6.A. Assessing Arabic contributions to the sciences

Opinions on the quality of Arabic contributions to the sciences during the period from about 800 to 1500 A.D. have run from dismissive and scornful to highly positive (in the latter case, even if one excludes sites dedicated to promoting Islamic achievements). For example, the heading for the online document

http://www-history.mcs.st-and.ac.uk/HistTopics/Arabic_mathematics.html

(from the MacTutor site at the University of St. Andrew's in Scotland on the history of mathematics) is

Arabic mathematics: forgotten brilliance?

but passionately anti – Islamic websites contain strongly negative statements like the following:

> Islam's "golden age" was parasitic on the Christian cultures and peoples it conquered, and ended when it "killed the host."

This statement appears on the site http://www.1timothy4-13.com/files/bible/psword.html as an advertisement for the book, ***The Sword of the Prophet – The Politically Incorrect Guide to Islam; History, Theology, Impact on the World***, by S. Trifković (1954 –), but there are also numerous other places where one can find similar assertions. Our purpose here is to discuss some of these strongly negative statements and potential arguments against such views.

In a similar direction, some militantly conservative political commentators have strongly challenged the accuracy of comments that U. S. President Barack Obama made concerning the contributions of the Islamic world to science during his speech at the University of Cairo (Egypt) in June of 2009. The nominally nonpartisan websites **factcheck.org** and **politifact.com** have posted discussions of several assertions in the speech, and the results (along with criticism from one source) are posted at the following sites:

http://www.politifact.com/truth-o-meter/statements/2009/jun/19/ann-coulter/ann-coulter-criticizes-obama-muslim-history/

http://factcheck.org/2009/06/obama-and-islamic-history/

General comments, disclaimers, and motivation

Ever since the emergence of Islam during the first half of the 7th century, relations between the Islamic world and the Western world have fluctuated extensively from friendly to confrontational, with some phases of constructive interaction and tolerance, but also phases of mistrust, intolerance, exploitation, outright hostility, and inexcusable brutality (and ***both sides have mixed records*** — discussion of whether one side has a worse record than the other is legitimate but will not be pursued here). In the current world there are strong forces pulling in both directions. The purpose here is **not** to take positions on present day issues that are highly controversial or polarizing; such sensitive matters are far beyond the scope of this course. However, it does seem appropriate to comment on some of the highly questionable, and often totally false, information on the medieval Islamic world's contributions to science originating from

some militantly anti – Islamic writers and organizations. There is also no intent to advocate positions for or against certain current political, economic or human rights issues; we shall only suggest that such positions should be based upon accurate information and sound logic in order to be credible. Finally, we repeat that our discussion is essentially **limited to issues involving the sciences**.

One obvious question concerns the reasons for writing this document, so we shall attempt to do so. A major aim of this course is to educate prospective teachers in mathematics and to provide them with information they need to know. In some communities, many people may have strongly negative views about some non – Western cultures and may interpret comments about their positive contributions as smokescreens, perhaps designed to promote some hidden, nefarious political agenda; furthermore, there are some frequently visited websites that take strong — sometimes even highly incendiary — positions, often arguing their points with statements of highly questionable validity. Educators should have the background necessary for providing accurate and articulate responses to any challenges of these sorts.

Remarks on a specific example

There are many books like the one cited above, and since **(1)** it is not feasible to discuss them all, **(2)** in many cases the contents of different books overlap substantially, we shall concentrate on the following book by R. B. Spencer (1962 –), who has written extensively on Islam (both in print and electronically) and also directs the tenaciously anti – Islamic website **http://www.jihadwatch.org/**.

> ***The Politically Incorrect Guide to Islam (and the Crusades).***
> Regnery Publishing, Washington, DC, 2005.

The title of the book clearly indicates its goal of strongly challenging some widely held views about Islam, and the following comments from the back cover are more explicit:

> Everything (well, almost everything) you know about Islam **…** is wrong because most textbooks and popular history books are written by left – wing academics and Islamic apologists who justify their contemporary political agendas with contrived historical "facts." **…** Spencer refutes popular myths and reveals facts that you won't be taught in school and will never hear on the evening news [Fox News Channel and various other openly conservative outlets should perhaps be exceptions].

Many books with such an aggressive tone try to discredit their opponents using a technique known as a ***straw man argument***, which misrepresents the disputed points in a weakened or misleading manner and then refutes these incorrect assertions. Therefore, an important first step is to understand exactly what is being challenged, and this should be done using sources for the disputed material. As indicated before, our interest here is restricted to the book's discussion of science, and so we only need mainstream references for science and Islam during the so – called Golden Age of Islamic culture. There are numerous articles available on the Internet (for example, on the ***Wikipedia*** website one has **http://en.wikipedia.org/wiki/Science_in_medieval_Islam** as well as **http://en.wikipedia.org/wiki/Islamic_Golden_Age**) and they contain a great deal of useful information, but we have noted that some of them have unresolved reliability problems, so other references are also needed. Here is a list of several good references in print:

H. R. Turner, ***Science in Medieval Islam: An Illustrated Introduction***. University of Texas Press, Austin, TX, 1997.

G. Saliba, ***Islamic Science and the Making of the European Renaissance*** (Transformations: Studies in the History of Science and Technology). MIT Press, Cambridge, MA, 2007.

A. Al – Daffa, ***The Muslim Contribution to Mathematics***. Croom Helm Ltd., London, 1977.

R. Rashid, ***The Development of Arabic Mathematics; Between Arithmetic and Algebra*** (translated from French to English by A. Armstrong). Kluwer Academic Publishers, Dordrecht, NL, 1994.

N. Schlager (Ed.), ***Science and Its Times, Volume* 2 (700 – 1499).** Gale Group, Farmington Hills, MI, 2001.

Note. Luke Hodgkin's book on the history of mathematics (see the list at the end of Unit **0**) contains a particularly extensive account of Arabic mathematics, including some fairly recent discoveries.

The portion of Spencer's book dealing with science is Chapter **VII** (titled *How Allah killed science*) on pages 87 – 98, and the following excerpt from pages 89 – 90 summarizes the author's basic viewpoint:

> In fact, Islam was not the foundation of much significant cultural or scientific development at all. It is undeniable that there was a great cultural and scientific flowering in the Islamic world in the Middle Ages, but there is no indication that any of this flowering actually came as a result of Islam itself. In fact, there is considerable evidence that it did not come from Islam, but from the non – Muslims who served their Muslim masters.

One crucial issue in this paragraph is exactly what the author means by advances which "actually came as a result of Islam itself." Clearly there are many places in the sciences where advancements were directly motivated by specific religious issues, but clearly there are also many places where the motivations were more general and had little or nothing to do with religion directly. There are several responses to the author's assertion. On a general level, it seems apparent that Islamic culture at the time viewed the sciences as important enough to promote their study, sometimes at levels which are comparable to those of Hellenistic culture, and the extensive support of the sciences, particularly by the Abbasid Caliphate in Baghdad (754 – 1258), strongly indicates that "Islam itself" played at least some role in the "great cultural and scientific flowering in the Islamic world in the Middle Ages." On a more specific level, the historical record clearly indicates that concerns of Islamic culture — for example, requirements for highly accurate astronomical measurements and the need for efficient methods to implement fairly complicated inheritance rules — were important motivations for the development of Arabic mathematics.

As Spencer correctly notes, the first phases of Arabic science and mathematics drew very heavily on contributors who were not Muslims, and he concedes that "There is no shame in any of this. … Every culture builds upon the achievements of other cultures and borrows from those with which it is in contact." He then adds that "the historical record simply doesn't support the idea that Islam inspired a culture that outstripped others." The previously quoted phrase, "There is no shame in … this," might also apply here if the author's assertion is justified, but instead he proceeds in a much different direction:

> There was a time when Islamic culture was more advanced than that of Europeans, but that superiority corresponds exactly to the period when Muslims were able to draw on and advance the achievements of Byzantine and other civilizations. … But when they had taken what they could … and sufficient numbers of Jews and Christians had been converted to Islam or thoroughly subdued, Islam went into a period of intellectual stagnation …

As before, a crucial issue is exactly what the author means by the phrase, "draw on and advance the achievements of … other civilizations." If the intention is to assert that very few Muslim scholars made highly original contributions in Arabic science compared to non – Muslims, then the passage is simply (and perhaps dangerously) incorrect. Regardless of the motivation, the chapter's contents promote this mistaken impression. Nearly equal numbers of Muslim and non – Muslim contributors to Arabic science, philosophy and technology are cited in the book; this may suggest nearly equal overall contributions, but even though non – Muslims made numerous key contributions, the actual ratio of Muslim to non – Muslim contributors was very substantially higher. Furthermore, virtually none of the specific accomplishments in Arabic science are even mentioned, and when they are mentioned this is done in a very inaccurate and misleading manner. This is particularly apparent in the discussion of contributions to medicine on page 93, which notes the establishment of professional standards in Arabic medicine and then diverts the discussion with criticisms that Renaissance scholars in the late 16th century made more substantial advances; such criticism has some validity, but one can also argue that it is overstated, condescending, inaccurately justified, and not really appropriate (one expects, or at least hopes, that each generation or culture will succeed in areas where its predecessors did not). Furthermore, the author's assessment of al-Khwarizmi's work does not specifically mention his most important legacy — namely, a systematic description of basic methods for solving algebraic equations — and it seriously misrepresents several other important points. For example, a substantial portion of the material is essentially a statement that the standard base **10** numeration system was developed in India centuries earlier. It is difficult to understand why the author dedicates so much time to this issue in his discussion of al-Khwarizmi's contributions, for it is universally understood that al-Khwarizmi's account of the base **10** numeration system was intended as an account of concepts that had been previously developed in India. Also, there is an assertion that al-Khwarizmi's work did not "[open] up new avenues of mathematical and scientific exploration … in the Islamic world." Strictly speaking, this assertion might not be provably false because we cannot say for sure that any specific Arabic mathematician was motivated by the earlier writings of just one individual, but on the other hand one can point to subsequent work in several directions (for example, Omar Khayyám's highly original study of solutions to cubic equations) which went substantially beyond the material in al-Khwarizmi's writings and reflects the latter's influence; in particular, Chapter 5 of Hodgkin's book includes a detailed and documented analysis of several key examples. Finally, the Golden Age of Arabic science lasted for more than six centuries, and such a sustained record of activity hardly seems consistent with the author's claim that the culture was mainly built on the efforts of outsiders and failed to advance after the latter were assimilated.

Spencer correctly notes that the Sufi scholar **al-Ghazali** (Abū Ḥāmid Muḥammad ibn Muḥammad al-Ghazālī, 1058 – 1111) was an important and extremely influential figure in the history of Islamic thought. Al-Ghazali's writings were sharply critical of Greek philosophical influences in Islamic thought at the time, and one measure of his impact

was a much stronger emphasis on orthodox religious principles in subsequent Islamic thought. However, Spencer's extremely negative characterization of al-Ghazali as "the chief spokesman for a streak of anti – intellectualism that stifled much Islamic philosophical and scientific thought" is at best highly debatable. He was definitely opposed to rational inquiries that were not tied to religious observance, and one aspect of his philosophy was interpreting natural cause and effect in a manner consistent with supernatural phenomena. Such views did hamper or even stop further progress in some directions. However, while some later writers may have used al-Ghazali's work to defend their own anti – intellectual views, this does not mean that such uses were in fact justified or fully reflected his views. A careful examination of his work (which is absolutely necessary when analyzing any complex and abstract philosophical writings of this sort) will reveal that al-Ghazali's perspective was not intrinsically anti – scientific, and in fact he supported efforts to permit ***some*** approaches to scientific inquiry that led directly to important new advances. Here are some online links with more extensive information on al-Ghazali and his work:

http://en.wikipedia.org/wiki/Al-Ghazali

http://www.trincoll.edu/depts/phil/philo/phils/muslim/ghazali.html

http://plato.stanford.edu/entries/al-ghazali/

http://www.ibe.unesco.org/publications/ThinkersPdf/ghazalie.pdf

http://www.ghazali.org/

Spencer's narrative may also leave the impression that there was very little progress in Arabic science or philosophy after al-Ghazali and that Islam itself was responsible for this. Although activities in these areas had already begun to decrease shortly before his time, the decline was gradual and a substantial amount of respectable work was done over the next three to four centuries. There are many different opinions about the causes of this decline, but it is safe to say that most authorities believe a combination of factors contributed to it. The factors include numerous, sustained, and often extremely violent political/military conflicts that took place beginning in the 11th century (the Middle East was, and still is, both a cultural and a military crossroads) and related social and economic issues. Religious considerations played limited roles in some instances and destructive conflicts among Islamic states also took a heavy toll, but other important influences, like invasions from many directions and cultures, had little if anything to do with the Islamic faith itself.

Consequences of Islamic conquests

At the end of the chapter under discussion, Spencer makes an openly ironic (in fact, sarcastic) assertion that two positive legacies of Islam involved the rapid growth of the Ottoman Turkish Empire during the 14th and 15th centuries. Here is a specific quote from page 97:

> These aren't really Islamic "achievements." They are consequences of the violent doctrines of Islam we explored earlier. But in terms of their real effects upon the world at large, they amount to more than a whole stack of Islamic philosophical treatises ...

We shall disregard the extremely harsh and incendiary anti – Islamic rhetoric in this passage, limiting ourselves to commenting upon the two "positive" developments which

Spencer cites and the broad range of causes for them.

Specifically, Spencer connects the Turkish conquest of Constantinople in 1453 with a flight of Byzantine scholars to Western Europe which, in his words (page 97),

> led to the rediscovery of classical philosophy and literature, and to an intellectual and cultural flowering the like of which the world had never seen

and he also claims that "the fall of Constantinople to the Muslims in 1453 closed trade routes to the East," motivating the maritime explorations which led to opening of the Western Hemisphere at the end of the 15th century.

Both assertions are at best highly questionable conclusions based upon partial information. Certainly there was a flight of scholars from the regions ruled by the Byzantine Empire and some other states (for example, the Empire of Trebizond on the southeast coast of the Black Sea) during and after the Turkish conquests, but as Spencer notes this took place over a considerable period of time and for a variety of reasons, some of which directly involved the expansion of the Ottoman Empire and others which did not. Certainly the 15th century collapse of the Byzantine Empire and neighboring Christian states led to a final surge of Greek scholars to the West, but by that time contacts between Greek scholars and Western Europe had developed, and scholars in Western Europe had already assimilated very large portions of Greek and Arabic knowledge; the infusion of Greek scholars at the end of the 15th century served more to improve and fill in knowledge of classical Greek works than to change the course of scholarship. This impact was unquestionably quite positive and also led to significant advances, but these were definitely not revolutionary; certainly the invention of the movable type printing press in 1452 did have such an impact on the spread of knowledge, and evidence would be needed to show that effects of Greek scholar migration at the time were comparable or nearly so. The process of absorbing Greek knowledge began about four centuries earlier, and extensive contacts with Islamic scholars during the intervening time had also played an indispensable, perhaps even dominant, role in the rediscovery of classical writings.

Although the 15th century conquests of the Ottoman Empire inevitably led to some disruptions of overland trade routes to Asia, the author's claim that trade routes were closed is misleading, and his statements on this subject ignore several important and separate developments during the 15th century which were probably even more important. The main effects of the 15th century Turkish conquests on trade routes were significant changes in the competitive positions of the countries which dominated trade routes with the East, with advantages for some and disadvantages for others (in fact, Ottoman control over some major routes was not established until early in the 16th century). The changes adversely affected some — but not all — traders and benefited others.

However, there were also several important developments which disrupted the trade routes but were not related to the end of the Byzantine Empire. During the 14th and 15th centuries the political and economic situation in central Asia deteriorated significantly for a number of reasons, and consequently the overland trade routes to China through this region because increasingly dangerous and unreliable. None of this had much if anything to do with the Ottoman Empire, which was geographically and politically far removed from the troublesome areas in central Asia (mainly the "-stan" countries that were formerly part of the Soviet Union; see the maps on the next page). As we have already noted, it is inaccurate to say that the final Ottoman conquest of Constantinople actually closed the overland trade.

Map of overland trade routes between the West and East

(***Source:*** http://www.silkroadproject.org/Portals/0/images/lg_routes_map.jpg)

Current political map

(***Source:*** http://www.silkroadproject.org/Portals/0/images/lg_PoliticalMap_color.jpg)

In any case, other developments clearly played important roles in the search for maritime routes which led to the opening of the Western Hemisphere. A high level of European activity in maritime exploration was already well established by the middle of the 15th century. In particular, Portugal has succeeded in building maritime routes to Africa which went far beyond earlier limits, reaching increasingly larger portions of the African coast, and culminating with the voyage of Bartolomeu Dias (1451 – 1500) past the southern tip of Africa in 1488 and the voyage of Vasco da Gama (1460 – 1524) to India in 1497 – 1498. The reasons for Portugal's activities involved its national interests and increasing trade with non – Mediterranean Africa, and the growth of the Ottoman Empire at the other end of the Mediterranean was not a decisive factor. In view of the maritime breakthroughs which took place during the 15th century, it is not at all surprising that Christopher Columbus (1451 – 1506) was interested in taking things one step further by searching for a new westward trade route to the Far East that would radically transform commerce between Europe and Asia and challenge the dominance of some powerful Italian city – states like Venice and Genoa. It is ironic that even though he did not succeed in achieving his goal, the impact of his discoveries was far greater than he ever imagined (and it is also very ironic that his argument supporting the 1492 voyage relied heavily on some seriously inaccurate estimates for the circumference of the earth which contradicted the reasonably close value given by Eratosthenes many centuries earlier — in fact, Portugal had previously declined to support Columbus' plans because they did not trust his estimates!).

Final remarks

Given that the original versions of many classical Greek works are lost and our knowledge of them comes from translations into Arabic, the role of Arabic science in preserving classical Greek writings is an obvious, indisputable and extremely important legacy from the Islamic Golden Age. However, there are other major impacts that are equally important. Arabic science was a meeting ground for Greek and Indian mathematics, and its synthesis of ideas from the two cultures led to advances incorporating the best ideas from each of them. In particular, Arabic science made very substantial improvements to many subjects (within mathematics, trigonometry is an especially noteworthy example). Although one cannot point to long lists of breakthrough results in Arabic mathematics which compare to those of the cultures which preceded and followed it, the Arabic mathematical legacy includes the notion of polynomial expressions and the earliest development of decimal – like expansions with no finite stopping points. Furthermore, recent research indicates that numerous findings of mathematicians from the 16th to 18th century had been known centuries earlier to certain Arabic mathematicians, and these scholars also anticipated other developments in European mathematics during that later period. Anticipating future progress is not the same as actually achieving that progress, but it deserves to be recognized.

Finally, one of the most original and far – reaching legacies of Arabic science is its strong emphasis on experimental work and the associated advances in knowledge, without which science as we currently know it — and the related sources of motivation for mathematics during the past millennium — would simply not exist.