Chapter One
Introduction

Recent studies in the field of the history of Islamic science (to be defined later in this chapter) have made significant interpretational changes toward Islam’s contribution to the grand narrative of the history of science. Increasingly, these studies demonstrate that a substantial amount of genuine science was undertaken in the Islamic civilisation at least up until the sixteenth century leading to major discoveries, which predated similar discoveries in the West and which also impacted upon the European Renaissance. For example, in the late 1950s, E. S. Kennedy and his students at the American University of Beirut discovered an important work of a fourteenth century Muslim astronomer, Ibn al-Shāṭir (d.1375), showing that his astronomical inventions were the same type of mechanism used by Copernicus a few centuries later,¹ and may have played a key role in the Copernican revolution.

An unprecedented acceleration of research in the history of Islamic science started from the 1950s onwards. More recently, eminent historian of Islamic science George Saliba informs us that Shams al-Dīn al-Khafri (d.1550) was a brilliant astronomer whose ability to work with the mathematics of his time was unsurpassed even by Nicolaus Copernicus (1473-1543). In fact, al-Khafri could use mathematics much more fluently and competently than Copernicus.²

Interestingly, recent studies in the history of Islamic science illustrate that Islam’s contribution to science was even richer and more significant than was previously thought. Islamic science was not only important for the rise of the Renaissance of the twelfth century in Europe, but it also played an important part in the development of the exact sciences during the Renaissance of the sixteenth century. Jan P. Hogendijk and Abdelhamid Sabra have recently argued that ‘the Islamic tradition in the exact sciences continued well into the nineteenth century, and abundant source material is available in the form of unpublished manuscripts in Arabic, Persian, and other languages in libraries all over the world.’ Because important sources have not been identified and studied, there exists no reliable survey of the entire field.³ Still newer discoveries may lie just over the horizon.

In chapter two I will justify the above claims using recent evidence from the fields of the history of Islamic mathematics, astronomy and medicine. It is important to state at this point, however, that this study does not attempt to provide new insights into the extent of the scientific work that was undertaken in the Islamic civilisation, nor their significance in the grand narrative of the history of science. Sufficient literature on this already exists. This work is essentially a detailed critique of one of the most disputed aspects of the history of Islamic science: the fate of Islamic science after the eleventh century. There is hardly a book on the general history of science, or the history of Islamic science, that does not attempt to offer an explanation for the fate of Islamic science after the eleventh century, or the so-called golden age.

In their attempt to provide explanations for this fate, the great majority of authors periodise the scientific achievements of the Islamic civilisation into a golden age and a decline age.⁴ This periodisation stipulates that before Islam there was no science worth mentioning.⁵ A period of translation (the
eighth and ninth centuries) followed during which the Arabs appropriated the ancient sciences, otherwise known as 'foreign' or 'rational' sciences ('ulūm al-aqīlī or al-'ulūm al-aqīlīya). And finally a period of original thinking and contribution followed - known as the golden age, which lasted from the end of the ninth century to the end of the eleventh century. Islamic science then declined after the eleventh century. The decline theory is the conventional view found in literature that attempts to deal with the fate of Islamic science. Although the decline theory has become the accepted paradigm, I will show in chapter four that other theories exist to describe the fate of Islamic science. In chapter four I will present a detailed review of the various theories postulated regarding the fate of Islamic science. I will then test the accuracy of these theories in chapters five, six, seven and eight using cases studies of the scientific activity of mathematics, astronomy and medicine between the eleventh and sixteenth centuries from various parts of the Islamic civilisation.

In the detailed critical review presented in chapter four I show that most authors accept and vouch for the theory that Islamic science declined uniformly after the eleventh century. In other words, they assume that all fields of Islamic science declined after the eleventh century across the Islamic civilisation with its vast geographical expanse. These authors – or let us call them the decline theorists – accept the existence of Islamic science after the eleventh century and postulate that Islamic science was always inferior in both quantity and quality to what had gone before the eleventh century. Several consequences appear to follow from this view. First, since the decline was largely uniform, it follows that some common factor must be responsible for such a decline. Since for long periods of time the only factor that different regions of Islam had in common was religion, the decline theorists will naturally look to characteristics of Islam to explain the decline. Among many other factors the most often cited factor that has apparently caused this decline is the famous work of the eleventh/twelfth century theologian Abu Hamid al-Ghazālī (d.1111). The major work of al-Ghazālī that is blamed in this regard is his Tahafut al-Falasifa (Incoherence of the Philosophers). Others attribute the decline of Islamic science to the closing of the door of Ijtihād (creative legal reasoning). These are only some examples.

Of course if a substantial amount of original scientific practices were found to have been conducted after the eleventh century, the decline theory would be proven false. In addition, if science in different parts of the Islamic world were shown to have experienced different fates, the decline theory would be seriously undermined. One of the contentions of this study is that both these circumstances have now come to pass. Since the theory of the decline of Islamic science is accepted by most authors and has become the preferred paradigm (as I will demonstrate in chapter four), the question that is generally asked is what caused this decline? Hence, I initially intended to survey the factors that led to this decline and assess their accuracy. To investigate these factors, and as a logical step, I began by surveying scholarly work that has already been carried out in the field.

An extensive critical review of scholarship exclusively or partially devoted to the general question of the fate of Islamic science between the eleventh and sixteenth centuries revealed that although the decline theory has gained wide currency and may have been established as the preferred scholarly paradigm, there is no agreement among authors about what exactly happened to Islamic science after the eleventh century. To my surprise, the lexicon that describes the fate of Islamic science after the eleventh century includes such terms as: 'decline,' 'decadence,' 'stagnation,' 'fragmentation' and 'standstill,' to name just a few. More importantly, and for the first time, I found what no one else has discovered before. I found that six centuries ago Ibn Khaldun (1332-1406) provided a theory that described the fate of Islamic science in a more sophisticated and complex manner than all other authors that came after
him, including contemporary scholars. In fact, Ibn Khaldun’s theory was not utilised except in the work of two scholars who, in any case, failed to represent it adequately (as I will show in chapter four).

The point that I wish to make here is that Ibn Khaldun’s theory went unnoticed by proponents of the decline theory (and proponents of other single-faceted theories), because those proponents did not expect to find such a detailed analysis in the work of some one like Ibn Khaldun. Additionally, the key problem of the decline theorists is that after Ibn Khaldun there was a centuries-long gap in which authors used simple, dismissive terms and concepts defined by a limited, although highly persistent, bundle of interpretative views with the dominant theme of decline. These persistent themes by which Islamic science is constructed and represented were deeply embedded in many scholarly works. In addition, many authors failed to build on the work of others, they ignored major pieces of evidence, and in most cases were not trying to discern what happened to Islamic science but were referring to the subject as part of another project. Therefore, the focus of this work was changed. Instead of continuing the analysis of why Islamic science declined, I aimed to explore why adequate scholarship failed to explain the fate of Islamic science after the eleventh century.

One of the assumptions underlying adequate scholarship is that a systematic effort allows faulty theories based on mistaken assumptions, or unsustained predictions, to be either ‘repaired’ or ‘abandoned.’ In historical study, a basic requirement is the checking of original sources in order to review the primary evidence and the judgments drawn at the earliest steps in a sequence. Therefore, in view of the fact that Ibn Khaldun’s theory is six centuries old, and that evidence of original scientific activity beyond the eleventh century emerged after the 1950s, what would one expect the state of scholarship to be? One would expect that with the availability of such evidence the usage of ‘decline,’ and other single-faceted and failure-centred terms, would begin to disappear from the lexicon, scholars would show awareness and criticism of each other’s work, and development of more sophisticated concepts would emerge. This, as I will show, did not happen.

Therefore, based upon insights drawn from theoretical and practical aspects I intend to demonstrate that, with the exception of George Saliba, the scholarly community failed to understand the fate of Islamic science after the eleventh century. Also, in their attempt to provide explanations for the fate of Islamic science authors invoke dominant and single-faceted claims, in ways that work to reinforce their acceptance as common sense truths. These claims work to construct a simplified model of the fate of Islamic science, and thus describe all branches of this science in terms of failure. In doing so, they impose tight scholarly constraints on the possibilities of other alternatives.

Thus, in the corpus of texts that contains the work of some of the ‘best’ scholars, the myth of the decline theory remains not only intact but also powerful. Convinced of its merit, scholars passed it on and vouched for it, falling to distinguish facts from decisions based on consensus, emotion or tradition. There are very few noteworthy cases in which Islamic science is being represented in ways that do not imply negativity. There are also few narratives that present more complex descriptions, as that of Ibn Khaldun. However, as I shall demonstrate, even Ibn Khaldun’s complex theory, which is arguably the most adequate in the scholarship, is non-comprehensive. Other than Ibn Khaldun, Professor George Saliba is the only other scholar who presents a challenge to the common argument that Islamic science declined after the eleventh century. In the absence of any significant challenges to the common claims of decline, it is evident that, at the very least, scholarship seems to offer support to the work of discourses that construct the fate of Islamic science in single-faceted, simplistic and reductive terms.
The aim of this work, therefore, is to comprehensively survey and evaluate scholarship on the fate of Islamic science between the eleventh and sixteenth centuries. More specifically, this work will assess the logic and empirical accuracy of the decline theory. This work also investigates the procedural and social-physiological factors that may give rise to inadequacies in the scholarship under question. I will also construct a more appropriate intellectual model for the fate of Islamic science, one that examines the cultural environment and the interactions among different cultural dynamics at work.

A number of methodological approaches can be used to evaluate the scholarship under study (positivist, relativist, Marxist or post-modernist, to name a few). These approaches might well have valuable insights to offer, but do not yield a community that can investigate what happened to Islamic science. However, a normative approach will be used in this study. The conception that will be adopted here is widely recognised and yields some fairly straightforward criteria, which makes it possible to examine whether a functioning community exists that could investigate the fate of Islamic science after the eleventh century. The key point is that the approach used here is a normative one - what should be the case rather than what actually is. What factors would facilitate (or hinder) the production of reliable knowledge in a scholarly community?

Significance of the Book

The importance of this study lies in the fact that for the first time it exposes the inadequacy of the scholarly community in understanding one of the most challenging questions in the history of Islamic science: what happened after the so-called golden age? It provides explanations for this inadequacy and it indicates what a more adequate theory of the fate of Islamic science would look like. That is, a framework for scholars to work within which will be less misleading.

This study is significant from a number of other perspectives. At a general level, it is significant for its focus on a body of scholarly writings from some of the world’s most renowned scholars, with the potential to influence a wide audience, including specialist scholars and the general public. As the review of literature in chapter four reveals, apart from some long-held theories and views about the fate of Islamic science, there has been little serious and comprehensive analysis of what actually happened to Islamic science between the eleventh and sixteenth centuries. The study also makes a useful contribution to ongoing debates in the field of the history of Islamic science, particularly about its fate, and the causal factors involved. Since no clear account is given for what happened to Islamic science, it is impossible to discuss the reasons for its fate. This study encourages both scholars and students to look beyond the traditionally offered conventional causal factors.

At a more particular level, the study’s significance and originality lie in addressing a gap in current research on the history of Islamic science. In chapter four it becomes evident that scholarship has essentially failed in understanding what happened to Islamic science and that after Ibn Khaldun there was a centuries-long gap in which even excellent historians used simplistic and dismissive terms in describing what happened. Furthermore, examination of the evidence for specific areas shows that different fates awaited Islamic science in different areas at different times. Certainly the study shows that there is no evidence of a general decline, and that it is clear that Islamic science flourished for centuries after the eleventh century.

Originality also lies in the method for arriving at the above conclusion. By analysing the understanding of the fate of Islamic science that is
embedded in various texts, the study seeks to document the ways in which these texts may work to reinforce, or to challenge, conventional understanding of what happened to Islamic science. It also shows that erroneous notions proved resilient, despite ongoing research that challenges the long-established assumptions that Islamic science suffered a general decline.

On one hand its originality and significance also lie in the intellectual framework (model) that is constructed in chapter ten. Composed of conceptual examinations of the nature of the Islamic empire, the distance it covered, the geographical and societal variations it underwent, this framework provides a more or less consistent account of how the fate of Islamic science should be viewed and examined. On the other hand, the importance and originality of this account lies in how this framework allows us to participate in discussion between the leading scholars in the field of debate. It also allows us to make an informed contribution to this discussion by suggesting the ways in which certain problems are to be overcome.

In short, the original contribution of this work lies in the complex process of review, construction and application which is utilised in order to develop a theoretically sophisticated framework. This process can be applied to some of the most urgent and far-reaching practical issues in contemporary history of science, such as the fate of Islamic science and the role different factors played in shaping it.

**Definition of Islamic Science**

Here, Islamic science (which is sometimes called Arabic science) will not imply the religious Islamic sciences (such as Shari'ah Law, Fiqh or Jurisprudence, or the study of the classical sciences of the Qur'an), or the type of science that is based on the idea that all knowledge, including scientific knowledge, can be found in the Qur'an. The latter view examines the scientific content of the Qur'an which suggests that from relativity, quantum mechanics, big bang theory to the entire field of embryology and much of modern geology, has been 'discovered' in the Qur'an. Its adherents claim that scientific experiments have been devised to discover what is mentioned in the Qur'an but not known to science. Although this view is now the most popular version of Islamic science, it is not the one implied here.

Islamic science, as used here, does not imply the mystical perspective that equates Islamic science with the study of the nature of things in an ontological sense. In this viewpoint, 'the material universe is studied as an integral and subordinate part of the higher levels of existence, consciousness and modes of knowing.' Given such a context, science is not a problem solving enterprise and socially objective inquiry but more as a mystical quest for understanding the Absolute.' This view also advocates the idea that 'in this universe, conjecture and hypothesis have no real place; all inquiry must be subordinate to the mystical experience.' Thus, its advocates view all science in Islamic civilization as sacred science, a product of a particular mystical tradition that traces its roots to the Greek neo-Platonists.9

For the purposes of this study, Islamic science simply means a systemized knowledge derived from observation, study and experimentation carried on in order to determine the nature or principle of what is being studied.10 It was written mainly in Arabic and is within the context of Islamic civilization. Many individuals from different ethnic and religious backgrounds were actively engaged in this undertaking, including Christians (such as Hunayn bin Ishaq), Persians (such as Ibn Nawbakht), Sabians (for example Thabit bin Qurrah), and Jews (such as Masha'allaah). Arabic was the main scientific language used, but was not necessarily the native language of these scientists, who may have been Persian, Turkish
or of some other origin.

While the terms 'Islamic science' and 'Arabic science' are modern historical terms within the context of Islamic civilisation, this science is Islamic in the sense that it suited the new and growing needs of the Islamic civilisation, was available entirely in Arabic (which had replaced Syriac) and was familiar to an increasing number of Muslim translators, students and scientists. It is in this context that the term 'Islamic science' will be used here.

**STRUCTURE OF THE BOOK**

Chapter two highlights some of the ways in which classical and contemporary scholars have understood the importance of Islamic science in the grand narrative of the history of science, and how this understanding has progressed in recent years. It also demonstrates that although the contributions of Islamic science remain largely unappreciated, modern studies illustrate that productive and original scientific research continued, at least, up to the sixteenth century, in the Islamic empire.

Chapter three examines the nature of an ideal scholarly community, the qualitative standards that it requires for, and the constraining problems that may hinder the production of reliable knowledge. It examines the type of scholarly community which would be necessary to study the fate of Islamic science. This chapter sketches a rough outline of an ideal scholarly community in the way some scholars define it. This chapter examines the qualitative standards of a scholarly community and the way it is supposed to - ideally - function. The aim is to show that members of a true scholarly community would - among other things - communicate effectively; show awareness and criticism of each others’ work, accumulate evidence, use mutually understood terms, discuss and adopt or reject certain terms and concepts, and develop more sophisticated concepts. Also, the aim is to show that a scholar should have integrity, objectivity and fairness. An explanation of how constraining factors can hinder the production of valid knowledge will also be made. It is on the basis of this understanding that chapter four seeks to examine the adequacy of the scholarly community in understanding and describing the fate of Islamic science between the eleventh and sixteenth centuries.

Chapter four presents the first comprehensive review of scholarship on the fate of Islamic science between the eleventh and sixteenth centuries. The chapter does not review studies on specific topics, but those that make general statements about the fate of Islamic science. The review begins with the primary work of Ibn Khaldun’s *al-Muqaddimah*, and moves on to cover the ideas of some of the most prominent scholars leading to our present time - such as Sarton, al-Hassan, Saunders, Sayilli, Sabra and Saliba. For the first time, Ibn Khaldun’s theory on the fate of Islamic science is comprehensively presented here. The intent of chapter four is to demonstrate that there are diverse opinions to describe what happened to Islamic science, such as decline, decadence, stagnation, fragmentation, standstill, and that Islamic science froze. It shows that the decline theory is the most prominent and persistent of all. The most interesting finding of the chapter however, is that six centuries ago, Ibn Khaldun provided a more sophisticated and complex theory regarding what happened to Islamic science, future scholars’ awareness of which went largely unnoticed.

Chapters five, six, seven, and eight constitute the practical aim of the study, where four case studies of distinct branches of Islamic science belonging to different geographical areas, are examined. No special plan or principle of selection governed the choice of these case studies, except that the branches of Islamic science chosen are, perhaps, the most researched. All these case studies are drawn from the context of modern
studies in the history of Islamic science. The aim of examining these branches of Islamic science is to see how far they fit into the theoretical claims established in chapter four. For the period between the eleventh and sixteenth centuries, chapter five examines the fate of mathematics in the Maghrib; chapter six examines the fate of astronomy in Persia; chapter seven examines astronomy in Egypt and Syria, and chapter eight examines medicine in Egypt and Syria.

Chapter nine discusses the reasons for the failure of the scholarly community in understanding what happened to Islamic science, and why mistaken theories such as the decline theory persisted for a long time, remaining in use today. This chapter consists of a number of hypotheses about the processes occurring at various junctures in the production, reception, assessment and dissemination of scholarly knowledge. These hypotheses will be supported with evidence gathered in the previous chapters, and at other times will be backed up by our understanding of the nature of the scholarly community described in chapter three. Amongst other things, this chapter argues that understanding of the theory of the decline of Islamic science is a social misconstruction of reality, a collective error, a widespread agreement about facts or interpretation that is mistaken.

Chapter ten argues that a comprehensive approach to the study of the fate of Islamic science is clearly needed, one that examines both the cultural and environmental factors, and the interaction between different cultural dynamics at work. However, since so many original documents on Islamic science have not yet been examined, it is not possible to state with confidence what the final model will look like. But on the basis of what is known, some tentative generalisations are made. Chapter eleven reflects on a few of the limits of the study, its originality and suggests directions for future research.

The next chapter will show that a huge and brilliant entity, the Islamic Empire, undertook a great deal of scientific research. This chapter highlights some of the ways in which classical and contemporary scholars have understood the importance of Islamic science, and how this understanding has progressed in recent years.