THE SIGNIFICANCE OF THE SCIENTIFIC LEGACY
INTRODUCTION TO THE CONFERENCE

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In the vast terrain of the Muslim world there lived people of many races and many creeds; people who - it is said - inherited the cultures and civilizations of the ancients. Across centuries of history, their traditions were passed down to new generations, adding insight and vision to what the Muslim civilization achieved in the arts, in science and in values, as well as to the new spiritual, national and human connections and extensions that civilization caused to take root.

People in the Islamic civilization played an active and distinguished role in shaping history, leaving us a huge well defined legacy of books, monuments, arts and values. MS works written in Arabic form a sizable part of this legacy, covering a wide range of human knowledge in religion, literature and science. This heritage developed and progressed with the passage of time, nurtured by a great nation. Much of it survived, interacting with changing times. Parts became obsolete but were preserved in honour of the past. Other parts came to a standstill when minds went dry and men of learning lost interest in thinking and experimentation. There was no deficiency in the heritage itself, but a kind of atrophy of human energy that stopped the development of this heritage so that it remained frozen in its place, although still the keeper of marvellous inventions, experiences and creations: a store of valuable human achievement.
Muslim science was early based on a defined methodology based on logical enquiry and the search to understand relations of causality; establishing theories or hypotheses to explain repeated phenomena. Serious work in medicine grew out of questions on the nature of a disease, its causes and the reason it responded to certain drugs, the power of each ingredient of a medicine, the rationale for mixing these ingredients or using them separately. Another source of progress was the adoption of an experimental methodology. This we can see summarised in a brief to scientists by Abu 'Abdallāh Zakariyya ibn Muḥammad al-Quzzwini: "If you wish to be sure of (the validity of) your results, you should continue experimenting and beware of slowing down or losing interest. If you fail once or twice, the cause may be because of a missing factor or because a [specific] problem has occurred." 2

'Experimentation' is a topic repeatedly mentioned in medical books and chemists’ manuals, particularly those of the school of Jābir ibn Hayyān. A good representative of this school in its later stages was Muḥammad ibn Maymūn al-Marrākīshī al-Himyari, a chemist from Morocco who took up Ibn Hayyān’s findings and developed them through his experimental work in the Mustansiriyyah and Nizāmiyyah schools in the mid-7th century AH. He, in turn, was followed by al-Jīlākī.

An experimental methodology - questioning, experimentation, proof and verification - was specifically described by al-Ḥasan ibn al-Haytham (d. 430AH/1038AD). In the introduction to his work, al-Shukūk 'alā Baṭlāymūs, 3 he wrote:

"Truth is sought for its own sake. The seeker is interested in nothing except the existence of that which he seeks.

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1 Ibn al-Qīf, 685AH, p 130.
3 al-Ḥasan ibn al-Haytham, al-Shukūk 'alā Baṭlāymūs, pp. 3-6, eds. 'Abd al-Hamīd Ṣabrī and Nābil al-Shihābī, Cairo, (1971).

Finding the truth is difficult and the road to it is rough and truths are submerged in illusions. People generally think well of scientists. If you look at works by scientists and go with a natural tendency merely to understand their reports and their arguments, the truth - for you - will be what they have asserted. But God has not made men of learning infallible, nor has He protected their learning against shortcomings and error. If He had, then scientists could not have disagreed about anything, nor would their opinions have ever differed. And we know that this is not so. The seeker after truth is not he who looks into the works of his predecessors while giving free rein to his natural predisposition to think well of them. The seeker after truth will - on the contrary - suspect his good opinion of his predecessors, he will analyse what he understands of them and will follow only evidence and proof, not the word of any man; for Man is by nature imperfect and prone to error.

The person who looks into scientific works - if his aim is to find out the true facts - has to make of himself the opponent of everything he reads. He has to think carefully about both text and notes, and attempt to attack them from every side. He should also hold his own self suspect and so be scrupulously fair in his dealing with the work. If he follows this path, possible shortcomings and obscurities in the works of his predecessors will become apparent and the facts (for which he searches) will be revealed to him."

Muslim scientists worked freely with scientists of different faiths and races; they established certain traditions and basic methods. No obstacle was to be put in the path of any seeker of knowledge, no information was to be concealed, and no embargo put on researching any topic, because (religion apart) there is no difference or discrimination in science.
This noble humanist tradition started early with the work of pioneering translators, and continued in Islamic science. Ibn Khaldün, writing about his professor and most influential mentor, the distinguished thinker Muḥammad ibn Ibrāhīm al-Abīlī al-Tīmīsānī, who was the leading authority on taʿlīm science (i.e., arithmetic, geometry, music and astronomy), mentions that he stayed incognito in Fas (Fez) with the Jewish master of these sciences, Khallūf al-Maghīlī. Ibn Khaldūn studied with the Jewish scientist and mastered all his teacher's arts.

Ibn Khaldūn also reports that his contemporaries depended on an astronomical almanac (zīj) attributed to Ibn Išāq the Tunisian. It was said that his information was based on observation and that a Jew of Sicily - a professional observer and an adept in astronomy and related sciences - used to send him information on the changes and movements of planets.

The Muslims' attitude to science was to attribute it to Man: scientific work is a purely human effort and operates outside the range of the sacred. Dealing with it and exchanging it is not conditioned by race or faith. It is set within a current of thought continuous and indivisible. Gaps of time may occur in its history, but they do not separate thoughts, or isolate a maxim or formula from its explanations or applications.

Our most important works of reference on the history of science and biographies of scientists include representatives of all races: Ibn Juljul's Tabaqāt al-Aṭibā' wa al-Ḥukamā (Classes of Physicians and Philosophers), al-Qīfī's Tabaqāt al-Ḥukamā (Classes of Philosophers), and Ibn abī Ṣayyba'ī's Tabaqāt al-Aṭibā' (Classes of Physicians) are notable in this respect.

The earliest of these works, Ibn Juljul's, starts at the first generation with Hormus (Hermes?), an Ancient Egyptian philosopher, fictitious according to Nallino, then Hormus II, or Oramuz of Babel, to whom were attributed works on art, medicine and philosophy, and then Hormus III, also Egyptian. These three biographical accounts, hazy and confused as they are, and full of myths and conflicting information, nevertheless give the impression that early writers knew that Greek scientists and philosophers were the second generation in the history of science and knowledge in general; that they absorbed the science of the Ancient East from Egypt, Iraq and India, and that the earliest original works were lost or incorporated in the work of the following generation, their original source forgotten and consequently not mentioned.

Ḥunayn ibn Ishaq al-Isbādi, in a history of physicians (and some philosophers who lectured on medicine) mentions a question raised in a debate: "A questioner asked if there was any physician earlier than Hippocrates, for he was the first and all philosophers took from him and learned of him and followed in his footsteps. And the answer came: The matter is not as you imagine, for Hippocrates too depended on the scientists who came before him."³

The contention, so often made in studies of the history of Arabic science, that it is no more than a reflection and an echo of the Greek tradition which forms the basis of Western civilization is far from true or fair. It will take time and effort, studying the material of these sciences and revealing their facts, to change the attitude of scholars and restore Arabic science to its rightful place in history: as the vanguard preparing the way for modern science.

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Early Muslims recognized the plurality of scientific sources and that the Greeks - although the best of their books were early available in Arabic translations - formed only a stage at which scientific concepts converged, crystallized and clarified. Muslim historians classified ancient nations, including the Greeks, according to civilization in a chronological history. They classified the Romans separately from Greeks and Franks (for the concept of the West as covering all such civilizations had not yet been born). Their classification followed the old system published by Šā'īd al-Andalusi where they were entered under the Third Nation.

Al-Jāḥiz classified the Greeks separately from the Roman Byzantines, whose civilization was still actively in power in his age. His recorded evaluation of both civilizations is significant in differentiating clearly between them on grounds of race and culture:

“If the laity realized that the Rūm (Roman Byzantines) have no wisdom (philosophy), rhetoric or far-sightedness, for theirs is the wisdom of the hand, of carving, joinery, painting and sewing, they would exclude them from the ranks of men of letters, and erase them from the record of philosophers or men of learning. The Book of Logic, the Universe and Corruption, and the Book of Metaphysics - among others - are by Aristotle who is no Rūmī. The Almagest on the planets and the stars was written by Ptolemy, who is not a Rūmī. Nor were Euclid or Galen Rūmīs.

These people are from a Nation that has declined but left behind the traces of its intellect; they were all Greek. Their religion is other than that of the Rūm and so is their literature. These were scientists; those others were craftsmen. The Rūm acquired the books of the Greeks because they were close neighbours; they appropriated some

and converted some to their own ways except for what was already too well known of the [Greeks'] books or too famous of their wisdom, so when they were unable to change their titles they claimed that the Greeks were a Roman tribe .... they even claim that our men of learning are followers of theirs and that our philosophers have followed the example of their philosophers and that they are one and the same."

These few general points are all that space will allow here. They are offered simply to remind us of a few facts of which the reader is already well aware, and as a brief introduction summarizing the past to pose the question: why should we explore our scientific heritage today?

It has been remarked that scientific MSS of the Arabic heritage are still out of circulation. They seem to have no place in the swelling current of documentation and preservation activities taking place today. Young researchers are not familiar with their idiom, an idiom removed from what is currently in use in other subjects. They find difficulty in following details and symbols in figures and letters. Methods of making good use of these MSS are not clear to them, nor how to get at the information that is stored within them.

The publication of the correct texts of scientific books started in Europe, possibly in conjunction with the scientific and cultural revival of that world as it laid the foundations for its Renaissance. It sought out resources from various older cultures extant at the time, the most important of which was the Arab culture. Ibn Sīnā’s Qānūn (Rome, 1593) was one of the first works of science published at the time, and the later 2-volume Latin translation was based on the Rome edition. Another early publication (1594) was Euclid’s Elements of Geometry.

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9 Šā'īd al-Andalusi, Tabaqāt al-Umm, p. 30.

In the first half of the twentieth century important texts were published, some in Cairo and some in Hyderabad, but their distribution was limited. The texts were published without introduction, explication, or the analysis and comparison necessary for any positioning in the history of science. This was followed by a successful movement - limited in number though its practitioners were - to identify important specialized texts and to put them forward in editions which attempted to set precedents for a scientific procedure in publishing, applying the methodology used in editing the Greek and Latin heritage. They did their best to make the MSS of science accessible both to specialists and to intellectuals in general.

MSS on medicine have probably been the ones most published. Important work has been done on MSS on numerical sciences which - despite their difficulties - have been edited, translated into European languages and placed in their proper position in the history of science. We mention among these the works of Roshdi Rashed, 'Abd el-Ḥamid Sabra and others. Some texts on astronomy were published in Spain, in what is more or less an extension of the orientalist tradition in which the editing and notes were mainly relevant to the translated text. We can say, however, that the interest in the scientific heritage is still in its beginnings and is being nurtured by mature and admirable efforts.

There is, therefore, a pressing need to ease some major obstacles out of the way of promoting this important section of our MS legacy.

A clear priority is to study closely the experience and problems of editing various branches of the scientific heritage and to make good use of different orientalist experiences and learn the methodologies used by European academies in editing scientific texts in Greek and Latin.

Original Arabic MSS of authorized scientific texts are a good source of assistance, for these are old versions, read, collated, corrected and authorized. Such a MS is considered a reliable

original, commented on by men of learning who verified the accuracy of its content, studied it and taught it to their students.

An example is a good Andalusian copy of Ptolemy’s famous Almagest11, extracted from the library of rare astronomical works collected by Shaykh Muṣṭafa Ṭādī and now kept in the National Library in Tunis (No 7116). It was copied in 478 AH. in Córdoba from an original collated with the copy of Shaykh Abū al-Qāsim al-Munajjim, who had copied it and corrected it from the copy of Abū al-Ḥasan al-Ṣūfī12. It is noted in this version that any colophon, correction or derivation marked with “Jim” was made by al-Ḥajjaj ibn Yūsuf ibn Maṭar13, the translator of the Khalīfah al-Ma’mūn, and what was marked with “Khu’” came from a different original.

Ptolemy’s work was the basic reference on astronomy in the early Islamic world, for it pulled together all that the Greeks had achieved in that science. Its 13 essays put forward the rules (with their detailed proofs) for plotting the positions of the earth and the planets. The translation was by Iṣḥāq ibn Ḥunayn ibn Iṣḥāq al-Mutāabbib14 (d.298AH/910AD) who states in the introduction that every note, correction, explanation, margin etc. was by Thabit ibn Qurra al-Ḥarrānī al-Ṣābi’i (d.288 AH/901AD).

15 An astronomer and mathematician with an interest in philosophy, he was born in Harran and lived in Baghdad where he came under the patronage of the Abbasid Khalif al-Mu’tadid. His works give evidence of his high standing. See al-Fihrist p.295, ‘Uyūn al-Anba’ p.295 and Hukama’ al-Islām p.20.
A look at the detail of this copy reveals - besides its correctness and reliability - that it represents a methodology for producing scientific works which depend on numerical letters in mathematical demonstrations. Works of science that were not verified are pitfalls of mistakes and misinterpretation.

It is this kind of practical approach, which makes use of several different scientific conventions, that is needed to design a new and proper methodology for editing and publishing Arabic scientific books.

Our scientific heritage - scattered in the libraries of the world - needs a new analytical guide. A Union Catalogue needs to be compiled and classified into scientific disciplines, and taking into account all printed, handwritten and private catalogues and giving information on all compendia and versions of each MS. Such a complete survey would place a clear responsibility on the shoulders of Arab research institutes; it would also be a powerful document and incentive to revise unfair opinions and judgements which have - after all - been formed on the basis of very limited material.

We have now lost contact with idioms and terms which our ancestors worked for centuries to establish and define. An example is the book on herbs by Dioscorides which was translated into Arabic during the reign of the Abbasid Khalifa al-Mutawakkil. The work to define its terminology occupied generations of Arab scientists till the time of Ibn Jujul in Andalusia16. Now this heritage with its detailed branches gives us the opportunity to discover our rich stock of terminology, it makes it possible for lexicography to flourish once again, and with it the art of formulating new words to embody contemporary concepts. This task is undertaken by our Academies of Language, and some of them have already done much good work. The epistemological importance of our scientific heritage thus becomes clear - as has been stated by our colleague, Dr İbrâhîm bin Murâd - for what it carries of concepts ready to be revived, and experience worthy of being understood.

Historians of science and specialists are aware of what this legacy can contribute to modern science and have ambitious plans in that regard, but most chroniclers of civilization itself have as yet not noticed the importance of the content of MSS of science to their study. An example is the work of Abu al-Wafâ' al-Bûzjânî17 in al-Manâzil al-Sâbi' in which he includes detailed information on taxation, revenue and salaries of the military; information not to be found anywhere else. Another example is al-Tâṣâ'ir fi Šinâ'at al-Tadbîr by Ibn Zahr al-Ishbîlî, which contains important details of internal conflicts and conspiracies among the rulers in the Murâbît State in the Maghreb18. The book, however, is a medical text, generally not studied for such information. There are many more examples.

One matter remains which needs to be mentioned: it concerns the true relationship between the theoretical aspect of some sound experimental sciences and their practical applications. Examples of these applications have come down to us in the form of historical monuments as well as objects from the lesser arts now preserved in the museums of the world and in private collections. A book I have in mind is Mâ Yahtâj ilâyih al-Šaâ'i min 'IIm al-Handasah, again by Abu al-Wafâ' al-Bûzjânî; the title clearly states the specialization and the targeted reader, and the book was published to demonstrate through example the

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17 An astronomer, mathematician and engineer/architect, born in Bûzjân and lived in Baghdad, his works are distinguished in the history of science (328-388AH/940-998AD), see al-Qufi, Akhbâr al-Ibnûn, p. 188 and al-Sâddî, al-Wâfi bi al-Waṭfîyât, 209/1.
relationship between the obvious theoretical aspect of a science and its (not so obvious) practical applications.

One of the categories we find for science is the 'science of arches in buildings'; a branch of architecture, it "teaches you the circumstances of buildings and the manner of their perfection, building fortified citadels, raising fair mansions and constructing bridges etc. [It teaches] the manner and condition of digging rivers, the technology of canals, the discovery of water sources and the transfer of water from the depths of the earth to its highlands". We know that great construction projects were studied on the basis of science. Plans for them were designed and exhibited and used as blueprints for actual building work. Al-Maqrizi tells us that the architect who built the mosque of Ibn Tulun drew his designs on parchment. Al-Jahiz also says that parchment was used for drawings of buildings and designs of decorations.

All that remains to us of that great civilization, all its achievements, is based on science; a science with sound bases, rules and proofs. Architecture did not depend only on inherited traditions, born in the architect's mind and executed by the builder. Some of the great building projects achieved are truly puzzling and pose numerous questions. The plan, elevations and decorations of the Madrasa of Sultan Hasan in Cairo, for example, must have taken a great deal of work in preparation. There must have been studies involving the function of the building, its site must have been studied to make the best use of its properties. The four madrasas (schools) were arranged with ten storeys each. The entrance was endowed with grandeur of great significance. The wide extending façade was bound with designs of perpendicular dimensions, holding it firmly to the ground. Arches were raised spanning 25 metres over the great iwans (arcades). All this must have needed exact and detailed calculations, based on the theories of geometry in those books that we imagine were only concerned with theory devoid of any possibility of application. It is our fault that we have not explored the relation which doubtless existed between theory and practice.

We should today discuss ways to create a new consciousness of our scientific legacy; ways in which the attention of universities - particularly in the Arab world - can be attracted to it. Perhaps some well endowed organizations could adopt a project of publishing an Arabic periodical, to be run by a group of enterprising and creative scientists. Such a periodical would:

- Publish serious informative studies on important and rare MSS of sound scientific experimental works.
- Publish short texts selected from various sciences, with analyses and diagrams, accompanied by translations and studies.
- Publish catalogues or book lists of scientific books, classified by subject or region, to highlight the geographical scope of cultural contributions.
- Assign a section to discussions and debates on certain problems.
- Publish detailed information on unpublished scientific material, demonstrating its position in the history of science.
- Present models and studies of the methodology of publishing scientific MSS.
- List and review new scientific publications.
- Open its pages to scientific writings in all languages, and to scientists of all nationalities.
- Guarantee continuity to create a new school concerned with our scientific heritage and its history.

19 Tashkubrizi: Mi‘alab al-Sa‘dah wa-Misbah al-Ziyadah, 1/375, Cairo, (1968).
20 al-Maqrizi, al-Maw‘iq wa al-Fithr fi Dhikr al-Khitat wa al-‘Athar, 2/265, Cairo, 1270AH.
Each section of this periodical should be edited by a specialist working on the Arab Islamic heritage.

This would be one way of reviving and making good use of this important heritage and placing it in its true position among the great contributions to human civilization.

CONCEPTUAL TRADITION AND TEXTUAL TRADITION: ARABIC MANUSCRIPTS ON SCIENCE

Roshdi Rashed

Islamic manuscripts have received intensive and renewed interest over the last five decades. During that period, institutes specifically concerned with manuscripts have been established, and collections of manuscripts have been organised and classified. An example is the Iranian Collection. The institutes are both public and private, such as Al-Furqan Islamic Heritage Foundation, which is hosting our meeting today. Yet despite these commendable and important endeavours, the condition of Islamic manuscripts remains bewildering to students and observers alike.

Although the Islamic tradition has the richest and largest manuscript heritage which has been preserved, it has been the least studied, edited or even indexed. This contradiction still prevails in the field of Islamic manuscripts. The road is still long and the trail is rugged. My purpose here, however, is not to investigate the reasons for this contradiction and its continuation. I have only mentioned this state of affairs at the outset to draw attention to the fact that such a contradiction becomes more serious when we look in particular at the tradition of scientific and mathematical manuscripts.

Scientific tradition has not enjoyed the same good fortune as have the traditions of religion and literature. Religious institutes