

**THE UNITY OF SCIENCE AND SPIRITUAL KNOWLEDGE:  
THE ISLAMIC EXPERIENCE**

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In this paper the term science is understood in the restricted sense of an organized, orderly and objective knowledge of the natural order. Science understood in the above sense is not the product of the modern mind alone. Such forms of knowledge had also been extensively cultivated in pre-modern civilizations such as in the Chinese, Indian and Islamic civilizations. These pre-modern sciences, however, differ from modern science with respect to goals, methodology, sources of inspiration, and their philosophical assumptions concerning man, knowledge, and the reality of the natural world.

Another major difference between pre-modern and modern sciences pertains to the place of science in relation to other kinds of knowledge. In pre-modern civilizations, science was never divorced from spiritual knowledge. On the contrary, one finds an organic unity of science and spiritual knowledge. The main aim of this paper is to explain how this unity was achieved in pre-modern times. My specific reference is to the Islamic scientific tradition. However, many of the features of Islamic science mentioned here equally apply to the other pre-modern sciences.

By spiritual knowledge I mean knowledge pertaining to the spiritual order. The essence of spiritual knowledge is knowledge of the world of the Spirit. In Islam, this knowledge refers to the knowledge of the One, of God and His Unity. The principle of Divine Unity (al-tawhīd) constitutes the central message of Islam. In Muslim classi-

fications of knowledge composed over the centuries, the knowledge of taw-  
hīd has always held to be the highest form of knowledge as well as the  
ultimate goal of all intellectual pursuits.

Spiritual knowledge is not confined solely to the world of the pure  
Spirit. It is also concerned with the manifestations of the Spirit  
in the different orders of reality that make up the whole universe.

A fundamental component of a Muslim's knowledge of God is the knowledge  
of the universe as an effect of the divine creative act. Knowledge  
of the relationship between God and the world, between Creator and crea-  
tion, or between the Divine Principle and cosmic manifestation consti-  
tutes the most fundamental basis of the unity of science and spiritual  
knowledge. In Islam, the most important sources of this type of know-  
ledge are the Qur'an and prophetic hadīths. To understand the Islamic  
conception and experience of the unity of science and spiritual know-  
ledge, it is necessary to refer to some of the key concepts and ideas  
embodied in this knowledge.

#### 1. The Qur'an as Source of Both Science and Spiritual Knowledge

The Qur'an is the fountainhead of Islamic intellectuality and spiri-  
tuality. It is the basis not only of religion and spiritual knowledge  
but of all kinds of knowledge. It is the main source of inspiration  
of the Muslim vision of the unity of science and spiritual knowledge.  
The idea of this unity is a consequence of the idea of the unity of  
all knowledge. The latter is in turn derived from the principle of  
Divine Unity applied to the domain of human knowledge.

Man gains knowledge from different kinds of sources and through

various ways and means. But all knowledge ultimately comes from God Who is the All-Knowing. In the Qur'anic view, man's knowledge of things corporeal as well as spiritual is possible because God had given him the necessary faculties of knowing. Many Muslim philosophers and scientists assert that in the act of thinking and knowing the human intellect is illuminated by the divine intellect.

The Qur'an is not a book of science. But it does provide knowledge of the principles of science, which it always relates to metaphysical and spiritual knowledge. The Qur'anic injunction to "read in the Name of Thy Lord" has been faithfully observed by every generation of Muslims. It has been understood to mean that the acquisition of knowledge including scientific knowledge should be based on the foundation of our knowledge of God's Reality. Islam, in fact, gives legitimacy to a science only if it is organically related to the knowledge of God and of the world of the Spirit. Consequently, Islamic science possesses a religious and spiritual character. According to the famous Muslim scientist, Ibn Sīnā (Avicenna), that science is true science which relates knowledge of the world to the knowledge of the Divine Principle.<sup>1</sup>

## 2. Nature as Source of Scientific and Spiritual Knowledge

Nature is a source of many types of knowledge: mathematical, physical, and metaphysical; scientific and spiritual; qualitative and quantitative; practical and aesthetical. This is because, as a world and viewed in its totality, the reality of nature is comprised of many aspects. Each type of knowledge corresponds to a particular aspect of nature that is singled out for study. Modern science has chosen

to study only some of these aspects. In conformity with its scientific conception of nature and its reductionistic and materialistic world-view, modern science ignores, belittles or denies altogether the metaphysical, spiritual, qualitative, and aesthetical aspects of nature. Eddington and Whitehead have rightly asserted that modern science is a kind of subjectively-selected knowledge since it deals only with those aspects of the reality of nature which the so-called scientific method is competent to study.<sup>2</sup>

In Islam, the unity of nature is regarded as an image of the unity of the Divine Principle. The goal of Islamic science is to demonstrate the unity of nature, that is the interrelatedness of all its parts and aspects. Consequently, Islamic science seeks to study all the different aspects of nature from a unified and integrated standpoint. For example, the fundamentality of the mathematical aspect of the universe is well recognized in Islamic science. According to the Ikhwan al-Ṣafā' (The Brethren of Purity), an eleventh-century brotherhood of Muslim scientists and philosophers, "the whole world is composed in conformity with arithmetical, geometrical and musical relations."<sup>3</sup> But this mathematical content of the universe was never studied in Islam from a quantitative point of view alone. Muslim mathematics was both a qualitative and a quantitative science.

Following the Pythagoreans, whose mathematical conception of the universe found easy acceptance into the Islamic world-view, many Muslim mathematicians speak of the "virtues" and "personalities" of various geometrical figures. One of their declared aims in studying geometry is to help prepare the human soul in its journey to the world of the spirits and eternal life.<sup>4</sup> Similarly, the science of numbers is seen

to be related to spiritual knowledge. Numbers are not merely quantitative entities on which may be performed the arithmetical operations of addition, subtraction, multiplication and division. Numbers are also qualitative entities. In its qualitative aspect, number is the spiritual image resulting in the human soul from the repetition of unity. Numbers are therefore regarded as the projection or as so many expressions of unity. Knowledge of the generation of numbers from the number one presents to the human mind a powerful illustration of the generation of all things from God. The Ikhwan al-Ṣafā' compared the creation of the world by God to the generation of numbers from One.<sup>5</sup> The number zero, whose historical origin may be traced to the metaphysical speculation of the Hindus, is said to symbolize the Divine Essence which is beyond all determinations including Being.

Mathematics as cultivated by the Muslims emerges as a primary link between the physical world and the spiritual or metaphysical world of the Platonic archetypes. Arithmetic and geometry, the foundation of the mathematical sciences, find their application in the domain of the physical sciences as well as in the domain of metaphysical knowledge of tawḥīd. Muslim philosopher-scientists like al-Fārābī, Ikhwan al-Ṣafā' and Quṭb al-Dīn al-Shīrāzī considered mathematical training indispensable to having a sound knowledge of spiritual truths.<sup>6</sup>

Nature is also a source of spiritual and metaphysical knowledge because it is not merely 'natural.' Nature also possesses a 'supernatural' aspect. In Islam, the natural and the spiritual are closely intertwined. Spiritual reality manifests itself in the natural world while remaining independent of the latter. The two orders are connected by means of a vertical, metaphysical relationship. The natural world

is variously described in the different religious traditions as an effect, a manifestation, symbol or reflection of the spiritual world. Conversely, the spiritual world is described as the cause, principle, root or archetype of the natural world.

In the religious and intellectual history of the West, however, a sharp distinction has often been made between the natural and the spiritual in a manner which is not conducive to the realization of the unity of science and spiritual knowledge. The natural world is identified with the profane and the spiritual with the sacred. There was also a sharp line drawn between the natural and the supernatural or between nature and grace. In modern science, nature has lost its sacred character. The natural world has been emptied of its spiritual content. Consequently, nature is no longer seen as having a meaningful role in religious and spiritual life.

The fact that there is something of a spiritual order that resides in nature finds numerous expressions in Islamic philosophical and theological literature. In the language of the Qur'an, nature is said to bear within itself the imprints of God. The phenomena of nature in the macrocosmic world as well as within the souls of men are said to be the āyāt (signs) of God. The verses of the Qur'an are likewise called the āyāt of God. Nature is therefore regarded as a divine revelation, a counterpart of the Qur'an. It conveys to man its metaphysical and spiritual message of transcendence. In this religious and spiritual conception of nature lies the basis of unity of science and spiritual knowledge.

Nature is also said to be a book of symbols. According to al-

Ghazzālī, everything that exists in the natural world is a symbol of something in the higher world.<sup>7</sup> Symbol in its traditional sense is to be distinguished from allegory. As traditionally understood in Islam, symbol is the "reflection" in a lower order of existence of a reality belonging to a higher ontological status. That higher world which is symbolized by the natural symbols is the spiritual world. For example, the sun symbolizes the Divine Intelligence; the empty vastness of space symbolizes the Divine All-Possibility and also the Divine Immutability; a bird symbolizes the soul; a tree symbolizes the grade of being; and water symbolizes knowledge and rain revelation. We can go on and on giving countless other examples.

There is an inner nexus between the symbol and the symbolized. This nexus is metaphysical and not physical in nature. Knowledge of the meaning of a symbol or of this inner nexus cannot be gained through logical or mathematical analysis or through empirical investigation. This knowledge belongs to that science traditionally called the science of symbolism, which is metaphysical in nature. The science of symbolism is of crucial importance to the quest for the unity of science and spiritual knowledge. For this reason, this science was cultivated in almost every pre-modern civilization. However, by its very nature, this science poses a certain difficulty to the modern scientific mind. This is because this science presupposes the acceptance of divine revelation and intellectual intuition as two fundamentally real sources of objective knowledge. It also presupposes the acceptance of other levels of existence than the physical and of the hierarchic reality of the universe. These presuppositions are found to be contrary to many of the basic assumptions of modern science.



The science of symbolism implies that natural objects are not to be regarded simply as facts as is done in modern science. Natural objects or phenomena that admit of empirical and mathematical study are also to be viewed as symbols. What this means is that the reality of a natural object is not exhausted by its scientific and mathematical content. Symbolic knowledge of natural objects is not only possible but also is no less real than the corresponding scientific or mathematical knowledge. Muslim scientists of past centuries had shown that symbolic and scientific knowledge of natural things are not contradictory or unrelated. In fact, symbolic knowledge of nature helps to reveal the metascientific or metaphysical significance of scientific facts, theories and laws discovered through empirical study of the natural world. And in a number of known cases, it was that symbolic knowledge itself which inspired Muslim scientists to embark upon new areas of scientific study leading to original discoveries in those areas. A good example is of how Suhrawardī's twelfth-century metaphysics of light and cosmology based on light symbolism helped to bring about intense scientific activity in the field of optics in thirteenth-century Islam. Quṭb al-Dīn al-Shīrāzī and his student Kamāl al-Dīn al-Fārsī made important discoveries in this field.<sup>8</sup>

The harmonious relationship between scientific and symbolic knowledge of nature is well illustrated by Ibn Sina in his work known as Oriental Philosophy. In this work, scientific facts became transformed into symbols which were to act as guide posts for the traveler upon the path of spiritual perfection in his journey through and beyond the cosmos to the Divine Presence.<sup>9</sup> Ibn Sīnā had drawn the scientific facts in question from a wide range of sciences including mineralogy,

biology, astronomy, physics, cosmology, sociology and anthropology as these sciences were known to the medieval world of his time. Physical and astronomical realities of the universe of which this scientific knowledge is a description were no longer seen in this work as external objects and phenomena to be scientifically analyzed and manipulated. Thanks to the symbolic knowledge of nature, Ibn Sina was able to see these realities as part of a cosmos of symbols through which his spiritual journey to God must pass. Scientific knowledge of the physical world can, therefore, play an important role in the formulation of the idea of a spiritual journey through the cosmos provided that the traditional knowledge of symbols is present and accepted.

Since nature is regarded as a divine revelation it is a source for gaining knowledge of God's Wisdom. Muslim scientists firmly believe that God's Wisdom is reflected in innumerable ways in His creation. They study such things as natural forms, forces, energies, laws and rhythms not only to gain scientific knowledge as currently understood but also to arrive at a better knowledge of the Divine Wisdom. Let us take the example of zoology. Muslim zoological studies were pursued with diverse ends in view. There was first of all the scientific study of the anatomy and classification of animals. Muslim classifications of animals were based on numerous criteria such as the nature of their habitats and the way they organize their

defense from external attacks.

Muslim interest in animals also arose out of practical concerns, the most important of which is the medical. Considerable attention was given to both veterinary medicine and pharmacological uses of animals. Then, there was the study of animal psychology and physiology. Another major concern displayed by Muslim zoologists was with the spiritual, symbolic, and moral significance of animals.

What is of great significance from the point of view of our present discussion is the fact that there existed many individual scientists and treatises in Islam which testify to the unity of scientific and spiritual knowledge in the domain of zoology. In al-Jāhiz, the ninth-century author of The Book of Animals, the most famous Arabic work on zoology, scientific, literary, moral and religious studies of animals are combined. According to him, the primary goal of the study of zoology is the demonstration of the existence of God and the wisdom inherent in His creation. Al-Jāhiz treated zoology as a branch of religious studies.

In the fourteenth-century zoological work of Kamāl al-Dīn al-Damīrī, entitled The Great Book of the Life of Animals,<sup>10</sup> we encounter another good example of the combining of spiritual, moral, religious and juridical, literary, scientific and medical perspectives in studying animals. Al-Damīrī even dealt with the significance of

animals in the interpretation of dreams, a discipline which is inseparable from spiritual knowledge. The injunctions of the Sharī'ah, the sacred Law of Islam, concerning dietary prohibitions related to animal flesh have inspired the study of animals from a religious and juridical point of view. Muslim concern with religious and juridical status of animals according to the Divine Law of Islam provides one of the main frameworks for the unity of science and spiritual knowledge in zoology. Many Muslim scientists were interested in discovering the scientific justification for these religious dietary prohibitions.

Careful observation was made of animal behaviour and the inner qualities and the genius of a particular animal species with a view of deriving spiritual and moral lessons from that animal species. There is a metaphysical basis for the belief that animals have much to teach man concerning the Divine Wisdom and about his own inner nature. According to Islamic spiritual tradition, man is a total reflection of the Divine Names and Qualities whereas the animals are only partial reflections. However, the reflections in animals are often more direct than those in man. Animals are symbols of cosmic qualities and of spiritual attitudes. By virtue of possessing both good and evil qualities, animals present themselves as moral teachers to man.

From the Islamic point of view, a true zoology or science of animals only emerges when all of these different

aspects of animals are taken into consideration. There is unity of scientific and spiritual knowledge in this conception of zoology. The link between the two types of knowledge is preserved not only in zoological works but also in works of art. Muslim artists drew miniatures of various animal species, which successfully captured the inner qualities of these animals. By virtue of the link that exists between the inner qualities of animals and the spiritual world, these works of art serve a kind of spiritual function, namely to enable man to contemplate the visible world as a reflection of the spiritual world.

### 3. Nature as a Source of "Divine Laws"

One of the main features of modern science is its success in the discovery of more and more of what is called in Western intellectual history "laws of nature." The idea that the cosmos has its own laws is found in all civilizations. There is order and harmony in the universe. However, in modern science, the "laws of nature" have lost their spiritual and metaphysical significance. In fact, the "laws of nature" are seen by many people today as being opposed to the "laws of God" found in religion. This modern cleavage between the "laws of nature" and "the laws of God" has disastrous consequences for the unity of science and spiritual knowledge. If we wish to restore this unity in the modern world, then one of

the possible avenues is through the reassertion of the meta-physical or spiritual status of the "laws of nature."

In Islam, there has never been any cleavage between the "laws of nature" and the "laws of God." The "laws of nature" too are divine Laws. All laws are reflections of the Divine Principle. God is the Law-Giver. He manifests His Will both in the cosmos and in the human domain through laws. In the human domain, God had prescribed a Law (Sharī'ah) for every people. The Islamic Sharī'ah is only the last to be revealed. While there are many different Divine Laws revealed to mankind in its history, which are spoken of in Islam as nāwāmīs al-anbiyā' (Laws of the prophets), there is only one Divine Law governing the whole of creation. This latter Law is called nāmūs al-khilqah (Law of creation).

Although we speak of a single Divine Law governing the whole cosmos, there are different sets of laws for different orders of creation. Even within the same order of creation, such as in the natural order, there exist different laws for different species of beings. The Qur'an itself speaks of each animal species as an ummah (religious community) implying that God has promulgated a law for each species of being. The Qur'an also speaks of each creature as possessing its own nature. The goal of Islamic science is to know the true nature of things as given by God. Islamic science also seeks to demonstrate the unity of the "laws of nature" as a reflection of the unity of the Divine Principle.

To know the nature and law of each species of being is to know the islām or manner of submission of that species to the Divine Will. This is the Qur'anic way of looking at the unity of the "laws of nature" and the revealed Law of religion. According to the Qur'an, all creatures other than the human species are necessarily Muslims, understood in this universal sense, since they cannot rebel against their own nature. In the human order, those people are Muslims who submitted to the Divine Law which God has promulgated for them. Man alone among the creatures is capable of revolting against God's laws and his own nature. From the metaphysical point of view then, there is no difference in nature between the "laws of nature" and the revealed laws of religion.

The laws governing the different orders of creation are not of the same degree of fundamentality or universality. Some laws are more fundamental and universal than others. There is an hierarchy of universality of laws of creation corresponding to the hierarchy of the created order. For example, biological laws are more fundamental and universal than physical or chemical laws since the former laws concern the biological domain which possesses a higher ontological reality than the physical domain which gives rise to the latter kind of laws. But the biological laws themselves are subject to a higher set of cosmic laws which are spiritual in nature. If the attempt to unify all the known existing laws in physics

and biology is progressively pursued and in an objective manner, then a point is reached whereby the higher, non-physical orders of reality would have to be seriously considered and examined. In other words, there is a limit to the universality of physical laws.

#### 4. Cosmological knowledge as source of conceptual framework for the unity of science and spiritual knowledge

In the foregoing discussion, I have dealt with some of the most important teachings of Islam, which provide the necessary philosophical and religious justification for the unity of science and spiritual knowledge. I asserted that this unity is realized when each of the particular sciences is organically related to the supreme knowledge of tawhīd. But what is meant by this "organic relation" and the concrete manner in which it could be achieved need further clarification.

The various natural and mathematical sciences are particular sciences in the sense that they deal with particular domains of reality. The supreme knowledge of tawhīd is a metaphysical science. It is the most universal science since it deals with the Supreme Reality which contains all things. Between the supreme knowledge of tawhīd and the particular sciences there lies a body of knowledge called cosmological knowledge.

By cosmology, I do not mean the modern discipline known by the same name. Traditional cosmology, whether



in Islam or in other civilizations, refers to that science which deals with the structure of the cosmos and its qualitative content. Insofar as cosmology deals with the whole reality of the cosmos, it is a universal science. In his famous treatise on the classification of the sciences entitled Iḥṣā' al-'ulūm (Enumeration of the Sciences), al-Fārābī considers cosmology a branch of metaphysics. He also maintains that from cosmology may be derived the principles of the particular sciences. Indeed, in Islam, cosmology plays an important role as a bridge between pure metaphysics and the particular sciences. Cosmology is a source of conceptual framework for the unity of science and spiritual knowledge.

What is meant by science being organically related to the metaphysical knowledge of tawḥīd is that the former is conceptually integrated into the latter type of knowledge. The particular sciences may be conceptually integrated into the metaphysical science of tawḥīd because the Divine Principle is the metaphysical source of the world of multiplicity dealt with by the particular sciences. However, the necessary "conceptual tools" for that integration need to be derived from cosmology.

Cosmology is competent to supply these "tools of conceptual integration" because its goal is "to provide a science that displays the interrelation of all things and the relation of the levels of the cosmic hierarchy to each other and finally to the Supreme Principle. Thereby it provides a knowledge that permits the integration of multiplicity into Unity."<sup>11</sup>

Cosmologically speaking, the world of sense perception is only one of many levels of existence. Muslims develop many cosmological

models, each of which having its basis on certain scriptural data. Each model may be identified with the use of one or more types of symbolism. For example, in the cosmological model of Muslim Pythagoreans, such as the Ikhwān al-Ṣafā', a combination of numerical, alphabetical, alchemical and astrological symbolisms is used to depict the levels and qualities of cosmic reality.

The Peripatetic model, such as that of al-Fārābī and Ibn Sīnā, makes use of the symbolism inherent in the geocentric scheme of Ptolemaic astronomy. The model of Ishrāqī philosophers employs the symbolism of light. The Sufi cosmological model of Ibn 'Arabī presents all cosmic qualities as reflections of the Divine Names and Qualities and each level of cosmic existence as a "Divine Presence." But regardless of the type of symbolism used, we may discern in all these models three fundamental levels of cosmic existence, namely the spiritual, the subtle, and the physical. This division of the cosmos is a qualitative or "vertical" one for it refers to three different levels of qualities.

Cosmology provides us with knowledge of how the three worlds are related to each other. The spiritual world is a principle of the subtle world and the latter a principle of the physical world. Cosmology therefore demands that the physical world be treated not as an autonomous domain which is cut off from higher orders of reality. It insists on the relevance of spiritual and subtle entities in the study of the physical world. For example, the traditional "ether" is a non-physical, subtle entity. Knowledge of this "ether" is essential to the understanding of the origin of the physical cosmos.

Similarly, living forms studied in the biological sciences are

essentially related to the spiritual and subtle worlds. The question of the origin of life on Earth cannot be resolved in terms of physical entities alone no matter how deep we penetrate into the molecular world. Life is a non-physical entity. It is an animating principle or energy which has penetrated into the physical realm. Molecular activities associated with living forms are not the source of life. Rather, they are a particular manifestation of life on the physical plane. The Islamic cosmological principle which is essential to the understanding of the mystery of life is the idea of the Universal Soul (al-nafs al-kullīyah). The Universal Soul is the "soul" of the natural order. It is to the natural order what the human soul is to the human body.

The Universal Soul, an entity which animates the whole cosmos, is what generates life in plants and animals. Plant and animal souls with their numerous respective powers or faculties are considered as so many faculties of the Universal Soul. The Universal Soul is itself created by God. Knowledge of the cosmic function, powers and qualities of the Universal Soul, especially in relation to the natural order, is indispensable for the integration of the biological sciences into the spiritual knowledge of tawhīd.

It is beyond the scope of this essay to go into a discussion of all the relevant cosmological principles. The examples I have given are sufficient to demonstrate the importance of cosmology as a source of conceptual framework for the unity of science and spiritual knowledge.

## 5. Conclusion

There is a need to revive traditional cosmology in the modern

world. This cosmology has an important role to play in any proposed project aimed at realizing the unity of science and spiritual knowledge. The revival of traditional cosmology does not call for the abandonment or neglect of the experimental method and the modern tools of scientific research and inquiry, which have proved so successful in the quantitative study of nature. But it does call for fundamental changes in the modern attitude toward reality and knowledge. The acceptance of traditional cosmology has profound methodological consequences. It means that the modern scientific method has to drop its claim of being the sole way of knowing things. Other possible avenues to knowledge of the universe need to be acknowledged.

Modern science must come to terms with the historical fact that there have been societies and civilizations which cultivated diverse ways of studying and knowing the natural world. This diversity of ways of knowing is not to be construed as a kind of "epistemological anarchy" as imagined by some contemporary philosophers of science. Such societies and civilizations have seen unity in this diversity, thanks to the traditional doctrine of the hierarchy and unity of modes of knowing.

The spirit of reductionism which has come to characterize modern science has impoverished the natural order. The revival of traditional sciences and the cosmological sciences on which they are based may help to bring about in modern man a consciousness of the richness of reality.

## Notes

1. F. Brunner, Science et réalité, Paris, 1954, p. 13.
2. S.H. Nasr, Man and Nature: The Spiritual Crisis of Modern Man, Allen and Unwin, London, 1976, p. 28.
3. See S.H. Nasr, An Introduction to Islamic Cosmological Doctrines, Shambhala, Boulder, 1978, p. 45.
4. Ibid, p. 49.
5. "Know, oh Brother (May God assist thee and us by the Spirit from Him) that God, Exalted Be His Praise, when He created all creatures and brought all things into being, arranged them and brought them into existence by a process similar to the process of generation of numbers from one, so that the multiplicity [of numbers] should be a witness to His Oneness, and their classification and order an indication of the perfection of His Wisdom in creation. And this would be a witness to the fact, too, that they [creatures] are related to Him who created them, in the same way as the numbers are related to the One which is prior to two, and which is the principle, origin and source of numbers, as we have shown in our treatise on arithmetic." Ikhwān al-Ṣafā', Rasā'il, 'Arabiyyah Press, Cairo, 1928, trans. by S.H. Nasr in his Science and Civilization in Islam, Dewan Pustaka Fajar, Kuala Lumpur, 1984, pp. 155-6.
6. I have dealt with the views of al-Fārābī and Quṭb al-Dīn al-Shīrāzī on this question in my doctoral thesis, Classification of the Sciences in Islamic Intellectual History: A Study in Islamic Philosophies of Science (To be published).
7. See his Mishkāt al-anwār, trans. by W.H.T. Gairdner, Muhammad Ashraf Publications, Lahore, pp. 121-5.
8. For a discussion of these discoveries, see E.S. Kennedy, "The Exact Sciences in Iran under the Seljuqs and Mongols," Cambridge History of Iran, vol. V, ed. by J.A. Boyle, Cambridge, 1968, p. 676.
9. See H. Corbin, Avicenna and the Visionary Recitals, trans. W.R. Trask, Spring Publications, Texas, 1980.
10. For a modern study of this work, see J. de Somogy, " 'Ad-Dāmīrī's Ḥayāt al-ḥayawān: An Arabic Zoological Lexicon," Osiris, vol. 9 (1950), pp. 33-43.
11. See S.H. Nasr, "The Cosmos and the Natural Order," in Islamic Spirituality: Foundation, ed. S.H. Nasr, vol. 19 of World Spirituality: An Encyclopedic History of the Religious Quest, Routledge and Kegan Paul, London, 1987, p. 350.