Questions from the Audience

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1. Question for Dr. Kheirandish: What about mathematics inspired you in the first place to pursue a career in this field?

EK: I have always been fascinated by mathematics and inspired by mentors from my father to teachers in high school and college. I got drawn to the history of science and mathematics later in my graduate studies, as I realized the historical meaning of the 'mathematical sciences' is much broader than what they are in modern times; for example, fields like optics included subjects from geometry and natural philosophy to perception and perspective, an early 'interdisciplinary' subject.

2. How much science developed at Gonde Shapur university during Sasssanid Zoroastrian rule in Persia when some Greek scholars attended?

JH: We do not know much about science in Sassanid Iran because there are few original sources of a technical scientific nature. It is very difficult to reconstruct scientific knowledge from general pre-Islamic works and from traces in later traditions, primarily in the Islamic world.

It turns out that there was a highly developed astronomy in Sasanid times, see for some reconstructions, B.L. van der Waerden's book Science Awakening Part 2: the birth of astronomy (who uses general sources) and E.S. Kennedy, The sassanian astronomical handbook Zij-i Shah (which is more technical and detailed).

3. Can you share the link of the virtual platforms for the project? Windows into Second life?

EK: Second Life was an online platform on which we had a virtual gallery that Harvard University owned in the form of an 'Island' which is no longer live. We included a general description of it on our virtual book event site, as an online virtual world where people could create and visit spaces, and how other platforms are being created for a variety of activities. At the time, we used it in a way referred to in the book as a way of 'displaying together manuscripts from around the world that you could never, in real life, see together', with 'no limit to the number of pages you can add'.

4. What do you think about the influence of al-Khwarizmi's Algebra on the structure of Fibonacci's Liber Abaci and books on Commercial Arithmetic?

JH: Leonardo received his mathematical education in modern Algeria so he was influenced by many Arabic works. This includes Khwarizmi's arithmetical work and also the Algebra of Abu Kamil (ca. 900 CE), which was influenced by Khwarizmi's algebra. Leonardo may not have known the Algebra by Khwarizmi itself because that work seems not to have been available in the

Maghreb. Leonardo was also a creative mathematician so the Liber Abaci contains many discoveries of his own. Often it is difficult to tell the exact inspiration.

One can say that the Liber Abaci is much longer and contains a lot more material than the Algebra of Khwarizmi or Abu Kamil, and the structure (division into chapters) of the Liber Abaci is very different from the Algebra of Khwarizmi or Abu Kamil. Commercial arithmetic was a special genre in medieval Islamic and European mathematics. Algebra was sometimes used in solving commercial arithmetic problems (in which case Khwarizmi was always indirectly an influence). I have the feeling that many so-called "commercial arithmetic" problems have no practical application, but were designed and solved for fun and to challenge other mathematicians. Then mathematics becomes a kind of sport: this happened in the Islamic world, continuing the tradition in other cultures (Babylon, India). The Liber Abaci is available in an English translation by L.E. Stigler and it is great fun to read the work.

5. Will you provide links for the Harvard films on History of Science mentioned by the speaker?

MS: We wrote and produced the following films for the Harvard Shorts Film Festival. You can watch the films at the following Vimeo links:

When Optics was More Than Physics
An Early Science Quartet ca 1000 CE & Beyond

6. How much the mathematics of that Era has inspired today's technology?

EK: The historical term closest to the concept of technology today is the ancient Greek term techne, and Arabic-Persian terms san'a, meaning craft and involving practical knowledge in contrast to Greek term episteme and 'ilm, in Greek, and Arabic-Persian involving theoretical knowledge. Though technology as distinct from science is a modern concept, fields involving both theoretical and practical knowledge include those like mechanics, which was considered a mathematical science, and often involved tools and productions.

7. How to reach you for the collaboration?

MS: Please email info@farhang.org with your request.

8. How easy was it to find the resources for this inclusive research?

EK: This book draws its resources from a combination of my courses and publications all referenced in its endnotes and the bibliography. As such it was not difficult to find them; my aim was to prioritize both primary and secondary source that would serve the interests of both the academic and non-academic community.

9. Can you explain the relation between mathematics and the Iranian Calendar? And is it true that the Iranian Calendar is one of the most precises calendars?

JH: The Iranian calendar is a solar calendar. The center of the sun is in the plane of the equator twice a year, once at the beginning of spring (spring equinox), and once at the beginning of autumn (autumn equinox). The Iranian new year begins at the spring equinox. If one uses this rule, the year is always accurate. The same is true for the lunar calendar: if one decides that the month starts when the crescent is seen, this is always accurate, and does not involve computation.

In medieval and modern chronology, one wants to have the calendar and compute these events in advance and here is where mathematics comes in. Computation of the spring equinox is based on the astronomical determination of the solar year; this type of year is called the "tropical year". According to modern astronomy (and even according to al-Biruni) the length of the tropical year fluctuates a tiny little bit but one can take the average; the modern value of the average is 365 days 5 hours 48 minutes 45.5 seconds. If one wants the year to always be an integer number of days, one has to decide which years are 365 days and which years are 366 days. In the Julian calendar, after 3 days of 365 years, there was always 1 year of 366 days. Over a number of centuries, this rule turned out to be slightly inaccurate, so it was changed and now we have the Gregorian scheme (if the year number is a multiple of 100 but not a multiple of 400, it is not 366 but 365 days). Such a rule is called an intercalation scheme. Iranian mathematicians such as Omar Khayyam discussed other (33-year) intercalation schemes which are a bit more accurate than the Gregorian scheme. Yet the effect is only noticeable after many centuries.

10. Were there Jewish, Christian, or Zoroastrian scientists in Isfahan and Baghdad at that time who also contributed to sciences? If yes, did they work closely with Muslim scientists?

JH: There are many examples of Jewish, Christian, or Zoroastrian scientists contributing to the sciences in early 9th-century Baghdad in particular.

There were also minorities working in 17th-century Isfahan. Examples of the much more common case of the former are figures involved in the early scientific movement of Baghdad during the Abbasids, figures like the Jewish Masha'allah, Zoroastrian Nawbakht, Christian, Qusta ibn Luqa, or Sabean Thabit ibn Qurra.

For a thorough account of the translation and scientific movements of that period, see Dimitri Gutas's Greek Thought Arabic Culture: The Graeco-Arabic Translation Movement in Baghdad and Early 'Abbāsid Society (2nd–4th/8th–10th centuries, London, Routledge, 1998, variously referenced in the book.

11. Very interesting book Thanks for the presentation, I would like to ask about chosing the two cities. Why you chose Baghdad and Asfahan?

EK: The two cities were in dialogue in a historical manuscript I came across, and decided to use them to highlight historical contrasts between them as cities within Arab and Persian speaking lands, representing different cases as major crossroads in science at different times. Baghdad

being active during the reception of the ancient sciences especially those in Greek starting in the 2nd/3rd cen. CE, and Isfahan, hosting various European visitors during 16/17th cen. CE.

12. Could you explain a bit about your inspiration to do this book in a fictional format.

EK: The book has a modern section in each chapter which may be considered a historical narrative in style, though it may still not be called 'fictional', as nothing in it, as in the whole book, is imaginary: the journeys of the young generic character to various cities, libraries, museums, universities, follow actual events very closely in an exact order and chronology. My inspiration to use such a format was to make the 'story' of early science appealing to a more diverse group of people, one that may attract and inspire them more, and stay with them longer.

13. Are these databases open source or only accessible to members of academia?

Question is not clear.

14. In your presentation there was no mention of Farabi, known to have made major contributions to the understanding on our knowledge of eyes and their treatment. Did Farabi preceded or succeeded Al Haythum? Thanks for your clarification.

EK: Farabi is mentioned in the book as a second teacher after Aristotle, and he preceded Ibn al-Haytham by close to a century. Farabi is best known as a philosopher, not a scientist, and his treatment of the subject of eye and vision is limited to a passage in a work he composed on the classification of the sciences.

15. Thank you so much. Do you think that Ibn al Haytham was accepted more in Europe than in his home region because Arabic/Persian scholars were familiar with the information and Europeans not?

EK: Ibn al-Haytham was not 'accepted' more in Europe but his work on optics was much better transmitted to Europe than in his own native lands. Arabic and Persian scholars remained largely unaware of that great work with exception mentioned in the talk and detailed in the book, though his other works in astronomy and mathematics were known to more people regionally.

16. Thank you so much for this fascinating book and presentation! I'm wondering if you envision any future possibilities in terms of climate change issues, and environmental injustice standing on this deep rooted ancestral wisdom and science for the world and the Western world.

JH: Our historical research is not directly related to climate change and environment, but helps to develop good relations between cultures, based on mutual respect and trust. Trust is a necessary condition for the solution of climate change issues and environmental injustice on a world scale.

17. Is the book available in digital format? And can you buy it online and download it?

EK: Yes. Relevant information is to be posted on the website of farhang.org/Isfahan.

18. Would it be possible to please share with the attendees a list of the websites and resources mentioned during this presentation?

www.jphogendijk.nl (general website)
www.jphogendijk.nl/publ.html (list of publications, most of which can be downloaded)
www.albiruni.nl
www.ibnalhaytham.nl
www.alkhwarizmi.nl
www.samarkand.eu
Short Film: When Optics was More Than Physics
Short Film: An Early Science Quartet ca 1000 CE & Beyond

19. Do you agree that majority of the scientific works produced by Muslim scholars translated to European languages without mentioning the original authors? Simply stolen.

JH: I would not use the word "stolen". In general the European authors in the middle ages are open about the Arabic influence on their work and consider this aspect as something valuable. (An anti-Arabic attitude is only found in the Renaissance in some authors, for example F. Vieta). In medieval European translations of works from the Arabic, references to the authors are usually correct: in a few cases the Arabic work was anonymous and there are also cases where the author was named but no precise information was available on him (for example: the Latin translation of the Optics of Ibn al-Haytham was attributed to "Alhazen" or "Alhacen" and it took historical research to identify him with "Al-Hasan ibn al-Haytham"). In a few cases work was adopted without noticing this (for example, Leonardo Fibonacci excerpting the work of Abu Kamil on pentagons and decagons).

Several modern Arabic conspiracy theories which imply that work was stolen in or after the Renaissance (for example: Naperian logarithms, or the symbol x by Descartes) have been disproved by historical research: Naperian logarithms and the symbol x were not used in the Arabic tradition. Finally, there are also cases where independent discovery has been proved (for example, decimal values of pi by al-Kashi (ca. 1420 CE) and Ludolph van Ceulen (1596) who did the computations correctly and arrived at the same answers; Van Ceulen found even more decimals than al-Kashi).