tables made the drawing of charts and maps easier. We do not exactly know when the plane table was introduced in Ottoman Turkey. It is clear, however, that it was used by late 19th century.

This paper aims to investigate a plane table "invented" by an Ottoman military officer named İbrahim Halil and his treatise concerning his invention named *küçük plançete* (lit. small plane table). The treatise was published in 1894, and included the instrument's design and use.

Keywords: Plane table, surveying, map-making, Ottoman military.

Kaan Üçsu is a research assistant at the Department of the History of Science of Istanbul University. He pursues his PhD dissertation on the modernisation process of the Ottoman cartography in the 17th century. He is also interested in the 19th century Ottoman cartographical works made in modern military institutions and popularisation of science in Turkey in 19th and 20th centuries.

SHIPSHAPE COLD WAR: THE CONSTRUCTION OF RESEARCH VESSELS IN EAST AND WEST GERMANY

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In July 1978, the West German chancellor Helmut Schmidt personally decreed that the budget for a projected research vessel should be doubled giving oceanographers and polar researchers 100 Million Deutschmark to create what was to become, in a sense, one of the largest and most sophisticated maneuverable scientific instruments to be built at that time: the icebreaker *RV Polarstern*, completed in 1982. The size of the budget shows just how important politicians considered oceanographic and polar research to be during the Cold War. The *RV Polarstern* was far more than an instrument through which more information could be obtained about the vast unknown 'inner space' of the deep sea. With the construction of the *RV Polarstern*, West Germany was able to trump East Germany. What might seem like a foregone conclusion, however, was anything but that. While the research vessel *RV Meteor (II)* was built in 1964 with great fanfare in West Germany, between 1964 and 1968, no less than seven research vessels of similar size and sophistication were constructed in Wismar in East Germany, following an order by the Russian Academy of Sciences.

This paper will compare the development of research vessels in East and West Germany during the Cold War. Previously unstudied archival material from East German shipyards and research associations, oral history, and the collections of the German Maritime Museum (which include early models of the *RV Polarstern* to study its hydromechanical properties) serve as the basis for this study.

Keywords: Research vessel, oceanography, polar research, Cold War.

Martin P. M. Weiss is a postdoctoral researcher at the German Maritime Museum in Bremerhaven. He wrote his PhD on the changing public role of Teylers Museum in the nineteenth century at Leiden University and subsequently worked for the European Commission in Brussels and at the Deutsches Museum in Munich.

HOW TO MAKE THE ARC SPEAK? EXPERIMENTING IN ELECTROACOUSTICS

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Around 1900, carbon arc lamps were widely used for street lighting and as projection lamps. William du Bois Duddell in London and Hermann Theodor Simon in Göttingen managed to tame the hissing of the electric arc and actually made it speak, listen, and sing. Its capacity to produce rapid electric oscillations, combined with its function as a loudspeaker and microphone, made the carbon arc a perfect candidate for wireless telephony through electric oscillations. The speaking arc, however, never made it beyond its existence as a lecture demonstration, while another device, the amplifier tube, fulfilled the arc's promises of sound amplification and wireless telephony.

In our presentation we will discuss our experiments with a set of instruments purchased from the German company Max Kohl at the Fondazione Scienza e Tecnica in Florence. Making the arc speak, or listen to us, proved to be more challenging than we anticipated. As is often the case, rather than giving answers, re-working the apparatus opened up a whole new set of questions that had not arisen from our previous reading and interpretations of the written and material sources. Operating the electric arc provided new experiences of what electroacoustics could be, very different from hi-fi electronics. We also experienced that working with currents of 100 volts and 10 amperes comes with its own risks - don't try this at home!

Keywords: Speaking arc, singing arc, electroacoustics, re-working experiments.

Roland Wittje is associate professor in history of science and technology at the Indian Institute of Technology Madras in Chennai. He has replicated some of Heinrich Hertz's experiments on propagation of electric force and published on the history of electroacoustics.

Paolo Brenni is specialised in the history of scientific instruments and of precision industry in the period from the beginning of 18th century to the mid-20th century. He works in Italy but he also collaborates with various European museums and scientific institutions. He is actually the president of the Scientific Instrument Society.

**THE MIGRATION OF OBJECTS AND IDEAS BETWEEN THE OTTOMAN EMPIRE
AND NORTHERN EUROPE IN THE PERIOD 1500-1700**

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TRADE AND TRIBUTE – EUROPEAN OBJECTS IN THE OTTOMAN EMPIRE

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It is well known that intriguing and intricate objects made by the finest craftsmen in Europe, as well as specific skills such as portrait painting, were much sought after both at the Sultan's Court in Istanbul, and amongst those members of society who aimed to emulate courtly fashion. Especially sought after and prized were scientific instruments, clocks, watches and automata.

Formal cultural connections started when Mehmet II in 1479 asked the Republic of Venice for a portrait painter (who duly arrived in the person of Gentile Bellini), starting a flow of 'tributes to the Sublime Porte' that continued in this vane for centuries. However, what has been largely overlooked is the less prominent, but hugely profitable trade of such objects that was almost a business amongst equals.

This paper will revisit the cultural, political and religious context in which these objects found their way East - and subsequently often back West into European collections where they can still be seen and marveled at today.

Keywords: Sublime Porte, *Türkenverehrung*, Georg Hartmann, Elizabeth I, Murad II, clocks, watches.

Silke Ackermann is Director of the Museum of the History of Science in Oxford, UK. She previously worked at the British Museum in London in a range of curatorial and managerial positions. She has a particular interest in the transfer of knowledge between the Islamic World and Europe.

**THE PRACTICE OF LENDING AND BLENDING:
KNOWLEDGE CONSTRUCTION IN THE WAKE OF A SWEDISH EMBASSY
TO THE OTTOMAN EMPIRE, 1657-8**

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This paper examines the dissemination of knowledge about Ottoman society through the perspective of the attempted establishment of a Swedish embassy in Constantinople in 1657-8. The embassy, headed by a Swedish nobleman, Claes Rålamb, was largely unsuccessful in its diplomatic endeavours, but its members amassed a wealth of information during their seven months in Constantinople. After their return, they continued to process the information and study the artefacts brought back from the journey, among them texts and images bought in Constantinople, as well as their own diaries and letters. The present paper explores what was gleaned from this information over a period of several decades, including highlighting the complex nature of categories of information including scholarly works, eyewitness accounts, and “Ottoman” and “European” knowledge. Through analysis of these records, the Swedish experience can open a discussion of how knowledge circulated in the early modern world.

Keywords: Knowledge circulation, early modern period, travel writing, Sweden.

Charlotta Forss is a fourth year PhD student in history at Stockholm University. Her doctoral thesis analyses the constructions of the continents as concepts in early modern scholarship on geography and in travel writing. She completed her undergraduate degree at Uppsala University, Sweden, and her master’s degree at Cambridge University, UK.

THE MEDIUM IS THE MESSAGE? THE MATERIALITY OF INSTRUMENTS BETWEEN EAST AND WEST

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Abstract

This paper uses a comparative case study to investigate what was specifically European about aspects of the early 'Scientific Revolution'. Its starting point is the phenomenon of printed paper mathematical instruments in 16th-century Europe – astrolabes, globes, maps, sundials and volvelles. Though they surely have a much lower survival rate than instruments in metal and ivory, the rare survivors suggest a vigorous and rapidly developing intellectual and commercial environment.

The apparent absence of such printed paper instruments from the Ottoman Empire points to a significant difference between East and West; the contrast is especially striking because metal mathematical instruments such as astrolabes and quadrants emerge from a common culture – a shared intellectual heritage with both the same literary genres of instrument texts and the same manufacturing skills, as well as similar roles for makers, patrons and wider audiences.

However, this seemingly dramatic contrast between metal and paper instruments is more interestingly nuanced than one might initially think, and cannot be attributed simply to prohibitions on printing within Islamic realms. Wood block printing had been practised in both the Near and Far East for hundreds of years before Gutenberg, and paper itself had been introduced to Europe from Islamic culture. If we seriously examine paper as a material – including derivatives such as pasteboard and card – and attend to the medium's associated techniques, we can open up a new comparative perspective on the mobility (or immobility) of objects and ideas, and also on the controversial issue of the "decline of Islamic science".

Keywords: Mathematical instruments, astronomy, East and West, printing, materials, paper, metal, 16th century.

Stephen Johnston obtained his BA and PhD from the University of Cambridge and, after working at the Science Museum, London, joined Oxford's Museum of the History of Science in 1995. His research focuses on the mathematical arts and sciences, particularly in the 16th century.

HOW DID THE TORQUETUM (OR TURKETUM) GET ITS NAME?

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Representing the essential circles of the heavens with flat plates rather than circles or spheres, the torquetum has long been known among the instruments of medieval astronomy. The earliest surviving exemplar of the device in brass dates from the 1440's; several later, highly decorated exemplars made in the 16th and early 17th centuries are held in European collections. Tracing its inventor, however, has proved more difficult; was it Franco of Liège in the late 11th century, Jābir ibn Aflah in 12th-century Spain, Naṣīr al-Dīn al-Ṭūsī in 13th-century Marāgha, or Franco of Poland in the 13th century? Might the instrument have Indian or Chinese origins, as Needham suggested? Does the name found in the earliest Latin manuscripts, "turketum," suggest a "turkish" origin? Or should we believe Regiomontanus who in the 1460's named the device the "torquetum," employing the Latin verb torquere (to twist, turn, torture)? This paper will revisit the historiographical discussions of the name and will consider more recent scholarship on circulation of artifacts and texts between Islamic, Ottoman and Latin worlds. Pursuing a name will let us follow the flow of "instruments between East and West."

Keywords: torquetum, turketum, Jābir ibn Aflah, al-Ṭūsī, Regiomontanus.

Richard L. Kremer teaches history of science at Dartmouth College and curates this institution's collection of historic scientific instruments. Kremer studies the instruments, tables and codices of medieval and early modern Latin astronomy. His most recent publications examine the paper instruments of Johannes Stabius, astrologer for Emperor Maximilian I.

**MATERIALITY AND THE FORMATIONS OF IDENTITIES:
THE ROLE OF OTTOMAN OBJECTS IN EARLY MODERN SWEDISH
*KUNSTKAMMERN***

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The Ottoman Empire occupied an important place in the cultural imagination of seventeenth century Sweden, at the intersection of diplomatic relations, warfare, commercial trade, scholarly research and cultural fantasies. A place where this interest took material shape was two types of collections, the *Kunstkammer* and the armory. This paper examines the existence of Ottoman objects in three such Swedish collections from the seventeenth and early eighteenth centuries: the armory of the commander Carl Gustav Wrangel at Skokloster castle, the *Kunstkammer* of the scholar Johannes Schefferus in Uppsala, and the *Kunstkammer* of the royal official Mårten Törnhielm at Malmvik, west of Stockholm. How were the Ottoman objects ranged in relation to objects from other parts of the world? How were they described and defined in inventories and other textual sources? In what kinds of narratives were they inscribed? What kinds of meanings and values were attached to them? How did the objects interact with visual and literary representations of the “Turk?” By discussing these questions, the paper addresses more fundamental questions of the role of material objects in the formation of knowledge, world views and identities.

Keywords: Kunstkammer, armory, materiality, Carl Gustav Wrangel, Johannes Schefferus, Mårten Törnhielm.

Mårten Snickare is professor of art history at Stockholm University. His research focuses on visual and material culture in the early modern world. Currently he is doing research on early modern colonialism and globalization in relation to art and objects; a monograph on the collecting and display of colonial objects in seventeenth century Sweden is in manuscript form. Snickare has been a research fellow at Yale University 2005-06, Clark Art Institute 2010 and Humboldt University 2012.

TURKISH AND THE TURK AT *TRE KRONOR* IN THE FIRST HALF OF THE 17TH CENTURY

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The Kunstkammer of Queen Christina at Stockholm Castle, *Tre Kronor*, developed in the 1640's. It grew quickly, particularly after the sacking of Prague, when a great many objects arrived as war booty. Agents were also employed for the purchase of objects, and gifts were added to the collections. Many objects left Sweden with Queen Christina after her abdication and later, when the castle burned in 1697, objects and documents were destroyed. Understanding the collection is therefore difficult although some of the objects and documentation have been preserved. The paper will discuss what the sources say about the site and collections, particularly the clocks, globes and mathematical instruments.

Furthermore, objects from Turkey in the castle collections, the motif of Turkey, and the Turks will be discussed. For example, the inventory list mentioned a large brass clock with a Turk on top. What impression of the Ottoman Empire could have been mediated through the collections at Stockholm castle?

Keywords: Kunstkammer, collecting, Turkish, clocks, 17th century, war-booty

Inga Elmqvist Söderlund holds a PhD in art history and she is a research fellow at The Royal Swedish Academy of Letters, History and Antiquities, affiliated to the Department of Art history at Stockholm University. Her research concerns the relationship between early modern art and science. She has also worked as curator in several museums, as director of the Observatory Museum in Stockholm from 1996-2013.

**THE SILK BAGS, CALLED *KESE* AND THE UNIQUE SEALS' CAPSULES,
CALLED *BAYSA*, ATTACHED TO TATAR DIPLOMATIC LETTERS OF
17th CENTURY**

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Sweden possesses a rich collection of records (84) from Tatar Khanate in the Crimea to the Swedish Royal House, kept in the National Archives in Stockholm. Most of these documents sent from Crimea were delivered in colorful bags, called *kese* or *kise*, together with pear shaped tickets or labels with the names of addressees, known as *kulak* (lit. 'ear'). Nowadays, these satin or silk bags are kept separately. Some of the address labels of the 17th-century letters are attached to the bags by the round wax seals, enclosed in the capsules made of silver, bone or a gilded brass. These protecting capsules are called *baysa*. The wax seals were attached by string and often, probably not always, covered by the *baysa*. The expression *baysa* was often used and therefore also became commonly known as a synonym to seal. Some letters, as from Khan Bahadur Giray's nameless first wife, in a grass-green taffeta bag, dated, 1047, i.e. 1637/8, were apparently never read. Its address label is still not opened and the wax seal is untouched. The Tatar wax seals are very rare and even rarer are the *baysas*. Probably the last remaining capsules of this type, attached to the letters of Nureddin Adil Giray (1660), Qırım Giray (1667), Tokhamish Giray (1681) and Nureddin Sa'adet Girey (1681) are found in National Swedish Archives.

Keywords: Tatar diplomatic records, letter attires, seals.

Elżbieta Świącicka is an Associate Researcher at Stockholm University Institute of Turkish Studies (SUITS). She has been teaching Turkish Literature and Ottoman history at the Department of Oriental Language at SU. She has a Master's degree in Oriental Philology from the Jagiellonian University, Cracow. E.Ś. is also a qualified archivist. Research interest: Turkish lexicography, Ottoman history concerning Sweden's relations with the Ottoman Empire and the Crimean Khanate.