

THE
END
MATTERS

WHAT WAS ISLAMIC IN THE ISLAMIC SCIENTIFIC TRADITION?

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Science is universal. This is not a postulate, but a basic feature which defines scientific knowledge itself. A scientific result, of whatever kind, can only be fully communicable and provable by stringent arguments. But this epistemic universality is not at all separate from the living history of human beings and from institutions. That is to say that this universality is not an immediate given of the consciousness, but rather reveals itself through a lengthy and bold conceptual process. This work organizes itself along the lines of scientific traditions in which human beings and institutions are active. But these people and these institutions arise from a value-based system.

Islam provides a whole set of fundamental values. Among those values, one finds the uniqueness of truth, the lack of contradiction between revelation and reason, and thus between the two types of knowledge that they produce, the equality of human beings *in jure* before the truth and in the search for it, the pursuit of knowledge as a means to strengthen one's faith and as a form of prayer, the obligation to communicate knowledge and not to keep it to oneself, etc.

These values, among others, have without the least doubt pushed forth research and have fostered creation of open scientific communities. Furthermore, these values provide the framework to examine the formation of scientific communities in classical Islam—communities which had multiplicity of backgrounds and religions. This is quite a distinctive feature of these communities when compared to their contemporaries. Also, there are the scientific disciplines brought forth by Islam as a religion: ethno linguistics, lexicography, philology, and other linguistic disciplines which were needed in order to understand the Qur'ān and comment on it, the historic critique of the testimonies to authenticate the Prophetic sayings (*al-*

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ḥadīth), the science of time keeping (*‘ilm al-mīqāt*)—which was a kind of applied astronomy—in order to determine times for prayers and other religious practice.

How can we understand various aspects of the question of decline of the Islamic scientific tradition: when? how? why?

This question is difficult even today. Even though we now know more about some of the scientific traditions of classical Islam, we still do not know them all, and we do not know them completely. It is therefore difficult to approach the question of the decline of something before knowing completely what this thing was. But we can still tread lightly and present some conjectures in this difficult territory.

Let us note first that the decline is not an event—then and there—but a long process which took several centuries. Furthermore, it did not follow the same pace everywhere, nor did it happen in the same manner. Let me explain myself briefly on the question of when, how and why? There was the decline *manu militari* which occurred during the time of the conquest of al-Andalus. This military conquest erased not only scientific activity, but also the scientific heritage, and finished by eliminating all Moorish art and handicraft. Then, if one goes east, the Mongol invasion, even if it did not obliterate science and civilization, it at least dealt it a solid blow. One of the results of this—a result of no mean significance—was the emergence of a new style of composition which in itself constituted an obstacle for creative research. The immense loss of manuscripts following this invasion seems to have reinforced the genre of compendia and encyclopedias in order to save what remained. However, writing compendia and encyclopedias, as well as summaries and commentaries, could only weaken the original research. Yet this research continued to be carried out in most fields, albeit at a slower pace than before.

The Ottoman Empire came later, with its economic system and military organization. Science and research did not seem to have been a high priority for this empire. Finally, the geographical discoveries and the end of the Muslim monopoly in international trade accelerated a certain decline in economic activity, the effects which were soon evident. These events, along with the emergence of new powers—notably Portuguese and Spanish—which did not cease attacking the borders of the Ottoman Empire, further strengthened its domination as well as its feudal and military aspects and increased its indifference to science.

Let us now come to science itself. Sciences like mathematics, optics, mechanics, astronomy and pharmacology had reached a sort of logical

“completion” that was not surpassable without a revolutionary reform. Let me illustrate this with a few examples.

In algebraic geometry, for instance, we have shown that the tradition of al-Khayyām (1048-1131) and of Sharaf al-Dīn al-Ṭūsī (ca.1180) which was at the level of seventeenth century mathematicians like Descartes and Fermat, could not go farther without the invention of an effective and new symbolism. Some later mathematicians were moving toward this innovation, but the decrease in the pace and intensity of research did not allow for this reform to succeed, and it was the privilege of Descartes to come up with it.

Another example is found in number theory. Around 1630, al-Yazdī arrived at the same findings as Descartes and Fermat. But to go farther than that would have required the invention of a new method (the infinite descent) whose discovery was the privilege of Fermat. One can easily give many other examples, but this date, namely 1630, is the one where the sun of the mathematical sciences is setting in the eastern Islamic part of the world, while it is rising up in the Christian West.

It is the combinations of such events, both external and internal to science, in the midst of economic and social decadence, as well as reaching the summit of a certain type of research, which are the causes behind the end of scientific innovation in Islamic civilization. In other words, it was at the moment when one had the direst need for intensifying the research at hand, which was already quite advanced, and when one needed to nurture it with other methods and other languages, that economic and social decadence made Islamic societies turn their back to science.

What is your opinion about the Goldziher thesis (which still exists in various forms) that it was a case of the Orthodoxy versus foreign sciences?

The “thesis” of Goldziher is derived from ideology and is not the result of real historic research. The works of the School of Marāghah in astronomy, of Kamāl al-Dīn al-Fārisī in optics, of al-Kāshī in algebra, of al-Yazdī at the beginning of the seventeenth century and many others show that this all-embracing “thesis” explains nothing. Even if we examine the foundations of philosophy where the “thesis” of Goldziher risks having more impact, we still find that it is nothing. But it is necessary to distinguish between the philosophy of the scholars like Quṭb al-Dīn al-Shīrāzī, Kamāl al-Dīn al-Fārisī, and al-Khafri from that of the philosophers like Mullā Ṣadrā and the Avicennians of the East as well that of the philosopher-theologians like Fakhr al-Dīn al-Rāzī and his successors. To put all these philosophies in the same bag is the surest way to understand nothing in the history of philosophic thought.

Moreover, the most “orthodox” thinkers could perfectly grasp philosophic thought and conceive their own philosophy. I am not referring to Ibn Ḥazm and his book on the various philosophic systems, but to Ibn Taymiyyah, who is well recognized as the representative par excellence of “orthodoxy”. It is enough to carefully read his book *Answer to the Logicians* (*Fī-radd ‘alā al-manṭiqiyyīn*) or his several-volume work *On the Protection against the Opposition of Reason and Transmission* (*Dar’ ta‘arūḍ al-‘aql wa’l-Naql*) to convince oneself of his philosophic competence.

In fact, the murky “thesis” of the German scholar is based on two ideas which, according to me, are highly questionable: the opposition between what he calls “the orthodoxy”, that is, the upholders of the sciences which collectively accept the Revelation as the foundational source, and the sciences common to all people, who thus do not hold among their sources the Revelation. The second idea accepts philosophic thought only in the Hellenistic form and style. Now these two opinions are inaccurate. We find excellent scientists such as the mathematician and theologian Kamāl al-Dīn ibn Yūnus and the professors of the legal School of Baghdad, al-Niẓāmiyyah, among those whom Goldziher classifies among “the orthodox”. Let us remember that those sciences (mathematics, astronomy, etc.) were taught in this school which, according to the criteria of Goldziher, were considered “orthodox”. Moreover, there were two reasons at least that the Hellenistic approach to philosophy stopped finding champions such as al-Fārābī or Ibn Rushd: the development of other strands of philosophy, as those indicated previously, and the victory of several forms of Avicennism. Finally, it was because this Greek style of philosophy confined itself to commentary of Aristotle. It had become the philosophy of professors, as is evident from the example of Ibn Rushd himself and ‘Abd al-Laṭīf al-Baghdādī.

In general, historians of science are beginning to accept a revised version of their estimates of the Islamic scientific tradition, thanks to work done by you and a handful of other historians of science. What do we need to fully integrate the new findings into the main stream academic discourse (such as textbooks)?

Previously, the history of science in Islamic civilization was not integrated into the academic curriculum. There has certainly been progress here and there, but this progress is still insufficient. There are several reasons for it—the prejudices are often very deeply rooted. But there is also a strong ideological tendency to completely dismiss Islamic civilization outside history, in the last analysis, for political reasons. There is also a weakness of research and sometimes insufficient quality of certain works which feed into the discipline. The first requirement is, thus, to create an institute of research

and training in this area. As far as I know, there is nobody in the countries of Islamic civilization doing this. In the West, the only institution which comes a little close to this model is the Centre of History of Sciences and Arabic and Medieval Philosophies in Paris. This Centre, which is a part of the French National Center for Scientific Research, cannot singularly fulfill such a task. It is necessary to give historians the main scientific texts. These texts are in Arabic and need to be published with critical editions, precise translations and solid commentaries. Quality books on the history of the various disciplines are also needed. But above all, it is necessary to banish apologetic works.

From your travels in the Muslim world, do you see any prospects of a new generation of Muslim scholars emerging to reclaim their own heritage and build upon the legacy?

The Islamic world is currently, for obvious reasons, at the worst moment of its history. Formerly imperialism wanted to seize its wealth; today the present imperialism wants to seize the wealth and the human beings at the same time: i.e. their culture and thought. They have to change their own ideas and beliefs. The pressure is so strong that we witness irrational and excessive reactions. So there is a portion of the elite which wants to know nothing of the history of Islamic civilization. There is another group which clings only to a more or less dogmatic interpretation of the religion of the Islamic civilization. The third group, to which you refer, does exist. What is surprising is that this group seeks support in people already scientifically minded, who are often left wing oriented, who understand that there can be no “imported” solutions. This group is gaining strength, despite the current unfavorable circumstances.

A related question: what is the significance of the pre-modern scientific tradition for contemporary science, for both the West and the Muslim world. In other words, other than the historic, is there any real significance of the work of say, Ibn al-Shāṭir; Ibn al-Haytham? What I am trying to say is this: Newton still stands firm and tall in the modern scientific tradition, although many of his ideas and theories have been replaced. But not many would place Ibn al-Haytham, Ibn al-Shāṭir and al-Bīrūnī on a similar pedestal.

It is a truism to say that not only is the political history written by the conquerors, I mean militarily and politically, but so also is the history of science and the history of civilization. Let us imagine for one second that it was India which colonized England and not the other way around. You would have found *Brahmagupta* in a much better position in the annals of the history of mathematics. By using this example, I mean to say that historic objectivity

is the result of a long, meticulous and critical research. Naturally, Newton is in his place because of celestial mechanics and because of the first unification, in history, of mechanics, optics and magnetism, and also because of his mathematical work. On the other hand, because of the ideology of historians, Ibn al-Haytham does not occupy the place which he deserves. To say it briefly and without the slightest thoughtlessness, his place is between Ptolemy and Newton, and at the same level. I think of his reform of the science of Optics and, more generally, of physics, his criticism of the astronomy of Ptolemy, his reform of Statics and his immense mathematical contributions in the same way as that of Newton. His Optics is a part of the science of Geometrical Optics, and all his other works are comparable to the works of his eminent successor. It is to say that the one as much as the other is part of contemporary mathematical sciences, but differently, as far as these sciences integrated the valid results and the methods discovered by them.

For the Muslim world, there are two additional aspects of considerable significance. The first is the cultural history, which includes the scientific aspects of the culture. The second is more pragmatic: it is about the formation of the scientific lexicon, not only of Arabic but also of Persian. There are still many untapped lexical treasures which will be of great benefit if we wish to practice science in their own languages.

The relationship between science and society has become so intertwined with economics, politics, wars and other extra-scientific domains that it seems impossible for any other civilization but the modern western civilization to develop its own matrix and framework of inquiry of nature. In other words, is modern science a universal enterprise or do you think that any alternate metaphysical and ethical framework is possible?

Modern science, as well as sciences of the past, are universal. But as I already said, scientific traditions are cultural, they are national, they are regional. This is apparent in how priorities are determined, as well as in the allocation of resources and investments, in the position of knowledge and the status of scholars in society, in the scientific and technical goals which we try to achieve and, naturally, in the ethical standards of society.

Through your work on the scientific manuscripts of the Islamic civilization, you have demonstrated it to be a wide-spread geographical activity (from Baghdad to Cordoba to Samarkand). What were the channels of communication between scientists? How did science, as a social effort, contribute to the society at large? In other words, what was the relationship between society and applied sciences?

Science was an important dimension of the Islamic city. One aspect was the

time-keeping (*mīqāt*) in the mosques. Astronomy was necessary to view the lunar crescent for religious purposes. It must not be forgotten that each of the large mosques had an astronomer associated with it. This was the case of Ibn al-Shāṭir in Damascus, for example. The mosque also used algebra for the calculation of successions and the inheritances. Many jurists were themselves mathematicians, contrary to Goldziher's claim. This was the case of al-Baghdādī, who wrote the famous book of arithmetic and algebra, *al-Takmilah*. It was also the case of al-Khuza'ī and of many others. The hospital, an institution that spread throughout the Muslim world, used science in its medicine, pharmacology, and other areas. Astronomy and arithmetic were in observatories. It is significant that the impact of the application of sciences in the economic realm occurred only towards the end of the eighteenth century, and the industrial science of the nineteenth century brought about the most powerful changes. But at this moment, the Muslim countries were out of the game. Some, like Egypt and Turkey, tried to rise out of their own slumber, but that is another history.

What is the direction of your future research?

The collected volume on *Science in Islamic Civilization*, of which I had the scientific responsibility, published by *Enciclopedia Italiana*, has just appeared. It is the vastest and most rigorous collection dedicated to this subject. It is a large volume of about one thousand pages of text in double columns. This book, in Italian, is going to be translated into English and into Arabic. I, myself, wrote several chapters of this work. Last year I published the fourth volume of my *Mathématiques infinitésimales du IX^e au XI^e siècle*. This large volume of over a thousand pages deals with the works of Ibn al-Haytham on geometrical transformations and analytical art, as well as similar works by Thābit ibn Qurra and al-Sijzī.

My current research has several foci. First of all, I am working on the fifth volume of *Mathématiques infinitésimales du IX^e au XI^e siècle*, where I deal with spherical geometry as well as with the astronomy of Ibn al-Haytham. With this volume, the reader will have in hand the majority of the mathematical and astronomical work of Ibn al-Haytham, with translation, analysis and commentary.

Secondly, I am working on the history of dioptrics, the geometry of the projections, as well as on the theory of conics. It is an English translation of a previously published book, but revised and increased by half, entitled *Dioptrics, Geometry and Applied Mathematics in the 10th Century: Ibn Sahl, al-Qūhī and Ibn al-Haytham*. I am revising the English translation.

The third direction of my work concerns the philosophy of mathematics in classical Islam, which is a very rich discipline and has remained unnoticed until very recently. These works, with the others in the history of the sciences and the philosophy in the classical Islam, allow us not only to better understand the modes of integration of the Greek science in the Islamic culture, but also the role of science written in Arabic in classical modernity, that is the approximately the period between 1550-1650 AD. It is for this reason that I decided to write about the Arabic translation of the *Conics* of Apollonius, and its impact on the research, as well as on the mathematics of Descartes and Fermat.

This research makes it obvious that, if we ignore the scientific contributions of the Islamic civilization, we shall not understand the development of Greek science itself any more than the classical modernity during the sixteenth and seventeenth centuries. All these works are, however, needed so that this evidence is established.

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