The Sociology of Early Modern Science

An Interview with Prof. Toby Huff

Interviewed by: Mohammed Alrushoodi

Introduction

Our guest today is Dr. Toby Huff, a well-known sociologist who works now as a Research Associate, Department of Astronomy at Harvard University and is a chancellor professor emeritus at University of Massachusetts. Dr. Huff's research is often focused on comparative sociology and history of science. His book *The Rise of Early Modern Science: Islam, China and the West* is a masterpiece in investigating why modern science was achieved by the West, but neither by the Chinese nor during the golden age of Islam, when both enjoyed roughly paralleled capacities. Our conversation today will mostly be around the same subject.

Q1: Dr. Huff, welcome to Hekmah Journal. I would like to start our interview with a question we often ask our guests in the same discipline as yours: what made you interested in the sociology of Arabic/Islamic science?

Thank you for this invitation. The late nineteen sixties and early seventies was a period in which American scholars became increasingly interested in comparative and historical studies of other great civilizations. The work of Joseph Needham on *Science and Civilization in China* (1954-2004) was the most influential of such endeavors. He highlighted as never before the issue of why China failed to give birth to modern science, but also the question of its stalled economic and political modernization.

At the same time, there were other outstanding scholars who were interested in these same comparative questions in the context of the history of Arabic-Islamic science and civilization. In some ways, the question of why modern science did not emerge in Islamic civilization was more poignant because it was clearly more scientifically advanced than either China or Europe during Islam's "golden age" from about 850 to the end of the thirteenth century.

My mentor, Benjamin Nelson (d.1977), was very aware of all these developments and encouraged his students to study them. He also embarked on the (re)founding of the *International Society of the Comparative Study of Civilizations* (in 1971) whose existence is now imperiled.

Beyond these influences we must recall the great importance in sociology of the work of Max Weber (1856-1920), who had in fact raised all the critical questions that Joseph Needham and others finally took seriously in the middle of the 20th century; though it must be noted that as a Marxist in his early days, Needham was anti-Weberian.

On the other hand, the most important sociological study in the history of science, Robert Merton's classic, *Science, Technology and Society in the Seventeenth Century England* (originally completed in 1938), had been inspired by some passages in Weber's classic, *The Protestant and the Spirit of Capitalism* (originally published in 1904/5 and first translated into English in 1930 by Talcott Parsons.)

It was in this context that I became interested in the particular problem of what seemed like arrested scientific development in the Islamic world. Here again it was a particular influence flowing from Benjamin Nelson's teachings at the New School for Social Research that got me engaged with this big question. As a medievalist (who later became a sociologist), Nelson knew that there was a great deal of intellectual ferment in the medieval Christian world. It showed itself not only in philosophy and theology, but in scientific inquiries, as well as in legal developments that Nelson was well aware of. In various papers published in the nineteenth sixties, Nelson argued – contrary to the then-common perception— that Christianity had been an essential help to the development of modern science, law and philosophy, and this appeared to be entirely different from the Islamic case. Looking at the problem from a distance, it seemed that whereas Christianity was the bosom within which modern science arose, in the Islamic world, the earlier flowering of scientific inquiry was cut short so that the scientific revolution did not emerge there. It was thought that at least once upon a time, the Islamic context had been favorable to scientific inquiry, but clearly something had gone wrong in the Muslim world. Hence the two contrasting situations offered a unique experimental contrast that I, perhaps naively, decided to take up despite cautions from colleagues at Harvard.

Q2: In your studies, you have been particularly focused on the factors that made the rise of modern science possible in the West and nowhere else. In this field, you have advanced Weber's studies on cultural phenomena that have originated in the West but achieved a "universal significance and value." Previous to this, Needham advanced studies on the Western origins of science in the time of the technological superiority of China, while Nelson's studies of the 12th-13th centuries 'axial breakthrough' in Western Europe brought a somewhat different civilizational approach to the study of scientific breakthroughs. What are your original findings and contributions to this field of studies; and have you revised the perspectives of your intellectual predecessors?

As I indicated earlier, I had become interested in questions about the rise of modern science against the backdrop of the work of Max Weber, Benjamin Nelson, Robert Merton and Joseph Needham. Trying to address the major questions and proposed insights of all of these scholars was a profound challenge. Moreover, unlike many academics of his generation, Nelson was of the opinion that Christian thought had been an aid to the development of modern science, while the long-term development of science in the Middle East suggested that Islamic thought and culture had impeded scientific development.

Despite all of that background, there is no discounting the importance and influence of Joseph Needham's monumental volumes on *Science and Civilization* (amounting to 22 volumes) and which were only completed several years after his death. The concluding volume, 7 #2, appeared in 2004, four years after Needham's death. A significant part of Needham's influence stemmed from his ability to sharply and authoritatively articulate the problem of why did "modern science, as opposed to ancient and medieval science…develop only in the Western world?" (*Grand Titration,*1969). While examining a very broad range of possible factors and carrying out deep probings of the fundamental structures of Chinese philosophy of nature, he provided many insightful and sometimes provocative explanatory ideas. His deeply informed analysis of the Chinese philosophy of nature revealed how differently Chinese thinkers described and attempted to explain the workings of the natural world (for which there was no standard term). Their conceptual categories suggested remarkable patterns as well as alternative limits of change and alteration in the natural world that had been understood by leading philosophers of nature throughout Chinese history. It was in the context of these explorations that Needham discovered that the idea of laws of nature did not exist in Chinese thought. This had major implications for Chinese science and its practice. He showed at the same time how this alternative view of nature was embedded in the Chinese scheme of *yang* and *yin*, "energy" known as *chi'i,* and the five elements (or phases of) nature. These conceptions were still further ensconced in the framework of magic squares and hexagrams, that in the end, Needham saw as an "albatross" greatly impeding scientific progress.

After the appearance of the first three volumes of this master work, and recognizing that both Chinese astronomy and "physics" (which did not properly exist) had been

blocked, Needham's attention, moved increasing away from history of science to the history of technology. Despite this diversion, Needham's daunting intellectual undertaking captured the attention of several generations of historians of science, in effect, deflecting attention away from the historically more promising cultural scene, that of Arabic-Islamic science.

As it turned out, by the late 1960s and early 1970s a new cohort of historians of Arabic-Islamic science was beginning to report its findings suggesting that Arabic science had been more promising than suggested by earlier inquiries as a location for the emergence of modern science. A major reason for that, was the successful translation of the vast body of Greek mathematics and natural science into Arabic, and above all, the translation of Aristotle's nonpareil *Organon*, his vast work of philosophy, logic, and science This gave Middle Eastern scholars a sound new platform on which to launch a scientific research program, clearly setting it apart from the Chinese who lacked the Greek natural science foundations.

In the history of astronomy, many new studies of Muslim astronomers appeared, such as the work of the "Maragha school," but also that of Ibn al-Shatir (d. 1375), though he was not technically part of it. He was a timekeeper who had been working in Damascus in the fourteenth century and produced astronomical models that were in many respects mathematically equivalent to those of Copernicus but they remained entirely geocentric. In brief, there was a near mathematical alignment with Copernican models, but in fact no astronomical revolution is to be found in the work of Ibn al-Shatir, the Maragha school or any other Muslim astronomer because they were not able to make the leap to a heliocentric system embedded in an infinite universe.

On the other hand, there was a revolutionary development in optics that had a profound influence on Europeans and the broader scientific movement. That influence stems from the work of Ibn al-Haytham (d.1040) in optics, though too many commentators have neglected his larger influence. He worked out, in a precise mathematical/geometrical way, the fact that light travels in straight lines. This fundamental assumption was the basis on which Johannes Kepler could explain how lenses work in telescopes. Consequently, Ibn al-Haytham's work was hugely influential in this field of experimental science when it

arrived in Europe. Yet only recently has the larger impact of Ibn al-Haytham's work been adequately appreciated outside specialized circles, thanks to the work of A. I. Sabra and David Lindberg.

In short, even without such detailed knowledge of the work of the "Arab greats," it was easy for me to see that there was a highly significant comparative and civilizational question staring us in the face: why did Arabic-Islamic science fail to produce modern science, given its remarkably high level of discourse during its "golden age"? Furthermore, the work of Weber made it clear that exploring why modern science happened only in the West was a question parallel to that of why modern capitalism arose only in the West. Answering the question of why modern science was a unique development of the West "was the next step," as Weber declared at the end of his study on *The Protestant Ethic and the Spirit of Capitalism*. And since Needham too realized the uniqueness of the Western scientific achievement (but doubting Weber's ideas), it was imperative to take up this question.

I mentioned earlier the influence of the young Robert Merton. I should also note that he published his long-awaited work on the sociology of science in 1973. It was titled, *The Sociology of Science: Empirical and Theoretical Investigations.* I was asked to review it for the *Journal for the Scientific Study of Religion,* which was a formidable task. Although I suggested (JSSR 1975) that Merton's extraordinary work would long remain the most important book on that subject, I noted that over the course of Merton's career he declined to pursue the comparative, historical and civilizational dimensions of his work, opting instead to study "the reward system in science" rather than following his own hints about the "dynamic interplay" between science and society that obviously would be evident if one looked outside North America, Europe and Europe overseas. I suggested that far more attention should be directed in comparative and civilizational directions to philosophical, theological, and legal contexts that served so importantly to shape scientific inquiry, as had been suggested by Nelson and others.

For those reasons, it was Needham's comparative and civilizational orientation that opened important investigative avenues that American sociologists did not take seriously. To the degree that I was able to revise the perspectives of those earlier scholars, I would

point to the following. From a sociological point of view, there were then two approaches to these questions. On the one hand, Merton talked about the emergence of the "ethos of science," that "affectively toned complex of values and norms" that are taken to be binding on the scientist. The other side of this sociological approach looked at the evolution of the *role* of the scientist, which was the position of Joseph Ben-David who hardly acknowledged the importance of Merton's work and mentioned neither Merton nor the ethos of science concept (in his book, *The Scientist's Role in Society*, 1971). Of course, sociologically it makes sense to suggest that institutionalizing the "role of the scientist" was critical for the long-term development of science. The problem is that "the role" is, as Merton pointed out, a multiplicity, not a single thing. That is, the "scientist" (for which there was no English word until the early 19th century—and still none in Arabic), is a composite of a researcher, scholar/teacher, gate-keeper and so on.

Second, Ben-David entirely missed the fact that Europeans had institutionalized a sort of "neutral space" for inquiry (in Ben Nelson's sense) by allowing all sorts of public discussions to be carried on within the universities. The leaders of these discussions were both, highly religious scholars and proto-scientists who were asking the deepest questions about how the world works. Historians of medieval science, especially Lynn Thorndike, Charles Haskins, A. C. Crombie, and Edward Grant among many others, made this assertion very clear. Whereas Ben-David attempted to place the emergence of the role of the scientist in the seventeenth century, medieval and early modern historians of science were moving the inquiry in the opposite direction. This was why Nelson referred to the "axial breakthrough" in the medieval period, but not the much earlier "axial age" highlighted originally by Karl Jaspers.

Before pursuing that thread, let me bring in the insightful ideas of Thomas Kuhn (who died in 1996). His book, *The Structure of Scientific Revolutions* (1962, enlarged edition, 1970), was exceptionally influential in many circles during this period. Kuhn's idea of "paradigms" and "paradigm shifts" was interesting for understanding changes within the modern practice of science, but did not provide access to the comparative history of science. Nevertheless, he very insightfully referred to those "metaphysical commitments without which no man is a scientist," while providing no clue as to what these might be or

how they emerged. I thought this line of inquiry was worth pursuing but only after I had published the first edition of *The Rise of Early Modern Science* ... was I able offer a short answer to that question. This I set forth as a reply to a scholar writing in *Society* magazine in 1994. There I suggested[1] the following:

First, if science is to be pursued in the long run, it has to be believed that nature is a rational order, that is to say, an all-encompassing, coherent, orderly, and predictable domain. Without this axiomatic belief concerning the natural world, we could neither scientifically understand it nor explain it.

Second, scientific reasoning is predicated on the belief that human beings are endowed with reason and have the intellectual capacity to understand the workings of nature. Of course, particular theories may be wrong at any moment in time, but the assumption is that gradually over time nature will yield up its secrets to rational inquiry.

Third, it has to be taken for granted that it is permissible, and even mandatory, for men and women, using their powers of reason, to question all forms of truth claims, including religious, political, ethical, and even science's own claims. This is a very important consideration because it is by no means assured that the intellectual elite of any particular society or civilization will agree that it is permissible for ordinary mortals, especially lay persons—to speak out, to challenge and upset traditional understandings, based on scientific findings, and above all, to disturb revealed truths stated in sacred books. It is not even certain today in many parts of the globe that public information which describes the collective state of well-being (or ill-health) can be publicly viewed or

[1] T. Huff, "A Reply to Gray L. Dorsey," *Society* 32 #5 (1994): 6-7. A Fuller version appeared in "Science and Metaphysics and the Three Religions of the Book," *Intellectual Discourse (A Journal of the Kulliyah (Faculty) of Islamic Revealed Knowledge and Human Science*) International Islamic University Malaysia 8 #2 (2000): 173-198.

discussed without official authorization. In many societies, today all sorts of social statistics, economic results, and public health reports, are classified as state secrets, and cannot be published or discussed without obtaining official permission, or risk criminal sanctions, especially in Asia and the Middle East.

Thus we may say that these *metaphysica*l assumptions are the "commitments without which no man is a scientist." From this point of view, the rise of early modern science concerns the rise and institutionalization of these three enormously empowering principles, the *external* scaffolding that allows for the *internal* working of scientific communities as they push forward the boundaries of science. In saying all this, I hoped to shift the focus of attention away from the more mathematical and technical aspects of scientific inquiry (the internal requirements for the advance of science, such as modes of logic, high levels of mathematical calculation, and the use of experimental techniques), to the humanistic aspects of scientific practice. For, while certain technical and mathematical elements must be available if high levels of scientific inquiry are to be achieved, it is equally important that complimentary philosophical and humanistic assumptions be present (as stated in the paragraphs above), or the mere presence of mathematical and logical techniques will not enable scientific breakthroughs.

In the present context of Arabic-Islamic thought, we can see that virtually all the mathematical and logical elements, borrowed from the Greeks, were available (as I listed in the third edition of my b). What some might say was missing, a conception of experimental methods, was later supplied by Ibn al-Haytham. Yet, even with all those tools and advantages, apart from Ibn al-Haytham's advances in optics, a broad scientific revolution did not occur, above all in astronomy where it was most to be expected. In general, the pursuit of science in the Middle East waned from the 13th century onward due to weak institutionalization.

Given the foregoing account of how I proceeded and reformulated the views of other sociologists and historians of science, I may also say that I was initially put onto this particular path of inquiry by Benjamin Nelson's own concluding thoughts. He had written,

> it is not nearly so important whether in any given science a given people did or did not actually make an advance upon the Greeks in respect to one or

> another discipline - for example, chemistry, optics, and mathematics. The fundamental issue is whether there did occur a comprehensive breakthrough in the moralities of thought and in the logics of decision which open out the possibility of creative advance in the direction of wider universalities of discourse and participation in the confirmation of improved rationales.[2]

Although this proved to be a very good hunch, I found it necessary to reformulate the issues as stated previously above, while also including some of the insights of Kuhn, Merton and Ben-David. Indeed, it had occurred to me that Merton's notion of the "ethos of science," slightly recast, did in fact capture the essence of a very powerful strand of thought deeply embedded in medieval Christian teachings that reflected a still older and deeper set of metaphysical conceptions that had been fashioned by the Greeks, that is, Plato in his *Timaeus*.[3] It was precisely this ancient source of metaphysical thought, claiming that *man and nature* are rational entities, that got embedded in medieval Christian thought and which I articulated earlier on pages 6 and 7. As suggested earlier, those three metaphysical

[2] Benjamin Nelson, "Civilizational Complexes and Intercivilizational Encounters," reprinted in *On the Roads to Modernity. Conscience, Science and Civilizations. Selected Writings by Benjamin Nelson*, edited by Toby E. Huff (Lanham, Maryland: Lexington Books, reprinted 2012) pp. 98-99.

[3] I have spelled out these issues in three separate contexts. See Huff, ibid, "Science and Metaphysics…"; idem., "Some Historical Roots of the Ethos of Science," *Journal of Classical Sociology* 7/2 (2007): 193-210; and *The Rise of Early Modern Science*, 3rd edition, pp. 300-302.

assumptions serve as universal values for all scientists, or otherwise their claims of universal truth cannot prevail. There are still other values of this sort but I must refrain from outlining them here. Let me instead go back to the idea of "axial shifts" and "intellectual breakthroughs."

While Benjamin Nelson was aware of what seemed like a very broad axial shift in European thought of the medieval era, he put a great deal of stress on the idea of making theology into a "science." That idea had also been championed by the French Christian cleric, M.-D. Chenu. Both of these scholars recognized the singular importance of theological discussions for the evolution of Western thought and society. At the same time, they saw this outcome as the workings of Greek philosophy (the arrival of the "new Aristotle") in the universities, transforming Christian thought in the twelfth and thirteenth centuries. The result was the unfettered pursuit of philosophy and natural science (i. e., "natural philosophy").

Here we need to remember that for European scholars, those pursuing the "natural sciences" were known as "natural philosophers" all the way to the time of Newton. Clearly this development did have major implications for Western thought. A case had been made that the study of the "new" Aristotle and natural philosophy was connected to both advancing scientific thought *and* the emergence of "natural theology," a mode of thought based on the assumption that mere mortals have the rational capacity to divine God's meaning and purpose in the world. This was a mode of thought entirely absent in Islamic and Chinese thought. I have not fully answered the important question of the "axial shift" that I will take up in the next section.

Q 3. In your book, you have constantly stated that the foundations of the rise of early modern science (particularly the legal revolution that provided scientific researchers with freedom) were set in the Medieval Ages mainly through the Papal Revolution to separate the church from the state in order to protect the former and submit to the natural law. Are you suggesting that the Renaissance had started in Catholic Italy with no need of a religious reformation like the one that had occurred in Germany (Lutheranism)?

Insofar as the axial shift is concerned, my view is that there was in fact a very broad legal and cultural revolution during this period of time that was far broader than has been recognized by historians of this period. Starting with the arguments of Harold J. Berman (*The Legal Revolution. The Formation of the Western Legal Tradition*, 1983), I accepted the idea that the Papal Revolution had created a radical shift such that the sacred and secular domains became *legally* autonomous domains, though they were all embedded in the same evolving Western Romano-Canonical legal tradition. From a Muslim point of view, this was of course a radical departure because the shari'a was assumed to be all encompassing with no "zones of legal autonomy" imaginable. In that sense, Europeans did "imagine the impossible" that in effect separated "church and state" by giving rise to legally autonomous entities such as cities and towns, charitable organizations, universities, business enterprises, parliamentary bodies, and so. (This was equally impossible under Chinese law.) All of these entities were "legal fictions" covered by the newly emerging juridical concept of "corporations," or "whole bodies." They were endowed with a buddle of rights, to buy and sell property, to sue and be sued, to establish their own rules and law as well as courts, and in some cases had legal representation before the King's court regarding taxation. Many of the entities could also be called self- governing, and if so, could be assumed to proceed according to the principle of *election by consent*, entailing the idea that "what concerns all should be considered and decided by all," which is another component of *constitutionalism* emerging in this period.

From this revised point of view, one should acknowledge an axial shift, ~~but it was above all~~ structured and enabled by the legal revolution à la Berman, but now seen as far more extensive than even he had claimed. It included the founding of universities with their own zones of neutral space, the unfettered pursuit of science and natural theology and the legal transformation of urban law, royal law, mercantile law, and so on. The effects of these transformations for *economic* activity was very powerful (especially in the context of the rise of modern capitalism), and still remains to be spelled out by legal historians.

Furthermore, and which has been largely overlooked by historians and social scientists as well as many legal historians, there was a major transformation in what we

universally recognize as "due process of law." According to the emerging European legal doctrine (that was articulated by scholars in legal treatises, was established in court cases and articulated in Papal decretals), it was expected that every trial must involve a *plaintiff* and a *defendant, advocates* for those two parties, the appearance of witnesses, the presence of court recorders such as clerks, proctors and notaries, who record the names of those present at the trial, what was said, the documents presented, and so on. This was established legal procedure by the end of the 12th century-- all worked out by legal scholars usually attached to the schools and emerging universities. It was not just worked out as a matter of "customary practice" but was ensconced in major textbooks that were used in the secular and ecclesiastical courts across the continent.

In this context, one has to recognize the significance of the recovery of the Roman Civil Law tradition (11th century) that one could argue triggered off the whole transformation of the Western legal revolution sketched above. In whatever manner one regards all these changes, it is evident that European institutions were transformed, from top to bottom, during this period, roughly 1100 to 1450. There was an axial shift and the result was the creation of the hidden structures of modernity that propelled Europe into ascendance for roughly the next 800 years.

Nothing like this *legal revolution* occurred in the Islamic world during this same period. I do not know of any evidence to suggest that legally autonomous entities existed in the Muslim world, e.g., self-governing cities and towns, independent courts or even professional organizations of doctors and lawyers (among other entities), in this period from 850 to 1350. This is not a question of whether it is true or not that "what is not forbidden by the Shari'a is permissible." The reality is that the concept of a corporate personality, a "corporation" or "whole body" treated as a single entity and with a broad set of legal rights (including self-governance) did not emerge in Islamic law. ("Pious endowments, waqfs, to be discussed below, did not have that kind of legal autonomous.)

The best illustration of this radically different situation in Islamic law in the law of partnerships. It declares that if one partner in a business association dies or withdraws, the partnership ends. In contrast to that, European corporations live forever in law no matter how many "partners" continue in it or withdraw. All such European corporate counterparts

have a measure of self-government and can "legislate" their own rules and regulations, which cannot be done in Islamic law.

It goes without stressing that the Shari'a is composed of the Quran and the hadith collections, and is guided by restricted canons of legal argumentation such as *ijma* and *qiyas*. (though some legists rejected qiyas in favor of more literal interpretation). Accordingly, one cannot "fill in the gaps" (that are missing outside a modern legal system) simply by legal argument. The jurist must show that what he claims is lawful ("the right path") is fully consistent with the Quran and the hadith collections as well as the consensus of the scholars (at least in his school).

This is an entirely different approach than that of European law. For European law (Civil law and Canon law) allowed the creation of all sorts of new "rights," (for example, to have an attorney present); to see and examine authentic bank records, to create legal entities such as Merchant courts, professional associations of doctors and lawyers, and so on. I do not know of any examples of this kind of legal autonomy in early Islamic law.

At the same time, Europeans developed the idea of "natural law" that applies to all peoples, and which transcends Scripture. It can be found through human intellection, thinking and reasoning. Moreover, these newly conceived juridical ideas *became law*. From the 12th century onward the Canonists collected and systematized these legal rulings –created a system of legal *precedents* that came to form the *ordo iudiciarius*, the formal legal process. Nothing like this systematization and formalization of due process occurred in Islamic law during this period. Furthermore, Islamic legal practice was entirely opposed to the idea of creating legal precedents: the legal scholar (mujtahid) acting as a qadi was supposed to issue his own legal ruling while such judicial rulings were not systematically collected.

Q3b: As you stated above, the European legal revolution created a broad range of legally autonomous entities such as universities with the right to create their own rules and regulations, to buy and sell property, etc, and above all, established a relatively neutral cultural and legal space within which to carry on scientific and philosophic inquiry free from political and religious interference. How was this different from the situation in the Muslim world?

As I pointed out in my study, the schools of higher learning in Islam, the madrasas, were "pious endowments." They were based on a specific charter drawn up stipulating its organization, source of funds, administrative head, subjects of study, and so on. Once drawn up, no changes could be made to the madrasa's form or structure. (There was no "board of trustees" that could alter anything, nor was there a formal "faculty.") As pious endowments, they were meant to fully conform to the spirit and letter of the Shari'a. Following that conception, they were designed to preserve and pass on the "religious" or "transmitted sciences." This meant the study of Islamic law and its auxiliary sciences. These included Quranic exegesis, study of the hadith collections as well as Arabic grammar, lexicology, and Arabic genealogy. Astronomy, Greek philosophy and the natural sciences were excluded as being "foreign" or alien sciences. These schools tended to be based on rote memorization.

The most important result of this was that the study of the natural sciences took place entirely privately, through tutoring *outside* the madrasas. Consequently, astronomy and the natural sciences flourished only under royal patronage. Scholars like al-Farabi, Ibn Sina, and Ibn al-Nasir are examples of this. At the same time some physicians who were self-supporting were significant contributors to the spread of Greek natural philosophy in the Muslim world and did make some advances, such as Ibn al-Nafis and Ibn al-Quff. And, as discussed earlier, the most revolutionary advance was that of by Ibn al-Haytham in optics. Whereas his work greatly influenced and stimulated Europeans, progress in optics in the Muslim world dissipated after his death, having no students.

Similarly, and as noted earlier, al-Shatir's work in astronomy was technically innovative, but it was not revolutionary because it remained with the confines of the earth-centered universe. In addition, since the pursuit of astronomy fell outside the madrasas, al-Shatir the time-keeper (*muwaqqit*) had no followers. The limits set for the pursuit of science were mainly set by the narrow conception of the madrasas as conceived by the religious scholars, the ulama, who remained skeptical and generally unsupportive of the natural sciences.

As brilliant and original as some of these scholars may have been, they did not have an institutional base for continuous work and in the end, did not generate a "scientific

revolution." Most important of all, they did not win an institutionalized "neutral space" within which future natural scientists could carry on their inquiries. In the meantime, many tradition-minded ulama thought such studies were anti-religious. Even famous observatories that flourished for a time were either allowed to decay or torn down by their opponents.

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Q3c: Now with regard to the Renaissance of the fourteenth and fifteenth centuries: one could argue that this cultural flowering was the delayed response of all this fermentation in European universities and learned circles, further leavened by new Greek materials brought from Byzantium, Spain, or the Middle East. Within the universities, the humanist shift was connected to a program of studies focused on the study of grammar, rhetoric, poetry, history and ethical thought. It hoped to develop in students a sense of eloquence in writing and speaking, along with a sense of ancient humanist ideas. This was not the seedbed of the new interest in philosophy and the natural sciences which had a very different genesis discussed earlier, that came by way of Aristotle's "natural books" and the assimilation of the rationalistic thought of Plato's *Timaeu*s.

The question of religious reform per se and the Reformation is interesting. There was a certain continuity between the methods and questions raised by the humanists and the early reformers giving birth to the Reformation. What I have argued, however, is not that there was "no need" for a reformation, but that the "ethos of science" had already been developed in

the universities earlier, for example, before 1650. That ethos of disinterested inquiry was instilled in university students across Western Europe with the result that we can make up lists of contributors to the scientific revolution (and their innovations) that were either born in or lived in a broad range of European countries. These included scholars in Italy, France, England, Denmark, Germany, the Netherlands, Poland and so on (see Table 10.1 of my third edition.)

Given that background, and the broad range of scientific discoveries made long before the emergence of the Royal Society of London (1661), it is clear that the scientific

movement was spread all across Europe and was not in its early phases indebted to Protestantism. Later on, however, there is evidence to suggest that young scholars in Protestant countries had a greater inclination to study the natural sciences than law, philosophy and the humanities. At the same time, it is perfectly acceptable to suggest that in the seventeenth century in England, a "puritan spur" to scientific inquiry did manifest itself as Merton suggested. But the foundations of early modern science had already been sown.

Q4: In your book, you said that empiricism had often been attributed to the Renaissance while disregarding the contours of empirical logic set by Arabic scientists such as Ibn al-Haytham. Could you elaborate on that? Were the empirical methods of any difference than the ones done in the West?

From the time when British and American historians of science began looking at the possible contributions of writers in Arabic to our understanding of empirical and scientific methods, they referred to the work of Ibn Sina and other physicians, as well the more advanced techniques of astronomers and opticians who were able to carry out something close to actual experiments. As mentioned earlier, it was A.I. Sabra who worked assiduously to assemble all reliable copies of Ibn Al-Haytham's *Optics* and then to translate the most authentic version of it. It was really as a result of all that work and Sabra's subsequent translations that we came to know how well al-Haytham understood the *camera obscura* and experimental methods. Still earlier scholars such as Bernard Goldstein (and George Saliba) wrote about the uses of theory and observation in medieval astronomy and thought that some middle eastern scholars saw a parallel between astronomical observation and other kinds of scientific inquiry.

While we can say that some Middle Eastern physicians and opticians did use various experimental techniques (giving patients placebos, using various psychological stimuli, etc), the case of astronomical observation and al-Shatir's role is more problematic. For sure, when working with Ptolemy's data, Arab-Muslim astronomers could make

predictions about where stars and planets should appear. But as far as collecting new observations, the historical record does not support such a general process. The great astronomers such as al-Tusi, Ibn al-Shatir and others were all working with *models* of how the stars and planets should appear, given certain geometric assumptions formulated by Ptolemy, along with his data. They might attempt to use local observations of the sun to modify a particular planetary model, but did not attempt to build a whole new system based on the existing Ptolemaic data. Nor did they compile a new data base that could replace that of Ptolemy.

In order to improve on such a data base of existing planetary observations, scholars would have to set up a research program of 30 years (for the planet with the longest cycle, Saturn, or observe just half the cycle, 15 years.) The Maragha observers were unable to fully complete the cycle and failed otherwise to get more precise observations.

As far as historians of astronomy have been able to determine, Ptolemy's tables remained unchanged all the way to Copernicus. Thus, even the much touted Alfonsine Tables "revised" in Spain (ca. 1252), were virtually identical to those of Ptolemy as shown by Owen Gingerich. In effect, the Arab-Muslim astronomers were mainly altering parameters for their models, not collecting extensive new observations. No major collections of new astronomical observations were introduced until the time of Ulug Beg (d.1449) and his team in Samarqand, yet they did not supercede Ptolemy. Consequently, the most exact naked-eye observations were made by Tycho Brahe (d. 1601) in the last quarter of the sixteenth century.

In brief, al-Shatir's work was entirely based on making different mathematical assumptions for the parameters of the planets. He arrived at models of the planets that were concentric, thereby removing the equant (the off-center point of revolution introduced by Ptolemy), and some of his planetary models were identical to those of Copernicus; yet only Copernicus was able to make the necessary additional modifications in order to make the leap to a heliocentric universe.

Copernicus's great innovation was based on "thinking outside the box." Technically, there was a parallelogram device (see p.72, REMS, 3rd ed.) that goes all the way back to the Greeks and which was known to several Muslim astronomers, including al-Qushji

(d.1474) who had worked with the astronomers in Samarqand. This device was used in a work by the outstanding European astronomer, Regiomontanus (d. 1476), whose work was known to Copernicus. The genius of the latter was his ability to see that the orbits of the sun and the earth could be reversed using this geometrical device, and the observational results would be the same. If, so Copernicus reasoned, we can assume that the sun is near the center of our universe and the earth is orbiting it. If we do that, then a variety of puzzling astronomical observations become fully explainable. This included the proportional arrangement of the planets around the sun (based on the periods of their revolutions) along with the elimination of the previously inexplicable puzzle of retrograde motion as the earth overtakes the speed of the permanent stars that appear to "go backwards." That's the short version of the Copernican revolution. Neither Ibn al-Shatir nor his later co-religionists, al-Qushji and Shams al-Din al-Khafri (d.1550), among others, were able to make that leap of the imagination using the same data as Copernicus.

From an external or sociological point of view, the great impediment to scientific advance in the Muslim world was that the formal study of astronomy was never institutionalized in the madrasas, and consequently Ibn al-Shatir's important work was neglected in the Muslim world and remained unknown to the Western world until the 1950s when American historians of science found it and began studying it.

Perhaps a more subtle point is that, when Copernicus initially guessed that the sun might be the center of our universe, he knew that scientific opinion was against him. Consequently, he searched the historical record for ancient scholars who might have believed in the heliocentric orientation of our universe, and he could use their views to support his own innovation. The idea that our universe is earth-centered was equally well entrenched in the Muslim worldview and was buttressed by standard geocentric interpretations of the Quran. Moreover, Muslim scholars as late as the early nineteenth century denied that the earth could move. Given the fact that the madrasas were pious endowments in which the teaching of the natural sciences was prohibited, it is reasonable to assume that Muslim scholars of that era would have been exceeding reluctant to imagine a heliocentric world with the earth circling the sun.

Q5: During history, we had Constantine and the Roman Empire's civilization and the prophet Mohammed and the Arabic civilization. Do you think that there is a correlation between theology and renaissance? If you do, what about the Greek, Chinse and Indian civilizations?

The subject of theology is far more complex than its simple-sounding name suggests. It is my view that theology is a unique Western formation (as suggested earlier) created by the fusion of Greek philosophy and Christian teachings. As the study of the nature and characteristics of God, it begins with assumptions that are unique to the Greek-Christian fusion and was largely foreign to Chinese and Islamic thought. A number of Chinese scholars such as Tu Wei Ming have pointed out that there was no theology in classical Chinese thought, mainly because there was no conception of a unique personal god-head. Furthermore, Chinese thinkers did not develop “dialectics” along the lines of Greek philosophers.

Although there is an Arabic word for theology, *kalam*, the term semantically means “disputation” or “discourse.” The central point is that kalam as a discipline always remained secondary to legal studies (fiqk) and was largely seen as a tool for rebutting those who challenged Islamic orthodoxy. Accordingly, it was not seen as the tool for discovering God’s nature or qualities, but an ancillary activity, inferior to fiqk and legal studies. That stands in marked contrast to medieval Christian scholars who claimed that theology is “the queen of the sciences.” Within the context of Western civilization and Western Christendom, theological discussions were of the greatest significance in forwarding religious and intellectual change. To speak of theology outside that tradition is problematic.

For a deeper understanding of these issues and especially the role of kalam in Islamic thought I can only refer the reader to the classic study by A. I. Sabra, "Science and Philosophy in Medieval Theology: The Evidence of the Fourteenth Century," *Zeitschrift für Geschichte der Arabisch-Islamishen Wissenschaften* 9 (1994):1-42.

Q6: None of the revolutions or phenomena that you consider crucial and decisive for the rise of modern science (legal revolution, intellectual breakthrough, belief in rationality of man and nature, emergence of theology with its dialectical inquiry, universities as autonomous corporations, which provided home for a community of scholars and space for scientific discourse, etc.) took place in the medieval Russia. Russia encountered 'European' science when it was 'imported' in the 18th century; however, since then scientific inquiry has been pursued independently there and Russian science has achieved a remarkable progress, although the cultural framework and institutional context were significantly different than those in the West. Can we regard science that has originated in the West to be a phenomenon with a great 'coefficient of expansion' (in Durkheim-Mauss' terms)? What are the factors and conditions of its successful 'expansion'?

All the missing ingredients listed in the question suggest why Russia played no part in the scientific revolution of the 16th and 17th centuries. Hence, there is a difference between giving birth to modern science in the first place and later attempting to adopt and assimilate the cultural and institutional structures of modern science that made the revolution possible.

The effort to bring the study of the modern sciences to Russia, as the question suggests, began with Peter the Great and resulted in the founding of the Russian Academy of Sciences in 1725. This effort became known as the "Petrine Project." It was designed to transplant the Western scientific enterprise, focused on teaching and research in all the major sciences. Scholars within the Academy were enjoined to prepare textbooks suitable for their students. Each department also contained major Western scholars to make the transfer of scientific knowledge more authentic, complete and up-to-date. Likewise, the Academy established its own journal as early as 1728. Still other young scholars attended Western styled universities in adjacent countries. Not surprisingly, Russian scholars had to invent the discipline of Russian philology in order to update the Russian language and accommodate the new learning.

The subsequent pursuit of modern science in Russia is remarkable in that Russia claimed no outstanding ancient legacy of scientific achievement such as China and the Islamic world did claim. If one were to compare Russian achievements in the nineteenth and twentieth century with those of the Muslim world, China and India, Russian achievements would stand out. The discrepancies between modern Russian scientific achievements and those of China, the Muslim world and India surely represent a major research question for future historians of science and comparative civilizations. How is it that Russian researchers could, in less than a century, surpass the Muslim world and China in scientific inquiry when those civilizations claim long histories of scientific achievement?

In this broad sense, modern science as a cultural and institutional complex does indeed have a propensity to expand and travel to other cultures and civilizations. Some scholars and scientists

have claimed that science as an enterprise is fragile and easily destroyed. Yet the history of science globally does not confirm such a view. Loran Graham, for example, a leading historian of Russian and Soviet science has pointed out how much science and scientists in Soviet Russia were repressed, imprisoned and executed, and yet Soviet science managed to recover and accomplish worthy scientific goals in the twentieth century.

On the other hand, that repression and sometimes brutal treatment of scientists did have a major impact on overall scientific output. For example, it is noticeable how few Nobel prizes Soviet Russian science was awarded in the natural sciences (including medical sciences), in the 20th century. I do not have a definitive list of Nobel Prize winners at hand, but using the various online lists, including Wikipedia (and excluding winners in literature, peace, and economics), I find only 16 winners for Russia with its very large population.

This compares unfavorably to Switzerland's bounty of approximately 20 winners with its small population (about 6 million). On the basis of this ranking, Russia is not yet in the league with Germany, France, U.K. or the United States, though it has a population as large or larger than most of those countries. Moreover, official Soviet reports indicate that the Soviet scientific establishment was larger than all the European countries taken together. It was also one and a half times larger than the Japanese. One GOSPLAN ("State

Committee for Planning") official stated that the average Soviet scientist was four times less productive than the average American scientist.[4] This suggests that Soviet ideology and social conditions were not ideal for engendering scientific inquiry and innovation. (There are but two Muslim Nobel prize winners in science, the Pakistani Abdus Salam and the Egyptian Ahmed Zewail.)

In short, denying scientists complete freedom of inquiry and failing to support them officially and culturally does lead to reductions in scientific achievements. Scientists as a group, with their high levels education and technical achievement can be very mobile which has given rise to the idea of a "brain drain" seen when highly qualified personnel leave one country for another. This happened to Nazi Germany with many scientists escaping to England and the U.S. Likewise, after the collapse of the Soviet Union, chances for emigration emerged enabling many scientists to flee to the West, enriching STEM fields in the US and elsewhere.

As I suggested in question 2, I conclude from a sociological point of view that

there are what can be called cultural and metaphysical assumptions that must be in place if scientific inquiry is to endure and if any particular people is to be able to achieve its full intellectual potential. These include legal and other institutional arrangements that are necessary if scholars are to be empowered to pursue their research long-term, without the impositions of political or religious censors. Such freedom of expression must apply equally to the social, economic, political, and natural sciences if loss of information, both good and bad, is not to be sacrificed to political expediency. Repression of scientists may not entirely eliminate the scientific enterprise in any particular country, but it surely will significantly reduce scientific output and induce scientists to either quit the field or

[4] Loren Graham. *What have We Learned About Science from the Russian Experience*? (Stanford University Press, 1998, p. 89.)

emigrate. In general, however, it must be said, that in our modern world science and its insights are indispensable for modern economies, efficient government, and proper understanding of the environment. Without it, each of those areas are likely to suffer, as will the people concerned.

It thus appears that modern science does have a certain "coefficient of expansion" for the reasons stated. Nevertheless, that expansion is tied to the conditions I referred to in the discussion earlier. The history of the importing of modern science to Russia in the 18th century, as suggested, is an especially interesting case. In more modern times, sociologists and social historians have written about the spread of science around the world, first to European colonies and then beyond. The most recent work along these lines known to me is William E. Burns, *The Scientific Revolution in Global Perspective* (Oxford, 2016), not without flaws. This opening to the comparative analysis of the spread of science was given a significant articulation by George Basalla back in the 1967: "The Spread of Western Science" (*Science* #3775 [5 May]: 611-622).

If we take modern science as a complex embedded within Western civilization, it is a challenge to understand how elements of the scientific enterprise could be transferred to other civilizations – which is distinct from other Western countries, underdeveloped as they may be. For the last four or five hundred years modern science has been almost entirely a product of Western civilization, but the question at this juncture of history is whether or not that civilizational complex can be successfully transferred to other civilizations, to the Muslim world, India, and China. Others might suggest that the center of scientific innovation could shift to Asia or some other non-Western setting. This remains to be seen. Most problematic of all is the future trajectory of scientific achievement in China. Its scientific establishment could become as large or larger than Russia's, but would its productivity and scientific achievements surpass those of Russia?

We can grant that modern science practice has been successfully transferred to Russia and that Russian scientists have many successes to their credit. Yet, as noted, various objectives measures suggest that Russia, despite having a very large scientific-technological establishment and very high levels of funding, and even appearing in the vanguard of modern science in the twentieth century, under performed.

A poignant historical illustration of official Russian repression has been provided by Loren Graham in his short biography of Peter Palchinsky. There Graham pointed out that among other charges against him, Palchinsky was executed in connection with his efforts to establish "an independent and influential profession of engineering." Given the totalitarian conditions that prevailed, the effort "had no chance of success in the Soviet Union controlled by Stalin."[5]

Many outspoken critics of the current regime have been silenced. It remains the case that it is vital for the long-term pursuit of science that legal safeguards establishing legal autonomy for all researchers be put in place. From the twelfth and thirteenth century onward in Europe, the status of legal autonomy was granted to a variety of social, political, charitable and professional groups in Europe. For example, both doctors and lawyers formed legally autonomous associations that allowed them to make their own rules and regulations and these have continued to be honored for centuries. Conversely, Russia seems to be quite different with very weak protections for human rights and freedom of expression. It appears to be consigned to limping along indefinitely, with a flagging economy, without safeguards for human rights and only spasmodic successes in the STEM fields.

Q7: In your book, you mentioned that some scholars, like Vern Bullough's The Development of Medicine as a Profession, ignored the Arabic influence. What are the reasons in your assessment?

It seems most likely to me that in the early nineteen sixties when Vern Bullough wrote his book, not many good sources on Arabic medicine were available in Western languages, especially English. Consequently, at that time, it was difficult to do justice to the Arab

[5] Loren Graham, *The Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union* (Cambridge: Harvard University Press, 1993), pp.105-6.

contributions to medicine. My very brief account of Islamic medical history benefitted from many studies published after Bullough's account had been published.

Q8: In chapter two, you discussed the effect of a printing ban in Islamic societies on the scientific movement. Even though the ban was on the religious texts only and the Mufti allowed printing medical books, for example, so how does the ban affected the scientific movement?

My original discussion of this topic occurred in a chapter on what I called "cultural climates" in which I tried to characterize the many adverse cultural factors impinging on Arabic-Islamic science. One particular social factor that I mentioned was the commitment to make intellectual discourse as open and accessible as possible rather than limiting access and preserving exclusionary elitism. In that regard, it strikes me that historically the advent of the printing press opened up new avenues of communication and hence a form of democratization of inquiry. I spoke of this in the historical context of Judaic and Islamic teachings whose message was that religious and philosophical inquiries should be keep secret, or in any case, shielded from the gaze of the uneducated. This position was articulated by Ibn Rushd in his reply to al-Ghazali.

When Elizabeth Eisenstein published her classic study, *The Printing Press as an Agent of Change: Communication and Cultural Transformation in Early Modern Europe*

(1979, 2 vols.), she made a strong case for believing that the printing press aided the advance of modern science by publishing key works in that revolution, and hence making available to a broader public the new scientific findings. Too many scholars came to believe that the spread of the printing press was a sort of panacea, if not the major catalyst for social and scientific change. There is a significant difference been aiding the spread of new scientific ideas and the social, cultural and intellectual conditions that enabled the revolution in the first place.

Furthermore, it was noted, if only obliquely, that the invention and use of moveable type print technology was a Western invention and that the press had been blocked in

Muslim countries. China, too, had not introduced modern printing until much later, though it had invented block printing as far back as the tenth century.

While I agree that the availability of the modern printing press is a great boon to free communication and open inquiry, it is not as decisive as was once thought because it is other institutions, such as madrasas and universities, that more directly limit or open up free inquiry. Hence, for better or worse, I omitted most of that discussion in the third edition of the book.

Nevertheless, it does seem likely that if printing presses were freely available in the Middle East in the fifteenth and sixteenth centuries, the spread and dissemination of works like Ibn al-Shatir's (which had been lost), would have enabled his contemporaries and succeeding generations to follow up on his important beginnings.

In addition, it is not so clear what is "religious" and what "scientific" when it comes to the content of actual books. For example, Plato's *Timaeus*, a major work in Greek *philosophy*, has troubling implications for a God-centered worldview. Yet it was an exceedingly important book for European medievals because it sketched a whole philosophical-cosmological view of man, nature and our universe that remained part of the Western metaphysical and philosophical orientation ever after. On the other hand, the *Timaeus* was not fully translated into Arabic back in the 9th century, or thereafter. What if it had been printed, in full, in Arabic in 1550? Might it have had a significant impact on the more conservative 'ulama who were then opposed to heliocentrism and other Western theological ideas?

Q9: Al-Ghazali does not think that there is a necessary connection between cause and effect. You said in your book that this "undercut[s] a general belief in the rational powers of human agents". We see some similarities between Al-Ghazali's position and Hume's. Why didn't Hume have "the deep impact" that Al-Ghazali had in the Islamic civilization?

Hume did have a deep impact, one that provoked Immanuel Kant to write his great philosophical work, *The Critique of Pure Reason* (1781), an inquiry that provided a different defense of rational and scientific inquiry.

Second, Hume's philosophical skepticism came nearly a century after Newton's *Mathematical Principles of Natural Philosophy* (1687) in which he demonstrated the connections between celestial and terrestrial bodies, i.e., the universal effects of gravitation. Of course, there were natural scientists who doubted various parts of his theory, but Newton's arguments won the day because there were all sorts of empirical tests that could be and were tried in England and on the Continent by the large body of practicing natural philosophers of the age. In other words, the practice of science had already been institutionalized based on the rationalist principles that had been taught in the universities, deeply indebted to the works of Aristotle and Plato. Seventeenth century scientists, especially British, had conducted a great variety of experiments to show, in laymen's terms, "if you do this, you will get that." For example, light could be generated by producing friction on a spinning glass cylinder that had been vacuum sealed. Francis Hausksbee lit up a whole room in this way in 1706. Temperature and air pressure were shown to be correlated, and so on. However, doubtful causation might appear philosophically, empirical results of many kinds suggested otherwise by seventeenth and eighteenth century natural philosophers.

Q10: Even though many scholars of the history of science seem to think that Al-Ghazali had damaged the scientific movement within Islamic societies, there are many great scholars who came after him such as Ibn al-Nafis, Ibn al-Shatir, Ibn Al-Quff, al-Tusi and so forth. What is your assessment of this?

The damage that al-Ghazali did was to cast doubt on human abilities to discover the structure of the world while suggesting that human beings could only arrive at useless "hypotheses." For him the only sure knowledge was that of faith and religion. This was a good position to take if you wanted to preserve belief in every aspect of the Quran, not a

good position if you had doubts about ninth and tenth century cosmology, geology, and so on. Beyond that, al-Ghazali claimed that to hold certain philosophical points of view was criminal, that legal action could be taken against the accused. So far as we know, this rarely if ever happened, but the psychological effects were such as to make scholars very cautious about what they said and wrote that might offend religious scholars, who had the power to chastise if not formally punish them. This would be equivalent to what in the Western world today is known as "prior restraint:" forbidding certain expressions of opinion before they occur.

Of course, al-Ghazali's worries did not affect all fields of inquiry, especially those forms of medicine that did not challenge traditional or religiously sanctioned points of view. The cases of Ibn al-Nafis and al-Quff are interesting because they did conduct investigations that challenged proper medical inquiry in that they conducted at least partial autopsies, a very impious act. What they actually did remains unclear, but we do know that post-mortem examinations that would in fact enhance our knowledge of the human body, were proscribed in the Muslim world all the way to the second quarter of the twentieth century. Conversely, Europeans routinely conducted such examinations from the thirteenth century onwards.

Q11: In your assessment, to what extent were the Arabic scholars in conflict with the body of ulama in comparison with pre-Copernicus, Christian Europe? Are there any parallels between that era and Al-Ghazali's, for example?

It's is interesting to compare the cultural climates in Europe and the Muslim world in the period from 1200 to 1500. Once we dig below the surface, especially in philosophy, theology, and law, most similarities disappear.

As I have stressed in earlier questions, the European legal revolution of the twelfth Century and later connected to the recovery and transformation of Roman law, greatly altered the European legal and cultural scene, especially in comparison to the Muslim world. A central element in that transformation was the rise of the universities and the

embedding of Aristotelian philosophy in the curriculum. Religious scholars did recognize that Greek philosophy raised questions for Christian belief, but the rationalist outlook that they had already imbibed, blunted conflicts between religion and science.

However, there was one episode in which the bishop of Paris, Steven Tempier, issued a condemnation of certain philosophical assumptions in 1277. His action, however, did not affect all universities and had limited effects at Paris. His list of condemned philosophical propositions was a sort of shopping list of philosophical propositions that the theological faculty were encouraged to avoid. But in the end, after skirting direct confrontations, most scholars continued on with their studies while some were encouraged to sharpen their criticism of weaknesses in Aristotle's thought.

Most important of all is the fact that the teaching of Aristotle's works had been built into the university curriculum, with times and dates specified for their discussion, and this represented the voice of the faculty. Aristotle's naturalistic modes of thought and inquiry had already been widely established.

Given that situation and outlook, it was very different from that of the madrasas in which the prime discipline was Islamic law while Greek natural philosophy in particular was excluded.

Beyond that, there was a general antipathy toward what were known as the "foreign sciences," that is, Greek natural philosophy. This negative view affected the study of astrology and astronomy (the two hardly distinguishable in this era). Consequently, those who cast horoscopes and even the more scientifically oriented astronomers were perceived as verging on impiety. Despite those negative attitudes, we know that there were outstanding students of astronomy and that Muslims pioneered the building of observatories while carrying on their work. The observatories in Maragha, Samarqand and Istanbul were the most notable, yet each was either intentionally destroyed or allowed to completely disintegrate. That was not something that happened in Europe in the period we are discussing.

Q12: You mentioned the role that Al-Shafi'i played in restricting the role of reason. The periods of authorship throughout the Islamic history came after the tyranny had a grip on the state. As a sociologist, don't you think that Islamic scholars, such Al-Shafi'i, were writing their works influenced by the assumption that they were living under a corrupt rule? Don't you think, as a result, that they had expanded the role of fiqh in a certain way where scholars only, excluding the rulers, have the necessary means to maintain more spiritual authority versus the political one?

The idea of a "state" in this context seems problematic to me. If one simply means the rulership of a non-religious person in a defined territory, then the meaning is clear. However, questions about legitimate authority to decide religious and philosophical questions need to be situated in the particular history and cultural context of the Muslim people. Students of that history have pointed out that Muslims did not believe in natural law as Europeans did, but assumed that only God could give mankind laws and appropriate moral guidance. All morality in that view comes from God, not human actors. Furthermore, some Muslim thinkers, even al-Ghazali, insisted that human acts are right or wrong only because God declares them so. The underlying assumption is that human reason or abilities are insufficient to arrive at morally correct behavior. (See the discussion earlier, pp.11f)

Whatever the motivation might have been, the religious scholars just could not contemplate the idea that "secular" actors could be trusted with altering or changing the sacred law, very unlike the European situation where the Church, however reluctantly, did cede the rule of the secular domain to princes and other rulers. All of that resulted in major legal innovation.

By way of contrast, Islamic legal scholars confined themselves to the "roots of law," the sacred sources such as the Quran and the hadith collections and the minimal guidance of consensus (*ijma*), on the one hand, and analogy (*qiyas*) on the other. Al-Shafi'i was bold in working through all the permitted modes of reason and rational justification but in the end felt that "reason" bordering on "personal opinion" (*ra'y*) or "personal preference" (*istihansan*) was too risky to allow in matters as grave as religious destiny and legal responsibility. By and large, political figures traditionally were not empowered to make

such decisions. Though very assertive rulers tried to force their own will in certain situations, such acts did not become part of the shari'a. Al-Shafi'i's position seems consistent with the longer and broader Muslim tradition and its intellectual foundations. As discussed earlier, Islamic legal procedure did not take advantage of the process of collecting precedents that could become operative legal precepts (which would become juridically operative), thereby closing off a path of "innovation."

Q13: Some Middle Eastern scholars have suggested that the Muslim world retained economic superiority compared to the Europe as late as the eighteenth century. What is your assessment of that issue?

Measuring relative levels of economic development has always been an especially risky undertaking. Nevertheless, ingenious economists have arrived at increasingly well-considered comparative estimates. According to the work of these scholars reported in the last ten years or so, it appears that by 1500, the Muslim world had fallen significantly below the levels experienced by leading European nations. Some estimates place GDP per capita of the Muslim world (the Ottomans) at only 60% of the average for Western Europe (i.e., England, Holland, Italy, Poland, Spain).[6] Consequently, the slide down the economic development slope must have occurred considerably earlier.

Moreover, from an institutional point of view (defined by legal structures), Europe was far ahead of the Middle East. This was especially so with regard to the legal structures that facilitated business partnerships, banking and commercial activities. This was also true with regard to "human capital formation" measured by literacy and the level of book printing that clearly do serve as major indicators of human development. Recent *Human Development Reports* put out by the United Nations Human Development project provide even more exact and discouraging comparisons between Europe and Arab countries today.

Jan Luiten Van Luiten, *The Long Road to the Industrial Revolution* (Brill, 2009), p. 271-2.[6]

Economic historians now agree that there was a "commercial revolution" in Europe sometime around 900-1450. Following that there was a "little divergence" of economic ascendance centered on the North Atlantic, especially the cities of London, Antwerp and Amsterdam. This was another indicator of the European economic ascendance that began much earlier than some previous students of the Middle East may have believed.

Q14: Early modern science thrived in the 16th and 17th centuries, during which the Latin language had been collapsing while vernacular languages rising. Nowadays, we see English dominating in almost all scientific disciplines, even in social sciences! From your point of view, how is that going to affect the scientific movement in the long term?

To the degree that scientists and scholars publish in a "universal" language, their findings will be more well-known. At the same time, using such a universal language makes it is easier for both submitting authors and referees to determine what the current state of thought is on any particular subject. This is all too the good. It will serve to elevate studies in virtually all fields, making sure scholars who otherwise would not be well-informed, would have to improve their knowledge of the particular field in which they work before attempting to publish. It should also serve to more carefully scrutinize working concepts, as scholars whose native language is not English would bring such conceptual issues to the attention of those whose primary language maybe English. Humanistic and literary studies people may wish to publish in a non-English language, and there is nothing wrong with that. But in general, having a larger body of scientists using English as the language of publication will ensure greater understanding and, hopefully, a more vigilant pool of peer reviewers.

Q15: Even though philosophy and metaphysics had a crucial role in the rise of modern science during Middle Ages, philosophy departments nowadays are struggling, if not dying, in favor of engineering, technology departments and so forth.

How will that affect modern science in the future, particularly during our time when science is quite appreciated and respected around the globe? Is metaphysics still as important as then?

Philosophers are always digging into what they see as confused, muddle, or warranted linguistic and conceptual usage. At this stage of scientific and intellectual development, traditional philosophers are perhaps no as crucial as they were centuries ago. Nevertheless, there are many philosophical and conceptual questions that arise with regard to artificial intelligence, the nature of "computer thinking" (if that is what it is), and related questions about what it means to be human. Those questions will not go away and philosophers conversant with the new digital world we live in will be studying all these questions. I expect their thoughts and analyses of the world that engineers and computer scientists have created will be valuable. It is rare, but not unheard of, for those deeply involved in a new "form of life" to understand the larger philosophical implications of such ways of life; consequently, the work of philosophers will be needed in order for us to have an adequate understanding of these new forms of existence. For example, the provocative idea of "singularity" when human and artificial intelligence would merge, surely needs the attention of philosophers and social scientists. Such discussions will not be able to avoid many metaphysical questions that will arise.

Q16: To what extent do you think the contribution of non-Western peoples (Indians, Chinese, Arabs, etc.) to Western academia are enlightening their descendants in the present civilization?

As suggested earlier, the influence of non-Western researchers and thinkers will be able to exert itself mainly through use of Western languages, especially English. For centuries, there have been Western scholars and travelers who have encountered the alternative philosophical and religious points of view of non-Western cultures. Some have even "gone

native" in the sense that they adopted non-Western patterns of living, religion, and, in some ways, became different "personalities."

Perhaps the greatest difficulty of the present situation, arises from the fact that today there are many more literate and well-trained scholars and intellectuals from non-Western societies who carefully follow discussions in mainstream Western publications. This has often resulted in strained discussions in which the interlocutors (from "East" and "West") did not share the same perspectives, methodologies or value commitments. This debate became acute in the 1990s when Prime Minister Lee Kuan Yew of Singapore claimed that there are "Asian Values" which differ from those of the West.

Whenever observers from "the other" culture or society attempts to speak about or characterize another cultural setting, there are risks of skewed perception, incomplete study and misinformation. This is not new, as anthropologists have been engaged in this kind of inquiry for more than a century. But now such encounters of "the other" in professional and other Western publications, face spokespersons from the other worldview who are far more informed and articulate than was the case in the nineteenth fifties and sixties. In other words, "native speakers" now have easy access to mainstream discussions around the world and this does accentuate alternative points of view. Such encounters are likely to become more common.

On the other hand, communications within the natural sciences are less likely to face such disparities of understanding. The challenge will be for non-Western scientists to master the "state of the art" knowledge now existing in the STEM disciplines and then to advance beyond that. Sociologists of science in the Western world, have many times suggested that this or that country was losing its lead in one or another science. I am not an expert in that field of studies, but my impression is that such results have been inconclusive. Still others have forecast that China or some other non-Western country has, or is about to, overtake "the West." Evidence for such a view is still lacking. Nevertheless, we should expect to find at least some breakthroughs in some areas of the natural sciences arising outside the West. In general, I am not aware of scholarly journals in non-Western languages that are considered leading edge or more scientifically advanced than Western journals.