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IBN SĪNĀ'S COSMOLOGY:
A STUDY OF THE APPROPRIATION OF
GREEK PHILOSOPHICAL IDEAS IN 11TH CENTURY ISLAM

BY
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ABSTRACT

This is a study of the appropriation of Greek philosophical thought in Islam as illustrated through the system of Ibn Sinā in general and his cosmology in particular. Concerned not so much with mathematical or astronomical problems as with philosophical issues in cosmology, this study examines and evaluates Ibn Sinā's theses and arguments on a variety of cosmological issues, from the general cosmic picture, celestial system and motion, the concept of nature, change and generation, the problem of causality, necessity and chance, the notion of place and void, to the question of cosmic origin and emanation, the issue of eternity of the universe, the classification and hierarchy of beings, to the problem of individuation. It is the contention of this study that while it is true that Ibn Sinā derived much from the Greek philosophical tradition, still his cosmology cannot be dismissed as simply Aristotelian or Neo-Platonic. As this study shows, Ibn Sinā not only appropriated, elaborated, sifted and refined it, making new attempts at resolving vexed problems and developing a new system of his own, but he succeeded in integrating those foreign ideas within the Islamic *Weltanschauung* or "islamized" them---as we may so say.

ملخص البحث

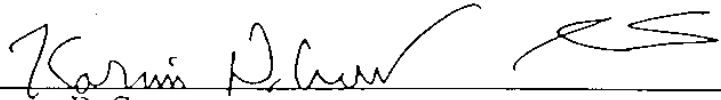
هذه دراسة عن موقف المفكرين المسلمين في انعصور الوسطى، وموقف ابن سينا على الأخص، من آراء فلاسفة اليونان، كيف استفاد منها وكيف استعملها لإقامة مذهبه المبني على مبادئ التوحيد غير المناقض لتعاليم الإسلام. هذه الدراسة، وإن لم تتناول المسائل الرياضية والحسابية المعلومة في علم الهيئة، فإنها تحاول عرض واستقصاء وتحليل آراء ابن سينا المتعلقة بالأمور الكونية والإلهية وما وراء الطبيعة، فتبحث عن طبيعة العالمين (فوق فلك القمر وتحتة) ونظامهما، وعن ماهية الطبيعة والحركة والتغير والكون والفساد، وعن مشكلات السببية والبحث والاتفاق، وعن نظريته في المكان والخلاء، كما تفحص أيضا عن مذهبه في علاقة الموجودات الحوادث بواجب الوجود تعالى ونسبتهما إلى القدم والبقاء، وعن رأيه في التجوهر والتعين والتشخص. وقد تبين من هذه الدراسة أن ابن سينا لم يقتصر على الأخذ والإقتباس من تراس الفكر اليوناني، بل أسهب فيه وهذب، وأتقن فيه وأحكم، فحل مشكلاته ومعضلاته، وهو مع ذلك قد نجح في محاولته لإدماج آراء هؤلاء الفلاسفة والتوفيق بينها وبين مبادئ الإسلام، كما نجح في بناء مذهب فكري جديد.

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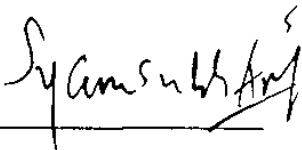
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“Ibn Sinā’s Cosmology: A Study of the Appropriation
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I hereby declare that this thesis is the result of my own investigation, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references and a bibliography appended.

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INTRODUCTION

It is often claimed in histories of philosophy that Islamic philosophy's only merit is its transmission of Greek thought, mainly Aristotelian and neo-Platonic one.¹ False as this claim is, it oversimplifies the subject in a misleading way. By dispensing with the need to study Islamic philosophy in its own right, such a claim relieves one of all the technical obstacles to a proper understanding of the subject. A strange language, a different religion and an altogether foreign cultural context---these and numerous other considerations are dismissed at once. Far from being like parrots, at best repeating what had been said in classical antiquity, the Muslim philosophers were by no means passive recipients of Greek philosophy. In fact, they adopted and adapted, commented and elaborated, criticized and sifted, revised and refined; they introduced distinctions, remolded concepts, reinterpreted and infused new meanings to old terms, while making new attempts at resolving vexed problems and developing new systems of their own. In short, they sought to 'naturalize' as well as integrate those foreign ideas into the Islamic *Weltanschauung*, that is to "islamize" them, so that it became part of Islamic culture and civilization.

A case in point is Ibn Sīnā (980--1037 C.E.),² the most systematic and original of all Muslim philosophers. Admittedly, much of what Ibn Sīnā discussed was not new; many of the ideas already existed in Aristotle or Plotinus. Nevertheless, Ibn Sīnā, who was a Muslim by faith and culture, had the insight to put those ideas in a new context and apply them in the construction of a system that was to make

¹ For a survey of reductionistic views, see Hans Daiber, "What is the Meaning of and to What End Do We Study the History of Islamic Philosophy? The History of A Neglected Discipline," in his *Bibliography of Islamic Philosophy*, 2 vols. (Leiden: E. J. Brill, 1999), 1:xi--xxxiii; cf. Dimitri Gutas, "The Study of Arabic Philosophy in the Twentieth Century - An Essay on the Historiography of Arabic Philosophy," *British Journal of Middle Eastern Studies* 29/1 (2002): 5--25.

² That is Abū 'Alī al-Husayn ibn Sīnā. For a detailed survey, see Soheil M Afnan, *Avicenna: His Life and Works* (London: George Allen & Unwin, 1958) and Dimitri Gutas, *Avicenna and the Aristotelian Tradition* (Leiden: E. J. Brill, 1988).

entirely his own. Indeed, in philosophy as in many other things, the quest after originality is an idle pursuit. Ideas grow out of other ideas; they are suggested by random thoughts and can be developed out of all recognition. This holds true in the case of Ibn Sinā. He did not merely receive and slavishly reproduce what came down to him through Hellenism. Nor was he a mere commentator on Aristotle.³ Rather, as this study attempts to show, Ibn Sinā not only appropriated the tradition, but most importantly he developed a complete and elaborate system of his own. It is my contention that while it is true that he derived much from Aristotle,⁴ still Ibn Sinā's philosophy cannot be dismissed as simply Aristotelian. Philosophy is an edifice of human wisdom, with each age contributing a building block. No philosophy can be isolated; it is always either a continuation of, or a response, sometimes revolutionary, to a previous philosophy. This holds true even in the case of the seemingly original Greek culture itself. For as Rudolf Macuch rightly points out:

We know, since Hegel, that history is a dialectical process and that without a thesis and an antithesis there would be no synthesis. There is, in spite of all new contributions to human culture, no absolutely independent culture and civilization. The Greeks were the first Orientalists in history. They not only adopted the Semitic alphabet invented by the Phoenicians, but they also absorbed Oriental cultures, digested them and presented them to us in such an admirably new form that their different originals often become quite unrecognizable. They also preserved for us much precious information about Oriental peoples and cultures which would otherwise have got lost. But from their very beginnings they transmitted to us many Oriental thoughts in such a completely Hellenized form that we are often tempted to take them for original Greek. The greatness of the ancient Greek spirit consists

³ Regarding the encyclopedic *kitāb al-Shifā*, for instance, Paul Lettinck correctly observes that: "Ibn Sinā's way of discussing things, his formulations and examples are independent of Philoponus, and generally one may say that it is a unique and original work regarding style and content." Lettinck, *Aristotle's Physics and Its Reception in the Arabic World* (Leiden: E. J. Brill, 1994), 2.

⁴ By the time of Ibn Sinā, nearly all of Aristotle's works were available in either Syriac or Arabic versions or both. See Ibn al-Nadim, *Kitāb al-Fihrist*, ed. G. Flügel, 2 vols. (Leipzig: F.C.W. Vogel, 1871), 1: 248--51; also F.E. Peters, *Aristoteles Arabus* (Leiden, 1968), and D. Gutas, *Greek Thought in Arabic Culture: The Graeco-Arabic Translation Movement in Baghdad and Early 'Abbasid Society (2nd-4th 8th-10th Centuries)* (London: Routledge, 1998).

exactly in that perfect assimilation of manifold Oriental ideas in a new vestment which gave birth to our Occidental civilization. There have always been and will be mutual influences between the cultures.⁵

This work is a study of the appropriation of Greek philosophical thought in Islam as illustrated through the system of Ibn Sinā in general and his cosmology in particular. I borrow the term “appropriation” (instead of “reception”) as used by Professor Sabra⁶ to describe what the Muslims of the eighth, ninth, tenth and eleventh centuries did and achieved following their full exposure to Greek learning, whereas by the term “cosmology” I mean a general explanation for the universe as a system of interconnected and interdependent entities. Although this work is focused on Ibn Sinā as an “appropriator” of Greek philosophical thought, this does not mean that this was his only source of inspiration. Studies by scholars such as Jolivet and Marmura have shown that he was also familiar with and influenced by the Kalām thinkers.⁷

The chief aim of this study is to attempt an analytical exposition of Ibn Sinā’s cosmology and examine his theses and arguments on a variety of cosmological issues, ranging from the general cosmic picture, celestial system and motion (Chapter One), the concept of nature, change and generation (Chapter Two), the problem of causality, necessity and chance (Chapter Three), the notion of place and void (Chapter Four), to the question of cosmic origin and emanation (Chapter Five), the issue of eternity of the universe (Chapter Six), the classification and hierarchy of beings (Chapter Seven), to the problem of individuation (Chapter Eight). Our concern is therefore confined to philosophical issues in cosmology, and not so much with mathematical or astronomical problems.

⁵ Rudolf Macuch, “Greek and Oriental Sources of Avicenna’s and Sohrawardi’s Theosophies,” in *Graeco-Arabica* 2 (1983), 15.

⁶ See A. E. Sabra, “The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement,” *History of Science* (1987): 223--43; cf. Muhsin Mahdi, “Approaches to the History of Arabic Science,” in the *Encyclopedia of the History of Arabic Science*, ed. Roshdi Rashed, 3 vols. (London: Routledge, 1996), 3: 1026--1044.

⁷ This could be the subject of a separate study. See J. Jolivet, “Aux Origines de l’Ontologie d’Ibn Sinā,” in *Études sur Avicenne*, ed. J. Jolivet and R. Rashed (Paris: Les Belles Lettres, 1984), 221--36, and M. E. Marmura, “Avicenna and the Kalām,” *ZGAIW* 7 (1991-92): 172--206.

CHAPTER ONE

CELESTIAL SYSTEM, NATURE AND MOTION

Following Aristotle, Ibn Sinā divides the universe into two realms: the celestial world (*samā'*) of heavenly substances or spheres (*aflāk*) above the lunar orbit, and the terrestrial world of generation and corruption (*'ālam al-kawn wa al-fasād*) below the sphere of the moon. In what follows, we shall consider at some length (1) Ibn Sinā's picture of the universe in general, (2) his denial of the existence of many universes, and finally, (3) his views concerning the nature and motions of heavenly bodies.

1.1. General Picture of the Cosmos

Drawing on Aristotle's cosmology and Ptolemaic astronomy, Ibn Sinā constructs his own model of the universe according to which the cosmos consists of nine concentric spheres contiguously nested one within the other from the lowest sphere of the moon to the outermost starless sphere. These spheres are said to be concentric because they all share a common center, which is the center of the universe, taken as coincident with the earth's center. On this model, each of the seven known 'wandering stars' or planets (*al-kawākib al-mutaḥayyirah*)--namely, the moon, the two inner planets (Mercury and Venus), the sun, and the three outer planets (Mars, Jupiter, and Saturn), and the 'fixed stars' (*al-thawābit*) are assumed to be attached to eight solid but transparent spheres that carry them (*al-aflāk allatī taḥmiluhā*) as they revolve around the earth.¹ In addition, there is a ninth, outermost sphere (*kurah khārijah 'anhā muḥīṭah*), which defines the edge or boundary of the universe and supposedly

¹ See *al-Shifā': al-Ilāhiyyāt*, 401 lines 6--17; *al-Shifā': al-Riyādiyyāt: 'Ilm al-Hay'ah*, ed. Muḥammad Mudawwar and Imām Ibrāhīm Aḥmad (Cairo, 1980), 463; and *al-Shifā': al-Tabi'iyāt: al-Samā' wa al-'Ālam*, ed. Maḥmūd Qāsīm (Cairo: Dār al-Kātib al-'Arabi: 1969), 37 line 12; cf. Ibn Ḥammūdāh, *Mukhtaṣar 'Ilm al-Hay'ah li al-Shaykh al-Ra'is Abi 'Alī ibn Sinā in Kitāb al-Mahrajān li Ibn Sinā (Le Livre du Millénaire d'Avicenne)* (Tehran: Société pour la Conservation de Monuments Nationaux, 1956), III: 1--10. Ibn Sinā is following Ptolemy closely on this subject; cf. also "The Arabic version of Ptolemy's Planetary Hypotheses," ed. B. Goldstein in *Transactions of the American Philosophical Society*, 57/4 (1967): 27--9.

contains no star (*ghayr mukawkabah*), posited to explain the daily motion of the heaven, whereas the motion of the eight sphere (that of the fixed stars) is said to be due to the precession of the equinoctial points (*nuqtatā al-i'tidāl*).² Each of these spheres, according to Ibn Sīnā, is governed by an intelligence and a soul, which are the remote cause and proximate principle of their motion respectively.

Ibn Sīnā's model rests on four fundamental assumptions, namely: (1) that the universe is one in number, (2) that it is finite in extent and spherical in shape, (3) that it has a center, and (4) that the earth lies at its center. Let us first consider the third and fourth assumptions. Ibn Sīnā argues for the central position of the earth by means of a logical argument which derives basically from Aristotelian physical theory of natural motion and natural place of the four elements (earth, water, air, fire). For him as for Aristotle, any motion of natural bodies (that is, anything capable of motion and change, whether animate or inanimate) is either simple or composite, natural or unnatural. Simple motions, which belong to simple bodies (as opposed to composite bodies), are either rectilinear (*mustaqīmah*) or circular (*mustadīrah*). Simple rectilinear motions are either motion away from the center (*min al-wasaf*), motion toward the center (*ilā al-wasaf*), or motion about the center (*'alā al-wasaf*).³ Motion away from the center toward the cosmic circumference, termed upward motion, is natural to light bodies, whereas motion toward the center, called downward motion, is natural to heavy bodies.⁴ The motion of a body is said to be natural (*tabī'iyah*) if it drives the moving body toward its natural place in which it will rest 'naturally', that is, by nature and not by an external force, whereas unnatural motion is that which is due to some external force contrary to the thing's nature⁵---"nature" being identified

² *Al-Shifā': al-Ilāhiyyāt*, 392 lines 10--14; cf. *Maqālāt al-Iskandar al-Afrūdīsī fī al-Qawl fī Mabādī' al-Kull*, in *Aristū 'ind al-'Arab*, 265 = Genequand, *Alexander of Aphrodisias on the Cosmos*, 12 and 82--5. See also C. A. Nallino, "Astrologia e astronomia presso i Musulmani" *Raccolta di scritti editi e inediti* (Rome: Istituto Per L'Oriente, 1944), 5: 64--6 and 75, cited in G. Endress, "Averroes' *De Caelo*: Ibn Rushd's Cosmology in his Commentaries on Aristotle's *On the Heavens*," *Arabic Science and Philosophy* 5 (1995), 43-4; and R. Walzer, *al-Fārabi on the Perfect State* (Oxford: Clarendon Press, 1985), 364.

³ *Al-Shifā': al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 6 lines 5--7.

⁴ *Al-Shifā': al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 7 (line 18) and 8 (lines 1--6).

⁵ See *al-Najāt*, 109--10 (Cairo, 1938).

as an intrinsic principle of being moved and being at rest.⁶ Since the sub-lunar elements (*'anāṣir*) are natural simple bodies (*basā'if*), their motions must be both simple and natural,⁷ but also rectilinear and not circular because, if nothing hinders, each of the elements will by nature either move straight up or straight down, seeking its natural place.⁸ By 'natural place' (*ḥayyiz tabi'i*) is meant the place to which a natural body is moved or inclined to move and where it will rest naturally,⁹ namely, the cosmic center for heavy bodies, and the circumference for light ones. Given all these principles, it is reasonable for Ibn Sinā to conclude that the earth must lie at the center of the universe. This is so because the earth, being the heaviest of all the elements, must naturally move toward the center and cannot be placed anywhere but where it belongs by nature. Indeed, even if at any time it should not have been at the centre of the cosmos, it would have been bound to reach it long ago by natural rectilinear motion which, because of the finiteness of directions (*tanāhī al-jihāt*) within the universe, cannot be perpetual. And now that it is situated in its natural place, the earth must be at rest and motionless. That is to say, given its present natural position, the earth cannot have rectilinear motion; nor can it revolve about an axis at the center of the universe because circular motion belongs only to celestial bodies.¹⁰

Interestingly, however, Ibn Sinā discards other arguments for the geocentric thesis on the grounds that they all share one wrong assumption, namely, that "the earth is forced to stay at the center (*al-arḍ maqṣūrah 'alā al-qiyām fī al-wasat*)."¹¹ For how can, he asks, a thing be forced [to remain somewhere] except when it is not in its natural place?¹¹ Thus Ibn Sinā rejects, for example, the theory which says that the earth stays as it is and does not fall downward because it floats on water, or that it remains stable by virtue of its dryness. For still one can ask, Ibn Sinā contends, the further question of what then supports the water. He also rejects the idea that the earth

⁶ *Al-Shifā': al-Ṭabī'iyyāt: al-Samā' al-Ṭabī'i*, 34 lines 8--9. See also Chapter Two of this work.

⁷ *Al-Shifā': al-Ṭabī'iyyāt: al-Samā' wa al-'Ālam*, 9 lines 17--8.

⁸ *Al-Shifā': al-Ṭabī'iyyāt: al-Samā' al-Ṭabī'i*, 318 (lines 5--17) and 319 (lines 1--9).

⁹ *Al-Najāt*, 134--5 (Cairo, 1938).

¹⁰ *Al-Shifā': al-Ṭabī'iyyāt: al-Samā' wa al-'Ālam*, 55 lines 5--7.

¹¹ *Al-Shifā': al-Ṭabī'iyyāt: al-Samā' wa al-'Ālam*, 57 lines 6--7.

is at rest because it is like a cylinder in shape (*tabliyyat al-shakl*), having an extended plane surface top and bottom (*musattāḥat al-qa'r munbasīṭah*). Equally unacceptable to him is the idea that the earth has a ball-like shape (*kuriyyah*) and that it stays aloft and motionless, not supported by anything but staying where it is because it is pulled to every direction with the same force by the celestial sphere and therefore remains at the same distance from everything.¹² That this cannot be the case is explained by Ibn Sinā in the following passage:

As for those who say that [the earth is at rest and motionless] because of the attraction (*jadhb*) of the celestial sphere from all directions equally, their claim and opinion are flawed in several respects. First, if we suppose that this attraction has vanished, then the earth would either stay still in the center or it would rather move. Now if it were to move, then it certainly would move toward the sphere---for those people think that the sphere contains [the earth] and that the earth is in the middle---so that if it moved toward the sphere, then it would have turned its natural motion upward, which is impossible. But if it stays where it was, then the reason they give for the earth's quiescence is superfluous; even without that reason [the state of] being at rest would still be there. [For if there is] something whose very existence does not require the existence of something else, [then] this something else cannot be the cause for that thing which does not need it at all. Therefore, such an attraction cannot be the cause for the earth's quiescence. Secondly, small things would be attracted faster than big things; but why is it that a piece of earth is not attracted toward the sphere, and instead is moving away from it toward the center? Also, things near [to the sphere] would be attracted more than things far away, according to their nature; now, a piece of earth thrown up [to the air] is [on such an assumption] approaching the sphere, so that it should have been attracted to its [the sphere's] nearest point, rather than to the whole earth. Furthermore, as you know, rectilinear natural motion must lead to the place of rest (*jihat al-qarār*) naturally, and a piece of earth simply moves in order to be at rest, be it at the sphere [i.e. the periphery] or at the supposed

¹² *Al-Shifā'*: *al-Tabi'iyāt: al-Samā' wa al-'Ālam*, 56 lines 7--18 and 58 lines 6--16.

center; but it does not move toward the sphere---for otherwise the opposite direction of its motion would be more appropriate, since it is nearer. Therefore, it [the piece of earth] must have moved toward the center to be at rest by nature.¹³

As we can see, here and in the subsequent passages Ibn Sinā emphasizes clearly that it is neither 'by force' (*qasran*), nor 'by choice' (*ikhtiyāran*), nor 'by chance' (*bi al-bakht*), but rather 'by nature' that the earth stays where it is, at rest at the center of the universe. It cannot be due to some coercive factor, he says, because it is impossible for the sphere surrounding the earth to change the earth's inclination (*mayl*) by repulsion (*daf'an*). For if it were possible, then a piece of earth falling toward the center would move less quickly the closer it is to the earth, because the speed of a body moved by force diminishes the farther away it is from the moving agent. Nor can we say that it chooses to be so, because being inanimate the earth cannot have choice or will of its own, but simply behaves in accordance with its nature. Ibn Sinā also rejects the view that the earth owes its stability to chance on the grounds that what happens by chance cannot be perpetual and is itself due to some cause.¹⁴ As we can see, all these arguments for the stationary and central position of the earth ultimately rest on his theory of *mayl* which says, *inter alia*, that "every body will lose its inclination once it reaches its natural place."¹⁵

Turning to the idea that the universe is finite in extent and spherical in shape, having the outermost, starless sphere as its circumference and the earth at its centre, Ibn Sinā seems content with just a brief argument. For him as for Ptolemy whose *Almagest* he paraphrased, sphere is the only figure most fitting for circular motion such as that of celestial bodies, and is the noblest (*ashraf al-ashkāl*)¹⁶, most encompassing (*azyaduhā ihātatan*),¹⁷ and most perfect because of its unique form limited by a single surface. Most importantly, it is the only one which, by rotating on

¹³ *Al-Shifā'*: *al-Ṭabī'iyyāt: al-Samā' wa al-'Ālam*, 59 lines 7--19 and 60 lines 1--7.

¹⁴ *Al-Shifā'*: *al-Ṭabī'iyyāt: al-Samā' wa al-'Ālam*, 61 lines 1--13.

¹⁵ *Al-Shifā'*: *al-Ṭabī'iyyāt: al-Samā' wa al-'Ālam*, 69 lines 1--2.

¹⁶ *Al-Shifā'*: *al-Ṭabī'iyyāt: al-Samā' al-Ṭabī'i*, 41 line 14.

¹⁷ *Al-Shifā'*: *al-Riyādiyyāt: 'Ilm al-Hay'ah*, 16 (line 11) and 19 lines 5--10.

its axis, can move within its own limits without change of place. Indeed, sphere is among bodies as the circle is among plane figures; it is the most uniform of all solid figures, since it is equidistant every way from centre to extremity. Now, according to Ibn Sīnā, one can infer the universe's sphericity from the circular motion of the heavenly bodies. The cosmic sphere cannot be infinite, because an infinite body is logically impossible, as will be shown later. Being spherical, the universe is said to exhaust all space, so that there exist neither body nor place nor void outside this all-embracing cosmic sphere.¹⁸ This view has led Ibn Sīnā to maintain, paradoxically, that the universe is not in a place, since 'place' is defined as that *in which* a body is found and that which contains or surrounds the body¹⁹---a definition which doubtless presupposes the existence of at least two contiguous bodies, 'place' being the innermost surface of the containing body in direct contact with the contained body, and implies that no two bodies can occupy one and the same place at the same time.²⁰ Now it is easy to see why the universe or heavens as a whole cannot be said to be in place: the whole body (that is, the universe) is surrounded neither by another body nor by a void, since it is assumed that there is no such thing and there exists no material body beyond the universe to serve as its container. (We shall return to this problem of place and void later). To be sure, denial of a place to the last, outermost sphere constituting the whole universe is a consequence forced upon Ibn Sīnā in order to avoid an infinite regress of material places; for if the outermost sphere is contained by another sphere, the latter, in turn, would require a further containing sphere, and so on, *ad infinitum*, a process that would inevitably lead to the assumption of an infinite universe.

Not only the whole cosmos is thought to be spherical but also the earth is believed to have a ball-like shape.²¹ That the earth cannot be flat almost necessarily follows from the theory of elemental motion according to which the heavy element

¹⁸ See *al-Shifā': al-Ṭabī'īyyāt: al-Samā' al-Ṭabī'ī*, 104--5.

¹⁹ *Al-Najāt*, 118 (Cairo 1938).

²⁰ *Al-Shifā': al-Ṭabī'īyyāt: al-Samā' al-Ṭabī'ī*, 263 line 14.

²¹ *Al-Shifā': al-Ṭabī'īyyāt: al-Samā' al-Ṭabī'ī*, 41 line 8.

earth is naturally inclined toward the center of the universe, just as the light one by nature tends to move up toward the circumference. Thus, supposing that the earth was originally in the state of dispersal, when the dispersed particles of earth travelled to the center (i.e. to the earth), they would naturally impinge upon one another and form a spherical body, because any anomalies (*taḍāris*) would be self-correcting: a lump on the sphere would be heavier than the counter-balancing portions of it, and so it would continue to press toward the center until all was in balance, just like the case of water seeking its own level, although such a process would no doubt take a very long time, was gradual and hence hardly noticeable, given the earth's dryness and hardness.²² Indeed, for Ibn Sīnā the sphere is just the natural shape (*shakl ṭabī'i*) of simple bodies,²³ which is why each of the elements is supposed to seek and stay at their proper natural place, forming its own sphere and surrounding one another.²⁴ Furthermore, given its central position and being mostly composed of the heaviest element, the earth cannot but be spherical, for only a spherical body could be equidistant (*fī sawā' al-wasat*) from all the points on the cosmic circumference.²⁵ The sphericity of the earth can also be inferred from the curved, crescent-like (*hilālī*) or even sometimes circular shadow which it casts on the moon's surface no matter at what position it passes the moon.²⁶ Added to that is the observation that the portion of the sky that is visible changes as one moves even quite a short distance north or south on the earth's surface.²⁷

²² See *al-Shifā': al-Ṭabī'iyyāt: al-Samā' wa al-Ālam*, 19--21; cf. *al-Najāt*, 135 (Cairo 1938).

²³ See *al-Najāt*, 135 (Cairo 1938); cf. *Al-Shifā': al-Riyādiyyāt: 'Ilm al-Hay'ah*, 19 lines 7--10.

²⁴ See *al-Najāt*, 136--7 and 144-5 (Cairo 1938).

²⁵ *Al-Shifā': al-Riyādiyyāt: 'Ilm al-Hay'ah*, 21--3.

²⁶ *Al-Shifā': al-Ṭabī'iyyāt: al-Samā' al-Ṭabī'i*, 42 line 13.

²⁷ *Al-Shifā': al-Riyādiyyāt: 'Ilm al-Hay'ah*, 20--1; cf. *al-Shifā': al-Ṭabī'iyyāt: al-Samā' al-Ṭabī'i*, 41 line 17. Ibn Sīnā does not, however, invoke the a priori argument found in Aristotle that all heavy bodies fall at equal angles to the earth's surface; that the angles between the line of fall and all lines on the earth's surface radiating from the point of impact are all equal. Consequently, lines of fall (that is, the lines directed toward the center of the universe) are not parallel to each other, for only if the earth were like a flat disk would lines of fall, vertical to the earth's surface, be parallel. See Aristotle, *De Caelo*, 296b 16--25.

1.2. Impossibility of Many Universes

Along with Plato and Aristotle, Ibn Sīnā denies the existence of other universes apart from our own. For him there cannot be more than one universe, and he adduces two arguments in support of this view. First, he says, if there were many universes (*'awālim kathīrah*) then a given body (say, water) would have several natural places differing only numerically yet placed and scattered in diverse directions. The body would consequently be subject to contrary natural motions (simultaneously towards and away from the centre, some would move downward while other upward); and since natural motions and natural places are interdependent, this indetermination of motion would imply an indetermination of place. Moreover, the contradiction would result that places would be both determinate (since they would form a universe) and yet, at the same time and in the same respect, also indeterminate (since they would be the goals of contrary motions).

If [assuming that there were many universes] every universe is the same in form as another, such that in each universe there exist similar earth, fire, water and air, then bodies of the same species would tend [to move] to many natural places that vary in position or in nature, and this we have shown to be absurd. Rather, as we have explained in [the treatise on] the universal principles, there must be one place where all earths would gather forming a single sphere and fill it. Likewise is the place of each of the remaining elements. Now if that is the case, then [the element] earth, for instance, either would be forced to stay in all [those universes], so that it would have no [single] natural place, which is impossible; or its [current] place would be natural in all [universes], which is equally impossible, as we have explained; or its natural place should be one only, but it has been forced to remain in other places. But if so, how can it be distinguished from bodies that determine directions and are impenetrable? What then is the difference between them? And from this it would follow that one nature [i.e. a natural body] moves naturally towards contrary directions (*takūn ṭabi'ah wāḥidah tataharrak bi al-ṭab'i ilā jihāt mutadāddah*).²⁸

²⁸ *Al-Shifā': al-Ṭab'iyyāt: al-Samā' wa al-'Ālam*, 74 lines 5--14.

Secondly, if there were many universes, then there would be more than one center. But such a situation is impossible because, Ibn Sinā argues, the earth of each universe, each being the center, must by virtue of their similar nature eventually gather in one place, forming a new center; there is no reason why they should not do so (*hādhā al-ijtimā' mim mā lā māni'a lahu 'anhu fī ṭab'ihī*), for one and the same nature cannot be separated and differentiated (*fa inna al-ṭabī'ah al-wāhidah al-mutashābihah la taqtadī al-iftirāq wa al-tabāyun*).²⁹ That is to say, if there were another universe, its elements would be one and the same as those in our universe; and since all elements are essentially the same everywhere and so are moved toward their respective natural places, each element would be moved to its proper place in our universe---for example, earth would be moved to the center of our world---which is impossible because from the point of view of its own universe, earth would be moved upward (that is, away from its center), just as earth from our universe would be moved upward if moved toward the center of another cosmos.

All earths are one in [that they have the same] natural form. And as mentioned earlier, things that are one [that is, similar] in form must have the same natural place in which all of them should gather---as scientific verification and explanation has shown. It follows that all other earths cannot remain in various places naturally and have no choice but [to move and rest in] their natural place. Also, the earth that has reached its natural place will not move rectilinearly, as we already know; but neither will it move circularly, because by nature earth can only have rectilinear motion. And as we have explained, no single body can have a natural tendency for both rectilinear and circular motions.³⁰

In short, the assumption of more than one universe entails not only the denial of the identical natures of the elements and the oneness of their respective motions throughout the different universes, but also the denial of place as the principle

²⁹ *Al-Shifā': al-Ṭabī'iyāt: al-Samā' wa al-'Ālam*, 75 lines 1--3.

³⁰ *Al-Shifā': al-Ṭabī'iyāt: al-Samā' wa al-'Ālam*, 54 (line 17) and 55 (lines 1--7).

rendering the cosmos determinate in respect to direction---that is, in respect to “up,” “down,” and “middle.” For the natural motion of each element is defined in relation to its “where” or place in the universe; and it is either away from the center and toward the circumference (*min al-markaz ilā al-muḥīṭ*), or toward the center and away from the circumference, or about the center.³¹ In other words, if there were many universes existing in an infinite space where there is neither center nor circumference, there would be no motion, since bodies would have no place to serve as the goal of their motion and one could not point to one direction as up and another as down.

Furthermore, how can there be [many cosmic] heavens (*samāwāt*) for different places? What is it that makes their places different, such that there should be numerous centers? Indeed from the foregoing theses it is clear that heaven constitutes the cause for determining all other places, and therefore all other places cannot be the cause for defining its place. So the cause for [defining] the different places [of those heavens]---in such a way that they do not pass across one another and do not share one common place---must be something other than their own nature; nor can it be some other bodies whose very places are defined by them [i.e. the heavens]. And no doubt, it must be by constraint if not something natural---unnatural both in respect to the [celestial] body and in respect to the other bodies. But we have said that compulsory change of place (unnatural locomotion) is impossible in the case of this [celestial] body. Therefore, since it is impossible for the defining bodies that are similar in nature (*al-muḥaddidāt al-mutashābihat al-ṭibā'*---namely, the heavens of the presumed universes) to have different places by nature, just as it is impossible by compulsion, there cannot be many centers. Such being the case, we have made it clear that there cannot be many universes with similar elements having similar nature.³²

³¹ *Al-Shifā'*: *al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 6 lines 5--7; cf. Ibn Sinā, *'Uyūn al-Ḥikmah*, ed. 'Abd al-Rahmān Badawī (Cairo: Institut Français d'Archéologie Orientale, 1954); repr. in *Rasā'il Ibn Sinā* (Qom: Intishārāt Bidār, 1980), 35 (Page reference to the reprint edition).

³² *Al-Shifā'*: *al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 75 lines 3--13.

1.3. The Nature and Motion of Celestial Bodies

Before dealing with Ibn Sīnā's theory of celestial motions, it is worth discussing his views on the nature of heavens. According to Ibn Sīnā, heavenly substances differ fundamentally from earthly things in many respects. First of all, celestial things are simple in two senses: first, in that they are not composite and, second, in that they are made of a unique simple substance called aether (*athīr*), which unlike the four sublunary elements, is eternal and changeless in the sense that it is neither generated nor destructible (*lā yaqbal al-kawn wa al-fasād*).³³ This is because generation and destruction apply only to composites---that is, things which contain contrary qualities, and represent change into and out of opposites, as will be explained below. Indeed, this so-called 'fifth element' (*al-jism al-khāmis* or *al-ṭabī'ah al-khāmisah*;³⁴ the *quinta essentia* of the medieval scholastics) is immune not only to the process of generation and destruction (substantial change) but also to other kinds of change, such as locomotion (which entails movement to natural place in search of rest), alteration (qualitative change), and growth and diminution (quantitative change), since all these changes imply contrary qualities, whereas heavenly bodies are simply devoid of contraries (*lays lahā 'unṣur ayy shay' qābil li'l-diddayn*).³⁵ The simple celestial substance (the aether), Ibn Sīnā tells us further, moves only in a circle, circular motion being the only simple motion natural to it on the grounds that the other simple motion, the rectilinear one, is natural and belongs to the four simple terrestrial elements (fire, air, water, earth) or anything composed of them in which one element predominates (*bi ḥasab al-ghālib*).³⁶ For given that each of the simple (terrestrial) bodies has one natural motion only (e.g. either upward or downward) and since a motion can, if at all, have only one contrary, the conclusion is drawn that circular motion, which, however, has no contrary, cannot be the unnatural motion, let alone

³³ *Al-Shifā': al-Ṭabī'īyyāt: al-Samā' wa al-Ālam*, 34 line 6.

³⁴ *Al-Shifā': al-Ṭabī'īyyāt: al-Samā' wa al-Ālam*, 25 (line 9) and 15 (line 6).

³⁵ See *al-Shifā': al-Ṭabī'īyyāt: al-Samā' wa al-Ālam*, 28--34; the quoted sentence is on page 31 line 1.

³⁶ See *al-Shifā': al-Ṭabī'īyyāt: al-Samā' wa al-Ālam*, 17--18; cf. *al-Najāt*, 134--5 (Cairo, 1938).

be the natural motion of one of the four elements; rather, it should belong to another simple element, namely the 'fifth body.'³⁷ Moreover, because it has no inclination (*mayl*) for rectilinear motions, the heavenly substance is neither heavy nor light, whether actually or potentially, for heaviness implies downward motion towards the centre, and lightness implies motion away from the centre.³⁸ Above all, the reason why the celestial element deserves all these properties lies in the fact that it is ever actual, its matter being always attached to its form (*mawqūfah 'alā šūratihā*),³⁹ its form having no contrary and its properties unchanged.⁴⁰

The sphere (*falak*) has a physical reality (*jawhar jismānī*), is round in shape, and circular in motion by nature [*sic!*]; it never leaves its natural place and yet does not rest at one fixed position within its natural place; to its power and nature are due all that happens in the [terrestrial] world of elements. Its circular motion, which is meant for glorification (*tasbīh*), is due to God's command (*li amr Allāh*). It is absolutely impossible for it to have a rectilinear motion; nor can it be affected by elemental bodies (*al-ajsām al-'unsuriyyah*, that is, terrestrial elements)⁴¹...which [in contrast to celestial spheres] will not move at all [once they are] in their natural places and will not move at all according to [their] nature except when they are in foreign [i.e. unnatural] places; indeed they do not move by nature except in a straight line, and are constantly affected by aetherial bodies (*al-ajsām al-athīriyyah*).⁴²

Again, he elsewhere remarks that:

Every body which is generated has in it a principle or innate impulse for linear motion (*mabda' ḥarakah mustaqīmah*), and every body lacking this principle for linear motion is not generated. Now, a body which has such a principle for circular motion by nature is not generated out of another body, nor is it found in the place of another body. Rather, it is originated [not out of pre-

³⁷ See *al-Shifā': al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 11--12.

³⁸ See *al-Shifā': al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 7--9 and 64--5.

³⁹ *Al-Shifā': al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 30 (line 17); 31 lines 1--3; and 34 lines 7--11.

⁴⁰ *Al-Shifā': al-Tabī'iyāt: al-Samā' wa al-'Ālam*, 33 lines 4--5.

⁴¹ *Risālah fī al-Ajrām al-'Ulwiyyah* in *Tis' Rasā'il*, 57 lines 1--7.

⁴² *Ibid.*, 57 lines 11--14.