INTRODUCTION. The Major Breakthrough in Scientific Practice

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THE UNITY OF SCIENCE IN THE ARABIC TRADITION: SCIENCE LOGIC EPISTEMOLOGY AND THEIR INTERACTIONS

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To the memory of my late father Prof. Dr Aziz ur-Rahman who kindled in me a passion for the adventure of science and to my mother, Hilde Rahman, for her brave vision of a world without frontiers.

Shahid Rahman

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Τρανσχριπτιον Σψστεμ οφ τηε Αραβιχ Αλπηαβετ	
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فإذا جُمِعَ يَسيرُ ما نال كل واحدٍ من النّائلينَ الحقَّ منهم، اجْتُمِعَ من ذلك قدْرٌ جَليلٌ.

When, though, the little which each one of them who has acquired the truth is collected, something of great worth is assembled from this.

و ينبغي لنا ألا نستحيي من استحسان الحقِّ، واقتناء الحقِّ، من أين أتى. وإن أتى من الأجناس القاصية عنّا، والأمم المباينة.

We ought not to be ashamed of appreciating the truth and of acquiring it wherever it comes from, even if it comes from races distant and nations different from us.

(Al-Kindī في الفلسفلة اللأولى (*On the First Philosophy*, 1974, pp. 57-58)).

الرِّجالُ أربعة: رَجُلٌ يَدْري و يَدْري أنه يَدْري فسلوه،
و رَجُلٌ يَدْري و لا يَدْري أنه يَدْري فذاكَ ناس فذكِّروه،
و رَجُلٌ لا يَدْري و يَدْري أنه لا يَدْري فذلِكَ مُسْتَرْشِدٌ فعلموه،
و رَجُلٌ لا يَدْري ولا يَدْري أنه لا يَدْري فذلِكَ جاهِلٌ فارفضوه.

There are four kinds of men: men who know and know that they know; ask them.
Men who know and do not know that they know, they are forgetful; remind them.
Men who do not know and know that they do not know, they search for guidance; teach them.
And men who do not know and do not know that they do not know, they are ignorant; shun them.

(Al-Khalīl, in Ibn Qutayba *'Uyun al-Akhbār*, 1986, II, p. 142)

Knowledge was a major issue in science and philosophy in the twentieth century. Its first irruption was in the heated controversy concerning the foundations of mathematics. To justify his rejection of the use of the actual infinite in mathematical reasoning, Brouwer has made the construction of mathematical objects dependent on the knowing subject. This approach was rejected by the mainstream of analytical philosophers who feared a fall into pyschologism. Several years later, the question of the progress of scientific knowledge was put forward in the thirties by the post-positivist philosophers to fill the vacuum in the philosophy of science following the demise of the logical positivism programme. The answers given to these questions have deepened the already existing gap between philosophy and the history and practice of science. While the positivists argued for a spontaneous, steady and continuous growth of scientific knowledge the post-positivists make a strong case for a fundamental discontinuity in the development of science which can only be explained by extrascientific factors. The political, social and cultural environment, the argument goes on, determine both the questions and the terms in which they should be answered. Accordingly, the sociological and historical interpretation involves in fact two kinds of discontinuity which are closely related: the discontinuity of science as such and the discontinuity of the more inclusive political and social context of its development. More precisely it explains the discontinuity of the former by the discontinuity of the latter subordinating in effect the history of science to the wider political and social history. The underlying idea is that each historical and social context generates scientific and philosophical questions of its own. From this point of view

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the question surrounding the nature of knowledge and its development are entirely new topics typical of the twentieth century social context reflecting both the level and the scale of the development of science. To the surprise of modern historians of science and philosophy, the same kind of questions, which would allegedly be new topics specific to the twentieth century concerning the nature of knowledge and its progress, were already raised more than eleven centuries earlier in the context of the Arabic tradition which, as we discuss further on, developed a trans-cultural and trans-national concept of the unity of science (see the contributions of Deborah Black and Jon McGinnis which tackle the issue of the nature of knowledge). The neglect of the Arabic tradition in philosophy of science is a major a gap not only in the development of science but a fundamental flaw in the writing of its history and philosophy caused by the total reduction of epistemology to political and social history of science. How has this period of the history of science and philosophy come to be ignored? In what circumstances were the questions akin to the nature of knowledge raised in the first place? What is the relation between on the one hand the questions of knowledge and its growth and on the other hand the unity of science in the Arabic tradition? The answers to some of these questions are the aim of the present volume, the first of the series Logic, Epistemology and the Unity of Science to be devoted to a so-called non-western tradition. Let us first highlight in a kind of overview some landmarks concerning the *timing* of the emergence of the Arabic tradition and its significance for the history of science.

1. What happened in the ninth century?

Since the beginning of the history of science in the mid-eighteenth century and its firm establishment as an independent discipline in the nineteenth century, the history of science has been largely written by western historians. The views of most historians of the nineteenth century have succeeded in shaping the standard view, still prevailing today, concerning the Arabic tradition. In this respect, the received view's approach was motivated by two main concerns: (i) to recover the lost Greek heritage extant only in the Arabic version, and in the meantime to find out to what extent Arab scientists and philosophers are proved to be capable of correctly understanding sophisticated Greek thought; (ii) to assess the contribution of the Arabic tradition to the development of the so-called western science. The focus on the relation between the Greek and the Arabic traditions reflects the major concern of this approach which consists in examining what has commonly been called the reception of the Greek scientific and philosophical works in the Arab world. While it is true that the Arabic tradition was developed against the background of Greek scientific and philosophical writings — a phenomenon which is similar in this regard to the fact that Greek philosophy had emerged against the background of the achievements of the Babylonian and Egyptian civilisations, the standard approach seems to have gone too far in its assessment of the so-called reception-role of the Arabic tradition. Indeed, according to the received view the Arabic tradition seems to be deprived of any interest of its own. Indeed the impression given is that Greek philosophical doctrines have succeeded not only in overthrowing the Babylonian and Egyptian beliefs, but they continued to dominate throughout the classical Islamic era. It is thus not surprising that the received view came to the conclusion that the importance and the relevance of the Arabic tradition to the history of science lies only in its intermediary role consisting in handing almost intact the Greek works over to the medieval Europeans. It looks as if Greek scientific and philosophical books were brought to the Arabic libraries to save them from an imminent major disaster that could strike the Greek heritage. We have here some kind of paradox: many historians make such kind of definitive judgments by considering only few materials of a tradition which reigned uniquely over the scientific and philosophical scene for up to seven centuries. This paradox is symptomatic of the underlying epistemological approach to the

approach to the history of science which is by its very nature an open system. The assumption is that the study of the Arabic tradition was sufficiently exhausted to the extent that no new findings could have any significant impact on our present state of knowledge concerning the development of knowledge. This long-lasting prevailing view has recently been challenged by a careful study of some important Arabic scientific works. From the mid-twentieth century onwards some historians have set themselves the task of translating important Arabic writings aimed at filling the gap in our understanding of the development of the Arabic tradition. It is in this context that Sabra has challenged the use of what seems to be a neutral term to describe the transmission of Greek scientific and philosophical works. He argues that "Reception" might "connote a passive receiving something being pressed upon the receiver, and this might reinforce the image of Islamic civilisation as a receptacle or repository of Greek learning" (Sabra 1987, p. 225). He stresses that Greek science and philosophy was not thrust upon but rather "invited [as a] guest" by the Arabic Islamic society (ibid., p. 236). Sabra proposes instead "appropriation" to describe the "enormously creative act … the cultural explosion of which the translation of ancient science and philosophy was a major feature" (ibid., pp. 226-228). His argument seems to have little effect on the received view concerning the Greco-Arabic transmission. But some historians such as Willy Hartner and Gotthard Strohmaier have tried to refine their analysis of the periodisation of the development of Arabic science by admitting the existence of a second period during which the Islamic society was more productive and creative than receptive and imitative. The restriction of the application of the Reception concept to the early period of the translation movement can be seen as an important concession to the opponents of the Reception doctrine. But Dimitri Gutas, who precisely devotes a whole book to this question, rejects out of hand this compromise which consists in applying the Reception interpretation to the early period

> One such prevalent misconception [about the development of Arabic science] is that the translation movement went through two major stages, a 'receptive' one, roughly through the time of al Ma'mūn, and a creative one subsequently. Study of the translation complexes, as the example of the Kindī circle complex of the translations shows, invalidates by itself even the very posing of the question in such a way" (Gutas 1998, pp. 149-150).

Besides its passive connotation underlined by Sabra, the misconception induced by "Reception" is that the transmission can be understood as the result of direct cultural exchanges between on the one hand the Greeks, as producers and exporters (Strohmaier actually speaks of providers) of scientific and philosophical theories, and on the other hand the Arabs as users and consumers. Unlike the transmission of science and philosophy to medieval Europe, the Greco-Arabic transmission has taken place in an entirely different climate as Gutas rightly points out (ibid., p. 4). In other words the massive translations from Greek and Arabic into Latin starting from the twelfth century reflect the powerful and profound impact that the flourishing and advanced Arabic-Islamic civilisation has had on the medieval European psyche, where there is no equivalent driving force in the case of the Greco-Arabic transmission since the social and cultural environment in which Greek science and philosophy were developed was extinguished for so many centuries. Does it mean that no driving force can be found behind the translation movement? Is there only one or more than one driving force? And in the latter case, do they have equal influence in the development of Arabic science or do some of them play a much more prominent role than others? We shall see in a moment how Gutas deals with these various questions.

While agreeing wholly with Sabra on the creative nature of the translation movement, he expresses his reservation to the use of "appropriation" to describe the process of the transmission since he finds it a "surreptitiously servile term" (ibid., p. 187). No specific term has been proposed by Gutas since he prefers simply to call it a "creation of early ʿAbbasīd society and its incipient Arabic scientific and philosophical tradition" (ibid.). It looks as if the

language has run short of words since, among the many memorable moments of the history of science, this is the only particular historical moment for which no specific word could be found to mark the unprecedented large-scale scientific activity triggered by what some historians, including Gutas, call the political revolution. It seems thus that the description of the Arabic translation movement is no less problematic than the question of the assessment of the Arabic tradition itself (see Tahiri's introduction to his paper). What did happen in the ninth century is not the recovery of Greek science but the implementation of a new idea of science, where science and the scientist are conceived as institutions and instruments of research and development. Moreover, as we shall see in paragraph two and three of our introduction this new concept of science was first carried out by means of the creation in Bagdad of an institution, namely *the house of wisdom* (*Bayt al-Ḥikma*) and the production of an Arabic scientific literature with a technical vocabulary in a kind of what Gutas calls *a high koiné language* fit for inter and trans-disciplinary work in a way which might be considered to be an analogue to what has been described as the role of *lingua franca* given to formal language by the French Encyclopedists (see Rahman/Symons 2004, pp. 3-16). Both projects, the house of wisdom and the production of an Arabic *koiné* language, provided the instruments with the help of which the notion of the unity of science was implemented within the Arabic tradition.

2. Science awakening and the house of wisdom (*Bayt al-Ḥikma*)

There have been many conquests in history but few had such a direct and decisive impact on the history of science and philosophy as the Arabic conquest. One of its main features is that the expansion of the Arabic-Islamic civilisation and the development of science go hand in hand. The Arabs have not waited for science and philosophy to come to them, we have to bear in mind that the Arabic peninsula did not come under the rule of Alexander the great. They have had instead to go after knowledge. The task was very challenging since they have had to start from scratch. Gutas describes in the following passage how the scale of this ambitious intellectual project has required the unprecedented mobilisation of a huge amount of resources and the energy of an entire nation for more than two centuries.

> The Greco-Arabic translation movement lasted, first of all, well over two centuries; it was no ephemeral phenomenon. Second, it was supported by the entire elite of ʿAbbasid society: caliphs and princes, civil servants and military leaders, merchants and bankers, and scholars and scientists; it was not the pet project of any particular group in the furtherance of their restricted agenda. Third, it was subsidized by an enormous outlay of funds, both public and private; it was no eccentric whim of a Maecenas or the fashionable affectation of a few wealthy patrons seeking to invest in a philanthropic or self-aggrandizing cause. Finally, it was eventually conducted with rigorous scholarly methodology and strict philological exactitude — by the famous 2unain ibn Is1aq and his associates — on the basis of a sustained program that spanned generations and which reflects, in the final analysis, a social attitude and the public culture of early ʿAbbasid society; it was not the result of the haphazard and random research interests of a few eccentric individuals who, in any age or time, might indulge in arcane philological and textual pursuits that in historical terms are proven irrelevant. (ibid., p. 2)

This is modern science in the making. Modernity should be understood here not in the narrow sense which is traditionally associated with the advent of the new physics conceived as a finished product, but in the act of creating, through the close co-operation of the political power and the Arabic-Islamic society, a new and long-lasting dynamic structure. It turns out that the unstoppable growth of the new entity, which has proved to be far more outliving both the political entity which gave it birth in the first place and the social context of its formation, is designed to transform the life of the Arabic-Islamic society and with it the societies of the rest of the world. For the first time in history science becomes a profession. Unlike in the Greek tradition where it is practised by some happy few who have the luxury thanks to their

wealth to enjoy what they regarded as the supreme life by just contemplating nature. Science becomes in the Arabic-Islamic tradition a third institution with growing influence along side with the two extant most powerful institutions: the legal and the political powers. The result of this unprecedented collective hard and enduring work: by the end of the tenth century almost all non-literally and non-historical Greek books that were available were translated in Arabic. Greek science and philosophy has been transformed once and for all by "the magic translator's pen" as is nicely expressed by Gutas.

It should be noted however that the translation movement is not confined to the Greek writings though the latter form the bulk of the works translated, it is a more global and international phenomenon since it concerns all the books that are fit to be translated. There are Arabic versions of books written in other languages such as the Persian, the Sanskrit and possibly the Chinese language.[1] The successful achievement of this monumental enterprise, which can at any moment be interrupted or abort altogether for a variety of reasons, falls nothing short of a great miracle, the assessment of which has not yet begun, since it opens a new era in the history of human thought. The idea of knowledge has been completely reinvented through the systematic survey of all existing scientific writings. By the turn of the eleventh century the translation of Greek works has significantly died down reflecting the advanced level reached by Arabic science. As Gutas put it bluntly "the waning of the Greco-Arabic translation movement can only be seen due to the fact that it had nothing to offer… not in the sense that there were no more secular Greek books to be translated, but in the sense that it had no more books to offer that were relevant to the concerns and demands of the sponsors, scholars and scientists alike" (ibid., p. 152), in other words "the translated works lost their relevance and became part of the history of science" (ibid., p. 153). Consequently there was a shift in demand for more up-to-date research. Gutas further explains the major impact of the rapid spread of the Arabic scientific institution model far beyond the spatiotemporal context that gave it rise in the first place

> Once the Arabic culture forged by early ʿAbbasid society historically established the universality of Greek scientific and philosophical thought, it provided the model for and facilitated the later application of this concept in Greek Byzantium and the Latin West: in Byzantium, both in Lemerle's 'first Byzantine humanism' of the ninth century and in the later renaissance of the Palaeologoi; and in the west, both in what Haskins has called the renaissance of the twelfth century and in the Renaissance proper"(ibid., p. 192).

Contrary to the prevailing view according to which there is only one renaissance in history, Gutas seems to be saying that the Arabic tradition gives rise to a series of renaissances which reaches its climax in the advent of the famous south-western European Renaissance. The Renaissance proper as Gutas would like to call it now, which is recognised by the sociological doctrine as the starting point of the scientific revolution, appears to be then not the first of its kind as it is generally believed but the outcome of previous renaissances which originate in the foundation in Bagdad of the *Bayt al-Ḥikma* or the house of wisdom, the famous scientific institution that gives rise to the development of Arabic science by hosting the first movement of what can be called the translation project and (see below). But what about this crucial period during which the Greco-Arabic transmission took place? Can the ninth century be called a renaissance? Gutas appears to be somewhat hesitant. On the one hand he is inclined to describe it as the "real renaissance in the original sense of the revival of Greek learning" (ibid., p. 154). But on the other hand this "real renaissance" seems to be quite different from the traditional European Renaissance. He rightly points out that the "philological aspect of classical studies, which also has its modern origin in the European Renaissance, was wholly absent in the Arabic counterpart" (ibid., p. 155), for the obvious reason that the translation activity is very selective since it is restricted only to scientific and philosophical writings excluding thus the humanities (such as literary and historical works). As a result of this

methodologically worked out plan, the translation activity virtually ceased, as already mentioned, once its goal was achieved. Because of the advanced level reached by Arabic science in the eleventh century and reflected in the comprehensive philosophical and scientific work of Ibn Sīnā, there was no need to pursue Greek studies, for the "hurricane of Avicenna's philosophy quickly swept such tendencies" (ibid., p 155, see Ardeshir, Bäck and Thom's papers devoted to his encyclopedic thought). The second major difference is that the translation movement, as Gutas's fascinating account demonstrates, is much more than the mere revival of Greek learning. First of all if by revival Gutas means translation then it should be reminded once more that it is not only Greek learning which was revived through the translator's creative imagination but also the learning of other civilisations such as the Persian, Indian and even the Chinese. Second, the real intention of the translation project is not to revive the culture of previous civilisations, a task best left to the indigenous people, but the construction of knowledge according to a long term research programme.

Gutas describes the historical background of the foundation of the *Bayt al-Ḥikma* and its later development as follows

> It was a library, most likely established as a "bureau" under al-Man{ūr, part of the administration modelled on that of the Sasanians. Its primary function was to house both the activity and the results of translations from Persian to Arabic of Sasanian history and culture. As such there were hired translators capable to perform this function as well as book binders for the preservation of books. This was its function in Sasanian times, and it retained it throughout the time of Hārūn ar-Rash d, i.e. the time of the Barmakids [the secretaries of the ealy caliphs]. Under al-Ma'mūn it appears to have gained an additional function related to astronomical and mathematical activities; at least this is what the names[2] associated with the name *Bayt al-Ḥikma* during that period would imply. We have, however, no specific information about what those activities actually were; one would guess research and study only, since the people mentioned SOMETHING WRONG THERE IS NO WERE THEMSELVES?was himself a translator (ibid., p. 58).

In this passage, Gutas wants to make the point, strongly emphasised afterwards, that the Greco-Arabic translation, the subject of his book, is not conducted in the *Bayt al-Ḥikma*.[3] As a result, the whole translation movement during the early ʿAbbāsid era was conducted in two stages. (1) The first wave of translations of Persian heritage undertaken in the *Bayt al-Ḥikma* (conducted under the ruling of al-Man{ūr (754-775)); (2) the Greco-Arabic translation represents the second wave of translations (from the time of al-Mahdī (775-785) onwards). One of the main reasons given by Gutas for denying any role of the *Bayt al-Ḥikma* in the Greco-Arabic translation is that there is no mention of Greek works being stored on its shelves. To back his argument, he quotes 2unayn ibn Is1āq (d. ca. 873) who seems to have been complaining about the "efforts he expended in search of Greek manuscripts and again he never mentions that he looked for them right under his nose in the *Bayt al-Ḥikma* in Bagdad" (p. 59). This might be the case. But 2unayn's complaint might also indicate that Greek works were circulating in the society. Important manuscripts, which existed in a very limited number of copies, are not designed or expected to be stored in a public library. The absence of books from the shelves reflects their relevance to the concerns of society. This may explain why texts of humanities such as Persian, Ethiopian or 2imyarite manuscripts could be found in the *Bayt al-Ḥikma* but not Greek ones due to their scientific nature. By excluding the *Bayt al-Ḥikma* from playing any role in the Greco-Arabic translation, Gutas seems to create a gap between the two translation movements. A gap that he seems to narrow by appealing to the translation culture: "What the *Bayt al-Ḥikma* did do for the Greco-Arabic translation movement, however, is to foster a climate in which it could be both demanded and then

conducted successfully" (p. 59). According to Gutas, two common points can be found between the two translation movements: (1) the obvious point is that they are both part of the translation culture widely prevailing in the region. Gutas reminds us indeed of the existence of "pre-Islamic translations into Pahlavi [the Persian language] of Greek scientific and possibly philosophical works" (p. 25). This explains the fact that the earliest translation of Greek works into Arabic are made not directly from the Greek but through Pahlavi. (2) The heavily involvement of the state apparatus though for entirely different political motivations. Actually, the contrast that Gutas is struggling to make is that the Persian-Arabic translations were temporary and narrower in scope than the Greco-Arabic translations. The first was confined to the political sphere while the second was a social phenomenon. Neither the structure of the *Bayt al-Ḥikma*, as was inherited from the Sasanians, nor state resources could cope with the scale of the second wave of translations. This explains the role of the private sector which seems to be absent or at least very limited in the first wave of the translations. The private sector stepped in to satisfy the growing demand for knowledge expressed by the society.

There is in fact a third point, not political but scientific one, which can indeed intimately link the Greco-Arabic translations to the Persian-Arabic translations and ultimately to the activities of the *Bayt al-Ḥikma*. Despite the little historical information available about the *Bayt al-Ḥikma*, it is known for sure that a number of astronomers and algebraists, such as al-Khwārizmī (d. 850), were employed full time in the *Bayt al-Ḥikma*, in the service of the caliph al-Ma'mūn (813-833). This evidence indicates that the activities undertaken in the *Bayt al-Ḥikma* were not confined to its original task, which consists in translating the Persian heritage, throughout its existence. The nature of such activities seems to be broadened to include research and study which prompt Gutas' suggestion made in the aforementioned passage: "Under al-Ma'mūn it [*Bayt al-Ḥikma*] appears to have gained an additional function related to astronomical and mathematical activities." Research and study guess gains much assurances when we know that *Algebra* was not a Persian translated work but the result of al-Khwārizmī's studies and reflections on the Indian scientific practice. In chapter V (i.e. two chapters later) devoted to Applied and theoretical Knowledge of his book, Gutas describes the circumstances (and the motivation) of the composition of *Algebra* which gives us a more specific idea on the nature of research practised by scientists of the *Bayt al-Ḥikma*

> During early ʿAbbāsid times, however, Islamic law was also developing rapidly and algebra became an essential tool for working out all the intricate details of inheritance laws. Both of these applications are mentioned by Mu1ammad ibn Mūsā al-khwārizmī himself in the introduction to his *Algebra*. Al-Ma'mūn, he says: 'encouraged me to compose a compendious work on algebra, confining it to the fine and important parts of its calculations, such as people constantly require in cases of inheritance, legacies, partition, law-suits, and trade, and in all their dealings with one another where surveying, the digging of canals, geometrical computation, and other objects of various sorts and kinds are concerned.' (ibid., p. 113)

The significance of the *Bayt al-Ḥikma* lies not only in the continuity of scientific research since it paves the way for more translations from both the farther eastern tradition (mainly Indian sources) and the western tradition (Greek sources), but also in setting the pattern of how future scientific activities should be conducted. By contributing to the emergence of a new scientific tradition, the translations and the scientific activities taken place in the *Bayt al-Ḥikma* explain Gutas' insight according to which "the translations movement should be seen [right] from the very beginning as a part of a research processes"[4] whose aim is the construction of knowledge based on the constant interaction between theory and practice as was implemented by the early scientists working in the *Bayt al-Ḥikma*.

The details of such programme were clearly spelled out by the first Arabic philosopher al-Kindī (ca. d. 870)[5], called so because his name was traditionally linked to the introduction of

philosophy to the Islamic world. Its first step should be seeking to acquire it as he insists in his introduction of *On the First Philosophy*.

> The knowledge of the true nature of things includes knowledge of Divinity, knowledge of Unity and knowledge of virtue and a complete knowledge of everything useful, and the way to it; and the distance from anything harmful, with precautions against it. […] Devotion to this precious possession is, therefore, required for possessors of the truth, and we must exert ourselves to the utmost in its pursuit (al-Kindī 1974, p. 59).

The process of translations is the means to get rid of those linguistic elements that might jeopardize the universality of scientific writings, it tends to act as some sort of a filter through which only scientific thoughts are allowed to pass. The result of this process of acquisition is that knowledge becomes accessible to everybody. Because Arabic was the only global language in all walks of life and mainly in science and philosophy, knowledge is promoted to the international level. As a result it is no longer linked to a specific culture but it becomes the property of all humanity.

The second step of the construction of knowledge is to work on its unification in the sense of putting together its various pieces which were collected from the previous civilisations.

> It has been clear to us and to the distinguished philosophers before us who are not our co-linguists, that no man by diligence of his quest has attained the truth, i.e., that which the truth deserves, nor have the philosophers as a whole comprehended it. Rather, each of them has not attained any truth or has attained something small in relation to what the truth deserves. When, though, the little which each one of them who has acquired the truth is *collected* جُمِعَ, *something of great worth is assembled from this* اجْتُمِعَ من ذلكَ شيء له قدرٌ جليلٌ. […] Indeed this has been assembled only in preceding past ages, age after age, until this our time, accompanied by intensive researches, necessary perseverance and love of toil in that (our emphasis, al-Kindī 1974, p. 57).

The second step announces the following one which consists in building upon the achievements of previous civilisations. Al-Kindī tells us more precisely afterwards how the body of knowledge can be increased.

> In the time of one man — even if his life span is extended, his research intensive, his speculation subtle and he is fond of perseverance — it is not possible to assemble as much as has been assembled, by similar efforts, — of intense research, subtle speculation and fondness of perseverance — over a period of time many times as long. […] It is well for us — being zealous for the perfection of our species, since the truth is to be found in this — to adhere in this book of ours to our practice in all composition of presenting the ancients' complete statement on this subject according to *the more direct way and facile manner* على أقصد سبله و أسهلها سلوكاً to be followed for those who take it; and completing that which they did not say completely, و تَتْميمِ ما لم يقولوا فيه قولا تاما by following the custom of the language and contemporary usage, and insofar as is possible for us. (This) in spite of the disadvantage affecting us in this of being restrained from going into an extended discussion necessary to solve difficult, ambiguous problems (our emphasis, ibid., pp. 57-58).

The third step amounts then to seeking the progress of knowledge and to facilitating its learning for younger generations and its transmission to future civilisations since it is conceived not as a finished product but as an ongoing process. As a result knowledge needs to be continually and constantly worked out and perfected by correcting and improving the inevitable shortcomings inherent to the achievements of previous civilisations for which they should not of course be blamed.

> *Our most necessary duty is not to blame* و من أوجب الحقّ ألا نذمَّ anyone who is even one of the causes of even small and meagre benefits to us; how then shall we treat those who are responsible for many causes, of large, real and serious benefits to us? Tough *deficient in some of the truth* قصَّروا عن بعض الحقِّ و إن, they have been our kindred and associates in that they benefited us by the fruits of their thoughts which have become our *ways and instruments* سُبُلا و آلاتٍ leading us to much knowledge of that the real nature of which they fell short of obtaining (our emphasis, ibid., p. 57, Ivry's translation is slightly modified).

According to the Arabic conception of knowledge, there is no such thing as perfect knowledge. This idea is so deeply entrenched in the Arabic-Islamic culture that it is expressed in a variety of ways by many proverbs, one of them is the following: "a man remains knowing as long as he searches for knowledge and continues to study. When he thinks he knows, he has become ignorant لا يَزَالُ المَرْءُ عالِماً ما طلبَ العِلمَ فإذا ظنَّ أنْ قد عَلِمَ فقد جَهلَ."
Gutas is well aware of the fact that "renaissance" is not the appropriate word to describe the translation movement since the passage mentioned above is the only place where he brings it in the context of responding to other scholars. Throughout his whole book, he prefers rather to focus on the man whose vision and sagacity led to the foundation of the first scientific institution in history.

> The crux of the matters seems to lie in al-Man{ūr's creation, after the ʿAbbasid revolution, of a new social configuration in Bagdad through the genial idea of creating a new city. This meant, in essence, granting himself the licence to start everything anew by freeing him from constraints carried over from the previous *status quo* (Gutas 1998, p. 189).

The series of renaissances including the Renaissance proper appears to be then the result of the original creation of the famous house of wisdom from which all sprung.

> In this context, al Man{ūr's adoption of a Sasanian imperial ideology becomes possible and meaningful, as does the establishment of the attendant translation movement. The process once set in motion, proceeded for over two centuries on its own (ibid., p. 191).

These two crucial passages have far reaching implications on the periodisation of science. According to Gutas' analysis, it is the ninth century and not the Renaissance which should be the starting point not only of a series of renaissances but also of the scientific revolution. But he stops short from drawing such a conclusion for obvious epistemological reasons since he warns that his "book is not about Arabic science and philosophy" (ibid., p. 192). The gap left by Gutas' approach between political and social history and the history of science has been precisely bridged by Tahiri's paper which provides the very badly needed epistemological backing for Gutas' underlying thesis since it reaches basically the same conclusion by analysing the history of astronomy. Further analysis of Arabic scientific and philosophical writings will provide further evidence for making the ninth century a landmark in the history of science and philosophy and will indicate how it should be viewed and remembered in the history of science.

3. The Arabic language and the unity of science

Historians of science and philosophy are usually selective in their choice of the kind of questions they seek to answer. One of the remarkable historical facts seldom noticed is that science and philosophy have been developing without interruption since the ninth century as the great French historian Pierre Duhem shows in his monumental *Le Système du Monde*. How can we explain, in the case of astronomy for example, the fact that this scientific discipline has made no progress whatsoever since the second century (and a fortiori for much older scientific disciplines like mathematics)? A particularly tempting answer is given by the recent rising tendency in the history of science: the lack of progress is due to extrascientific factors. According to the sociological interpretation of the history of science which is in fashion nowadays in the humanities, major gaps in the development of science cannot be explained intrinsically but only by appealing to the political, social and cultural context in which science and philosophy are developed. After all, according to this view, science is a social and cultural phenomenon since it is the making of human beings and its development is determined by the social environment in which scientists live and work. That is why the so-called Dark ages, the period during which science made no progress in Europe, has been entirely blamed on the Roman-Christian societies for its failure to generate the kind of

changes badly needed for the development of science. It seems thus that medieval Europe had to wait for the emergence of the Arabic Islamic culture to see the light at the end of the long tunnel. This is at least the conclusion drawn by Gutas' analysis.

> Byzantine society, although Greek-speaking and the direct inheritor of Greek culture, never reached the level of scientific advancement of the early ʿAbbasids and had itself later to translate *from Arabic* ideas that ultimately go back to classical Greece. In such an analysis, the contribution of individuals is also to be put in perspective. Sergius of Reshʿaynā and Boethius, at the two antipodes of Greek cultural spread in the early sixth century, conceived of projects to translate and comment upon philosophy and the sciences as presented in the philosophy of Aristotle – and hence all knowledge, as understood in the Alexandrian scholarship of their age. The conception is to their credit as individuals; that they failed indicated the adverse circumstances of their environment (ibid., pp. 188-189).

Our analysis will show, however, that Gutas' conclusion is only half of the story. The other half is yet to be told. By focusing only on the extrascientific factors, there is the risk to neglect those epistemological and methodological considerations which might have influenced the lack of progress of science. Indeed, Gutas' work *Greek Thought Arabic Culture*, where he describes the political and the social factors that occasioned the translation movement, can be seen as a further support for the sociological interpretation of the history of science. Gutas justifies his approach by the fact that the translation movement as a social phenomenon has been very little investigated while "its significance for Greek and Arabic philology and the history of philosophy and science have been overwhelmingly studied to this day" (ibid., p. 2). He may have some point there but this might lead to overlook the fact that some crucial epistemological points with regard to the significance of the Arabic tradition has been missed out by most historians. Actually, while describing the political and the social context of what he calls the ʿAbbasīd revolution, Gutas' work draws the attention to one of the these important central epistemological points in the development of Arabic science: namely the fundamental role played by the Arabic language in the development of science and philosophy.

> The particular linguistic achievement of the Greco-Arabic translation movement was that it produced an Arabic scientific literature with a technical vocabulary for its concepts, as well as high *koiné* language that was fit to vehicle the intellectual achievements of scholarship in Islamic societies in the past and the common heritage of the Arab world today. […] its significance lies in that it demonstrated for the first time in history that scientific and philosophical thought are international, not bound to a specific language or culture (ibid., p. 192).

This aspect of the contribution of the Arabic tradition to the history of science and philosophy has been ignored or widely underestimated. How could the progress of a major scientific discipline, like mathematics for example, be achieved had not its various parts, scattered for so many centuries from the East to the West, brought together by a unifying language? How could the awakening of science even be imagined if it was still encoded in a language no longer in use? For science to be developed the way it did, it needs the emergence of a nation that should have such an admiration for its language and a passion for knowledge that sets itself the historical mission of collecting, processing and translating all scientific data produced by previous civilisations and making the resulting systematic work worldwide available and easily accessible through the unprecedented spreading and circulation of books. Historically the Arabic language shows indeed for the first time the possibility of the construction of a unified corpus of knowledge able to work as a worldwide vehicle for transmission of scientific and philosophical thoughts from one language and science to another. As mentioned above, the production of an Arabic *koiné* language provided one of the bases of the notion of the unity of science within the Arabic tradition. This might also help to understand why in the Arabic tradition the study of grammar and logic (see the chapter of Cornelia Schöck) — including poetics and rhetoric, was conceived as a kind of integration factor for all other fields on knowledge and science. Moreover, in the Arabic tradition

grammar, poetics and rhetoric were seen as closely linked with what we would call nowadays a normative epistemic logic conceived as an extended organon for the search and transmission of knowledge. Logic and grammar were at the center of the creation of a scientific Arabic *koiné* language with precise epistemic and epistemological aims.

Rashed, one of the first distinguished historians who questions the current periodisation of science in his investigation into the development of mathematics between the ninth and the seventeenth centuries, suggests that what he calls the notion of *differential* is much more adequate in historical scientific studies than the dominant continuity/discontinuity approach, currently widely used in the history of science. Rashed argues that the notion of differential, when applied to the history of mathematics can be used as an instrument in assessing effectively the actual increase of mathematical truths by comparing the state of each mathematical branch (its results, methods and ways of reasoning) at two important times of its evolution (Rashed 1987, p. 360). Indeed this approach cannot only help us to adequately determine the *timing* of the emergence of a new scientific discipline but also to illuminate *how* science is viewed and understood by indicating the underlying motivation of the context of its development. This is the method that underlies the analysis of our introduction. More precisely, we think that Rashed's notion of differential can be fruitfully applied to study the uninterrupted development of science and philosophy since the ninth century in the Arabic tradition by comparing it with the approach of the ancient Greeks. Now, certainly this would involve us in the development of a long an difficult thesis but let us simply highlight very briefly some relevant remarks which we think will be sufficient to suggest the main lines of the analysis which follows of such a comparison.

4. Some remarks in relation to the heritage of the Greek approach to scientific inquiry

In his *Posterior Analytics* Aristotle imposes strict conditions on the definition of *episteme*. Knowledge is produced by a demonstration which, he asserts, "must proceed from premises which are true, primary, immediate, better known than, prior to, and causative of the conclusion" (71b20). It is clear for the Stagirite that the mere use of syllogism cannot produce knowledge since he insists on the fact that "syllogism will be possible without these conditions, but not demonstration; for the result *will not be knowledge*" (our emphasis). This makes it harder for disciplines other than mathematics to reach one day the episteme status since they cannot fulfill the very tough Aristotelian criteria — by the way, the axiomatics of Euclid could not be captured by syllogism. It seems thus that Aristotle actually calls knowledge, is that knowledge displayed in what we call nowadays formal sciences – some interpreters would include here methaphysics. Since by definition this kind of knowledge is of things that cannot be otherwise than they are i.e. a necessary knowledge, Aristotle introduces a sharp distinction between mathematics and empirical sciences. But when it comes to physics for example, Aristotle's task is to give a discursive and systematic explanation of all kinds of change. The problem of physics is according to him to find the "principles of perceptible bodies" (*On Coming-to-be and Passing-away*, 327b7). The main conceptual apparatus that he invents for this purpose is the famous four causes doctrine.

> Now, the causes being four, it is the business of the physicist to know about them all, and if he refers his problems back to all of them, he will assign the 'why' in the way proper to his science (Physics II 7198a).

According to this view, knowledge in physics seems to be quite different from mathematics finding out all the four causes of any natural phenomenon. In his physical theory, he endorses Empedocles' fundamental idea that all substances are made of the four simple elements: earth, water, air and fire. Earth has some privilege in his explanation of motion. Though being made

of the four elements, it is also the natural place of terrestrial objects. As for the supralunar world, the matter from which it is made, that he calls *aither*, is of a completely different order because of the eternal, circular and regular motion of the heavenly bodies.

Aristotle is indisputably the philosopher of antiquity. His conceptual apparatus lays down both what type of questions should be asked and the terms in which they should be answered. This explains why philosophers who followed closely Aristotle's framework contributed little to the development of science. Indeed the great advances in such subjects as mathematics or astronomy are the work of men who were primarily scientists and not philosophers and manage to escape his influence. However, despite important scientific achievements, Aristotle's physical doctrine remains unshaken and the domination of his philosophical system seems to be the last word of the Greek tradition. The Greek heritage is now in the hands of their successors though it seems that the Greeks did not care so much about their legacy as is suggested by the eminent classical scholar G. E. R. Lloyd's perspicuous remark: "there were many [of the ancients] who recognised that civilisation had developed in the past, there were few who imagined that it would or could progress much further in the future" (Lloyd 1972, p. 394). The lack of the idea of scientific progress in Greek culture, which has an impact on their philosophical and scientific approach, explains at least in part why we have to wait until the ninth century for the emergence of their immediate successors. In his comprehensive study, Lloyd sums up the whole ancient Greek approach to scientific inquiry as follows

> Experimental method was only of very limited usefulness on the fundamental problem of physics, the question of the ultimate constituents of matter. Although quite simple experiments would have yielded useful information about the nature of certain compounds, the principal controversy between atomism and the qualitative theory of Aristotle, for example, was not one that could be settled by an appeal to either observations or experiments, since the controversy turned on the question of the type of account that was attempted. […] A more important point is that such experiments as were performed by the Greeks were usually set out with the set purpose of supporting the writer's own theory. The appeal to experiment was an extension of the more usual notion of appealing to evidence: experimentation was a corroborative, far more than heuristic, technique. Tests were conducted to confirm the desired result, and it is only in late antiquity that we find examples where attempts were made to vary the conditions of experiments systematically in order to isolate causal relations. […] Nevertheless the impression that much of the history of early Greek science leaves is one of the dominant roles of abstract argument (Lloyd 1970, pp. 140-141).

A second limitation is the little place given to practice in relation to theory which led to most of the philosophers after Aristotle to dramatically oppose the two activities. Theoretical studies which should be pursued for their own sake are extremely valued at the expense of practical arts which are viewed with disdain. This is true, as Lloyd explains, even for some scientific disciplines like medicine which is expected to be highly regarded for its noble cause.

> Many of the most famous biologists were doctors, who were motivated in their research partly by the desire to improve the treatment of the sick, and sought to apply their knowledge to this end. Yet not even the most famous and successful doctors in antiquity entirely escaped the disdain usually felt for the craftsman. In the Greek scale of values the theorist was always superior to the technologist (Lloyd 1972, p. 395).

It is clear that empirical sciences, and with them theoretical studies, cannot flourish in a cultural context where the role of practical arts in the prosperity and the well-being of the society is heavily undermined by its top elite. Lloyd has rightly identified the huge gap created by the Greek society between theory and practice as one of the main reasons preventing the development of scientific research.

> The institutions where extensive investigations were carried out were rare throughout antiquity. The ancients lack the idea that dominates our own society, that scientific research holds the key to material progress. […] The *raison d'être* of the Lyceum and Museum and of the many minor schools modelled

> on them was not any idea of *usefulness of scientific research*, but the idea of a 'liberal' higher education (our emphasis, ibid.).

The second main reason is the lack of co-operation and of scientific and philosophical exchanges because of the extrascientific motivations underlying the formation of many schools.

> The development of science and mathematics required other factors as well, particularly the idea of co-operation in research. Here both the Pythagoreans and the medical schools (in their very different ways) had important contributions to make. But in neither case was the chief motive for these associations any idea of the value of scientific research for its own sake. Religious and political ties helped to keep the Pythagoreans groups together, and the medical schools were exclusive associations formed from professional motives like a medieval guild or a modern trade union. Moreover the doctors, like the Pythagoreans, were on occasion secretive about their discoveries (ibid., p. 394).

More generally, the production of scientific and philosophical works and the spreading of ideas were greatly hampered by a deeply entrenched cultural tradition practised by many Greek philosophers who, because of their distrust of the written word, confine what they regard as their most important doctrines to oral teachings (ibid., p. 383). A diametrically opposed stance is expressed by al-Jāhiz (d. 868), one of the famous Arabic prolific authors

> Our duty is to do for those who will come after us what our predecessors have done for us. For we found more knowledge[6] than they found, just as those who will come after us will find more knowledge than we did. What is the scientist waiting for to display his knowledge in the open, what prevents the servant of the truth from devoting himself without fear to the task that he was assigned, now that the word has become possible, the times are good, the star of caution and of fear is extinguished, a wind favourable to study is blowing, babble and ignorance are no longer current, eloquence and knowledge are circulating freely in the market? For a man does not find a teacher to train him and an expert to educate him at all times (Al-Jāhiz 1969, I pp. 86-87).

On the methodological and epistemological levels, we find the already mentioned sharp distinction between mathematics and empirical sciences and mainly physics. In his *Almagest*, Ptolemy further widens the already existing gap between mathematics and physics by subordinating the latter to the former, the implication of this methodological decision and of his overall approach to astronomy will be convincingly refuted by Ibn al-Haytham (d. 1041),. The fourth limitation which is proved to have serious repercussions on the development of science is indicated by Ibn al-Haytham. He makes clear that his *al-Shukūk* is motivated first and foremost by epistemological considerations designed to break the deadlock caused by the Greek synthetic approach of exposing scientific theories which represents more an obstacle than an incentive to the progress of science since it closes the door for further theoretical research (for more details see Tahiri's paper).

What these shortcomings indicate is that Greek science and philosophy were developed in the context of Greek culture to a point that no further progress could be made unless deep changes in the approach to scientific practice happened. Any translation movement of Greek works would not be able to overcome these obstacles if the translation project was to be reduced to the only task of recovering and preserving the Greek heritage. The success of the translation project is due to the growing awareness that the scientific inquiry concerning nature as it was understood and practised by the Greeks was not able respond to the new questions and problems raised by this time. This awareness was actually brought to the forefront by a major shift of focus from the heritage of the Greek idea of logos to the Arabic concept of knowledge.

5. Knowledge in the Arabic-Islamic culture

The ʿAbbasīd dynasty[7] (750-1258) certainly gets great credit for making knowledge at the centre of their political strategy by working out and supporting the first ambitious scientific

research project in history which gives rise to the surge of an intensive scientific and cultural activity in Bagdad led by the prestigious institution *Bayt al-Ḥikma*. By learning from the mistakes of the Umayyads' rule[8] (661-750), the ʿAbbāsids succeeded where their predecessors failed. Short of full legal legitimacy, the ingenuity of the house of al-ʿAbbās lies in capturing the imagination of the Arabic-Islamic society by focusing, as we shall see later, on one of the fundamental components of its identity. The ʿAbbāsids' strategy was a resounding success because it was a response to the demand of the society since the quest for knowledge had already begun in earnest. This sets a precedent in the Arabic-Islamic history since knowledge proves to be for the first time the only credible alternative by means of which the political body can effectively justify its rule. As a result of the vulnerability of the political power due to the conditional support of the legal authority, the emerging distinctive political and social configuration is that the body politics finds its rule dependent on its unlimited support for knowledge and not knowledge which should rely on the goodwill of the politicians. This explains the remarkable longevity of their rule which reaches its climax with Hārūn al-Rashīd (786-809) whose legendary name is associated in the West with the famous *Arabian Nights*; but in the Arabic-Islamic conscience, he is remembered as one of the enlightened caliph (al-Rashīd literally means the well-guided) for chairing regular meetings of top intellectuals (jurists and theologians, linguists and grammarians, poets and writers, scientists and philosophers) to discuss hot topical legal, cultural and scientific issues.

But the development of Arabic science was undoubtedly not the work of politicians, it was the result of the unprecedented interactions among the intellectual elite whether they were jurists, grammarians, theologians, poets, scientists or philosophers, and its explanation must ultimately be found in the dynamics of Arabic culture and its specific approach to knowledge underlying the whole translation enterprise summarized by al-Kindī with the following words:

> We ought not to be ashamed of appreciating the truth and of acquiring it wherever it comes from أين أتى و ينبغي لنا ألا نستحييَ من استحسان الحقِّ، و اقتناء الحقِّ، من, even if it comes from races distant and nations different from us. For the seeker of the truth nothing takes precedence over the truth بطالب الحقِّ منَ الحقِّ and there is no disparagement of the truth, nor belittling either of him who speaks it or of him who conveys it. The status of no one is diminished by the truth; rather does the truth ennoble all (our emphasis, al-Kindī 1974, p. 58).

Al-Kindī's passage contains three crucial points which show the intertwining ethical and epistemological dimensions of the translation movement, namely:

> (i) The trans-national and trans-cultural conception of the unity of science
> (ii) Since each society can have some form of truth, the second step in acquiring knowledge, which is the harder task, is in recognising and appreciating it. The question now is how? The answer relates to the confluence of grammar, logic and Law in the translation project — this point is not explicit in this paragraph but it links the first and the third point and has been developed by al-Kindī before (recall the passages quoted in section 2 above).
> (iii) The supremacy of the truth (not authority), the search for which is the driving force behind the progress of knowledge, is the ultimate goal of the scientific inquiry.

In relation to the first point, it is important to see that the search for the unity of science involves a determined ethical perspective: the humility of learning from others and the ability of acknowledging one's own ignorance, and a social dimension: the need for seeking the interaction with other people. The idea of search for knowledge and its ethical and social implications is deeply entrenched in the Arabic-Islamic culture which goes back to the teaching of Islam i.e. to the seventh century.[9] Indeed the Arabic people of the seventh century *knew that they knew* little about the external world, a fact eloquently expressed by the Qur'ān

(sūrat 17, verse 85) "و ما أوتيتم من العلم إلا قليلا (you are given only a little knowledge)." Hence they are not only willing but what is more interesting they are ready to learn from the contributions of the previous civilisations. The Arabic-Islamic society has thus no privilege over other societies since the latter can have something that the former does not have: some form of truth, knowledge, wisdom. The Arabic intellectuals of the ninth century such as al-Kindī and Ibn Qutaybah were just following the same Islamic teaching, that was followed by their predecessors, which makes seeking knowledge a duty for every believer. Ibn Qutaybah (d. 889) explains the rationale behind the search for knowledge

> Knowledge is the stray camel of the believer العلم ضالة المؤمن; it benefits him regardless from where he takes it: it shall not disparage truth should you hear it from polytheists, nor advice should it be derived from those who harbour hatred; shabby clothes do no injustice to a beautiful woman, nor shells to their pearls, nor its origin from dust to pure gold. Whoever disregards taking the good from its place misses an opportunity, and opportunities are transient as the clouds. … Ibn ʿAbbās [the Prophet's uncle] said: "Take wisdom from whoever you hear it, for the non-wise may utter a wise saying and a bull's eye may be hit by a non-sharpshooter" (Ibn Qutaybah 1986, p. 48).

Since the Arabic-Islamic society cannot have the whole truth, it is urged by Islamic teaching to learn from a wide range of different societies by going as far as China.[10] If knowledge fails to come to the Arabic peninsula, its inhabitants have instead the duty to go after it, this is after all one of the main *raisons d'être* of the existence of the human being according to the Islamic doctrine. This is what led Sabra to speak of the translated Greek works in terms of an invited guest which is warmly welcomed by the traditional Arabic culture. Respecting the culture of one's neighbours, no matter how different from the Arabic culture, and getting acquainted with the culture of very distant people appears to be the first step in acquiring knowledge. Acknowledging one's own ignorance amounts in fact to acknowledging the contributions of those people to the formation of the unity of science. Al-Kindī expresses here his deep sense of gratitude to all ancient civilisations on behalf of the newly rising Arabic-Islamic civilisation:

> *It is proper that our gratitude should be great* فينبغي أن يعظم شكرنا to those who have contributed even a little of the truth, let alone to those who have contributed much truth, since they have shared with us the fruits of their thoughts and facilitated for us the true yet hidden inquiries, in that they benefited us by those premises which facilitate our approaches to the truth. If they had not lived, these true principles with which we have been educated towards the conclusions of our hidden inquiries would have not been assembled for us لم يُجْتَمَعْ لنا, even with intense research throughout our time (our emphasis, al-Kindī 1974, p. 57).

In relation to point ii) and iii), it is important to see that the way to acquire knowledge implemented by the translation project is connected with a specific feature of the Arabic notion of knowledge that stems actually from the development of Arabic society before the translation era, namely the role of Law and Grammar. Both disciplines were considered very early as scientific disciplines. They were and are even today the most important scientific disciplines for the Arabic culture because of the vital role they play in organising their social and cultural life. Moreover, as already mentioned in section 2 above, grammar and logic (including poetics and rhetoric) were conceived as the instruments of the scientific programme inherent to the notion of knowledge underlying the translation project. The link of knowledge with Law had the function of putting the scientific programme of knowledge acquisition into practice. The link of knowledge with logic had the function of designing a grammar of superior order able to render a language with the help of which different kinds of knowledge could be expressed and studied. Actually one might argue that this notion of knowledge stems from the use of the word *ʿilm*. Indeed; the Arabic word عِلم or *ʿilm* can mean both science and knowledge and it is remarkably used by the Arabic tradition in a wide sense similar to our usage today and quite different from the Greek meaning of *logos* — if the latter is understood as a theoretical notion of knowledge separated from the notion of practice. It is

Franz Rosenthal (1970) who connected the notion of knowledge of classical Islam, designed to introduce a major transformation in scientific and social practice, with Islam. In his researches, Rosenthal describes first the central position occupied by knowledge in the life of the Islamic society to the extent that he identifies knowledge as the distinctive character of the Islamic civilization:

> *ʿilm* is one of those concepts that have dominated Islam and given Muslim civilization its distinctive shape and complexion. In fact, there is no other concept that has been operative as a determinant of Muslim civilization in all its aspects to the same extent as *ʿilm*. This holds good even for the most powerful among the terms of Muslim religious life such as, for instance, *tawḥīd* "recognition of the oneness of God", *ad-dīn* "the true religion", and many others that are used constantly and emphatically. None of them equals *ʿilm* in depth of meaning and wide incidence of use. There is no branch of Muslim intellectual life, of Muslim religious and political life, and of the daily life of the average Muslim that remained untouched by the all-pervasive attitude toward "knowledge" as something of supreme value for Muslim being (Rosenthal 1970, p. 2).

If the Arabic *ʿilm* can fairly be rendered by the English word "knowledge", however Rosenthal finds that "knowledge" falls short of expressing all the factual and emotional contents of *ʿilm*. His book is designed to explain how Islam has created a knowledge based-society to the extent that he concludes that "Islam is *ʿilm*" (ibid, also chapter V). Rosenthal suggests that the root of *ʿilm* has a strong pragmatical feature that seems to derive from the term عَلَمَ *ʿalama* which means "way signs":

> For the Bedouin, he elaborates, the knowledge of way signs, the characteristic marks in the desert which guided him on his travels and in the execution of his daily tasks, was the most important and immediate knowledge to be acquired. In fact, it was the kind of knowledge on which his life and well-being principally depended (ibid., p. 10).

From this perspective, knowledge, *ʿilm*, is designed to be put to some practical use since it is oriented towards action. More precisely, knowledge can be seen as a mode of action i.e. as a way of acting according to a certain purpose.

Rosenthal's study of the notion of *ʿilm* might also explain the relation between knowledge and الشريعة or *sharīʿa*, i.e. Islamic Law, the prevailing understanding of Islam; and *sharīʿa* means way since it is designed to show how Muslims should behave according to certain rules or principles. This is how Islam has always been understood by the Islamic society. Furthermore since it was the first scientific discipline to be set up, Law is the knowledge par excellence in two respects: (a) Law is knowledge in itself by establishing the principles and rules which guide the action of the individual and the society; (b) and metatheoretically the knowledge of Law is knowledge by indicating the way for the constitution of future scientific disciplines. Indeed by borrowing some of its central methodological elements such as of analogy, Law served as a model for the constitution of Grammar. Furthermore the notion of Law as a normative metatheory of knowledge becomes logic. Significant is that logic; knowledge of knowledge, is also called *ʿilm*. Logic has in classical Islam an epistemic character and an epistemolgical role. Logic is epistemic because it is about the relation between an individual and some proposition(s) and has an epistemological role because it enables us to study all kinds of scientific knowledge. Back to Rosenthal again:

> Logic for the Muslims the 'organ' or 'instrument' (*ālah*), the instrument for logical speculation (*ālah an-nazⵔar*), the instrument for each discipline (*ʿilm*) and the means enabling the student to get its real meaning. It explained, and stood for, every one of the disciplines of knowledge. […] It was the science of scales (*ʿilm al-mīzān*), weighing the correctness of every statement. It compared to 'an equilibrating standard' (*ʿiyar al-muʿaddil*) by which the objects of knowledge are weighed.' It was 'the leader of the sciences' or 'chief science' (*raʾīs al-ʿulūm*) […]. It was, in a word, 'the science of knowledge' (*ʿilm al-ʿilm*) or 'the science of the sciences' (*ʿilm al-ʿulūm*) (ibid., p. 204).

The Andalusian encyclopedic thinker Ibn 2azm (d. 1064) further explains why logic (*manʖiq*, a noun derived from *nuʖq* which literally means speech) is knowledge of second order:

> The *nuṭq* mentioned in this discipline is not speech (*kalām*). It is the *discernment* among things and the *thinking about* the sciences and the crafts, business enterprises and the management of fairs (our emphasis, ibid., pp. 203-204).

Logic is knowledge of second order because its subject matter is knowledge of first order i.e. the rest of scientific and social disciplines. Since logic is first and foremost knowledge, though be it of second order, it has a clear normative aspect, i.e. its purpose is

> to provide all the rules (*qawānin*) that have the task of setting the intellect straight and of directing man toward what is right and toward the truth regarding any of *intelligibilia* with respect to which man may possibly err, all the rules that can preserve him from errors and mistakes with respect to the *intelligibilia*, and all the rules for checking on the *intelligibilia* with respect to which one cannot be certain that someone did not err in the past (Rosenthal 1970, p. 205).

The application of logic is universal and its purpose as we would say today is to determine valid statements for every domain of objects. The universal aspect of the normativity of logic with its epistemic character and its epistemological role has been summarised by al-Ghazālī's (1058-1111) definition of logic: "Logic is the canon (*qānun*), providing the rules and norms that is applicable to *all* human knowledge and on which *all* human knowledge rests" (our emphasis, ibid. p. 204). The formal nature of logic which consists in making explicit the structure of all scientific and social disciplines is considered by the Arabic tradition as the means by which knowledge could be unified as is rightly stressed by Rosenthal:

> The history of logical studies in Islam remains to be written. […] It is clear, however, that regardless of changes in approach and method, Muslim logicians never lost sight of the fact that the primary function of their labours was to find about "knowledge" and to contribute to a comprehensive epistemology for all aspects of Muslim intellectual endeavor, including theology and jurisprudence (ibid., p. 208).

The spirit of establishing rules and procedures for every scientific discipline which characterises the Arabic tradition explains also why geometry and algebra have come to be conceived by Arabic mathematicians as calculations (see Rashed and Heeffer's contributions respectively). It turns out therefore that *ars analytica*, the metamathematical theory which has the task according to Ibn al-Haytham to provide the method of finding mathematical proofs, is nothing other than mathematical logic as Rashed brilliantly explained in section 3 of his paper.

According to the Arabic meaning, knowledge is useful. Its usefulness lies in being an action guide since it comprises some principles of prediction. From this point of view, Islamic Law and Arabic Grammar are scientific disciplines since they fix by means of rules the pattern of the behaviour of both the society and its language, such rules act as way signs which are designed to be followed in the future. Another striking feature worth mentioning is that النحو or *naḥw* which is the Arabic word for Grammar shares the same meaning as that of *'ilm* and *sharī'a* since it also means "direction" or "way" and the context in which it is originally used means "follow this way".

These aspects of the notion of knowledge of the Arabic tradition led to overcome one of the main weaknesses of the inherited tradition of Greek science: the already mentioned underestimation of the notion of experimentation. It is once more the relation between theory and practice which is at stake here and the Arabic scholars noticed that this feature of their notion of knowledge might lead to new advances in relation to the stagnated science of the ancient Greek tradition. Ibn Qutaybah, who is more known as a man of literature and linguistics than as scientist, devotes a whole book to the pre-Islamic astronomy in the introduction of which he declares his main motivation.

> My purpose in everything that I reported here has been to confine myself to what the Arabs *know* about these matters and *put to use* (الإقتصار على ما تعرف العرب في ذلك و تستعمله), and to exclude that which is *claimed* (يدَّعيه) by those non-Arabs who are affiliated with philosophy (المنسوبون إلى الفلسفة) and by mathematicians-astronomers (أصحاب الحساب). The reason is that I consider the *knowledge* of the Arabs

> (علم العرب) to be *knowledge that (1) is plain to sight* (الظّاهِرُ للعيان), *(2) true when put to test* (عند الإمتحان الصّادِقُ), *(3) and useful to the traveller by land and sea* (النّافعُ لنازل البر و راكب البحر). God says 'It is He who has appointed for you the stars, that by them you might be guided in the shadows of land and sea.' [Qur'ān 6:97] (our emphasis and numeration; Ibn Qutaybah 1956, pp. 1-2).

This is in fact more than a mere provocation, it is a strong challenge to those astronomical works which either were translated or written following the Greek tradition. What is at stake here is the epistemological status of Greek scientific works: how can we know, let alone be sure, that a given discourse, among the various discourses concerning the nature of the physical world, is real knowledge and not simply a mere speculation. These epistemological and related questions concerning the nature of knowledge and its development have become quickly the dominant topic in the Arabic tradition as Gutas explains:

> Because of the spirit of research and analysis it inculcated, different fields of scholarly endeavour unrelated to the translations gained in sophistication , a plethora of ideas was available for ready consumption, and the areas covered by the translation literature were no longer the only ones to impress the powerful minds. Intellectual debates of all sorts became the order of the day and patrons became interested not only in the *transmitted* knowledge from the Greeks but in the main problems posed by this knowledge and in the various ideological challenges to it (Gutas 1998, p. 124).

Giving the status of the knowledge in the Islamic society, the Arabic tradition has shifted the focus of research from logos understood as theoretical speculations to the research of a complex notion of knowledge, where philosophy had no privilege status. According to this view, knowledge is not and cannot be dominated by a particular profession and surely not by philosophers since it is usually compared to the depth and magnitude of an ocean the grasp of which goes beyond the capacity of one man or a section of the scientific community. By identifying itself with knowledge, the Islamic civilisation has conceived a distinctive and global project, of which the translations were only an important first step, for its intellectuals, whether they are jurists or theologians, grammarians or linguists, philosophers or mystics, scientists or artists, writers or poets, who are all invited to co-operate to its development. It is in this dynamic and diverse intellectual life that we have to understand Ibn Qutaybah's intervention. Though being a non-specialist in science and philosophy, Ibn Qutaybah is not just criticising the Greek scientific tradition since he puts some concrete proposals to advance the debate. In the passage mentioned above, Ibn Qutaybah makes three interconnected suggestions to scientists and philosophers designed to help them check any discourse's claim to knowledge. Namely:

1) A scientific discourse should be first intelligible, but what does it mean for a set of words and inscriptions to be intelligible? Hence the second suggestion:

2) A discourse concerning nature is intelligible if it can be put to the test. According to this view, a claim such as "a table is made of earth, water, air and fire" is an absurdity since it cannot be put to the test. The fact that according to this point of view; intelligibility assumes the possibility of testing suggests that the Arabic tradition would reject the thesis of incommensurability. This applies in particular to Ibn al-Haytham critics to Ptolemy's *Almagest* discussed by Tahiri's paper in this volume and in the first chapter of Rashed's latest volume of *Mathématiques Infinitésimales du IX^{e} au XI^{e} siècle*.[11] Relevant to our discussion is that Rashed discusses the semantical changes brought about in the traditional conceptual apparatus by Ibn al-Haytham's attempt to elaborate an entirely new astronomical theory. We have here a concrete historical case of a scientific discipline going through the first critical transition of its evolution where semantical change goes hand in hand with theory change. More precisely and contrary to what the sociological doctrine wants us to believe, the emergence of the new theory assumed the intelligibility of the old theory — an intelligibility which was tested and subject of scientific controversies. It is, one might claim, within the dialogue triggered by scientific controversies that the semantical changes take place. In our example the point at stake is the notion of *falak* which was used by Arabic astronomers to

translate the central concept of Greek astronomy *orb* which refers to the spherical bodies that cause the motion of the planets. In his *Configuration* however, Ibn al-Haytham is led to change its meaning in the sense of "the apparent path of a particular star in the sky … without referring to the spherical bodies" (Rashed 2006, p. 44). This is the Arabic meaning of *falak* already strongly defended by Ibn Qutaybah. In his *Adab al-Kātib* or *Education of the Secretaries*, he explains that *falak* means the "orbit (*madār*) of the stars with which they are associated و الفلك مدار النجوم الذي يضمها" (Ibn Qutaybah 1988, p. 69).[12] It seems thus that Ibn al-Haytham reinstates the original meaning of the Arabic word. It can be fairly assumed that Ibn al-Haytham should have been aware of the controversy between the Arabic and the Greek approaches to astronomy since it was widely known (it was explicitly reported for example by one of his predecessors al-|ūfī (903-986) in his *Kitāb /uwar al-Kawākib* or the *Book of Forms of the Planets*). It remains to be determined whether Ibn al-Haytham was specifically aware of Ibn Qutaybah's philological arguments. It turns out that before Ibn al-Haytham, Ibn Qutaybah was one of the first leading critics of Greek astronomy by strongly expressing his deep dissatisfaction with the way astronomical research was conducted. Anyway in fact it is Ibn al-Haytham, more than any body else, who seems finally to satisfy Ibn Qutaybah's requirements. Ibn al-Haytham's powerful works signal a major breakthrough in scientific practice since they show that the intense theoretical researches undertaken since the beginning of the translation movement have finally begun to bear their fruits. This is one of the first major breakthroughs in the history of science in relation to the influence and heritage of Greek science. We would have liked to call it in fact a revolution in the proper sense of the word since this is what actually happened. The Arabic tradition has indeed turned upside down the Greek scientific practice.[13]

The onslaught on Greek scientific claims gathers momentum by spreading to other scientific disciplines like medicine. Ibn Māsaway (d. 857), a personal physician to the caliphal court[14], seems to have learned Ibn Qutyabah's lesson. He wants to put effectively to the test Galen's medical claims by dissecting his son had the caliph, as he complains in the following passage, not intervened to prevent him from doing so:

> Had it not been for the meddling of the ruler and his interference in what does not concern him, I would have dissected alive this son of mine, just as Galen used to dissect men and monkeys. As a result of dissecting him, I would thus come to *know the reasons* for his stupidity, rid the world of his kind, and *produce knowledge* for people by means of what I would write in a book: the way in which his body is composed, and the course of his arteries, veins, and nerves. But the ruler prohibits this (our emphasis).

Ibn Māsaway's story[15], that recalls Abraham's sacrifice, illustrates how the son was offered up as a sacrifice to scientific knowledge (and held up not by the intervention of the Divinity but of the ruler Law). It seems to me that Ibn Māsaway's statement expresses too the attitude of the whole Arabic scientific practice towards the Greek scientific and philosophical discourse which is held not as truth but as just claims needing to be carefully checked and systematically tested. Dissecting the Greek logos with the aim of producing knowledge is the hallmark of the period of the translation movement which reaches its climax in the eleventh century when Ptolemy's optical theory was overthrown by Ibn al-Haytham's *al-Manāz□ir* (or *Optics*) and his *Almagest* was completely discredited by *al-Shukūk*.

Ibn Qutaybah's second suggestion actually involves two powerful incentives to the progress of science. The first is a heuristic one by directing theoretical research to subjects where testing claims and counterclaims are possible. The second is methodological: scientists are prompted to devise adequate methods and instruments aimed at testing their hypotheses. The underlying idea is that the refutation of the proponent's claims should not be purely rhetorical. Real arguments and counterarguments should be fully substantiated and systematically backed by hard evidence.[16] Understanding what is said and to be sure of its truth-value by systematically testing its content are two heuristic suggestions designed to check the claim of

a discourse to knowledge. The second suggestion announces in fact the third since the link of knowledge to testing involves some form of a twofold action: the action of testing and the result of a knowledge aimed to improve a given practice

3) Ibn Qutaybah's last point, which he further supports with the verse from the Qur'ān, that the Arabic astronomical knowledge is "useful to the traveller by land and sea" remarkably confirms Rosenthal's insight into the pragmatical root of the Arabic understanding of knowledge. The crux of Ibn Qutaybah's point is that the truth of any theory must be reflected in its ability to trigger some practical benefits at some stage of its development. Furthermore by requiring from a physical theory to be of practical benefit, Ibn Qutaybah puts a strong pressure on scientists and philosophers to justify the huge resources devoted to theoretical researches. They have to show in particular that their inquiries are not simply a waste of time and money but they are relevant to the needs of the society by yielding tangible results. It appears thus that Ibn Qutaybah's third suggestion is the ultimate test for any discourse on nature since any acquired knowledge must yield sooner or later some concrete results. The point at stake actually is the relation between theory and praxis which in the Arabic tradition seems to involve a non-vicious circle known nowadays as internal pragmatism: theory should improve practice and practice should improve theory. This explains why the Arabic tradition closely binds theory to experience. We have witnessed indeed in this period an unprecedented surge of interest in all kinds of empirical science. Contrary to the stagnated heritage of the Greek culture which fails to see the role of practice in shaping scientific theories, the Arabic tradition has cultivated the modern way of doing science by developing theoretical scientific branches, like mathematics for example, for their own sake and at the same time putting them at the service of empirical sciences (actually Ardeshir's paper indicates that Ibn Sīnā makes what seems to be the first clear distinction in history between pure and applied mathematics). Geometry was masterfully used in architecture and agriculture; algebraic techniques were conceived to assist Islamic laws and to stimulate trade by facilitating commercial transactions; astronomy was developed to respond to religious and other practical needs giving rise to the emergence of practical astronomy: many observatories were built for more accuracy and lasting observations; hospitals were set up to benefit from and to direct medical researches; etc. to put it shortly, science has never been in action as it was in the Arabic tradition as a result of closely tightening theory and practice. The close combination of علم (*'ilm*) and عمل (*'amal*, the Arabic word for action) is effectively and definitely crystallized in the Muslim mind by the Arabic language due to the similarity of the two words in sound and meaning to the extent that it becomes unthinkable to conceive knowledge without corresponding actions as is articulated by Ibn Qutaybah: "if there were no action, one would not search for knowledge, and if there were no knowledge, one would not search for action العَمَلُ لم يُطلبْ العِلمُ لولا العِلمُ لم يُطلبْ العَمَلُ و لولا" (Ibn Qutaybah 1986, II p. 141). The nature of the relationship between knowledge and action is further studied by al-Ghazālī for whom knowledge is the form of action or as we would say today the construction of a procedure since "action can take form only through knowledge of the manner in which the action can be undertaken" (mīzān, p. 328). It is thus not surprising that the ability to match science with action is the basic skill required from the education of future civil servants of the empire by the influential writer Ibn Qutaybah whose *Education of the Secretaries* was offered to Ibn Khāqān, a senior Secretary of State.

> In addition to my works [which provide linguistic, literary, and religious training], it is indispensable for the [secretary] to study geometrical figures for the measurement of land in order that he can recognize a right, an acute, and an obtuse triangle and the heights of triangles, the different sorts of quadrangles, arcs and the other circular figures, and perpendicular lines, and in order that he can *test his knowledge in practice on the ground and not on the survey-registers* معرفته بالعمل في الأرَضينَ لا في الدّفاتر و يمتحن, *for knowledge [of the external world] stemming from practical experience is nothing like theorising about it by contemplation* فإنَّ المَخْبَرَ ليس كالمُعايَن. The Persians [i.e. the Sasanians] used to say

> that he who does not know the following would be deficient in his formation as state secretary: he who does not know the principles of irrigation, opening access-canals to waterways and stopping breaches; [measuring] the varying length of days, the revolution of the sun, the rising-points [on the horizon] of the stars, and the phases of the moon and its influence; [assessing] the standards of measure; surveying in terms of triangles, quadrangles, and polygons of various angles; constructing arched stone bridges, other kinds of bridges, sweeps with buckets, and noria waterwheels on waterways; the nature of the instruments used by artisans and craftsmen; and the details of accounting (our emphasis, Ibn Qutaybah 1988, I p. 15).

The underlying idea is that a purely descriptive theory has less value if its assertions cannot be translated into practice since the aim of science is not to describe nature which is the Greek way of inquiring (through logos) but to produce knowledge by effectively acting upon it. It is this outstanding insight which led the Arabic tradition to ignore the sharp demarcation lines drawn by the Greek imagination that keep the various scientific disciplines quite apart. But the practical benefit goes beyond the material aspect of theoretical researches. The usefulness of a scientific theory should nevertheless be understood in a wider sense including the possible application of its concepts and forms of reasoning to another theoretical, empirical or even social discipline. Logical concepts were fruitfully used in Grammar and the analysis of the Arabic language, logical rules were applied to legal reasoning, Ophthalmology was fully and definitely integrated into Optical studies, Algebra was closely developed in conjunction with Geometry, Arithmetic was effectively applied to Algebra, etc. Was this interdisciplinary approach a happy coincidence or something which was carefully worked out? One of the remarkable features of many Arabic and Islamic intellectuals is the encyclopedic nature of their formation which was sustained throughout the classical Islamic era from al-Kindī to Maimonides, to refer just to those major figures who are known to the western historians (see Rashed's paper). Gutas has rightly emphasised the crucial role played by the encyclopedic formation in al-Kindī's top objective

> It is important, first of all, to keep in mind that al-Kindī was not a philosopher in the sense that he was only or primarily a philosopher. He was a polymath in the translated sciences and as such very much a product of his age. He wrote on all the sciences mentioned above: astrology, astronomy, arithmetic, geometry, medicine. This broad and synoptic view of all sciences, along with the spirit of encyclopedism fostered by the translation movement for the half century before his time, led him to develop a *research program* whose aim was *to acquire and complete the sciences* that were transmitted from the ancients (our emphasis, Gutas pp. 119-120).

The underlying idea of encyclopedism is that science is conceived as a whole or unity and not as a mere collection of scientific disciplines which have nothing to do with each other, and the cross-fertilisation of the various scientific branches is the means by which the whole body of knowledge can make further and sustained development. Al-Kindī's answer to the fundamental task that he sets himself inaugurates a new and fruitful approach to science. By seeking the progress of knowledge through the cross-fertilisation of scientific disciplines, the first Arabic philosopher introduces a major shift in the role of the philosopher since his path was closely followed by all his successors. Indeed al-Kindī's successors have further specified that logic, as explained above, is the knowledge which could unify all knowledge. Strikingly, we have to wait until the twentieth century to see the very same idea explicitly expressed by Otto Neurath[17]:

> Encyclopedism based on logical empirism was the general historical background which underlay the proposal of an international encyclopedia of unified science. The general purpose of the *International Encyclopedia of the Unified Science* is to bring together material pertaining to the scientific enterprise as whole. […] The collaborators and organizers of this work are concerned with the analysis of sciences, and with the sense in which science forms a unified encyclopedical whole. The new *Encyclopedia* so aims to integrate the scientific disciplines, so to unify them, so to dovetail them together, that advances in one will bring about advances in the others (Neurath 1938, p. 24).

That is what all the papers of the present volume have in common: they illustrate the idea of the unity of science in the Arabic tradition by exposing the connection, established by Arabic scientists and philosophers, between different scientific disciplines that contributed to the growth of knowledge. Bearing in mind that this is just only a start and a sample of the way in which interdisciplinary scientific exchanges were constantly sought and systematically practised throughout the classical Islamic period, we hope that our volume will inaugurate a new and fruitful approach to the study of the Arabic tradition. Furthermore, according to our view, the aim of this volume coincides with the general aims and motivation of the whole collection Logic, Epistemology and the Unity of Science. One can even see the research project of the encylopedists as a resumption of an old research programme that goes back to the first Arabic philosopher, but this is the start of another story.

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[1] One of the fruitful direct contacts between the Arabs and the Chinese was the introduction of paper-making technology into the Islamic world in 751, making obsolete all other writing materials. The quick use of paper in writing leads to the unprecedented spreading knowledge.

[2] Gutas is referring here to a number of scientists (mainly algebraists and astronomers) such as al-Khwārizmī, Ya1yā ibn Abī-Man{ūr and Banū-Mūsā.

[3] Gutas’ claim seems to be challenged by Rashed’s recent study of al-Kindī’s works, see fn. 5.

[4] P. 150.

[5] One could assume that he was speaking here as if al-Kindī was, at least implicitly, the director of the programme of *Bayt al-Ikma* for three reasons: (1) according to Rashed, “le caliphe al-Ma’mūn se l’attacha et l’intégra à la “Maison de la sagesse”, *Bayt al-Ikma*, qu’il avait fondée; […] il avait d’aillaurs été chargé par al-Ma’mūn de controler les traductions faites au *Bayt al-Ikma* et d’en améliorer l’arabe.” (Rashed 1998, p. v); (2) he had the strong support of the ruling power because of his close ties with the caliph al-Ma’mūn and his successor al-Mu'tai{m (833-842). The latter had appointed him as tutor of his son A1mad and was the addressee of a number of his epistles including *On the First Philosophy*. (Gutas 1998, p. 123, Rashed 1998, p. v); (3) he tries to implement effectively his programme by gathering around him a circle of scientists and collaborators (Gutas, p. 119; Rashed 1998, p. v). Rashed adds: “de nombreux thèmes et concepts élaborés chez les Grecs ont été choisis et repensés par al-Kindī, integers à l’œuvre originale qu’il lui-même construite. ”

[6] Al-Jāhiz actually uses the more general term عبرة or *'ibra* which can be translated as lesson. It is rendered by knowledge here since this is the topic discussed in the passage. *'Ibra* is one of the key words in Arabic culture since it indicates not only the necessity of change but also seems to describe how change is brought about. In its

general sense, it conveys the idea that the good development of a society as well as of an individual depends on their ability to draw the right lessons from their own experience and the experience of other people (past and present).

[7] After successfully ousting the Umayyads, the ʿAbbasīds moved the capital to Bagdad, their new founded city. Their rule lasted for more than five centuries until it was brought down by the invasion of the Mongol.

[8] The Umayyads established Damascus as the capital of the Islamic state. Their rule did not last long mainly because not only of their inability to broaden the basis of their power, as Gutas explains, but also of their failure to win the hearts and the minds of the masses due to their lack of vision for the long term development of the society.

[9] For more details on the impact of Islamic teaching, whose exhortation goes back to the seventh century, on the permanent establishment of the 'search after knowledge' tradition, see Rosenthal chapter V, section 1 "On Knowledge", p. 70.

[10] The tradition generally attributed the two following famous statements to the Prophet: (1) Seeking knowledge is a duty for every believer; (2) Seek knowledge, even if it be in China.

[11] In this chapter Rashed presents a recently discovered astronomical material entitled the *Configuration of the Movements of each of the Seven Wandering Stars* which was written by Ibn al-Haytham after his famous *al-Shukūk*. The historical significance of this monumental work can hardly be overemphasised since it demonstrates that Ibn al-Haytham has finally come to the conclusion that astronomy cannot be founded as a physical theory by just reforming Ptolemy's *Almagest*.

[12] The same explanation could be found in his *Kitāb al-Anwā'* where he criticises the way astronomers use the Arabic word *falak*. Referring to the *Almagest* in which Ptolemy assumes that the heavenly bodies are moved by spherical bodies, Ibn Qutaybah admits that he cannot comprehend Ptolemy's statement speaking of something that it can hardly be seen "I have *heard* قدْ سمعتُ و some who say that *aflak* (the Arabic plural of *falak*) are circles (*aʾwaq* the plural of *ʾawq*) around which move the stars and the sun and the moon, and that the sky is above them [all]"; and he continues his strong attack by expressing his puzzlement as to how *falak* has become to refer in their astronomical works to supposedly large physical bodies that can only be heard of but can never be seen: "I have no way to find out how is that and I do not find it corroborated (شاهِداً *shāhid*)" by the Arabic tradition (our emphasis, Ibn Qutaybah 1956, § 139, p. 124).

[13] A point which is not missed by the eminent historian of science Gérard Simon when he describes Ibn al-Haytham's approach to optics as a scientific revolution, making it de facto the first scientific revolution in the history of science. For, he remarks, that the Greek conception of sight finds itself transformed by his work. Indeed, Ibn al-Haytham establishes experimentally that the phenomenon of sight is the result of light coming in and not out from the eye as is assumed by Ptolemy:

> la révolution opérée par le très grand savant arabe Ibn al-Haytham, connu en occident sous le nom d'Alhazen, qui a substitué à une théorie de la vision faisant sortir de l'œil des rayons lumineux une théorie antagoniste faisant entrer dans l'œil des rayons lumineux ; ce qui l'a obligé à se demander sur de nouvelles bases comment la vision pouvait être un sens à distance, faisant percevoir le monde extérieur, alors que c'est dans le corps que se produit la sensation (Simon 2003, p.7).

Simon explains that the *timing* of this revolution is rather an evidence once again of the fact that scientific change is brought about by a change of approach in the conduct of the scientific inquiry. This is particularly true in relation to connection of sight with optics where the empirical turn triggered by Ibn al-Haytham has its roots in the role given to sight by the Arabic science and culture. Indeed as emphasised by Ibn Qutaybah in his objections to Greek astronomy, sight has been always considered and used in the Arabic tradition not as the platonic apprehension of ideas but as the instrument with the help of which the validity of uttered, reported or written statements could to be systematically checked and tested:

> Culturellement, la possibilité de géométriser la vision n'est pas surprenante pour des théoriciens qui conçoivent le flux visuel comme une émanation de l'âme, et pour des astronomes pensant que la vue nous livre ce qu'il y a de plus noble et de plus divin dans le monde, l'harmonie des mouvements célestes. La vision, pour un Ptolémée, peut échapper partiellement à la contingence et au désordre du monde sublunaire, car elle est le sens qui nous met en contact avec les régions éthérées, à la manière dont l'ouïe est un sens intellectuel parce qu'elle donne à percevoir les rapports mathématiques des harmonies musicales. L'optique, là encore, s'insère dans la culture de l'antiquité, et plus particulièrement ici dans une tradition pythagoricienne et platonicienne. Avec Ibn al-Haytham, et en particulier son *Traité d'optique*, l'insertion culturelle de l'optique change. Elle reste certes science de la vision et science des géomètres, mais, en tant que désormais elle se donne la lumière pour objet et l'œil pour champ d'étude, elle devient science de la matière et tisse des liens très neufs avec la médecine. En bref, elle s'autonomise et se complexifie, tout en gagnant en rigueur expérimentale (ibid., pp. 87-88).

[14] Though being a personal physician to al-Ma'mūn and his successors, Gutas points out that it seems that he "conducted his research in the course of his practice as chief physician in the hospital in Bagdad" (p. 118).
[15] For further details see al-Qif}ī 1903, pp. 390-392 and Gutas 1998, pp. 118-119.
[16] Al-Ghazālī formulates Ibn Qutaybah's first two criteria in the following way: "knowledge is the perception (*ta{awwur*) of things through thorough understanding (*ta Iaqquq*) of quiddity and definition, and assent (*ta{dīq*) with regard to them through pure, verified (*mu Iaqqaq*) certainty" (*Maqā{id*, II, 86, in Rosenthal p. 62).
[17] Interesting is the fact that Rahman and Symons (2004, pp. 3-16) show that Neurath's Encyclopedism is linked to a conception of the relation between theory and practice strikingly close to that of Arabic tradition as discussed above.

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OVERVIEW

The book is divided into two parts, the first on Epistemology and Philosophy of Science and the second on Logic, Philosophy and Grammar. Ibn Sīnā receives the lion's share in both parts. This is hardly surprising given the great interest in Ibn Sīnā's philosophy due to the wide availability of his philosophical and scientific writings and to both the originality of his thought and his encyclopaedic approach to knowledge. Scholars and historians have come to recognise Ibn Sīnā's works as a watershed in the history of Arabic science and philosophy. As more Arabic philosophical and scientific documents become available, it can be expected that in the coming years we will witness new research on other major Arabic-Islamic thinkers with a similarly thorough and in-depth investigation as that on Ibn Sīnā.

As already mentioned, Part I contains papers which focuses on the connection between, epistemology and science. In the first chapter of this part Mohammad Ardeshir discusses the question of the foundation of mathematics underlying Ibn Sīnā's philosophy: what and where are mathematical objects? From the analysis of the role of abstraction in the emergence of some fundamental concepts such as existence, object and unity, Ardeshir concludes that for Ibn Sīnā mathematical objects are those that have mental existence. In relation to epistemology of mathematics Ardeshir discusses Ibn Sīnā's answer to the question: how can we know mathematical objects? Ardeshir explains that for Ibn Sīnā intuition and thinking involved respectively in the discovery of mathematical propositions and the construction of mathematical proofs are eventually the means by which mathematical knowledge is attained.

Deborah Black's paper goes a step further in investigating Ibn Sīnā's epistemology by tackling the difficult question of self-knowledge. The question now is not how we know mathematical objects for example but how we know that we know mathematical objects? To deal with the complex problem of self-knowledge, Ibn Sīnā adopts a new way of reasoning that we nowadays call thought experiment. Black explains that Ibn Sīnā recognises two distinct levels of self-knowledge. (1) Primitive self-awareness: soul's awareness of itself and (2) reflexive self-awareness, which comes from our awareness of cognizing some object other than ourselves. But for Ibn Sīnā, the latter is a kind of second order knowledge and it presupposes primitive self-awareness which ensures the unity of the soul's operations. Black presents Ibn Sīnā's flying-man-argument - that might be considered one of the earliest uses of a mental experiment – in order to discuss the relation of self-awareness to the other reflexive varieties of self-knowledge. The paper could be seen as Ibn Sīnā's answer to some of the questions that Hans van Ditmarsch searches in his contribution on Ibn Khaldūn.

Albrecht Heeffer's contribution challenges the prevailing myth according to which "European mathematics is rooted in Euclidean geometry". This view, cultivated and sustained by modern historians of mathematics, was influenced by the growing epistemological dominance of the Euclidean ideal doctrine from the seventeenth century onwards. "Mathematics consists entirely of calculations" seems to be the conclusion drawn by Wittgenstein following the collapse of Hilbert's aprioristic programme. Heeffer ironically finds that this image of mathematics as procedures performed on the abacus fits in very well with pre-seventeenth century conception of mathematical knowledge. He shows how the practice of algebraic problem solving within the abacus tradition, which leads to the emergence of symbolic algebra, grew out of Arabic sources. Indeed early Arabic algebra provides rules and procedures for solving problems and the validity of the rules was accepted on the basis of their performance in problem solving. The prime motivation of Heeffer's analysis of the basic concepts of early Arabic algebra is to provide an explicitation of the epistemic foundations of

the conception of mathematics-as-calculation developed in the Arab world. Interesting is the fact that the conception of mathematics-as-calculation is not confined to algebra but seems to be a more unifying approach to the practice of mathematics since it is also applied to geometry (see Roshdi Rashed's contribution, third section).

In his *Ibn Sīnā naturalized epistemology*, Jon McGinnis reveals the dynamic aspects of the author of *al-Shifā'*s epistemology when it applies to empirical sciences. McGinnis focuses on the study of *Kitāb al-Burhān* which attracted little attention so far from the scholars and in which Ibn Sīnā exposes what can be called his theory of the logic of scientific discovery. The study is divided into two sections. The first treats Ibn Sīnā's theory of demonstrative knowledge, and how Ibn Sīnā envisions the relation between logic and empirical science, where it is argued that one of the primary functions of *Kitāb al-Burhān* is to provide heuristic aids to the scientist in his causal investigation of the world. The second half concerns Ibn Sīnā's empirical attitude in *Kitāb al-Burhān* towards acquiring the first principles of a science, where such cognitive processes as abstraction, induction and methodic experience are considered. McGinnis discusses Ibn Sīnā's scepticism towards empirical induction and Ibn Sīnā's preference for methodic experience (*tajriba*). Method experience; explains Mc Ginnis, is a type of reasoning that applies to empirical science and purports the need of revision when new empirical data become available. According to McGinnis' paper, it turns out that the kind of logic suitable for the formalisation of empirical sciences intended by Ibn Sīnā is not deductive logic but something what we would nowadays call some kind of non-monotonic and/or ceteris paribus reasoning.

Roshdi Rashed paper tackles the following crucial question: is there a philosophy of mathematics in classical Islam? If so, what are the conditions and the scope of its presence? To answer these questions, it is not sufficient, points out Rashed to present the philosophical views on mathematics, but one should examine the interactions between mathematics and theoretical philosophy. Rashed' paper proposes to tackle the question in a new and unexplored way and that touches the main conceptual target of our volume, namely: the unity of science in the Arabic tradition. Indeed, as remarked by our author, the links between mathematics and philosophy are sometimes tackled in the works of the philosophers of Islam as al-Kindī, al-Fārābī, Ibn Sīnā, etc.; but in a so-to-say totally external way In fact, there is a remarkable lack of studies aiming to understand the repercussions of the mathematical knowledge of the thinkers of classical Islam on their philosophies, or to discuss the impact on their own philosophical doctrines of their activities as scientists. Rashed's arguments Mathematics has provided to theoretical philosophy some of its central themes, methods of exposition and techniques of argumentation. The aim of Rashed's paper is to study some of the numerous interactions between mathematics and philosophy, in the context of tackling the question of philosophy o mathematics in classical Islam. More precisely, some of the themes discussed in this rich paper are mathematics as a model for the philosophical activity (al-Kindī, Maimonides), mathematics in the philosophical syntheses (Ibn Sīnā, Na{īr al-Dīn al-□ūsī), and finally the constitution of *ars analytica* (Thābit ibn Qurra, Ibn Sinān, al-Sijzī, Ibn al-Haytham). From the point of view of logic; this remarkable paper can be also understood as complementing the studies of Ahmed, Schöck and Thom who studied the interactions between logic; grammar and metaphysics but did not tackle the interaction between logic and mathematics as Rashed does.

Hassan Tahiri's paper stresses the epistemological consequences of Ibn al-Haythyam's *al-Shukūk*. The author presents Ibn al-Haythyam's systematic refutation of Ptolemy's *Almagest* as paradigmatic for the creative attitude of the Arabic Tradition towards the heritage of Greek

science. Contrary to his *Optics*, explains Tahiri; *al-Shukūk* is not only a book of science but a book about science since it is motivated by epistemological considerations designed to break the deadlock caused by the Ptolemaic exposition of science. Tahiri's main contribution is that it bridges the assumed historical gap between ancient and modern science by emphasising on the huge impact of *al-Shukūk* on later astronomical researches up to Copernicus. This historical fact, which shakes the basis of the received view's claim according to which Copernicus' *Revolutionibus* was the starting point of the scientific revolution, should, according to Tahiri; prompt the historians to revise the prevailing periodisation of the history of science. One remarkable point suggested in Tahiri's paper is his perspective on controversies that offers a new way to understand the relation between logic, epistemology and the role of the Arabic tradition. The point suggested by Tahiri is that through controversies; particularly in relation to the heritage of Greek science, the Arabic tradition expressed one of their most important achievements: the development of countermodels to the stagnated model of the ancient Greek science and therefore motivated the impulse to unexplored new paths of scientific enquiry.

Part II is composed of papers which exhibit the connection between logic, philosophy and grammar and starts with a paper of Asad Ahmed on the dichotomy *jiha-mādda* in the work of Ibn Sīnā as compared with the Greek version *tropos-hūlē.* The paper begins with the study of the word *(tropos)* in Aristotle, it shows how it became a technical term for the Commentators; how, as part of *eidos*, it came to be dichotomous with *hūlē*; how the *eidos-hūlē* and *tropos-hūlē* dichotomy was known to al-Fārābī; how Ibn Sīnā inherited this dichotomy; and finally, what role this dichotomy, along with several associated concepts, had to play in Ibn Sīnā's modal logic. According to Ahmed, the dichotomy *jiha-mādda* seems to have become a determining factor for Ibn Sīn#'s conversion rules of modal propositions and thus play a central role in his modal syllogistic. Moreover, the author suggests that this distinction is at the base of the distinction between unconditioned and conditioned necessity expressed by the couple *dh#tī/wa{fī*. While this paper explores the purely logical reasons underlying these distinctions. Cornelia's Schöck and Paul Thom's contributions to our volume complete the picture of these and related notions by providing the grammatical and metaphysical background.

Allan Bäck chooses, in his paper, to deal with the epistemological implication of a socio-cultural phenomenon which pervades our modern societies: multiculturalism. According to the author, the fact of the matter is that the emergence of the multiculturalism doctrine or at least its current surge can be seen as symptomatic of the abandonment of the flawed systematic philosophical approach, either to the foundation of science or to the explanation of its development, following the epistemological triumph of the historical-sociological approach to science. The author explains what is wrong with the current understanding of multiculturalism which, according to the view of Bäck, is related to the politically corrected practice reflecting the balance of power of the various conflicting social forces rather than to a philosophical position. The Arabic-Islamic tradition offers another approach to multiculturalism based on the principle of diversity which succeeded in producing a more tolerant society in which different communities lived together side by side according to their own customs and beliefs but without degenerating into a kind of relativism that serves as a justification of the "equal validity of all cultures." The search of certain form of unity or objectivity into the extant diversity seems to be the hallmark of the Arabic-Islamic tradition. *Islamic Logic* is designed to show how this approach is actually implemented in logical studies and more precisely in the investigation conducted by some Arabic-Islamic thinkers into the relationship between Greek logic and the Arabic language. It might be worth

mentioning that the author of this contribution begins by discussing a motivation and invitation letter penned by Shahid Rahman. Now, perhaps it might be important to point out that Rahman's aim was to avoid contributions where the main argument is to show that; Arabic author X, wrote the same as the nowadays author Y of the European (and modern) tradition. Interesting is the fact that Bäck's paper brings out what the editors were seeking for: a new alternative concept to our modern notion of multiculturalism based in the study of the Arabic tradition.

Hans van Ditmarsch contribution relates to the work of Ibn Khaldūn who was a 14th century historiographer. From a family originating in Seville, prior to its conquest ("reconquest") by the king of Castille, Ibn Khaldūn lived an itinerant life serving as a magistrate for Spanish and Moroccan Islamic courts. He is very well known in History but his epistemological and logical writings have not yet captured the attention of the specialists in the field. The unfortunate lost of Ibn Khaldūn's book on logic is a major impediment to the study of his thought on those issues. Hans van Ditmarsch, an international expert in dynamic epistemic logic, explores those fragments of Ibn Khaldūn's *Prolegomena*, the *Muqaddimah*. More precisely, the hypothesis van Ditmarsch was trying to confirm or reject was whether Ibn Khaldūn considered the three properties of knowledge as formalized in the logic S5: truthfulness, positive introspection, and negative introspection. In a recent publication of the author — not accidentally — entitled 'Prolegomena' refers to the existence of text fragments that suggest that the answer to that tripartite question is: yes, yes, no. The two relevant parts in Ibn Khaldūn's *Prolegomena* studied by van Ditmarsch are the chapters 'on reflection', and 'on the nature of human and angelic knowledge' in volume 2 (426-430 and 433-435), and a chapter "logic" in volume 3 (149-160). The author summarizes these notions as follows. Reflection is the faculty that distinguishes humans from animals, who only possess the faculty of perception. Reflection provides proof of the existence of the human soul, because it allows us to know things that are not directly observed. Reflection also allows us to interact with the sphere of angels. The power of reflection can be measured as the maximum length of a cause-effect chain: "some people can still follow a series of five or six", and as the ability to avoid actions that result in unpleasant consequences (the remark on the power of reflections suggests for the modern modal logician transitivity of the knowledge operator). It is tempting to see such reflection on acquired knowledge as a form of introspection in the modern epistemic logical sense. It is then comforting for a modal logician that awareness of knowledge provides proof of the existence of the soul. That knowledge of something corresponds to its being true seems also easily read into various phrases. The author did not find a reference to negative introspection. However it worth recalling that in the epigraph on the introduction of our volume it has been stated that the awareness of not knowing is considered to be in the Arabic tradition a condition of learning. Certainly this is a weaker statement than negative introspection that requires that for any proposition *p* if we do not know *p*, then we know that we do not know it.

The contribution of Ahmad Hasnawi's is intended to shed new lights on the little known but complex issue of the treatment of the quantification of the predicate by Ibn Sīn# and contains the first translation of the first two chapters of *Al-'Ibāra* — the third book of the logical collection of his philosophical encyclopedia entitled *al-Shifā'* (The Cure). Ahmad Hasnawi's paper can be seen as a response to Wilfrid Hodge's forthcoming "Ibn Sīn#'s *Al-Ib#r#* on multiple quantification: how East and West saw the issues" (presented at Trinity college's colloquium on the Aristotelian *Peri Hermeneias* 2005). Among the points discussed by Hodges, we mention in particular the reduction of the sixteenth doubly quantified sentences generated by the adjunction of the four quantifiers (every, not any, some and not every) to the

subject-predicate sentences. Unlike Ammonius and Tarán, Hodges points out that Ibn Sīn# succeeded in halving the list by "noting that if we replace the subject determiner in one of these sentences by its contradictory, then we get a sentence that is true if and only if the original sentence was false." For Hodges then, this is not a rule because Ibn Sīn# fails to further halve the resulting list. According to Hodges, the real rule applied by Ibn Sīn# and that prevented him from conducting the second reduction is stated much later. Hodges formulated it as follows: "In a sentence with a determined predicate, take the predicate as a whole, including the determiner, and regard it as a single universal". A claim challenged by Ahmad Hasnawi's paper. First of all, he reminds the reader that Ibn Sīn# broadened the study of the quantification of the predicate by systematically discussing the significance and the logical status of singular and indefinite sentences. On the question of double quantification, Hasnawi argues that what Hodges considers as a mere observation, which allows Ibn Sīn# to halve the list of sixteen doubly quantified sentences, is in fact a rule since it follows a systematic procedure. And contrary to Hodges'claim, Hasnawi mentions a passage where Ibn Sīn# states the equivalence of two sentences of the reduced list indicating that he was aware of the possibility of reducing further the remaining eight sentences. This evidence suggests, according to Hasnawi, that Ibn Sīn# seems to be more interested in the systematic explanation of the quantification of the predicate, designed to interpret the logic of doubly quantified sentences on the model of the sentences with an indefinite predicate (S is not-P), than with the systematic reduction of the doubly quantified sentences. More significantly, Ibn Sīn# calls "deviating" propositions such propositions where the predicate is quantified because, according to Ibn Sīn#, they do not correspond to the common use of language. That is why Ibn Sīn# declares that "there is no great utility in studying them in depth" since they have little application. This, according to Hasnawis's Appendix II; explains also why Ibn Sīn#'s successors seem to follow his advice by generally dismissing deviating propositions from their logical studies. An important point missed out by Hodges since his paper gives the misleading impression that Ibn Sīn#'s treatment of the quantification of the predicate is representative of the entire eastern tradition.

Cornelia Schöck tackles the issue of the relationship between Neoplatonic and Peripatetic metaphysics and logic on one hand and Arabic grammar on the other hand. She first reminds the reader of the little known fact that this relationship has its roots in a much older dispute between the grammarians and the theologians (*mutakallimūn*) in relation to the meaning of the "derived name" (*ism mushtaqq*). By broadening the perspective of her investigation, Schöck seeks to explain the origin of the distinction between the understanding of predications 'with regard to essence/essentially' (*dh#tī*) and 'with regard to description/descriptionally' (*wa{fī*). The first is derived from a technical term of Aristotelian logic, namely the logical term "essence", and the second comes from Arabic grammar. On the basis of the grammatical distinction of the Arabic notion of "derivation" (*ishtiq#q*), Schöck shows how Ibn Sīn#'s logico-linguistic analysis arrived at his famous two types of use of the 'derived' (*mushtaqq*) in language. Schöck explains that according to Ibn Sīn# "the derived" (*al-mushtaqq*) — namely "[the name of] the agent" ([*ism*] *al-f#'il*) and "the description/attribute which is similar to [the name of] the agent" (*al-{ifa al-mushabbaha bi-l-f#'il*) (cf. above § 4) — can be used in language to indicate five different meanings, namely:

[1.] It can stand 'with regard to essence/essentially' (*dh#tī*) to indicate:

[1.a] an essence and a quiddity to which is attributed an essential potency and quality, as for example 'rational' (*n#}iq*) in the statement 'All rational have the power of volition';

[1.b] an essence and a quiddity to which is attributed a passive-potency (*quwwa*) to be in a state (*1#l*) of being and to be in a contrary state of being, as for example 'moving'

(*muta Iarrik*) in the statement 'All moving are resting';
[1.c] an essence and a quiddity to which is attributed an active-potency (*quwwa*/*qudra*) for an action (*fi'l*/*'amal*) and for a contrary action, as for example 'speaking' (*n#}iq*) in the statement 'all speaking are keeping quiet' or as for example 'standing' (*q#'im*) in the statement 'all standing are sitting'.
[2.] It can stand 'with regard to description/descriptionally' (*wa{fī*) to indicate:
[2.a] an essence and a quiddity to which is attributed a quality (*kayfiyya*) by which the substance is in a state (*1#l*) of being, as for example 'moving' (*muta Iarrik*) in the statement 'All moving are changing [when moving]';
[2.b] an essence and a quiddity to which is attributed a quality (*kayfiyya*) by which the substance is connected (*muqtarin*) (cf. above § 6) and related (*mu*#f*) (cf. below § 8) to an acting/doing (*fi'l*/*fa'l*/*'amal*), as for example 'walking' (*m#shin*) in the statement 'All walking are changing [when walking]'.
One of the most significant products of this process of mutual rapprochement between grammar and logic, the author points out, is the synthesis of the Aristotelian accidental predication with the Arabic 'description' (*wa{f*). This explains why statements of empirical sciences belongs to the *wa{fī*–reading in which the necessary relation between the two terms is restricted to the time of the duration of the attachment of an accident to the essence and substance denoted by the subject-term. This is the time *when* the essence and substance is described as either being in a certain state (*1#l*) or as performing an action (*fi'l*/*'amal*). Schöck further examines the metaphysical implications of the *dh#tī*/*wa{fī* distinction. She argues that the latter is not only basic for Ibn Sīn#,'s modal syllogistic and epistemology, but also for al-Ghaz#lī's semantical-logical explanation of the names of God. The modern philosopher of logic might learn form Ahmed's, Schöck's and Thom's contributions that the distinction between definite descriptions and proper names might have a long and fascinating history.

Paul Thom's contribution starts where Schöck's contribution ends, namely with the investigation of the relationship between logic and metaphysics in Ibn Sīn#'s modal syllogistic and therefore completes the logical and grammatical researches of Ahmed and Schöck.
Thom points out that Ibn Sīn#, unlike Aristotle, states truth-conditions for the propositions that constitute his modal syllogistic. Ibn Sīn#'s characterisation of the subject of an absolute or modal proposition as standing for whatever it applies to, "be it so qualified in a mental assumption or in external existence, and be it so qualified always or not always, in just any manner", leaves open two ways to construe the propositions, namely *de re* and *de dicto* – the author remarks that his formulation self-consciously rejects the idea that the subject-term of an absolute or modal proposition applies just to what actually exists. Recent discussions of Ibn Sīn#'s modal syllogistic have adopted a simple *de re* reading of Ibn Sīn#'s *dhātī* propositions, and therefore either ignored or rejected the possibility of metaphysical applications for his modal theory. Thom contests this interpretation and identifies a class of metaphysical propositions (such as absolute propositions, statements of final causality and those of which the predicate is constitutive of the subject) which do not exhibit a simple *de re* form but involves both *de dicto* and *de re* elements. Interestingly, his attempt of interpreting Ibn Sīn#'s *dhātī* propositions that incorporates *de dicto* element shows that the combined *de dicto*/*de re* analysis gives just as accurate a formal representation of Ibn Sīn#'s modal syllogistic as does the simple *de re* analysis. Besides its application in metaphysics, Thom provides theoretical reasons for preferring it over the simple *de re* analysis.