



Foundations of Astrology

Classical & Medieval Texts

The Medieval Arabic Era:

**Ibn Sina – Al-Biruni
Correspondence**

Translated by Rafik Berjak

Ibn Sina—Al-Biruni Correspondence

**A series of correspondence containing questions from
Abu Rayhan Muhammad b. Ahmad al-Biruni to Abu 'Ali
al-Husayn b. 'Abd Allah ibn Sina**

By Rafik Berjak

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Translators' Introduction

Writing from Khwarazm, the modern Khiva and ancient Chorasmia, Abu Rayhan Muhammad b. Ahmad al-Biruni (362-442/973-1050) posed eighteen questions to Abu 'Ali al-Husayn b. 'Abd Allah ibn Sina (370-428/980-1037). Ten questions were related to various concepts and ideas in Aristotle's *al-Sama' wa'l-'Alam* (De Caelo).

Ibn Sina responded, answering each question one by one in his characteristic manner. Not satisfied by some of the answers, al-Biruni wrote back, commenting on the first eight answers from the first set and on the seven from the second. This time, the response came from Abu Sa'id Ahmad ibn 'Ali al-Ma'sumi, whose honorific title, *Faqih*, is indicative of his high status among the students of Ibn Sina. He wrote on behalf of his master, who was the most representative scholar of Islamic Peripatetic natural philosophy. «His long response thus brings to a conclusion this most challenging and remarkable set of exchanges between two of the greatest masters of Islamic thought, al-Biruni and Ibn Sina aided by his pupil,» wrote Seyyed Hossein Nasr, «an encounter which in its rigour and significance of the questions involved marks one of the highlights of Islamic intellectual history and in fact medieval natural philosophy and science in general.»¹ Based on a critical edition of the text published in 1995,² this first English translation of Questions and Answers will be serialized in *Islam & Science*.

¹ Nasr, Seyyed Hossein and Mohaghegh, Mehdi (1995), *Al-As'ilah wa'l-Ajwibah* (Questions and Answers), International Institute of Islamic Thought and Civilization, Kuala Lumpur

² *Ibid.* For a detailed note on "Questions and Answers" as a technique used extensively in the Islamic intellectual tradition, see Daiber, H., "*Masa'il wa-Adjwiba*" in *Encyclopaedia of Islam*, (new edition), vi, pp. 636-9, where Daiber mentions that «the oldest Islamic question-answer literature endeavours to solve philological and textual problems of the Kurban text.» He cites the correspondence between Ibn Sina and al-Biruni on the basis of 1974 Turkish edition of the correspondence, ed. Ulken, *Ibn Sina risaleleri*, ii, 2-9; ed. M. Turker, in *Beyruni'ye armagan*, Ankara 1974, 103-12. Daiber also cites numerous other examples of correspondence literature. It is also relevant to note that at the time when this correspondence took place, the technique of *reductio ad absurdum* used by Ibn Sina in his response to al-Biruni had already become a refined tool in this literature.

Part I

In this first instalment of the translation of the correspondence between Ibn Sina and al-Biruni, *al-As'ilah wa'l-Ajwibah*, Ibn Sina responds to the first question posed to him by al-Biruni who criticizes reasons given by Aristotle for denying levity or gravity to the celestial spheres and the Aristotelian notion of circular motion being an innate property of the heavenly bodies.

Keywords: Ibn Sina-al-Biruni correspondence; criticism of Aristotelian natural philosophy; *De Caelo*; levity and gravity; heavenly bodies, circular motion; al-Ma'sumi; celestial bodies; Islamic scientific tradition.

In the name of Allah the Most Merciful the Most Compassionate.

[1] The Grand Master, Abu 'Ali Al-Hussein Abu 'Abdullah Ibn Sina--may Allah grant him mercy--said, All Praise is for Allah, the Sustainer of the worlds, He suffices and He is the best Disposer of affairs, the Granter of victory, the Supporter. And Allah's blessings be upon our master Muhammad and upon his family and all his companions, and now to begin:

[2] This letter is in response to the questions sent to him by Abu Rayhan al-Biruni from Khawarazm. May Allah surround you with all you wish for, and may He grant you all you hope for and bestow on you the happiness in this life, and hereafter, and save you from all you dislike in both lives. You requested--may Allah prolong your safety--a clarification about matters some of which you consider worthy to be traced back to Aristotle, of which he spoke in his book, *al-Sama' wa'l-'Alam*,³ and some of which you have found to be problematic. I began to explain and clarify these briefly and concisely, but some pressing matters inhibited me from elaborating on each topic as it deserves. Further, the sending of the response to you was delayed, awaiting al-Ma'sumi's dispatch of letter to you. Now, I would restate your questions in your own words, and then follow each question with a brief answer.

[3] The first question: You asked--may Allah keep you happy--why Aristotle asserted that the heavenly bodies have neither levity nor gravity and why did he deny absence of motion from and to the centre. We can assume that since the heaven is among the heaviest bodies--and that is an assumption, not a certainty--it does not require a movement to the centre because of a universal law that applies to all its parts judged as similar. If every part had a natural movement toward the centre, and the parts were all connected, then it would result in a cessation (*wuquf*) <of all motion> at the centre. Likewise, we can assume that the heaven is among the lightest of all bodies, this would not necessitate (i) a movement from the centre until its parts have separated and (ii) the existence of vacuum outside the heaven. And if the non-existence of vacuum outside the heaven is an established

³ *De Caelo*

fact, then the heaven will be a composite body like fire. <And you also say> that the circular movement of the heaven, though possible, might not be natural like the natural movement of the planets to the east <which> is countered by a necessary and forceful movement to the west. If it is said that this movement is not encountered because there is no contradiction between the circular movements and there is no dispute about their directions, then it is just deception and argument for the sake of argument, because it cannot be imagined that one thing has two natural movements, one to the east and one to the west. And this is nothing but a semantic dispute with agreement on the meaning, because you cannot name the movement toward the west as opposite of the movement to the east. And this is a given; even if we do not agree on the semantics, let us deal with the meaning.

[4] The answer: May Allah keep you happy, you have saved me the trouble of proving that heaven has neither levity nor gravity, because in your prelude you have accepted that there is no place above the heaven to where it can move, and it cannot, likewise, move below because all its parts are connected. I say it is also not possible for it to move down, nor is there a natural place below it to where it can move, and even if it were separated--and we can make the assumption that it is separated--it would result in the movement of all the elements from their natural positions and this is not permissible, neither by the divine nor by the natural laws. And that would also establish vacuum which is not permissible in the natural laws. Therefore, the heaven does not have a natural position below or above to which it can move in actuality (*bi'l fi'l*) or in being, neither is it in the realm of possibility (*bi'l-imkan*) or imagination (*bi'l-wahm*) because that would lead to unacceptable impossibilities we have mentioned, I mean the movement of all the elements from their natural positions or the existence of vacuum.

[5] There is nothing more absurd than what cannot be proved to exist either by actuality or by possibility or imagination. If we accept this, it follows that heaven does not have a natural position, neither at the top nor at the bottom. But every body has a natural position. And to this, we add a minor term and that is our saying: «heaven is a body», and hence, it will follow from the first kind of syllogism (*shakl*) that heaven has a natural position. And if we could transfer the conclusion to the disjunctive positional syllogism, we could then say: its natural position is above or below or where it is. And if we hypothesize the negation of its being either above or below, we could say: it is neither up nor down; hence, the conclusion is: it is where it is.

[6] Everything in its natural position is neither dense nor light in actuality and since heaven is in its natural position, it is, therefore, neither light nor dense in actuality. The proof of this is that whatever is in its natural position and is light, it will be moved upward because it is light and its natural position is upward but it cannot be said that whatever is light, is in its natural position in actuality because this will contradict what I have just said: it will be «in its natural position» as well as «not in its natural position» at the same time; and that is self-contradictory.

And likewise for the dense. Because the dense is what naturally moves downwards and its natural position is down because anything that moves naturally, its movement takes it toward its natural position. And from the first premise, it is clear that the thing in its natural position is not dense in actuality, so when we add the results of the two premises, the sum of this will be that whatever is in its natural position, is neither dense nor light in actuality. And it was established in the second minor term that the heaven is truly in its natural position, therefore, the correct logical conclusion is that the heaven is neither light nor dense in actuality and it is not so potentially (*bi'l-quwwa*) or contingently.

[7] The proof of this is that the light and dense in potentia can be so in two situations: (i) It can be so either as a whole, like the parts of the fixed elements in their natural position, so if they were neither dense nor light in actuality, then they are so potentially, for the possibility of their movement by a compulsory motion which can cause them to move from and to their natural position either by an ascending or descending natural movement; and (ii) by considering the parts as opposed to the whole in the fixed elements. These parts are neither light nor dense in their totalities, because if it would move upward, some of the parts would move downward because they are spherical in their shapes and have many dimensions, but indeed, the levity and density are in their parts, so if the heaven is light or heavy potentially, that is in its totality--and we have proved that by nature, the upward or downward movement of the heaven is negated (*maslub*) to its totality, and to prove that we depended on some of your premises. So it was made clear to us that the heaven in its totality is neither light nor dense. And I say that it is neither heavy nor light potentially in its parts because the levity and the density of the heavy and the light parts appear in their natural movement to their natural position. And the parts which are moving to their natural position move in two cases: (i) they might be moving from their natural position by force, [in which case] they would move back to their natural position by nature or (ii) they are being created and moving to their natural position like the fire that emerges from the oil and is moving up. It is not possible for a part of the heaven to move from its natural position by force because that requires an outside mover, a corporeal or non-corporeal mover that is not from itself.

[8] The non-corporeal movers, like what the philosophers call nature and the active intellect (*al-caql al-facal*), and the First Cause (*al-'illatul ula*), are not supposed to create forced movement (*harakah qasriyyah*); as for nature, it is self-evident, and as for the intellect and the First Cause, their inability <to do so> is left to the Divine knowledge. As for the physical cause, it should be, if possible, one of the <four> elements or composed of them because there is no corporeal body other than these five--the four simple elements and <the fifth being> their combination.

[9] And every body that moves by itself and not by accident moves when it is touched by an active mover. And this has been explained in detail in the first chapter in the book of Generation and Corruption (*Kitab al-kawn wa'l-fasad*).

Thus, it is not possible for a part of the heaven to move without being touched by the mover during its movement toward it either by force (*bi'l-qasr*), or by nature (*bi'l-tab'*). The outside mover that moves it by force has to be connected to another mover, which in turn, has to be connected to the first mover of all. And if it was moving by nature, it will be either the non-composite fire or a combination in which the fire-parts are dominant. The non-composite fire does not affect the heaven because it engulfs it from all sides and the impact of bodies on bodies is by touch and there is no part in the heaven which is more passive than the other is, unless one of the parts is weaker in its nature. However, the weakness of the substance does not come from itself but through an outside factor.

[10] Thus, the question now returns to the beginning, to that of a compound mover in which the fire-part is dominant. It will not have impact until it reaches the sphere of the heaven and when it reaches the airy zone then it will turn into pure fire and burst into a flame as seen in the case of comets. And if it is too slow to reach that transforming stage, it would not touch the heaven, <it may be so> because in it are dense parts, earthly and others, which have gravity. Thus, it is not possible for anything to touch the heaven except pure fire. It is possible for pure or non-pure fire--and the compound is not pure fire--and for the one that is not pure fire it is possible for it to be in the neighbourhood of the three elements but it is not possible for it to touch the heaven by nature.

[11] As for the other elements, it is not possible for them to touch the heaven in their totality because they do not move in their totality from their natural position, neither in their compound form nor in their parts, thus, they cannot have any impact on the heaven because they are unable to touch it because when they reach the ether (*al-athir*), they will burn and turn into fire and the fire does not touch heaven, as we have proved. But ether changes and disjoins everything that occurs in its <realm> because it is hot in actuality and one of the properties of the hotness in actuality is that it brings together similar genera and separates dissimilar genera--it is the separator of dissimilar and gatherer of similar genera. And when the fire takes over a body that is being affected by it, if it were a compound body made from different parts, the fire will return it to its nature; this shows that <the body> did not change into something that is contrary to its essence by mixing with the affective element. As for the cold, it is not like this. And there is no doubt that the hot is most effective and powerful of all things; and the thing that is in its natural position strengthens its genus; and the whole is stronger than its parts. So what do you think of something that is hot in its natural position and it is whole, and it allows a part to enter into its sphere and it does not produce any effect <on this part>, neither changes it back to its nature, nor separates it, if it were compound?

[12] From these premises, it is clear that it is not possible for any part or compound from the elements to reach the heaven. Since they do not reach it, they do not touch it, and if they do not touch it, they do not produce any effect on it. None of the parts or the compounds has any effect on parts of the heaven and if

nothing is able to affect it, other than it, from whole or parts, simple or compound bodies, it is not going to be affected and moved potentially by itself. And if we would set aside our premise--and that is our saying, «and it is not possible <for the heaven> to be affected by anything other than by itself», which is true--the result is our saying: «it is not possible that it will be affected and moved by force»; and this is also true. So the heaven is neither light, nor dense potentially; neither as a whole or in its parts. And we have proved that it is not so in actuality. It is neither light, nor dense in general or absolutely. And that is what we wanted to clarify. But you can call the heaven light from the perspective in which people call a floating body, on top of another body, lighter than the latter by nature. So, from this perspective, it is possible that the heaven is the lightest of all things.

[13] Now, as to your saying that the circular motion <of the heaven> is natural to it, and your saying, «if it is said that this is not accidentally» *et cetera*, there is no one among the scholars who has proven the natural circular motion of the heaven, who has ascertained what you have said. I would have explained the reasons, had it not been a separate issue, taking too long <to explain>.

[14] As for your demonstration that the movement of the stars and the planets is opposite, it is not so. It is only different. Because the opposite movements are opposite in the directions and the ends, and if it was not that the high is opposite of low, then we would not have said that the movement from the centre is opposite of the movement to the centre; and this has been explained in detail in the fifth chapter of *Kitab al-Sama' al-tabi'i*. As for the directions of the two circular motions and their ends, they are, in our assumption, positional, not natural. Because in nature, there is no end to the circular movement of the heaven, hence, it is not opposite; hence, the two different circular motions are not opposite and this is what we wanted to clarify.

Part II

In this second instalment of the correspondence between Ibn Sina and al-Biruni, which is being serialized in *Islam & Science*, Ibn Sina responds to four questions raised by al-Biruni. The first of these four is a criticism of Aristotle for his over-reliance on the views of the ancients concerning heaven. The second deals with Aristotle's view that there are only six directions to space. The third pertains to the issue of continuity and discontinuity of physical bodies and the fourth is about the Peripatetics' denial of the possibility of the existence of another world completely different from the one we know.

Keywords: Ibn Sina-al-Biruni correspondence; criticism of Aristotle's reliance on the views of the ancients; notion of six directions of space; continuity and discontinuity of physical bodies.

[15] The second question: Why did Aristotle consider the views of the ancients and predecessors concerning the heaven and their finding <the celestial bodies> to be just as how he found them to be, a strong argument for immutability and perpetuity of the heaven? Anyone who is not stubborn and does not insist on falsehood would agree that this is not a known <fact>. We do not know more <about the celestial bodies> than what has been reported by the people of the Book⁴ as well as by Indians and other nations like them, appears to be false upon investigation. This is because of the continuous changes <which occur> on the surface of earth, <changes> that occur in increments or all at once. Likewise, the obvious alterations in the state of mountains since antiquity are proof of events resulting in changes.

[16] The answer: You should know that <Aristotle> did not give <the views of the ancients> as evidence; it was only something that came by way of speech which he mentioned at two places. <Further>, the case of mountains does not apply to the celestial sphere; even if nations witnessed mountains preserved in their totality, <this observation> does not disclose changes resulting from the action of the elements on their different parts, some of which are collapsing and folding upon one another, and some of which are altering their shapes and undergoing other changes beyond these--changes which have been mentioned by Plato in his book *Fi Siyasat* as well as in other books. It is as if you have taken this objection from John Philoponos, who was opposed to Aristotle, simply because he himself was a Christian. However, whoever reads his commentary on generation and corruption and his other books would find that he agrees with Aristotle on this issue. Or <you may have derived your arguments> from Muhammad ibn Zakariyyab al-Razi, who meddles in metaphysics and exceeds his competence. He should have remained confined to surgery and to urine and stool testing--indeed, he exposed himself and showed his ignorance in these matters. And you should also know that when Aristotle said, «the universe has no beginning» he did not mean that the universe did not have a Creator; rather, he intended to exalt and

⁴ The Arabs of Islam, Jews and Christians were called, «People of the Book».

protect the Creator from the charge of inaction, but this is not the place to discuss this.

[17] And as for your saying, «anyone who is not stubborn and who does not insist on falsehood»: this is an ugly and rude insult--either you comprehended the saying of Aristotle in this matter or you did not. If you did not, your belittling of someone who said something beyond your grasp is inappropriate. And if you did understand, your comprehension of the meaning should have prevented you from dragging in this quarrel; for your pursuit of what your intelligence prevents you from pursuing is inappropriate.

[18] The third question: Why do <Aristotle> and others say that there are only six directions to space? Their example is that of the cube, for which the six directions have parallels. If we add to these six tangent cubes, so that when the spaces are all filled in, there will be 27 cubes which will all be touching the first cube from angles and sides. And if the directions did not exceed that number, from which direction are these cubes touching the first cube when these directions do not exist in the sphere?

[19] The answer: The directions of any body are not parallel to its surface, but are rather hypothetical directions. The six directions that the philosophers meant are parallel to the extremities of the three dimensions of the body: the length, the width and the depth. In the third essay of his *Kitab al-samac al-tabici*, wherein Aristotle discussed infinity, he argued that since a body is limited, it is necessary that its length, width and depth also be limited and that each one of these have two extremities, their total being six. What parallels them is also six. So that which is parallel to the extremity of length is next to the centre of the world in which its length ends in the direction of the centre, being below, while it's opposite is above. And there is no name for the four remaining directions of a body, though that is only for living bodies. The direction of the extremity of the width in a living body, from which its movement arises, is called the right while its opposite is called the left. And the direction that parallels the extremities of the depth of the living body, is the one toward which the vision of the body is directed, and it is called front while its opposite is known as behind. These are the six necessary directions in every body.

[20] Your denial of the six directions of the sphere is incorrect. If the sphere was a body, it should have length, width and depth, they all being limited with two extremities, the total thus being six. The directions parallel to these six extremities are also six. When the premise is right, all conclusions are right, and the conclusion here is that the sphere has six directions. So how is it then possible that the six directions of a body are parallel to its surface while it is known that the sphere has directions from its sides that are different in observation? The direction of the north pole is neither the direction of the east or the west nor that of the south pole and likewise all other directions, and the same holds true for their correspondents. And if the surface of the sphere is one, then there is no one single

direction, neither in the demonstrative proof--as we clarified--nor hypothetically, as it is necessary for the body to have directions parallel to the surface. It is possible for angular bodies to have directions parallel to their surfaces, because their surfaces are straight by their position and view but not by their structure. So what really accompanies a body physically apart from their directions is what parallels its three extremities, and that is what the philosophers meant.

[21] The fourth question: Why did Aristotle oppose the position of the atomists--though their stance that a body is divisible ad infinitum is absurd--in that if two bodies are moving in the same direction, one ahead of the other, they will be unable to overtake one another, even if the velocity of the first is less? Take, for instance, the example of the sun and the moon. If there were a certain distance between them and if both moved [in the same direction] but the sun travelling a shorter distance than the moon in the same amount of time and if this continued ad infinitum, we would see the moon overtaking the sun. The atomists are also opposed to other things well-known to engineers. And what I just mentioned about those who oppose the atomists is also very absurd, so how can we get rid of both <of these groups>?

[22] The Answer: Firstly, it is not possible that a continuous thing that has no body, no surface, no length, no movement, no time, be composed of indivisible atoms. I mean a body without two dimensions and a middle upon which it is centred. Aristotle has explained it in the sixth chapter of *Kitab sam' al-kiyan* with strong logical and credible proofs; he has raised this objection himself and has provided an answer. But you should know that the saying of Aristotle that the body is divisible ad infinitum did not mean that it is actually divisible <but only potentially so>; it means <instead> that every atom in it has a middle and two dimensions. Some of these atoms are divisible into two parts adjacent to the two dimensions and the middle; these are the parts that are divisible in actuality. While other parts, even if they have a middle and a place to divide, are too small to be actually divisible, <hence> these parts are divisible <only> potentially and in themselves.

[23] My objection should silence those who say that the body is divisible actually, but the one who says that some parts of the body are divisible in actuality and some parts are divisible only potentially is correct, because movement brings finite division of the congruent parts though this is not actual division. So, this is the way leading to these two absurd notions, coming from both sides. And whatever Aristotle has said in response to this matter has been interpreted by interpreters only for the sake of argument and for finding fault with others. If it were not for my preference to avoid unnecessarily lengthening the matter, I would have mentioned all that, but whatever follows after already hitting the mark is sheer wastefulness and excessiveness.

[24] The Fifth Question: Why did Aristotle oppose the possibility of the existence of another world, outside our world, made up of a different nature? We did not

know the natures and the four elements until our existence here <in this world>, much like the one born blind who, if he did not hear people mentioning vision, would not be able to imagine the process of vision by himself and would not be able to recognize colours. <We also cannot grasp> a world that has the same characteristics as this world but is moving in directions different than those of this world, if both these worlds are separated from each other by a barrier (*barzakh*). An example of this can be demonstrated by a hill on the surface of the earth defined by three points, A, B and C; A and C being close to the surface of the earth as compared to B. Naturally, water will flow from B to A or to C; and these are two opposite movements to a known point.

[25] The Answer: This question is not mentioned in Aristotle's book, *al-samab wabl-cAlam*, as a denial of the existence of worlds other than this <world> because he did not address the case of those who claim the existence of worlds unlike this; he <only> responded to those who claimed the existence of worlds with skies, earths, and elements similar to this world in kind (*naw'*) and nature (*tab'*), with dissimilarity in character. And he supported this denial with the argument that «our reference to the world and the sky without specifying and without mentioning the elements is more general than our reference to a specific world or to this world from this part from this element.» Thus, the existence of other worlds beyond this one world specified by the elements is possible.

[26] The possibility of eternal things is a necessity (*wajib*), thus the existence of many worlds is *wajib*. The existence of other worlds other than this world is a necessity; some people considered them limited and others unlimited, and all of them have proved their points. The Philosopher has refuted this argument in his *Kitab al-sama' wa'l 'Alam* and he has made it clear that the existence of many worlds is not possible. Other philosophers said that the elements of the other worlds are not different from those of this world but indeed, they have the same nature. The Master said that if the elements of many worlds are not different from each other in nature and the things that depend on nature, <then> they depend on the direction of their natural movement and the elements of many worlds depend on their natural positions. So, if they were found in different positions over one another, they would be stationary in these positions by force. And whatever happens by force follows whatever happens by nature. It is known that <elements> were initially all together in one unit and they then separated and <hence> those who consider them to be different eternally end up with the impossibility of dealing with a situation in which they are eternally different and not different eternally and that is an impossible contradiction. And whatever comes by force necessarily vanishes and the thing returns to its original nature. So, those separated worlds will meet again though philosophers claim that they will never meet again, [hence we have a situation in which] they will meet and, on the other hand, yet they will not meet eternally. And this is <again> an impossible contradiction.

[27] There is no doubt that whatever happens by force has a cause. And these bodies are not supposed to force each other from their natural positions or to move to meet in unnatural positions, because we have already established that forcing bodies are forcing each other to move until they end up with a body moving by nature. And if there were a body that was moving by force to an unnatural position, such as the elements of the worlds, it is necessary that another body would move in that direction by nature. There is also no body except that composed from these elements, because we have made it clear that there is nothing here that has a position by nature, so if we consider that what moves by nature to its natural position is other than those present in their places naturally, that would be a contradiction. Hence, there is no other body except for these since there is no other body different from these. We will further clarify the correctness of this later. So, the result of the previously mentioned antithesis is that none of these bodies forces each other toward the movement of that direction, because none of them is moving to that direction by nature or otherwise. This is so because it has no forceful physical or non-physical cause because causes which are not bodies, like the things which the philosophers call «nature», «Intellect» (*'aql*) and the «First Cause» (*al-'illatul ula*) do not change order to disorder; their job is to transform disorder into order or to hold the order in place, hence there is no automatic physical or non-physical cause to do this.

[28] As for the accidental causes, such as chance, even if their aims are secondary, their causes are fixed by themselves--and whoever wants to clarify that should see the second article in the Philosopher's book, *Fi Samc al-kiyan* or our commentary on the first article in *Metaphysics*. We say that these have accidental causes while they also have natural causes. If we exempt the second premise, the logical result will lead to nullification of the first premise, and that is to say that there is no accidental or causal cause. People agree that it is impossible for a thing to be in this condition, and this is common sense. If books were not already full of refutations of this, I would have refuted it. And if a thing does not have an essential or an accidental cause, it would be impossible for it to exist without a cause. So, the existence of other worlds like this one is impossible, and this is what we wanted to clarify <in the first place>.

[29] I want to explain that the existence of a body other than these bodies is not possible in movement or characteristics because movement, by logical necessity, either is in a straight line or is circular. Assuming there is no vacuum, the moving bodies would be touching each other by necessity. Now, the linear movement is toward either the centre or intersecting the centre in its straight path, and is either coming from the two sides or is parallel to them. By nature, however, it is not permitted that the movement should be from one end to the opposite end or in relation to it. And all of this has been explained in Aristotle's books, particularly in the fifth article of the book *al-sama ' al-tabi'* and in its commentaries as well as in some of our own works.

[30] From this, we understand that the natural movements are finite in all bodies, either from the centre or to the centre. And as for the sensory characteristics, it is not possible for the number of these to exceed nineteen, as the Philosopher has explained in the third article of his *Kitab al-nafs* and <has been explained> in the commentaries of Themistius and Alexander <of Aphrodisias> and others. Were it not for the length, I would have elaborated on this issue further but I just wanted to briefly mention it.

[31] So, I say if nature does not give the higher kind the elements of the lesser kind, it will not be able to enter the second kind from the second category. The example of this is the body, the first of the lowest kind. If nature did not give it all the characteristic qualities of bodies, it would not be able to bring it up to the second higher kind by relation, that being the plant kingdom. And if all plant qualities--such as the ability to nourish and to grow and to procure--were not present in this kind, nature would not be able to take it to the next higher kind, which is the animal stage and the characteristics of the animal stage are divided into sense and intentional movement. So if this lower kind did not get all the cognitive senses (*hiss al-madrakah*) to sense all things, the animal kind would not be able to develop to the speaking kind (*al-naw ' al-nutqi*). Nature has, however, created in those who are born (*mawalid*), a speaking element. It is, thus, necessary that it gave them all sensory powers (*al-quwah al-hissiah*), and it followed these things with the speaking powers. So if the speaking kind has all sensory cognitive powers, then the speaking kind is aware of all the sensory things. Hence, there is no sensory thing except what the speaking kind can realize. There are no qualities but the sixteen that are sensed by themselves and three that are sensed accidentally, these being movement, rest and figure. There is no body that has any qualities except these. So, there is no other world opposite to this world with similar physical qualities. However, were there many worlds, they should be similar to this one, and we have already explained that there is no world similar to this one. So, to conclude, there is only one world and that is what we had wanted to clarify.

[32] Know that if there were another way to discuss this issue, it would necessarily lead to an endless discourse, and that would harm science in a sense and would play into the hands of sophists. And their cure is not in this medicine but in another medication, and for this we seek Allah's help.

Part III

In this third instalment of the correspondence between Ibn Sina and al-Biruni, five more questions are asked and answered. Al-Biruni rejects Aristotle's reasoning for his assertion that if the heavens were to be elliptical rather than spherical, a vacuum would be created. Al-Biruni also objects to Aristotle's assertion that the motion of the heavens begins from the right side and from the east. In his eighth question, al-Biruni asks how is it that Aristotle considered the element fire to be spherical. The ninth question deals with the movement of heat and the tenth with the transformation of elements into each other. Ibn Sina responds to all questions.

Keywords: Ibn Sina-al-Biruni correspondence; shape of the heavens; criticism of Aristotle's reasoning for the spherical motion of the heavens; sublunar physics; theory of transformation of elements.

[33] The Sixth Question: <Aristotle> has mentioned in Book II that <the shape of the heaven is of necessity spherical because> the oval and the lenticular shapes would require space and void whereas the sphere does not, but the matter is not so. In fact, the oval <shape> is generated by the rotation of ellipse around its major axis and the lenticular by its rotation around its minor axis. As there is no difference concerning the rotation around the axes by which they are generated, therefore none of what Aristotle mentions would occur and only the essential attributes of the spheres would follow necessarily. If the axis of rotation of the oval is its major axis and if the axis of rotation of the lenticular is its minor axis, they would revolve like the sphere, without needing an empty space (*makan khal*). This could happen, however, if the axis of <rotation of> the oval is its minor axis and the axis of <rotation of> the lenticular is its major axis. In spite of this, it is possible that the oval can rotate around its minor axis and the lenticular around its major axis, both moving consecutively without needing an empty space, like the movement of bodies inside the celestial sphere, according to the opinion of most people. And I am not saying this with the belief that the celestial sphere is not spherical, but oval or lenticular; I have tried hard to refute this theory but I am amazed at the reasons offered by the man of logic.

[34] The Answer: Yes--may Allah lengthen your life--your objection to Aristotle is sound and I have clarified this matter in some of my writings. Every commentator <of Aristotle> has offered apologies for his views. What comes to my mind now is what Themistius has said in his commentary on *Kitab al-Sama'*, <that is>, that the Philosopher's views should be interpreted in the best possible way. So we say that no void whatsoever would result from the circular movement of the sphere, whereas this is possible in the case of the oval and lenticular shapes. Despite this apology, he still denounces Aristotle's view, for it is possible to prove that the shape of the heavens is not oval or lenticular with arguments--some of which are natural proofs and others are mathematical. And since you have a mastery of mathematics and live in a region where <numerous> experts in geometry reside, there is no need for me to go into further details.

[35] Nonetheless, your assertion that no void would occur from the movement of the oval and lenticular shapes, as you have observed from the moving bodies within the celestial sphere, is not the same as <the other saying>, because in the celestial sphere there are, *vis a vis* the moving bodies, other moving bodies touching them consecutively. As for the heavens, if it were lenticular and moved, but not around the minor axis, or if it were oval and moved, but not around the major axis, then a void would necessarily occur because there is no body beyond the heavens that would be touched by the body of the heavens during the movement, as is the case for the bodies within the heavens.

[36] The Seventh Question: When <Aristotle> mentioned directions, he established that the right is the starting point for the motion of every planet; he then reversed the matter, for he said that the motion in the sky is from the east because that is the right side; and the reverse is not permissible, thus leading to a circular argument.

[37] The Answer: The Philosopher did not assert that the motion of the heavens is from the east because the east is right. What he asserted was that the east is the right side because motion appears from the east. The movement of animals appears from the right and, for him, the moving heavens are <like> an animal; thus, it necessitated that the east is the right of the heavens. It is impossible for a rational person to embark upon the task to prove that the heavens move from the east because there is no doubt about that; it has been always the case that the heavens move from the east. However the Philosopher wanted to clarify the nature of [what is meant by] the right of the heavens after he had asserted what is the right direction for the heavens with reasoning.

[38] The Eighth Question: <Aristotle> claimed that when planets move, the air that touches the planets is heated because heat comes as a result of motion and coldness is a result of rest. So when the heavens move quickly, the air being touched becomes hot, eventually becoming fire, known as Ether; the faster the motion, the stronger and more intense the heating. It is very clear that the fastest motion of the heavens occurs at the equator and when it approaches the two poles, the motion slows down. Let us assume that the heaven is A, B, C, D and the two poles are AB and the equator CD; the hottest points would be EF and these are the farthest points because here the motion is the fastest. Then, the motion slows down toward the two poles. The heat will gradually decrease until it disappears at the two poles. The fire image is presented here by the outer shape and the air image by the inner shape. This is what should occur according to the agreement of the ancients who agreed that the shape of the fire is spherical and so is that of air and nothing can illustrate this better than this figure.

[39] The Answer: According to most philosophers, the fire is not brought into being by the motion of the heavens but it is an independent element; it has its own sphere and a natural position of its own, like any other element. What you have said is nothing but the beliefs of those who considered the four elements to be

<only> one, two or three, like Thales, who considered them to be water; or Heraclitus, who considered them to be fire; or Diogenes, who considered them to be a substance between water and air; and Anaximander, who considered them to be air. Each one of them considers other bodies--as well as the generated accidents--as the accidents that appear in those bodies according to how they are shaped and do not consider that they are derived from another body. And Anaximander says--what you have mentioned--namely that the first element is air; when it is affected by cold, it becomes water and when it is heated by the motion of the heavens, it becomes fire or ether. However, Aristotle did not consider any of the four elements to be coming into existence from another element and the same is true for their parts. This objection <you raise>, then, does not apply to Aristotle or to whoever said the same thing, which is the right and wise saying. As for the shape you drew, it is not supposed to be like that. The two nooks, E and F, that you drew, only apply to the condition you described. But the figure to prove your point has a problem, and it is that the curve AE should meet the curve EB roundly, without nooks between the points. And so should be the case with the two curves AF and FB according to this illustration 2.

[40] The Ninth Question: If <it is in the nature of> heat <to> rise from its centre, how is it that the heat of the sun reaches us? Are rays bodies, accidents, or something else?

[41] The Answer: You must know that heat does not leave its centre because heat is motionless, except in the case of accidental motion, when it is inside a moving body, like a motionless person inside a moving ship. And you must also know that the heat of the sun does not come to us by descending down from the sun for the following reasons: firstly, heat does not move by itself; secondly, there is no hot body that descends from above and heats what is down below, neither does heat come down from the sun by accidents; third, the sun is not even hot because heat that is being created here is not descending from above for the three reasons already mentioned. <Rather>, heat occurs here from the reflection of light and air is heated by this process as can be observed in the <experiment of> burning mirrors. And you must know that the rays are not bodies--for if they were bodies there would be two bodies in one place, <and by that> I mean the air and the rays--but attributes of a transparent body. Aristotle has defined it in Book II of *Kitab al-Nafs* (On the Soul) and in Book I of *Kitab al-Hiss* (Sense and Sensibility). According to him, light is the perfection of transparency and is in itself transparent.

[42] The Tenth Question: What causes transformation of elements into each other? Is it the result of their proximity or intermingling or some other process? Let us take the example of air and water: when water transforms into air, does it become air in reality, or is it because its particles spread out until they become invisible to the sight so that one cannot see these separate particles?

[43] The Answer: The transformation of elements into one another does not occur the way you mentioned. Water does not transform into air by the separation and the spread of its particles in the air until they disappear from the sight; rather, the water particles take off their watery image and put on an airy image. For more details, one can see the commentaries on *Kitab al-Kawn wa'l-Fasad* and *Kitab al-Athar al-'ulwiyah* and the Book III of *Kitab al-Sama'*. But here I clarify this case according to their methods and the following logical example that they used to prove their sayings.

[44] Increase in the mass of bodies <can be explained> by means of an example: <Suppose>, we took a flask filled with water, sealed it tightly and exposed it to intense heat. The water particles in the flask would expand and crack the flask because their volume increased when they transformed into air. This happened either because of the spread of the space between the water particles, or not because of the spread of particles. But the void is impossible; therefore, it is necessary that the latter is true. <Thus> the reason for transformation <of water into air> is not the spread of its particles, but the acceptance of another image by its atoms.

[45] If it would be said that air or something else entered the flask and increased its volume, we would say: that is impossible because a full container cannot accept another body inside it until it is emptied of the first occupant, and the water cannot leave the flask because it is tightly sealed and there is no way out. I observed a little flask. We tightly sealed it and put it in a kiln. It did not take long before it cracked and everything that was in it exploded into the fire. And it is known that nothing mixed with the particles of the water that were inside the flask that could cause a change, because, firstly, the fire was not inside the flask and, secondly, it did not enter it because there was no way into the flask. It is, therefore, obvious that this transformation occurred through a change in the air and fire natures of <air and fire> and not through the spread of parts. I have provided an example which supports Aristotle's views on the generation and change as parts of nature; and this suffices, for further elaboration would demand tenuous efforts. Many objections could arise in this matter and if you encounter any, please convey your questions and I would explain to you, God willing.

[46] These are the answers to the ten questions arising from the *Kitab al-Sama'* of Aristotle; now we will answer the other questions by the permission of Allah the Exalted.

Part IV

In this fourth instalment of the correspondence between al-Biruni and Ibn Sina, al-Biruni asks eight more questions. His first question is related to the burning of bodies by radiation reflecting off a flask filled with water. The second question pertains to the well-known dispute about the natural tendency of the four elements in their upward and downward movements; the third relates to vision and the fourth deals with the habitation on different quarters of earth. In his fifth question, al-Biruni asks Ibn Sina how the two opposite squares in a square divided into four can be tangential. The sixth question is about vacuum. In his seventh question, al-Biruni asks: if things expand upon heating and contract upon cooling, why does a flask filled with water break when water freezes in it? His last question is related to one of the most important observable phenomenon: why does ice float on water.

Keywords: Ibn Sina-al-Biruni correspondence; eight questions about physics; Islamic scientific tradition; nature of vacuum; properties of water and air; burning of objects by reflection of light.

[Eight more Questions on Physics and their Answers]

[1] The First Question: If a spherical glass vessel is filled with clear water, it acts like a round burning glass. But when water is taken out and <the vessel> is filled with air, it does not burn and does not concentrate rays. Why does water act like that and not the air? And why does <water> have this ability to burn and concentrate rays?

[2] The Answer: Water has a viscous body of light colour and anything with such properties reflects light; this is why light reflects off a vessel full of water and successive reflections causes burning. As for the air, light does not reflect off it; rather, it reflects in it because air is in essence transparent. Therefore, if the vessel has only air in it, the reflection will not be intense.

[3] The Second Question: Who among the two is correct: the one who says that water and earth move toward the centre and air and fire move away from the centre or the one who says that all of them move toward the centre but the heavier one arrives at the centre before the lighter?

[4] The Answer: The saying of the second person is false because if the fire moved toward the centre, it would arrive at either the centre or it would never arrive. If it never arrived then it is not moving toward it, rather, it is moving toward the place where it arrives. And if it <is said that it> arrived at the centre, <then> that must be a lie because there is no fire ever seen coming down except by force such as falling fire balls. And what would such a person say about the fire that moves from the bottom <upward>; does it move naturally or by force? If he says that it moves by force, <then> it would become necessary that another body must move naturally toward it; and that is the one that first moved by force

as we clarified. And if he says it moves upward naturally, then we have a body moving upward naturally and there is no body that moves upward naturally. This is self-contradictory because there is no body among the four bodies that moves upward naturally. Likewise, the heaven does not move upward in totality or in parts as we have already proven. There is, thus, no body that moves upward and if there is one that moves upward by force, another body will, by necessity, move to its place naturally and that would create inconsistency. Hence, the latter is negated and that leaves the second as established, that is: fire moves upward naturally and that is what we wanted to clarify.

[5] The Third Question: How is vision possible? Why can we see beneath water whereas the ray of vision reflects off opaque bodies and the surface of water is opaque?

[6] The Answer: According to Aristotle, vision is not the result of the rays coming out of the eye; that is Plato's view. Although, upon examination, one finds that there is no <real> difference between the sayings of the two, for Plato said this for the commoners in their slang. This has been explained by Shaikh Abu Nasr al-Farabi this in his book *al-Jam bayna Ra'yain al-Hakimin*⁵. In Aristotle's opinion, vision results from the contact of the vitreous humour (*al-ratubatul jalidiyyah*) of the eye with the transparent surface; <upon contact, vitreous humour> picks up the colours that are facing it at the parallel point of the body of which the colour is the property. Since the vitreous humour is transparent, it would change and react to this colour. And when this gelatinous substance changes, it becomes the instrument through which the faculty of vision perceives, this faculty recognizes the reaction that occurs and that is how vision becomes possible. There are more details about it in the commentaries on Book II of *Kitab al-Nafs* (On the Soul) by the Philosopher and <in the commentaries> on his *Kitab al-Hiss* (Sense and sensibility). So if that was that, and <since> water and air are transparent bodies presenting the nature of colour to the senses, doubt should disappear.

[7] The Fourth Question: Why is only one quarter of the surface of the earth in the northern hemisphere settled and the rest is uninhabited while two quarters of the southern hemisphere are unsettled, <considering the fact> that laws pertaining to the two northern and two southern quarters are the same?

[8] The Answer: The reasons that hinder habitation of regions are either the extreme heat or the extreme cold. <The reason for extreme heat> is the successive reflection by oceans of the sun's rays at right angle and the perpetual rise of the sun in these regions, as at the two poles. The reason for extreme cold is the reflection of the sun's rays at obtuse angles which are wide open and the perpetual sunset in these regions. And this is related to my field. As for the computation of the area of a place that cannot be inhabited, that is the job of the mathematicians

⁵ *The Concordance Between the Opinions of the Two Wise Ones*

and if it were not for your competency in that field, I would have discussed the little bit of geometry needed for such calculations, according to my abilities.

[9] The Fifth Question: Suppose there are four surfaces (A, B, C, D) as in this figure and that, there are imaginary lines between them which have no width. These planes are obviously tangential to each other through their sides. Now, whereas a plane has no dimensions but length and width, and if plane A is tangential to plane B along its length and to plane C along its width, then how is it tangential to plane D, as, obviously, things that are tangential to each other do not have anything between them. So, if planes A and D are tangential, how can planes C and B be tangential?

[10] The Answer: Your saying--may Allah lengthen your life--that a plane does not have any dimension but length and width, is not sound. It is known that a plane has no dimensions except length; it does not have width; rather, it only has depth. It is apparent that if it had width then there would <also be> width to that width *ad infinitum*; and that is impossible. Therefore, it is impossible for plane A to be tangential to plane C along its width; if it is tangential at all; it has to be through the dimension of length as there is no other dimension to a plane than its length. As for your saying: «there can be nothing between the things that are tangential <to each other>», it is incorrect, because between every two things that are tangential, <there exists> a common boundary (*fasl*). And we are now going to clarify <the nature of> «tangent» (*al-tamss*) and «connection» (*al-itsal*) and <the difference between things> that can be said to be tangential and those which are not tangential.

Then we will return to the answer to the question, by the assistance of Allah, the Mighty and Majestic. We say that tangent, as the Philosopher has made it clear in Book V of *Kitab al-Sama' al-Tabi i*, is the meeting of the extremities of things that are tangential and here it becomes imperative that there be a common boundary between the two tangential things; what is between is something other than the two tangential things. As for connection (*al-itsal*), it is the union of the two joining things and here it becomes imperative that the common boundary between them be lifted. A body that has a side (*tarf*) and an extremity (*nihayah*) can be tangential as well as a connected to another body, but whatever does not have a side cannot be tangential and connected at the same time; this is how <the Philosopher> negated things that are composed of indivisibles in <his> Book VI. A body can be tangential to another along its plane that is its extremity, and a plane is tangential to another through a line which is its exclusive extremity, and a line is <said to be> tangential to another line through the point that is its exclusive extremity. And a point, because it does not have a side or an extremity--as it is <itself> the extremity of extremities--cannot be said to be tangential. And so is the case of existence of connection between three connecting quantities and vice versa, for as a whole, the point is indivisible.

And now we say that if any sort of meeting is imagined for the point, it should not be perceived in terms of tangent or union, but <in terms of> some other nameless kind. And you should know that this is also applies to planes and lines, for if the planes meet, <this union> will not be from the extremity which is the point; and it would not be called a connection or a tangent whatsoever; it cannot be defined in these terms at all. And you must know that if these bodies met in any of these manners and if they were planes, their meeting could not be considered to be through depth and if they were lines, they would not meet through planes and if they were points, they would not meet through lines and they keep their order. Thus, planes, when they meet, do not meet from the dimension of their extremities, and likewise, the lines and the point, when they meet, will not meet through another plane, line or point.

The proof for this is that if two planes met this way and they met on more than one side, they would be increased by one surface and that additional surface would undoubtedly be the depth; and depth is a result of the connection between two sides and we did not add any other quantity between the two surfaces; we only had two surfaces, so from where did this quantity appear between them? And if there already was an existent quantity between these two planes, then they did not meet in the manner <of union (*itsal*) or attachment (*tamas*)>; rather, it merely appears to be the case, and <in reality> they did not have a union or attachment and there is separation between them unless we make this meeting sequential, but we did not make it like that. Thus, the two planes did not increase by one plane upon union--and more surfaces would follow the same order--because if the two planes from them met and did not increase by one upon meeting, the rule of each part of the resultant four from the two pairs would be the same rule as that of the pair and likewise would be the case for the line and the point. Hence, we now say that plane A is tangential to plane B along its length only, or is connected to it, and plane C is likewise tangential or connected to it along its other length. So the three points (e, f and g) had met some kind of meeting, it necessitated their union so that the three points became one and from this emerged angle "h" and it is one point between both of them. If we added to the three united or connected planes, another plane (I), tangential or connected with its two lines to the line [connecting] planes C and B, its point "j" will be, metaphorically speaking, the common point between the three surfaces. So, if we assume them to be connected to each other, plane A will not exist in actuality; hence there will be no tangential <relation> assumed in this case; rather, the united planes will meet from the direction of the point which is the extremity of the extremities of the three lines which became one extremity. And if the extremities were not united and plane A in actuality and its point remained unconnected with the two points of planes C and B, then what would prevent plane I and its point, which is "j", to be tangential? And likewise is the case of planes C and B.

[11] The Sixth Question: If it is established for us that there is no vacuum inside or outside this world, why is it that if the air within a flask is sucked out and the flask is inverted on water, water rises up in it to the end of its limit?

[12] The Answer: It is not because of vacuum, but the reason for this is that suction did not create vacuum and sucking moved air inside the flask through forced motion and successive movements created heat; the heat expanded air and when air is expanded in the flask, it requires more space, hence it is necessary that some of it must go out and whatever can find space will stay in the flask and upon contact with cold water, this air will compress and contract, requiring less space and because vacuum is not possible, water rises up in the flask to the extent of contraction of the air. Don't you see that if you did not suck, but you did the opposite action of sucking--that is blowing--<your> successive blowings will heat up the air in the flask and if now you turned it upside down on the water, water will do exactly the same action <of rising> and this has been tested. And if you heat the flask, it would do this very same thing and this is enough for an answer.

[13] The Seventh Question: If things expand upon heating and contract upon cooling, then why does a flask full of water break when water within it freezes?

[14] The Answer: Indeed, it is possible to bring out the answer from the question itself. And that is <to say>, as the body expanded upon heating, it required more space, so it broke the flask. Likewise, when the body contracted upon cooling, it took less space and that would have created vacuum in the flask, so it split and collapsed because of the impossibility of <the creation of vacuum>. And for this phenomenon, there are other aspects in physics and that is the reason for many of these happenings, but in what we have already mentioned, there is enough of an answer.

[15] The Eight Question: Why does ice float on the surface of water although it is closer to earthy nature in its accumulation of cold and its rockiness?

[16] The Answer: This is so because upon freezing, water preserves airy particles which prevent it from sinking.

[17] And this is the answer to all of your questions. In case you have any confusion about these issues, I kindly ask you to refer them back to me so that I can explain and quickly send <the responses> back to you. And what can now cause a delay in these <responses> reaching you this time, as Faqih al-Ma sumi has already told me that he has finished copying them, by the grace and help of Allah. The answer to all the questions has now been completed. Thanks and praises are due to Allah, the Granter of intelligence at the beginning and at the end.

Part V

This fifth instalment of the correspondence between Ibn Sina and al-Biruni consists of al-Biruni's objections to the answers he received from Ibn Sina. It seems that al-Biruni was dissatisfied by Ibn Sina's responses to all but two of the first set of ten questions and all but one of the last eight questions he had sent to Ibn Sina. Thus, he wrote back about fifteen responses (leaving out the response of Ibn Sina to his sixth and eighth questions from the first set of ten, and the last question from the second set of eight). This section shows that al-Biruni's dissatisfaction with the answers he had received was ultimately based on his own independent views about the nature of the physical world which were in stark contrast to the views held by the Peripatetics who based their views on Aristotelian physics. These short and categorical responses to Ibn Sina's answers not only open a window to understand al-Biruni's views on the nature of the physical cosmos, they also reflect the vigour and intensity of the Islamic scientific tradition which was at that time appropriating Greek science through a transformative process.

Keywords: Ibn Sina-al-Biruni correspondence; Peripatetic natural philosophy; Islamic scientific tradition; history of physics; criticism of Aristotelian physics; natural elements; schools of thought in Islamic scientific tradition.

[1] On the first question: This is not definitive, as I say that it is not one of the elements in its natural position, because the downward direction is toward the centre and the upward direction is toward the perimeter, and the centre is a point. So if one part of the earth were put at the place of the point, even if it were small, <it would not fit in it>, but rather each one of its sides would compete to fit in. And such is <the case of> the perimeter: none of the ascending bodies would fit in it because it is plain and imaginary; and likewise, if there were a path between the water and the centre it would reach it. Therefore, it is not in its natural position above the earth, and consequently none of these bodies is present in their natural position. As such, these premises do not annul the claim of the one who said, «the heaven is dense», but its connections prevent it from gravitating towards the centre.

[2] On the second question: Abu Rayhan said: John Philoponos is far from <deserving> to be described as mischievous; Aristotle, the embellisher of his own infidelity, is more deserving of this description. And I think that you, O wise man, have not seen <Philiponos'> book *On the Response to Pericles* in which <the latter claimed> that the world is eternal, nor his book on what Aristotle embellished, nor his commentaries on Aristotle. And nothing caused the emergence of this objection except what has been accepted as restriction of necessary movements and times from their initial beginnings. Aristotle himself is close to this in his claim on the impossibility of the existence of eternity. When he evaded elaboration on this topic, he merely followed his caprice. Your claim that when Aristotle said «the universe has no beginning» he did not mean that it does not have a maker has no validity, because surely if actions have no beginning it is impossible to imagine that the universe has a creator: and if Aristotle's belief were

that the world has a beginning but not in time, what <business> does he have in mentioning the sect and their testimonies about the changes of attributes not necessitating changes in being!

[3] On the third question: Abu Rayhan said, «If one of its extremities were measured toward the centre it would be <regarded as> its bottom, and the opposite would be its top». If, however, it was not measured by its length, it is more appropriate to call it its width, rather than its depth. If one of its extensions deserves that label then the other one should deserve it too, and as such when a body moves in a straight line parallel to its centre, <it does> not always <move> downwards. However, you're saying «that the beginning of the movement of a living body is from the right» is a claim whose validity has not been based on truth: for verily what I see is from back to front--or am I not an animal? And likewise, no one denies that surely the sphere has length, width, and depth (not referring to any one of its extremities) <and> it <well> deserves every one of these labels. If only three of these extremities were designated with these labels, then tell me what is left for the rest of them? You will say either there is no end to dimensions or you would remove these extremities from them.

[4] On the fourth question: Abu Rayhan said: This is the answer of Muhammad bin Zakariyyah--since when has his opinion has become valid? – That superficial and imposing person! He said if a thing has two sides and a centre it will not be divisible eternally--and this is impossible. However, your claim does not hold in practical terms, because if antimony were ground finely, it would still not reach the atomic state to which you referred; therefore, division in actuality will discontinue before it reaches the state of your particles, and at any rate, what remains is <unnatural>, forced. He also said your saying necessitates that the side of a square is like the axis. Both, whether you agree with this or you disagree, the foundation you built will collapse; if you claim that there are spaces between the atoms, you will be asked about the spaces, whether they are smaller or are greater than the atoms themselves.

[5] On the fifth question: Abu Rayhan said, «I am either not aware of these sayings or they are inconsistent with each other, or whoever accepts them is declaring that the Creator, may He be Praised and Exalted, is unable to create universes beyond this one.» However, He who is able to create two distinguishable earths and two distinguishable fires is able to create for each of them a bottom and a top separately. If you do not accept this I will not accept the notion that movements from the centre to the perimeter are congruous and of the same kind. And <what> you said <was on the basis of> the saying of the Basarians. And in conclusion to the answer, <Abu Rayhan> continued, And if you label this as Sophistry, then I myself am the origin of this view, however, do not say that there is nothing besides these opinions and there is nothing unless it is tangible.

[6] On the seventh question: Abu Rayhan said, If you accept this as a given that the east of the heaven is the right, then the heaven ought to be all right and all left at the same time, because the east of each position is simultaneously the west of another; and it is inappropriate for one thing in one condition to be called by two names of opposite meaning.

[7] On the ninth question: Abu Rayhan said, If rays reflect from wherever they fall and are heated <as a result of this reflection, then> where is the proof for this? And where is the similarity between this <process> and burning mirrors? Indeed, its burning point is far from the spot of the reflection of rays. If you referred <in your claim> to the reflection, you should have illustrated that, because your words cannot be perceived without illustration. And how can what you say be accepted? The one who says that the ray is a body <has two choices>: (i) either he should prove the existence of vacuum--<and> in that case, what you say will not apply to him--or (ii) he should say that the ray exists in the sphere eternally, along with the air in it. Why do you not say that the water is not a body--because if it were a body, two bodies would exist in one location (and <by this> I mean water and clay). You must <also> say that light is a colour that is accepted by air or a transparent body; I say the opposite of that, and that is that light can be seen on non-transparent bodies and cannot be seen on transparent <bodies>, or what does not accept it. What is seen <of light> inside houses <for example> is what falls from it on the bodies <therein>, so if air were accompanying these bodies--and that is possible--then the light would not be seen and there would be no difference between it and other things.

[8] On the tenth question: Abu Rayhan said, The one who claimed that transformation is the spread of the particles of something between the particles of another thing did not say that the body requires more space if it were heated, but he said instead that fiery entities penetrate the body from its openings and pores, which increases <it> in its fiery parts; as a result of this its mass increases by the union of two bodies. When <for example> a glass vessel is heated, fiery particles penetrate its openings and expand it and thus it cracks. The proof of this <lies in> that we will only find the watery image, not the airy image, except when it condenses and unites: <only then> it abandons its image. If the water becomes air in reality it will not return to water when it condenses, and <yet> it would not <remain> air because returning to the watery state is a priority over another state. Furthermore, you are obliged to prove that when a body is heated and its dimensions increase, it is as if another body like it came to the world, thus decreasing the dimensions of the world as much as the increase of the former. <As a consequence> eventually there will be no space left--or else where are these increases going to be accommodated?

On the other eight questions:

[9] On the first question: Abu'l-Rayhan said, you were supposed to say that the reflection occurs off the bodies, and you should have illustrated <your claim>,

<for> otherwise your answer is nothing but affirming my saying through repetition.

[10] On the second question: Abu'l-Rayhan said, Your saying «if it never arrives, it is not moving» is incorrect, for we can say that a stone is gravitating towards the centre by nature, but never arrived at the centre because of obstacles preventing it from <doing so>. I consulted with the one who says this, and his response was: «I see this case like a two headed container filled with water, rocks being thrown in the container through one of the two openings so that the water <within> begins to rise; but I would not find any change <in its nature> as a result of <its> rising.» Neither can I see any changes in other objects that are moving upward. If the rise of water by the addition of the stones led you to the fire, <then> such is the metaphor for my interpretation; and you will find nothing but <the stone> arriving at the centre.

[11] On the third question: Abu'l-Rayhan said, your answer presented Aristotle's definition of the vision but not the explanation, and sometimes the definition of a thing requires many different interpretations. According to what you said, the one who sees would not be able to distinguish between dimensions, and <as such> he will perceive small <objects> nearby to be identical to large distant <objects>; and so too would be the case with sounds: loud sounds further away would be heard just as would quiet sounds closer by, the listener being unable to distinguish between the different sounds from their sources. If the transparent <body> were affected by colour, then a glass stained with black on one side when looked upon through any other side--except from the side opposite to the blackened side--should look black. The question was not about perception of what is under the surface of water, but I had asked <rather> about the understanding of how vision penetrates based upon the understanding of reflection of the rays simultaneously under the surface of water.

[12] On the fourth question: Abu'l-Rayhan said, Your linking heat to the continuing rise of the sun is a huge mistake which does not behove someone like you, because the place where the sun continuously rises also continuously witnesses the setting of the sun. Habitation does not occur there due to the <intense> cold, and <extreme> heat. Heat does not exist except in places where the time of sunrise is equal to the time of sunset in a single rotation of the heaven. As for the reflection at right and obtuse angles, and linking that to the cause of heat and cold, it is a matter that cannot be understood except by great explanation.

[13] On the fifth question: Abu'l-Rayhan said, If the width requires width, I say the surface has no length because length requires <more> length, and so on ad infinitum; this is pure sophistry. However, arguments should not be based on words but on meanings.

[14] On the sixth question: Abu'l-Rayhan said, I did not support but <only mentioned> the opinion of those who accept vacuum. If air expands by suction, as

you mentioned, and leaves the flask, where is it going to go if there is no vacuum in the world? <Abu'l-Rayhan> also claims that another equal quantity of air will be returned to the air whereupon it will shrink, and thus its expansion and contraction will be equal. Furthermore, <as for> your saying that it has been <proven> experimentally, I performed the experiment and the result was the opposite <to what you claimed>: the air left the flask in bubbles <while> no water entered in it whatsoever and I broke as many flasks as would be enough to hold the water of the <river> Jayhun.

[15] On the seventh question: Abu'l-Rayhan said, If the flasks were collapsing inward, then what you have said would have been correct, but the matter is to the contrary; they break outward, like a thing that is burdened by carrying something beyond its capacity.

[16] Objections of Abu Rayhan <al-Biruni> on the responses <he had received>; <from> a draft written in his hand and answers by one of Shaykh <Ibn Sina's> students.

Part VI

This sixth instalment of the correspondence between Ibn Sina and al-Biruni contains a response to al-Biruni by Abu Sa'id al-Ma'sumi, one of Ibn Sina's most accomplished students. A note at the beginning of this response suggests that al-Mam had been asked by Ibn Sina to respond to al-Biruni, and did as instructed by his teacher but his letter was lost and thus he later had to rewrite the answers from his notes. What has survived is a response to seven of the first set of ten questions posed by al-Biruni (answers to questions 3, 5, and 6 have been lost), and answers to all the eight questions from the second set of questions sent to Ibn Sina by al-Biruni. In his letter to Ibn Sina, al-Biruni had objected to the position taken by the Peripatetics on some of the most fundamental aspects of natural philosophy, for he held an independent position on these matters--a position that ultimately challenged many views of Aristotelian physics. Al-Ma'sumi's detailed explanation of these questions further elaborates views held by the Peripatetics.

Keywords: Ibn Sina-al-Biruni correspondence; Peripatetic natural philosophy; Islamic scientific tradition; history of physics; criticism of Aristotelian physics; natural elements; schools of thought in Islamic scientific tradition.

[1] The answers of Abi Sa'id Ahmad bin 'Ali to the objections of Muhammad bin Ahmad al-Biruni on the responses of Hujjat al-Haqq Abi 'AAI al-Hussain bin 'Abd Allah bin Sina, to his questions.

[2] When I found out, that what was written by Abi al-Qasim had been lost, I decided to recopy the response of my master--may Allah lengthen his life--from the original that was still with me, in order to regain his pleasure and love. This <new version> is not as elaborate as the first, due to my many engagements and preoccupations and studies--and this is also my excuse for any shortcomings and mistakes that may be found in it--because I have written it in a hurry and did not have the chance to recheck it, so <I hope that> if <my master> finds any mistakes in it, he will kindly correct and make an extra effort to hide such faults from a person who is indebted to him for his many favours and the one who executed his affairs following his passions, though not partial to any position. And I seek refuge in Allah against decrease and defect after increase and perfection and now return to the questions to say:

On your objection to the first question:

[3] You asked for a detailed explanation about the heavens having neither levity nor gravity. There is <already> enough clarity in the answer of the wise one and I also explained it at length along with all other questions that arise from this <view in the letter written> by Abi al-Qasim, <and> therefore I am not prepared to repeat that here, but I will briefly point out the main aspects, so I say:

[4] The possibility of presuming two motions for the heavens is only a conjuncture which does not necessitate a decree or change in nature, for it is possible to imagine the impossible, such as the union of two bodies in one place or <the presence of> one body in two different places; it is <likewise> possible to imagine fire being of the coldest substances, but this does not change its natural heat. Similarly, <it is possible to> imagine that water is one of the hottest things; such a case is that of <this formulation of> the motion of the heavens, but <all of this> is impossible to prove, as the wise one mentioned in his answers. <The fact remains, however, that> it is not possible <for either> the totality of the heavens or their parts <to have> either upward or downward movement, because if the heavens were to have this natural conflict, they would never be able to gain actuality, as a result of this idle power, as <such a> conflict does not benefit anything; in nature, there is nothing idle, and nor do we find anything idle in the divine worlds. But, this is not the subject for discussion, for this has been the opinion of the naturalists, <and> is a very popular idea in their tradition from the First Philosophy (*al-falsafa al-'ula*). Whoever is interested to gain knowledge about this, established on evidence, should consult Metaphysics. Based on this <view> they built their case for the elements, that they are neither light nor heavy in their totality but are so in their parts, because they are stationed in their centres and are not moving away from them--although it is possible to imagine a movement away from the centres, because it is possible to imagine the earth in the centre of ether either by nature or by force, but its existence is impossible in actuality--and that also applies to its parts because they move in actuality.

[5] <Regarding> your saying that «the heavy bodies are in their position and not in their centre because they are prevented <from being in there>», I say that it must be known that the centre is not only the centre point of the world, but it is also a common noun used to describe the position of any totality in nature. So, all the fire and water is in its centre, as is every <other> body, whereas if we were to consider the centre to be what you have imagined there would not be any body in its centre, because the centre is an indivisible point and bodies are divisible and their place is with them. If the fire were not at its centre, nor water, then earth too would not be in its centre--which is complete corruption of thought, but does not change the law of nature. And if we imagine the earth to be raised--even though this remains impossible--then its place will either (i) remain vacant, that is, will be followed by vacuum, and vacuum is not possible, or (ii) be filled by another body, and if this were the case it would not be filled naturally but by force due to the non-existence of vacuum. And the consideration of the fire is likewise.

On the second question:

[6] It would have been more appropriate if you had used gentler language for your purposes. Well, you asked the Wise One why he was so attached to the sayings of the ancients, and he answered you accordingly, and he says that he responded by way of oration after he had <already> presented proofs and evidence--as he is used to do in his books--and <therefore>, he should not be blamed for it. And had

you asked the wise one to support his views by arguments, he would have done that for you. It is not his fault if you failed to express yourself <properly>. I will mention to you a simple aspect of Aristotle's arguments when he argued about this question, although we do not believe in his stance regarding the infinitely pre-existent, and we ask refuge in Allah from bad consequences.

[7] In one of his formidable arguments he says that it is known that the limits and finitude (*nihayah wa'l mutanahi*) fall under correlation (*bab al-mudaf*), like the <relation between> a father and the son, and a brother and his brother, because we do not find any limit without a limiting <agent>, just as we do not find a father without a son, and vice versa. And when one of the two correlations exists potentially (*bi'l-quwwah*), then the second one also <exists> by force. And when one of them exists in actuality (*bil-fi'l*), so does the other, without one being prior to the other. If this were correct, we would say that time has an end, and its end is a period <of time> (*An*) that is indivisible, like a point on a line.

[8] Time is divisible, while limits and finitude fall under correlations, and we have said that when one of them exist potentially, the other does so as well and when we find one of them in actuality, we also find the other in actuality, so if we draw from these premises, a logical conclusion, we will say: If time has a beginning in existence, its beginning is a period (*An*) and this <beginning> will either come into existence simultaneously with time--and in this case time would have a correlation with the period--or the period would have come into existence before time, so that the period will exist <both> in actuality and potentially. However, we have established that the two <entities> in a correlation should coincide in existence--if one of them exists in potentiality, the other should also exist in potentiality, and if one of them exists in actuality, the other should also exist in actuality--therefore, what remains is that the existence of time should coincide with the existence of the period in order for both to exist in actuality, <for otherwise> the existence of the period before the time would require a time in the past before it and this goes on ad infinitum. <Therefore>, it is not strange to speak of an infinite action in the past as if it existed in an infinite time, just as we talk about the time in future. But what the Philosopher denies from infinity is the existence of something that does not have an end in an infinite time, as we cannot imagine a day that is not preceded by a yesterday or a chicken that is not preceded by an egg, ad infinitum.

[9] And this is what requires research based on logic and evidence, for the imagination based on senses and daily habits will not accept anything without limits, for it is <used to> the daily experience of things and time with limits. Exempt from this is to imagine the infinite eternal existence of the Creator--the Most High--in eternity, without an end, for this is not objectionable to the intellect. More wondrous is the <thought> that He existed in eternity, where there was neither time, nor light, nor darkness, nor creation. Then an idea comes to Him, so He creates things, and then gives in generosity what He kept from giving in posterity, so He performs an action with limitless power and then He puts [this

creation] in <the realm> of destruction and corruption, then He recreates it from the beginning! Is this not pointless? This is among the strong arguments that they present.

[10] Another proof they provide is that if Allah--the Most High--created the universe <in time>, then either He was knowledgeable about it before its existence or He was not. And the majority of them say that He was knowledgeable about it--and it is known that what is known with certainty is the Necessarily Existent (*wajib al-wujud*) by necessity. What is contingent, <however>, can either exist or not, and neither of these two <possibilities> is preferential. So, it is not known with certainty <whether the contingent exists or not>, but it remains conjecture. Yet, we know that the knowledge of Allah--the Most High--is certain, therefore, the existence of the universe is necessary (*wajib*) and not contingent (*mumkin*); and <as for> what is necessary, its doer (*fa'il*) did not do it by choice but by nature. Therefore, the consequence of the saying of the opponents is that He is a doer by nature <and not by choice>.

[11] Another proof <for this same argument>: If the Creator refrained from creating the universe in eternity, it could have been either for the lack of primal substance or for the lack of a pattern and form, or due to confusion of the concept, or for the action being inaccessible, or for <the action being> a folly. Now, the One Who <eventually> created the primal substance was, no doubt, able to create it from eternity, and He did not cause it to have potentiality <subsequently> because He is Immutable, free of incompleteness or addition--just as is the consideration of the pattern and the form. As for the confusion <which surrounds this>, it comes about from the lack of knowledge, and He is Greater and above that. As for the <suggestion of> action being impermissible, it is inapplicable here because impermissibility is that which does not emerge into actuality and its existence is essential. Further, the question of committing folly is impossible for al-Hakim; He is, therefore, the Effector in eternity.