Arabick Roots
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ENGLISH HERITAGE

Right: Signatures of Arab Fellows elected in the 17th and 18th centuries, in the Royal Society Charter Book.
Preface

No scientist works alone, and no scientist works without understanding and appreciating the work of those who have gone before. This was just as true at the beginning of English science in the seventeenth and eighteenth centuries as it is today. As Isaac Newton famously wrote, ‘If I have seen further, it is by standing on the shoulders of giants’.

This exhibition uncovers some of Newton’s ‘giants’. The early Fellows of the Royal Society were keenly aware of the rich scholarly tradition of the Arab and Muslim world. They took every opportunity to read and discuss the works of the Arab and Persian astronomers, physicians and mathematicians whose names are still remembered by scholars today – Ulugh Beg, Ibn al-Haytham, Ibn Sina, and many others. They also valued the living knowledge shared by ambassadors from Morocco and the kingdom of Tripoli, and they welcomed three such men into the Fellowship. Science has no borders, and the Society today is still proud to elect leading scientists from all parts of the world, and to promote international scientific collaboration. Arab and Muslim nations are taking an increasing role in modern science, and the rest of the world will watch developments in these countries with interest.

The Royal Society is very grateful to our lead sponsor The Qatar Foundation, and also to the Foundation for Science, Technology and Civilisation and our exhibition design partners Cultural Innovations for supporting ‘Arabick Roots’. We are pleased to acknowledge and thank Dr Rim Turkmani for her painstaking work as exhibition curator.

Dr Peter Collins
Director
Royal Society Centre for History of Science

Left and overleaf: Thomas Hyde’s Latin translation of star catalogues by Ulugh Beg and Mohammed Tizin.
This exhibition tells a fascinating story. Many of the founding members of the Royal Society, such as Edmond Halley and Robert Boyle, are well-known figures in science. What is less well known is how aware they were of the importance of building on what had been achieved in science before them, and in particular the many scientific resources written in Arabic and Persian. This story also shows that these great figures were not in the least bit shy of crediting their Arab scientific predecessors. It is very fitting that the Royal Society, 350 years later, pays this gracious tribute to their roles.

This unique exhibition responds to a much needed effort to bridge cultures. Unfortunately, much of the respect and understanding the founders of the Royal Society had for their forebears has been lost and the celebration of scientists in our school books is often confined to those from the West. We tend to fast forward from the Greeks all the way to the Renaissance, neglecting the contributions of the Chinese, Indian and Arab cultures, to name but a few.

We owe future generations a balanced history in which all cultures and civilisations are recognised and cherished for their contributions to our present knowledge. In highlighting our shared scientific heritage, this exhibition goes a long way to promoting inter-cultural respect.

It is a great credit to this distinguished institution that, right from the outset, they were open to organising this exhibition honouring the finest traditions of their founders. The Royal Society willingly opened its archives and library to enable this research, the fruits of which you see here.

The Foundation for Science, Technology and Civilisation (FSTC) has been delighted to be involved in this venture that goes to the heart of its mission of ‘using cultural roots of science to enhance social cohesion and to promote inter-cultural respect’. I congratulate the Royal Society for organising this landmark exhibition and I invite you to enjoy its content.

Emeritus Professor Salim Al-Hassani
Chairman
Foundation for Science, Technology and Civilisation (FSTC)
www.fstc.org.uk
www.1001inventions.com

Foreword
The old ‘new philosophy’

The late historian of science Marie Boas Hall spent decades editing the correspondence of Henry Oldenburg, secretary of the Royal Society from 1663 to 1677. Struck by his frequent references to Muslim scholars and the need to translate their work, she wrote, “At first thought, it seems unlikely that the Fellows of the Royal Society founded by the ‘new philosophy’ in England in 1660 ‘for the promotion of natural knowledge’, self-confessedly forward looking modernists, should have concerned themselves with Islamic learning. That they did so throws further light upon the complexities of the scientific revolution.”

This interest of the ‘New Philosophers’ in learning that was eight centuries old might seem surprising. But it becomes less so if we consider the ground they shared with their classical Muslim counterparts, some of whom are acknowledged as pioneers of the scientific method.

Ibn al-Haytham (or Alhazen, 965–c.1040), for example, followed a rigorous research procedure. He started by stating the problem, explicitly supported by observations. He critically reviewed previous work, conducted verifiable experiments to test hypotheses, interpreted the data and formulated conclusions, often mathematically. Only then did he publish his findings. Most modern scientists would follow a similar path. No wonder the pioneers of the scientific revolution could look backwards without betraying their Baconian principles, which demanded complete independence from previous traditions.

Johannes Hevelius, the first foreign Fellow of the Royal Society, expressed the indebtedness of his generation of scientists to Ibn al-Haytham by putting him on the title page of his Selenographia (page 28). There he portrayed al-Haytham as one of the twin pillars of the scientific method, symbolising rational thinking: he stands on a plinth that bears an image of the brain and the Latin word ratione (reason).

And although it may come as a surprise that Robert Boyle, the founder of modern chemistry, often turned to the ancient practices of Muslim chemists like Jabir Ibn Hayyam (Geber) (pages 39-42), Boyle and Geber both championed the experimental approach to chemistry, despite the nine centuries between them. Geber made this clear when he wrote, “The first essential in chemistry is that you should perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery. But you, O my son, do experiment so that you may acquire knowledge. Scientists delight not in abundance of material; they rejoice only in the excellence of their experimental methods.”

Seventeenth-century scientists knew that much essential Muslim knowledge had not yet reached the West. They recognized that the answers to many questions were to be found in Arabic and Persian sources, including masterpieces of Greek mathematics that survived as Arabic versions enriched with commentaries and solutions to equations (page 51). Most of the material that seventeenth-century scientists hoped to find in these manuscripts epitomised the new spirit of the Royal Society, with its emphasis on empirical data, experimental methods and observations. It was not the theoretical models of Islamic astronomers that interested Edmond Halley and Edward Bernard; it was their remarkably accurate observations and observational methods (page 24). Boyle was not interested in knowing to which of the classical elements a substance like sal-ammoniac belonged. His focus was on its description and properties, where it could be found in nature, ways of extracting it and any health and other benefits it might offer (page 40). At a time when Islamic medicine was going out of fashion, an interest in Muslim physicians’ use of herbs and drugs, and their method of immunising people against smallpox, remained strong (page 54). The philosophical story of Hayy ibn Yaqzan had remarkable influence on the ‘New Philosophers’ five hundred years after it was written (page 48).

“...the seeker after the truth is not one who studies the writings of the ancients and, following his natural disposition, puts his trust in them, but rather the one who suspects his faith in them and questions what he gathers from them, the one who submits to argument and demonstration, and not to the sayings of a human being whose nature is fraught with all kinds of imperfection and deficiency. Thus the duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and, applying his mind to the core and margins of its content, attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency.”

Ibn al-Haytham, Book of Optics (11th century)

Arabick material in the collections of the Royal Society

Early Fellows of the Royal Society wanted to extend their experimentation and observation beyond their own space and time, even if this meant learning Arabic in order to decipher the flood of Arabic and Persian manuscripts sweeping into seventeenth-century England. Evidence of this interest is demonstrated in many parts of the Society’s archive and library; in this exhibition we present a small taste of it.

As well as classical Arabic books such as Ibn Sina’s Canon of Medicine (page 53) and al-Idrisi’s Geography, the Society’s collection includes books in Persian, three beautifully illustrated books by the Ottoman scholar Katip Celebi (page 33) and even books in Syriac.

Two large collections of Arabic and Persian manuscripts formerly belonging to the Royal Society are now housed at the British Library, including manuscripts on astronomy, mathematics, and medicine as well as grammar, history and literature.
Edmond Halley also expressed his desire for texts in their original language. In a paper on the observations of Muslim astronomer al-Battani (page 38) published in the Philosophical Transactions of the Royal Society of 1693 he wrote, "I would have wished to be able to obtain from one of the best equipped libraries of Europe an Arabic copy of al-Battani, so as to be able to confirm our emendations; and I would appeal to those who know the language, since, at least as regards the observations, there is not much, and it is not difficult to compare the manuscripts and then communicate with us.”

Halley’s wish was not granted. But had he laid his hands on such a manuscript he would no doubt have translated it himself. When he located the Arabic version of the work of the Greek mathematician Apollonius (c. 262 BC – c. 190 BC) he took on the painful task of learning Arabic at the age of 50, with very limited resources, in order to translate it into Latin. The result was two books published in 1706 and 1710 (page 38).

**Arabick roots**

Arabic and Persian books and manuscripts were at the heart of the seventeenth-century fascination with Arabic and Islamic science. Scarce in England, they were abundant in the Muslim world, and an active manuscript hunt was necessary to bring them to European libraries. Enhanced diplomatic and trade relations with the Ottoman Empire, culminating in the establishment of the Levant Company in 1580, provided excellent routes for these manuscripts to be sent back to England. The manuscript hunt was supported by influential figures including King Charles I and William Laud, Archbishop of Canterbury (page 18).

Laud was so keen on collecting and using these manuscripts that he spent his own money on the project, sponsoring travellers to collect them from cities including Constantinople and Aleppo. He also established the first English Chair of Arabic at Oxford University in 1636. Laud donated his huge collection of oriental manuscripts to the Bodleian Library, and the history of many of these manuscripts shows that they were actively used in research. Laud’s collection had a librarian to match: Thomas Hyde, who later became the Laudian Professor of Arabic. Hyde communicated with scientists and philosophers at the Royal Society. He wrote to Boyle frequently, providing him with information from Arabic and Persian manuscripts and writing to Boyle that ‘if for the future I meet with anything in oriental authors, that may illustrate natural knowledge, I shall be sure to take notice of it’ (page 22).

But it was not only silk and manuscripts that were shipped back home through trade routes and diplomatic channels. There were also products like coffee, with its coffee-house culture. Two papers were published in the Philosophical Transactions about the coffee of the Arabs and how the tradition of drinking it in public houses was spreading in England, much to the annoyance of brewers. Coffee houses became an integral part of the intellectual life of the period: many of the Royal Society’s earliest Fellows would have held their heated discussions there. New trees and plants also found their way back to England. Three of these trees, imported in 1640, are still alive in and around Oxford, giving the term ‘Arabick roots’ a literal meaning (page 55).
Arabist Roots

Our shared sky

Newly developed models of the skies required better observations to support them, and observing an astronomical body like the Moon over a short period was often not enough. Modern observations had to be compared with those made over centuries or even millennia to discover how the trajectory or obliquity of an object evolved over time. Making observations in places such as Alexandria and comparing them with those made there during the ancient Egyptian, Greek and Islamic periods was the only way that seventeenth-century astronomers could arrive at convincing answers to some of the questions of the day.

To make use of this ancient data, the exact coordinates of the places from which the observations had been made were essential. Without these reference points astronomers could make little sense of their observations (page 35). The books of Arab geographers like Abulfeda of Hama became important because they included these coordinates. Comparisons of old and new observations would sometimes pose new questions, such as those concerning the acceleration of the Moon (page 37) or the axial tilt of the Earth (page 24).

Arabic and Persian astronomical tables and star catalogues were also invaluable in research. In 1683 Hevelius wrote to the Royal Society enquiring about a copy of the famous fifteenth-century star catalogue of Ulugh Beg of Samarkand, which he had heard about from John Wallis, and asking for it to be translated. The Society met his request and a translation was made by Hyde, enriched by the addition of the Arab astronomer al-Tizini’s sixteenth-century star catalogue. The finished product was sent to Hevelius, who used it to guide his mission of remapping the sky. Ulugh Beg had himself produced his catalogue by revising that of the tenth-century Muslim astronomer al-Sufi (page 30) (in whose observations Hevelius also showed interest). Al-Sufi in his turn had used the Almagest of Ptolemy of Alexandria for guidance in his observations, adding many stars not observed by Ptolemy to his new version. Tracing the roots of Ptolemy’s constellations would take us even further back to ancient Egypt and Mesopotamia.

This truly multicultural history of our shared sky is demonstrated best in the commentary that Thomas Hyde wrote to his translation to some of Ulugh Beg’s observations (page 26). To explain the context of the translation, and all the complexity in the names of stars and constellations, Hyde found himself having to use Latin, Arabic, Persian, Hebrew, Greek and Syriac, all in their original scripts and all on the same page.

Arabist acknowledgment

Many scientists of the seventeenth and eighteenth centuries were happy to use Islamic resources for their scientific content while clearly understanding where the contributions of Arab and Muslim scholars fitted within the history of science. Roger Long demonstrated this brilliantly in his book Astronomony (page 25) in which he used the observations of Muslim astronomers like al-Fergani and al-Battani, and then devoted a chapter to ‘Astronomy of the Arabians, Persians and Tartars’. This begins, “From the year 800, almost to the beginning of the fourteenth-century, Europe was plunged in darkness, and the most profound ignorance; but during this period several able men arose among the Arabians, and chiefly at Bagdad, which is very near the ancient Babylon; and some useful works were performed by them.”

Long continued to demonstrate wide knowledge of the history of Arabic and Islamic science, citing many names such as Al Tusï and Thabit Ibn Qurra (836–901) and demonstrating that his knowledge also stretched to mathematics, “It is, undoubtedly, to the Arabians that we are indebted for the present form of trigonometry; for although Ptolemy rendered the theory of Menelaus much more simple, yet he worked by very laborious rules.” Long, like many other scientists of the period, such as John Flamsteed and Christopher Wren, openly acknowledged the contribution of the Arabs and Muslims to science and philosophy, and demonstrated wide knowledge of this contribution.

The founders of modern science clearly recognised the importance of their Arabist heritage. We should recognise it too. Dialogue, not clash, between civilizations is at the heart of science and at the heart of the Royal Society.

Dr Rim Turkmani
Exhibition curator

This we now call the Gothick manner of architecture, though the Goths were rather destroyers than builders; I think it should be with more reason be called the Saracen [Muslim] style: for those people [the Goths] wanted neither arts nor learning; and after we in the west had lost both, we borrowed again from them [Saracens], out of their Arabick books, what they with great diligence had translated from the Greeks.

Christopher Wren, Memorial to the Bishop of Rochester (1713)
The Arabick roots of knowledge were significant at the founding period of the Royal Society. English philosophers showed continued appreciation for the classical science of the Arabic and Islamic worlds and interest in its living knowledge; they used both as sources for their research.

*Arabick Roots* uses the seventeenth-century spelling of Arabic that was seen as the key to unlock the treasure troves of knowledge coming from the East and that was often used to refer to languages that use the Arabic type such as Arabic and Persian.

Left: Europe’s oldest printed star map featuring Al-Sufi, one of the Arab astronomers highlighted in this exhibition.
The Royal Society elected three Arab Fellows in the seventeenth and early eighteenth centuries. All were prominent ambassadors who showed scientific curiosity, and they provided the Fellows with knowledge about popular medical practices and the ancient history of the region. They were Muhammad ibn Haddu and Mohammed Ben Ali Abgali of Morocco and Cassem Aligiada Aga of Tripoli.

1.1 (Right) Portrait of Muhammed Ibn Haddu by Godfrey Kneller (1684)

Ibn Haddu was Moroccan Ambassador to London in 1682. His visit to the Society was recorded by Robert Hooke, and John Evelyn described him as “the fashion of the season, a handsome person, well featured and of a wise look, subtle and extremely civil.”

© English Heritage. The original portrait can be seen at Chiswick House (www.chgt.org.uk).

1.2 (Left) Portrait of Mohammed Ben Ali Abgali by Enoch Seeman (c. 1726)

Abgali was Moroccan Ambassador to London from 1725 to 1727.

On loan from RichGallery London.

1.3 (Above) Royal Society Charter Book (1663)

Arab Fellows signed the Society’s Charter Book when they were elected. The first was Muhammad ibn Haddu the Moroccan Ambassador in 1682, the second was Mohammed Ben Ali Abgali the Moroccan Ambassador in 1726 and the third was Cassem Aligiada Aga the Ambassador of Tripoli in 1728.
A new philosophy and the quest for Arabick knowledge

In seventeenth-century Europe, men began to study the world in a new way, using methods we now think of as scientific. At the same time, trade routes to Arab countries expanded, allowing a greater flow of information in both directions.

The Royal Society was founded in 1660 by a group of men who wanted to know more about the world. They were called the ‘new philosophers’, because they believed experiment and observation were better tools than abstract argument. They tested old theories and questioned old beliefs, showing that it was possible to delve deeper into the natural world using instruments such as the microscope and telescope. Chemists like Robert Boyle and astronomers like Edmond Halley made important discoveries that changed the way people understood the world.
Arabick routes

England’s diplomatic and trade relations with the Ottoman Empire, boosted by the establishment of the Levant Company, enabled the exchange not only of goods but also of knowledge and manuscripts. Many aspiring Arabists learned Arabic while serving the Levant Company mission in Aleppo and acted as manuscript agents for sponsors such as William Laud, the Archbishop of Canterbury. Thousands of manuscripts were shipped back home along with fine horses, Damask silk, new varieties of trees and plants and even coffee-house culture.

2.2 (Above, right)
Charles I to the Levant Company (1634; reproduction)

Charles I asked the merchants of the Levant Company to send home a manuscript on every ship returning to England from the Levant.

© The National Archives.

2.3 (Right)
Questions for Barbary (1669)

The Royal Society asked Henry Howard, English ambassador to Morocco, to bring back information about life and popular knowledge in North Africa.

2.4 (Above)
Damask Silk

The English merchants employed by the Levant Company imported many different goods from the Middle East, including fine silk.

2.5 (Above)
The firman (decree) of Sultan Murad III (Constantinople, 1587)

This decree, published on the final page of the Arabic edition of Euclid’s Elements, gave European merchants the right to buy and sell Arabic printed books.

2.6 (Not pictured)
Oldenburg to English Consul at Aleppo (1666)

The Royal Society sent questions to the English merchants in Isphahān, ranging from “the present studies of ye Persians” to “How they unhusk their rice?”
The circle of philosophers and orientalists

Several Fellows of the Royal Society were part of a lively circle of philosophers and orientalists corresponding frequently on valuable knowledge in Arabic and Persian manuscripts. In some cases the orientalist and the philosopher were one and the same.

Robert Boyle FRS (1627-1691)

Britain's most famous chemist, he learned the 'oriental tongues' to study the Bible and read oriental scholars.

Edward Bernard FRS (1638-1697)

Bernard was a mathematician and an orientalist. The Savilian Professor of Astronomy at Oxford, he was particularly interested in translating ancient mathematical works and planned a 14-volume edition of ancient mathematicians. He used Arabic observations heavily in his astronomical research.

John Wallis FRS (1616-1703)

A renowned mathematician, he was a founding Fellow of the Royal Society and a very active member. He translated from Arabic and often quoted Arabic mathematicians in his lectures. He included Nasir Eddin Al-Tusi’s five-page proof to Euclid’s fifth postulate in his book, Opera Mathematica.

Edward Pococke (1604-1691)

The first Laudian professor of Arabic at Oxford University, sponsored by the Archbishop of Canterbury, William Laud. He lived in Aleppo for many years where he learnt Arabic and collected manuscripts for Laud. He realised that the old medieval translations of Arabic philosophy were probably corrupt.

Thomas Hyde (1636-1703)

Professor of Arabic at Oxford University, he searched the oriental manuscripts of the Bodleian library for useful knowledge that he communicated to philosophers. He translated Ulugh Beg’s star catalogue.

Henry Oldenburg FRS (1617-1677)

The first secretary of the Royal Society, he was very aware of the importance of Arabic learning. He was one of the most active members of the circle of philosophers and orientalists, and he was often the hub of its correspondence.

Edmund Halley FRS (1656-1742)

A leading astronomer, he was keen to use historical observations for the benefit of the new astronomy. He researched the observations of al-Battani and learned Arabic in order to translate the Arabic editions of Greek mathematicians.

John Greaves (1602-1652)

Greaves was both astronomer and orientalist. The Savilian Professor of Astronomy at Oxford, he travelled twice to the Levant where he collected manuscripts and observed with local astronomers. He translated Arabic and Persian books and wrote a book on Persian grammar.
Arabist astronomers

Several seventeenth-century astronomers made the effort to learn Arabic and Persian to have access to observations that would help them settle topical astronomical debates. This included the first five Savilian professors of Astronomy at Oxford. Some, like John Greaves, travelled to the Arab world where they made observations, learned Arabic and collected manuscripts.
Analysing the Earth’s axial tilt

Establishing the precise axial tilt of the Earth (also called the obliquity of the ecliptic) and whether it has changed over the years is important for many astronomical and calendrical calculations. To do this Edward Bernard, Fellow of the Royal Society and Savilian Professor of Astronomy, dug deep into a wealth of Arabic materials and discovered valuable measurements of this tilt that did not match the contemporary value. He initially interpreted this as observational error but others like Pierre-Simon Laplace confirmed what some Arab astronomers thought 800 years earlier – the tilt changed periodically.

4.4 (Above right)
Letter from Edward Bernard to John Flamsteed on the Earth’s axial tilt, printed in Philosophical Transactions (1684)

Bernard concluded the tilt is constant and attributed the disagreement between Arabic and contemporary values to observational errors.

4.5 (Not pictured)
John Flamsteed, Historiae Coelestis Britannicae (1725)

Flamsteed used the Arabic observations of the axial tilt provided by Bernard and agreed with him on his conclusion of a constant tilt.

4.6 (Above)
Al-Farghani, Elements of Astronomy
(Latin translation, 1689)

Al-Farghani’s work was among many Arabic resources used by Bernard. The book was first translated into Latin in the 12th century and was very influential during the Renaissance.

4.7 (Right)
Roger Long, Astronomy (1742)

Long used twelve of the Arabic values of the axial tilt provided by Bernard, but contrary to them he accepted that there had been a slow decrease over the centuries.

4.8 (Not pictured)
Pierre-Simon Laplace, Traité de Mécanique Céleste (1808)

Laplace found that the axial tilt changes periodically, as proposed by Ibn Thabit (circa. 900), due to perturbations to the Earth’s orbit caused by other planets.
Johannes Hevelius was a renowned Polish astronomer and in 1664 was elected the first foreign Fellow of the Royal Society. He had great respect for Arab and Muslim scholars, he cited them and depicted them often in his books. As he set himself up to re-map the sky he focussed his attention on the well-known fifteenth-century star catalogue of Ulugh Beg. Hevelius wrote to the Royal Society asking them to find and translate the catalogue. The Society appointed John Wallis to oversee the translation that was later sent to Hevelius.

Ulugh Beg was a Timurid ruler, astronomer and mathematician. He lived in Samarkand, which he turned into an intellectual centre that attracted many scholars to its Madrasa and observatory. He achieved remarkably accurate observations by building an enormous sextant in his observatory, parts of which still survive. He compiled his observations in a highly celebrated star catalogue in which he built upon the star atlas of al-Sufi and used al-Sufi’s observations of the stars too far south to be observed from Samarkand.

5.1 (Left and above) Thomas Hyde, Latin translation of star catalogues by Ulugh Beg and Mohammed Tizin (1665)

The Royal Society supported Hyde in completing this translation after it was requested by some of the Fellows. It was printed in Oxford using Arabic type provided by Archbishop Laud.

Our shared sky

The sky has always unified people across history and geography. Theories explaining stars and planets change, but observations always remain independently valuable. The new astronomy of the seventeenth-century needed Arabic and ancient observations to support its theories, especially when detecting movements of celestial bodies, which needed centuries and even millennia of observations.
Ibn al-Haytham (here Alhasen) sharing with Galileo the honour of holding up the title page of Selenographia. Both al-Battani and Ibn al-Haytham are cited in the book.

Hevelius produced this atlas of constellations after years of observations. He used the observations of al-Sufi, Ulugh Beg and Tolini as guidance but also identified many new stars.

Oldenburg promised to send Hevelius the coordinates of fixed stars according to ‘the tables of the celebrated Al-Sufi’, and the Arabic copy of Ptolemy’s Almagest, all prepared by Wallis.

Oldenburg told Hevelius that in response to his request “the Royal Society has decided that the whole of Ulugh Beg’s astronomical manuscript should be translated from Persian into Latin.”
Hevelius used the star catalogue of Ulugh Beg to re-map the sky, and Ulugh Beg used that of the tenth-century astronomer al-Sufi. Al-Sufi used the Almagest of Ptolemy of Alexandria to produce his catalogue. The roots of Greek star catalogues go back to ancient Egypt and Babylon. This has been always the way we mapped our sky, star by star.

5.6 (Above left)
The constellation Andromeda, depicted in Johannes Hevelius’s Firmamentum Sobiescianum sive Uranographia (1690)

5.7 (Above right)
The constellation Andromeda, depicted in a copy of al-Sufi’s star atlas (10th century)
Re-mapping the Earth and the sky

The seventeenth-century quest to re-map the Earth and the sky called for another quest – to find and translate the observations and measurements made previously by Muslim astronomers and geographers. Fellows of the Royal Society played an important part in this project.

5.8 (Not pictured)
Islamic celestial globe (18th/19th century)

The silver inlaid points surrounded by circles indicate more than a thousand different stars outlined in the form of 48 constellations.


5.9 (Bottom right)
Reflecting telescope made by Isaac Newton (1671)

Newton built his first reflecting telescope in 1668; this is his second model. It consists of two tubes, one sliding inside the other to focus the mirrors.

5.10 (Left)
Islamic planisphere astrolabe, Maghrib (18th century)

Astrolabes were used throughout the Islamic Golden age to map the sky and the Earth. Abulfeda used such an instrument to determine the coordinates of cities and other places.


5.11 (Above)
Islamic horary quadrant

Horary quadrants were primarily used to tell the time from the altitude of the Sun. They were particularly useful for determining the Muslim prayer times.


5.12 (Above)
Katip Çelebi, Jihannuma (1732)

This book, the title of which can be translated as Displaying the World, is among the first in the Muslim world to use translated European resources. It was printed in Constantinople on the press of Ibrahim Muteferrika who petitioned the Sultan to fund a press with Arabic type.
Brass, silver damascened and engraved cabinet with an Arabic inscription commemorating ‘the scientist king’, possibly referring to Abulfeda, the 14th century geographer and king of Hama, Syria. On loan from the Science Museum, London.

The secretary of Louis XIV reports “Mr. Thevenot has translated Abulfeda from Arabic into Latin. He has revised it with a gentleman from Marseilles who understands that language perfectly”.

From the 14th century original by Abulfeda, the ruler of Hama. The book described towns and cities and also gave their longitude, latitude and climate.
From astrolabes to telescopes

Astrolabes and quadrants gradually gave way to the newly-invented telescope, but this was not a swift change. Telescopes offered a closer look at stars, but mapping the coordinates of these stars remained the task of the traditional quadrant. Hevelius (left) was reluctant to use the telescope and claimed he could do as well with his quadrant and alidade (Arabic for ruler), a claim that was verified by Halley when he visited Hevelius. Eventually Hevelius fitted his telescope with a quadrant to get the best of both worlds.

Acceleration of the Moon

Halley began the research that led to the establishment of the secular acceleration of the Moon, a possible increase in the Moon’s mean rate of motion relative to the stars. Halley started by using al-Battani’s observations of the eclipses at al-Raqqqa (in modern Syria) and comparing them to ancient and modern observations. The debate was followed up by other astronomers, including Richard Dunthorne, Long and Laplace. All used al-Battani’s observations and those of other Babylonian, Greek and Muslim astronomers in addressing this question, which was finally settled in 1853.

Edmond Halley FRS
1656-1742

Halley (below) used Arabic observations, and learnt Arabic himself in order to translate two books from that language. He admired the tenth-century astronomer al-Battani for being a keen and very precise observer and the first to dare to criticize Ptolemy. Halley spotted unlikely observations in the Latin translations of al-Battani’s work, but he was confident that these were only translation errors. He wrote that he wished he could lay his hands on the original Arabic text “so as to be able to confirm our emendations”. 

Right: Hevelius making observations with a telescope, from Selenographia (1647)
Boyle (below) was England’s most famous chemist in the seventeenth-century. He was initially motivated to study oriental languages like Arabic and Syriac because of their biblical significance. Later he became more interested in the natural philosophy found in texts written in these languages, and his circle of orientalist friends helped him to find useful information in the increasing number of Arabic and Persian manuscripts that were arriving in England.
Boyle’s interest in Arabick science

Arab chemists influenced Boyle’s understanding of chemical processes and his natural philosophy. His main source of such knowledge was his friend the orientalist Thomas Hyde. As a librarian at the Bodleian in Oxford, Hyde had access to a treasure of Arabic and Persian manuscripts and periodically sent Boyle extracts from them including recipes out of a book “as thick as one’s thumb” by al-Iraq, a thirteenth-century Muslim chemist. Boyle also asked Pococke to translate for him the tables of longitude and latitude compiled by the Syrian geographer Abulfeda.

6.1 (Above) Notes written by Thomas Hyde to Boyle (c. 1667)
Here Hyde displays a wide knowledge of Arabic resources, providing Boyle with information about sal ammoniac, amber and petrifaction, and citing six Muslim scholars: Ibn al-Bitar, Ibn al-Talmiz, Ulugh Beg, Nassir Eddin, Al Gaphiti and Said Ibn Al.

6.2 (Bottom right) Printed table of oriental languages, including Arabic (17th century)
Found among the papers of Robert Boyle, this may be a specimen of Edmund Castell’s Lexicon.
Jabir Ibn Hayyan (Geber)
721-815

This legendary polymath excelled in any fields but it is his achievements in chemistry that made him famous in medieval Europe. The name ‘Geber’ was used by an anonymous European writer in the thirteenth-century as a pen-name for his book on alchemy. Geber believed in experimentation, “The first essential in chemistry is that thou shouldst perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery”. For such experiments he is credited with developing many items of chemical laboratory equipment.

Alembic

An alembic is a type of flask used for distillation and sublimation – the process where liquids are separated and purified. Alembics became essential pieces of apparatus used by early chemists and alchemists. Muslim chemists used this process to make essential oils and perfumes and other chemicals.

Like most alchemical terminology, the word ‘alembic’ originates from the Arabic: al-inbeeq, meaning “that which refines”. Geber (Jabir Ibn Hayyan) is renowned for developing the alembic in the eighth-century.

6.3 (Above)
The world’s oldest alembic (10th-12th century)
This Islamic glass apparatus, an alembic used for distillation, is reputed to be among the oldest to survive in the world.

6.4 (Not pictured)
Islamic chemistry glassware (7th-13th century)
Examples of Islamic glassware, used for chemistry and other purposes. The collection includes a rare 7th century phial.

6.5 (Not pictured)
European alembic (18th century)
Hand-moulded green glass alembic. Alembics were refined slightly over the years, but the essential design remained the same.

6.6 (Not pictured)
The Works of Geber, the Most Famous Arabian Prince and Philosopher (1686)
The real Geber was an alchemist in the court of Harun al-Rashid, but the Pseudo-Geber was himself also given royal pedigree. Newton had four different copies of this book in his library.

6.7 (Above)
Avicenna and Geber, Artis Chemicæ Principes (1572)
This Latin book claims to offer the best out of the chemistry of Avicenna (Ibn Sina) and Geber (Jabir Ibn Hayyan).

6.8 (Not pictured)
Drawing of alembics (late 17th century)
These drawings, found among Boyle’s papers, describe the use of alembics in different settings for chemical laboratory experiments.
Some of the early Royal Society Fellows were also leading Arabists. They were not only interested in what Arabic sources could tell them about science – they also wanted to bring literary and philosophical works to western audiences. Several Arabic grammars and dictionaries were published in this period and were read and used by Fellows.
Arabick in seventeenth-century England

Arabic studies in England had been promoted by Archbishop Laud, who founded an Arabic professorship at Oxford in 1636. English people studied eastern languages for a variety of reasons: to enable merchants to communicate with traders from the Arab world; to read early Biblical texts; and to learn about Arabic literature and culture. Edmond Halley was so keen to read mathematical works in Arabic that he ‘deciphered’ the language as though it were a code, using only a few pages of translated text as a guide.

8.1 (Left)
Engraving of Edmund Castell by William Faithorne (1669)
Castell worked on the polyglot Bible, and published a dictionary of seven oriental languages.

8.2 (Above)
Letter from Edward Pococke to Robert Boyle (1660)
Pococke asked Boyle to use his influence to encourage merchants in Aleppo to send back Arabic books.

8.3 (Not pictured)
Edmund Castell, Lexicon Heptaglotton (1669)
Castell’s dictionary of seven oriental languages (Hebrew, Samaritan, Chaldee, Syriac, Arabic, Ethiopian, and Persian) took twelve years and was a commercial disaster.

8.4 (Above)
Thomas Erpenius, Rudimenta Linguae Arabicae (1638)
Erpenius was professor of Arabic at Leiden and was the first to publish a detailed Arabic grammar for European readers.

8.5 (Above)
Proposal for printing a Turkish lexicon (c. 1670)

8.6 (Above)
The Grammar Book of al-Ajrumiyah
Originally written in the 14th century by Ibn Ajroom Al Sanhaji of Foz, this popular Arabic grammar book is part of the collection of the Royal Society library.
In 1671 Edward Pococke junior published a translation of the Arabic work Hayy Ibn Yaqzan by Ibn Tufail. The short novel describes the story of Hayy, a boy raised by animals on a desert island, who comes to an understanding of the world entirely through his own reasoning. The book caused an immediate stir in the western world. It was reviewed in the *Philosophical Transactions*. Robert Boyle wrote a similar story in English, and the ideas influenced John Locke, one of England’s most important philosophers.

Some mathematicians, including John Wallis, learned Arabic in order to translate the works of Greek mathematicians that only survived in Arabic. But these Arabic books were more than just translations: they were commentaries full of queries and solutions. Edmond Halley translated two Arabic mathematics books. John Pell translated the Greek geometer Apollonius from an Arabic manuscript after a heated debate with the Arabist Hugo Grotius, who asked Pell to leave the fame of translating such a work to him and went to great lengths to prevent Pell publishing his translation.
Alhazen and his problem

The tenth-century polymath Ibn al-Haytham, known in the west as Alhazen, was known as ‘The Physicist’ and ‘Ptolemy the Second’ in Europe. He is recognized as a pioneer of scientific method for his development of an experimental method to verify hypotheses. He left behind the notorious Alhazen problem (only solved in 1997): “Given a light source and a spherical mirror, find the point on the mirror where the light will be reflected to the eye of an observer.”

Ibn al-Haytham’s Book of Optics is now a thousand years old. It revolutionized optics and had a great impact on science in Europe, being cited by Roger Bacon and Johannes Kepler, among others.

The French mathematician René de Sluse and the Dutch astronomer Christiaan Huygens wrote to Oldenburg their “second thoughts on the problem of Alhazen”.

This Islamic cupboard has many drawers and may have been used to store medicinal preparations.

Islamic Pharmacy

The coat of arms of the Royal Pharmaceutical Society of London, depicted on a stained glass window. The figures are Ibn Sina (Avicenna) and Galen. Reproduced by permission of the Royal Pharmaceutical Society of London.
Arabick medicine

Some of the most influential writers from the Arab world were physicians. Their writings on medicine, disease, and how to live a healthy lifestyle were studied in European universities into the seventeenth-century. They commented on Greek and Roman authors, and added their own theories and observations.

9.1 (Illustrations left)
*The Maintenance of Health, Ibn Butlan* (11th century)

Ibn Butlan was an 11th century physician who originally practised in Baghdad. His book discussed hygiene, diet and exercise and emphasized the importance of a balanced lifestyle.

9.2 (Above)
*Ibn Sina (Avicenna), The Canon of Medicine* (1593)

The first printed Arabic edition of *The Canon of Medicine*. The work was completed in 1025 by Ibn Sina, a Persian physician and philosopher whose works were widely studied in the west. Printed at the Medici Press in Rome.

9.3 (Below)
Earthenware flasks and jars

Jars like these were widely used to hold medicinal preparations and ingredients in apothecaries’ shops.


Arabick roots, literally

Importing medical plants and herbs from the Arabic world goes back to the twelfth-century, but the foundation of the Levant Company gave it a new impetus. Merchants, diplomats and clergymen sent back bulbs and plants, with descriptions of how they were grown and used. Doctors who practiced in the Levant benefited from the long-established tradition of Islamic pharmacy and sent back dried specimens of medical herbs with descriptions and drawings.
Travellers to the Levant, delighted with the richness and diversity of its plants and trees, wanted to bring the splendour back home. Today, a long list of flowers that enrich English gardens and trees that line the streets of England have their roots back in the ‘Arabick’ world. Astonishingly, three of the trees brought back from Syria and planted in and around Oxford in 1640 by Edward Pococke are still alive. They are England’s oldest cedar, plane and fig trees.
English merchants based in Aleppo sent this description of Palmyra to the Royal Society. They were particularly interested in the ancient inscriptions and carvings.

John Greaves described the Egyptians’ use of large ovens to hatch several thousand eggs at a time.
Fight against smallpox

In the eighteenth-century a smallpox epidemic hit London. Little was known about the disease in England, so Fellows of the Royal Society turned to the Muslim physician al-Razi to learn about the disease. They also investigated methods of inoculation, an immunisation practice that was common in the Muslim world, where healthy people were given a mild dose of the virus from an infected person.

10.1 (Left)
Cassem Aga, on smallpox inoculation (translated from Arabic, 1729)

Cassem Aga provided a first hand account of inoculation and its safety record in ‘Tripoly, Tunis and Algier’, noting it was practised by both townsman ‘and wild Arabs’ (meaning nomadic tribesmen).

10.2 (Below)
The minutes of the meeting at which Cassem Aga signed the Charter Book and was admitted as a Fellow.

From inoculation to vaccination

Doctors working in the Ottoman Empire as physicians to the British Embassy in Constantinople or the English Factory in Aleppo were among the first to write letters home about inoculation. English people were still cautious about the practice because of its recent introduction in Europe. The account of Cassem Aga, the Ambassador of Tripoli, provided valuable reassurance about the long safety record of the practice in Muslim countries. In 1796 Edward Jenner replaced the smallpox virus with cowpox, achieving a method of vaccination that eventually led to the eradication of the virus.
Richard Mead, *A Discourse on the Plague* (1744)

Mead was a high-profile London physician who worked on the prevention of transmissible diseases and also helped to establish the practice of smallpox inoculation.

Richard Mead, *De Variolis et Morbillis* (1747)

While preparing his work on the smallpox and measles, Mead commissioned a Latin translation of al-Razi’s important treatise on the subject so he could include it in his book.

Silver medal (c. 1805)

This medal commemorates a smallpox vaccination programme in Prussia. Similar coins and medals were issued throughout Europe.

Smallpox vaccination kit (19th century)

The kit contains a steel and ivory lancet, a glass tube and a roll of bandage.


Inoculation in Palestine (20th century)

This picture shows a traditional method of smallpox immunisation being performed in Palestine, using sharp thorns instead of needles.


Richard Mead, *A Discourse on the Plague* (1744)

Mead was a high-profile London physician who worked on the prevention of transmissible diseases and also helped to establish the practice of smallpox inoculation.

Developments in science and innovation in the Islamic world

The Atlas of Islamic World Science and Innovation is a three-year project focussing on contemporary science and innovation in countries with large Muslim populations in the Middle East, Africa and Asia. Looking in detail at economically and geographically diverse countries, including Qatar, Egypt, Jordan, Malaysia and Pakistan, the project explores recent advances in science, technology and innovation and reviews the opportunities for, and barriers to, faster and further progress. Studies of these and other countries are being launched over the next 18 months, mapping key trends and highlighting signs of renewed ambition and investment in education, science and innovation.
الاسم المفرغ وجمع التكسير والفعل
المضارع الذي لم يتصل بالآخر في رأيًا، ألف فتكون علامات النصب في
الأسمة السنة كربت احات
والتاء وما السمه ذلك. واما الكسرة
فتكون علامات النصب في النسبة
فجمع واما حذف الحروف فتكون
علامات النصب في الانتقال الذي ربيعها
باثنون و نلفعض ثلاثة علامات
التكسير والياً الفتحة واما الكسرة
فتكون علامات الفعض في ثلاثة
مواقع في اسم المفرغ المتصدف وجمع
التكسير المتصدف وجمع الموجب السالم
واما