

Natural Knowledge in the Arabic Middle Ages

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The medieval Arabic-speaking world had southern Spain, or Andalusia, as its far western border and then stretched across North Africa eastward to include all of modern-day Iran. Its two major intellectual centers were Cordova in the west and Baghdad in the east. As for its temporal extent, what might be termed “the classical period” of Arabic philosophy and science roughly began in the first half of the ninth century with the “first” Arabic philosopher, al-Kindī, and continued until the end of the twelfth, when Persian began to emerge as a rival to Arabic for writing and thinking about philosophy and the “Aristotelian” approach to science began gradually to be abandoned. Certainly one of the significant contributions of those working in the medieval Arabic-speaking world was the continuation of a scientific tradition going back to the earliest Greek natural philosophers, which attempted to explain the various natural phenomena and physical features that make up our world.

The study of nature in the medieval Arabic-speaking world was characterized by two currents that usually flowed in parallel, while occasionally crossing over and feeding one another: these were the intellectual traditions associated with *kalām* and *falsafa*. Although one is tempted to translate these terms respectively as “theology” and “philosophy,” it is not clear how helpful such labels are for understanding the differences between the two, since both traditions were interested in roughly the same set of questions, and their answers often shared common intuitions. Perhaps a better way to distinguish between the two is to consider how the

historical actors viewed themselves and what they thought the differences were. The proponents of *falsafa* saw themselves as adopting, adapting, and generally extending the Greek philosophical and scientific tradition, while the advocates of *kalām* envisioned themselves as promoting a way of thought intimately linked with the Arabic language and the Islamic religion. The emphasis of this characterization is on the two groups' own perceptions of themselves rather than whether the perceived differences were as real as they thought.

This chapter focuses primarily on the notion of nature as it appears in the *falsafa* tradition, namely, as a continuation of Aristotle's discussion of nature as well as that by the Greek Aristotelian commentary tradition. At the end of this survey, however, there is also a brief discussion of *kalām* accounts of nature and its response to the Greco-Arabic conception of nature. To this end, we shall begin with the Arabic vocabulary used for nature as well as various definitions of nature either taken over from or inspired by Aristotle. This section is followed by some brief notes on certain post-Aristotelian Greek developments that would affect the discussion of nature in the medieval Islamic world. In the next two sections it is argued that the desire of Arabic-speaking natural philosophers to address these later Greek developments led first to what might be considered a uniquely Arabic conception of the coming to be of the various natures at particular times, culminating in Avicenna's "Giver of Forms." This is followed by a section that considers the reaction among Andalusian Peripatetics to these new theories, where the focus is primarily on Averroës' response to Avicenna's thesis. The chapter concludes with a brief look at *kalām* conceptions of nature and the general critique of an Aristotelian understanding of nature considered as an internal cause of motion and rest.

THE VOCABULARY OF NATURE

The English term "nature" comes from the Latin *natura*, which itself is derived from the Latin verb *nascor*, "to be born, spring forth, originate." Latin-speaking philosophers themselves frequently understood the philosophical sense of *natura* by reference to Aristotle's definition of the Greek term *phusis*, which, like its Latin cousin, comes from a verb (*phuō*) meaning to bring forth, produce, or engender. What is common to both the Greek *phusis* and the Latin *natura* is that a nature has the sense of something arising from within a thing itself rather than coming from without. It was in this vein that Aristotle provided what would become the classical

definition of nature as “a certain principle and cause of being moved and being at rest, belonging primarily to that in which it is essentially, not accidentally.”¹ Thus a nature, according to Aristotle, is something wholly internal to a thing that accounts for the various activities (or motions) of that thing.

In the Arabic-speaking world, although the philosophers sometimes used *ḥaqīqa* (“truth or reality”) to characterize a thing’s nature—and indeed this term was the preferred term in *kalām*—by far the most common philosophical term for nature was *ṭabī‘a* (and sometimes the etymologically linked *ṭab’*). Indeed, when we turn to the Arabic translation of Aristotle’s *Physics*, the rendering of the definition for nature is practically verbatim with its Greek counterpart: “Nature [*ṭabī‘a*] is a certain principle and cause on account of which the thing in which it is primarily is essentially, not accidentally, moved and at rest.”²

Virtually every Arabic-speaking philosopher simply assumed this definition, either implicitly or explicitly. Thus consider the first Arabic philosopher, al-Kindī (ca. 800–870 CE), who was associated with the ‘Abbāsīd court in Baghdad during the caliphal reigns of al-Ma’mūn (r. 813–833 CE), al-Mu‘taṣim (r. 833–842 CE), and al-Wāthiq (r. 842–847 CE) and was intimately involved in the earliest interpretations and dissemination of the newly acquired Greek sciences within the Arabic world. In his *The Definition and Description of Things*, he defined nature as “a starting point [*ibtidā’*] of motion and resting from motion, where the most important [starting point] is the powers of the soul.”³ (Here, one should note that *ibtidā’*, “starting point,” is etymologically linked to *mabda’*, the term for “principle” occurring in the Arabic translation of Aristotle’s definition.)

Also relying heavily on Aristotle’s definition of “nature” was al-Fārābī (ca. 870–950 CE), who was active within the circle of philosophers known as the Baghdad Peripatetics and was certainly one of the most important philosophical system builders in the medieval Islamic world. Unfortunately, despite his significant role in the history of philosophy done in Arabic, very little is known about the details of his life. As for a thing’s nature, he identified it with a thing’s essence (*māhīya*) and then immediately described the essence as “that on account of which that species does the activity generated from it as well as the cause of the rest of the essential accidents belonging to it, whether motion, quantity, quality, position, or the like.”⁴ In other words, like Aristotle before him, al-Fārābī understood a thing’s nature as an internal cause of the activities associated with it. Also, pseudo-Fārābī would define nature as “the principle of motion and rest, when [that motion or rest] is neither from something external nor a result of volition.”⁵

This strong reliance on Aristotle's definition of nature is also seen among the Baghdad Peripatetics, a group of philosophers whose activity extended roughly from 870 CE to 1023 CE and who focused primarily, though not exclusively, on aspects of Aristotelian logic. Thus both the Syrian Christian Yaḥyá ibn 'Adī⁶ (893–974 CE), who studied with al-Fārābī and subsequently became titular head of the Baghdad Peripatetics, and his student Ibn as-Samh⁷ (d. 1027 CE), for whom we have little biographical information, offered Aristotle's definition verbatim in their discussions of nature.

Also drawing heavily on Aristotle's *Physics* was Avicenna (980–1037 CE). Known in both the East and West for his unique philosophical system as well as his work on medicine, *The Canon*, Avicenna was associated in varying capacities—sometimes as court physician, sometimes vizier—with a number of short-lived sultanates in Iran. Like many before him, Avicenna approvingly cited and commented upon Aristotle's definition of nature and further noted that nature in the strict sense (so as to be differentiated from the vegetative, animal, and celestial souls) is “a power that brings about motion and change and from which the action proceeds according to a single course without volition.”⁸

Ibn Bājja (1085 or 1090 to 1139 CE) was the first of the great Andalusian philosophers as well as vizier of the governor of Granada for twenty years. In his commentary on the *Physics*, he gave this abridged definition of nature—“a principle of motion and rest in the thing”—neither mentioning nor commenting on the idea that the principle belongs to the thing essentially and not accidentally.⁹ Unlike earlier thinkers within the *falsafa* tradition, Ibn Ṭufayl (ca. 1110–1185 CE), the next in the line of great Andalusian philosophers, did not use *ṭabī'a* when he spoke of nature in his philosophical novel *Ḥayy ibn Yaqzān* (a genre of doing philosophy, one might add, that apparently had no earlier precursor). Instead, he used *ḥaqīqa* (“true nature”) to speak of a thing's nature, saying, “the true nature of any body's existence is due only to its form, which is its predisposition for the various sorts of motion, while the existence that it has due to its matter is a weak existence that is barely perceivable.”¹⁰ (Here it is worth noting that although Ibn Ṭufayl's account, with its introduction of “form” and “matter,” might seem to go beyond Aristotle's definition, his addition in fact encapsulates Aristotle's later identification of nature with form and matter.) The final figure in the triumvirate of Andalusian Peripatetics is the great Aristotelian commentator, Averroës (1126–1198 CE), who in addition to expositing the works of Aristotle was chief *Qāḍī*, or judge, of Cordoba and court physician to the Spanish Caliph, Abū Ya'qūb Yūsuf.

As one might expect, in both his *Epitome* and *Long Commentary* on the *Physics* he cited Aristotle's definition of nature verbatim and then commented upon it.¹¹

Despite the obvious similarities between Aristotle's original definition and its Arabic variants, there is a difference between them, not so much with the definitions themselves, but with the implicit connotations of the Greek and Arabic terms being defined. Again, the Greek *phusis* is derived from a verb that carries with it the connotation of coming forth from within. In contrast, *ṭabī'a* is derived from the Arabic verb *ṭaba'a*, *yaṭba'u*, *ṭab'*, which means to be sealed, stamped, or impressed (from without) and so also conveys the sense of being made or created so as to act in a determined way. Consequently, while the notion that a nature is a principle and cause is explicit in both the Greek and Arabic philosophical definitions of nature, the Arabic account additionally carries with it an implicit sense that a nature is imposed from without, whether by God or some other agent, and that it is only once a thing is so impressed that its nature acts as a cause of the various natural activities that arise from it.¹² This shift in emphasis may in part be explained by the fact that Aristotle did not see his "god" as a creator of the very existence of the physical world, but only as the explanation of the motion of an independently existing world, whereas later thinkers, particular those working within one of the various monotheistic religious traditions, viewed God as the Creator in the sense of the efficient cause of the world's very existence, a point to which we shall return in the next section.

This implicit connotation of the Arabic *ṭabī'a*, namely, that it is impressed upon a thing by an external agent, can be seen in the very earliest discussions of nature by Arabic-speaking philosophers. Thus, according to al-Kindī, "natural science is the science of moved things precisely because nature is the thing that *God has made* as a cause and a reason for the cause of all things subject to motion and rest."¹³ Similarly the iconoclast and renowned physician Abū Bakr Muḥammad ar-Rāzī (born ca. 864 CE) complains of Aristotle and certain Greek commentators, asking "Why do you deny that God, great and mighty, in Himself is what necessitates [and so makes exist] the powers of all other actions and *the natures of things?*"¹⁴ Here we see at least two of the earliest Arabic-speaking philosophers ascribing to God the explicit role of creating natures and the implicit role of impressing them into physical things. In the Islamic east, later philosophers, such as al-Fārābī and Avicenna, would relegate this task to an immaterial substance or angel below God, namely, the "Active Intellect" or "Giver of Forms." Before we can appreciate their

theories, however, we must consider certain developments within the Greek scientific tradition that were to influence Arabic discussions concerning nature.

HISTORICAL BACKGROUND

The Arabic translators' choice of *ṭabī'a* to render Aristotle's notion of *phusis* was not simply happenstance; rather, it seemed to be the product of developments in the Greek Aristotelian commentary tradition itself. Aristotle, having defined nature as a principle of change, further identified a thing's nature with its matter and form.¹⁵ He additionally argued that although the individual instances of a form-matter composite—such as a particular person, a given tree, a quantity of water, and the like—inevitably come to be at some time and cease to be at some time, matter and form absolutely—that is, the underlying stuff and what it is to be human, tree, water, and the like—are eternal and exist necessarily.¹⁶ Consequently, for Aristotle the matter of and forms in the universe need no efficient cause to explain their existence; rather, what needs explanation according to Aristotle is the cause of the changes in the universe, which Aristotle explained by appealing to an unmoved mover as an ultimate object of desire.¹⁷ In this respect Aristotle's unmoved mover, or "God," is not an efficient cause of the universe's existence at all, but only a final cause of its motion.

Such a position came to be unacceptable to a number of later Neoplatonists. Neoplatonism had its origins in the *Enneads* of Plotinus (205–270/71 CE) with its appeal to "the One," which later thinkers would identify with God, and which in a real sense was considered to be beyond existence and being, but from whom all being or existence emanates. Thus Proclus (412–485 CE), whose own thought was much indebted to that of Plotinus, complained against Aristotle that it was not enough that God should be the final cause of the universe, as Aristotle had maintained; one must also show that God is the efficient cause, the very source, of the universe's existence. Unlike earlier Neoplatonists, such as Plotinus and Proclus, later Neoplatonists were quite keen to show the harmony of the thought between Plato and Aristotle. Accordingly, as part of their attempt to reconcile these two, later Neoplatonists wrote commentaries on a number of Aristotle's works, which were in turn either translated into Arabic or were known in paraphrastic versions. These works greatly shaped the reception of Aristotle in the Arabic world.¹⁸ Thus in response to Proclus's complaint, his own student, Ammonius (ca. 440–520 CE), maintained that despite appearances to the contrary, and notwithstanding what Aris-

totle's earlier commentators might have thought, Aristotle himself had in fact held that God is both final and efficient cause of the very existence of the universe. Ammonius specifically argued as much in a treatise on Aristotle's "creator"—a treatise which is now lost, although we have hints of its contents from Greek and Arabic sources.¹⁹ It was this Ammonian interpretation of Aristotle that the Arabic-speaking world inherited and which in part may explain the choice of *ṭabī'a* as the translation for nature; for again Aristotle identified nature with matter and form, and yet if God is the efficient cause of the existence of the universe as a form-matter composite, as Ammonius had suggested, God would be such precisely by creating and then impressing the various specific forms into matter.

In addition to this issue of God's causal relation to the universe were developments concerning the question of how Aristotle's formal and material natures interacted. Latent in some of Aristotle's physical treatises (such as *On the Heavens*, *On Generation and Corruption*, and the *Meteorology*) is the idea that the specific natures of things supervene on their elemental or humoral mixtures.²⁰ This idea was articulated more fully by later thinkers, particularly Galen (ca. 129–210 CE) in his medical writings (such as *The Elements* and *Mixtures*). These Galenic treatises made their way into Islamic lands via the Persian city of Jundishapur—situated in the southwest region of modern Iran—when the city saw an influx of Greek scholars in the wake of the persecution of heterodox Christian sects and the closing of the Academy at Athens in 529 CE. These scholars brought with them the works of Galen and other medical authors, which provided the theoretical framework for medical practice in the Islamic world. Jundishapur was home to the first "teaching hospital," founded around 550 CE, and remained the center of medical learning in the region even after Muslims took control of the former Sassanid, or Persian, Empire. Eventually its position was usurped by Baghdad, after the 'Abbāsid caliph al-Manṣūr (r. 754–775 CE) asked the then head of the Jundishapur medical school to treat him. The caliph's request precipitated a migration of physicians to Baghdad and the gradual rise of Baghdad as the preeminent center of medical learning.

Galen had taught that the different proportions of the elements (earth, water, air, and fire) and the more complex elemental mixtures such as the humors (blood, phlegm, yellow bile, and black bile) determined both what species form or nature a physical thing would have as well as the characteristic differences among individuals within a species, for example, why a particular person is sanguine, phlegmatic, bilious, or melancholic. While this simplified account looks broadly Aristotelian, Galen, drawing on a Stoic (materialist) natural philosophy and his own findings, also hap-

pily criticized Aristotle on points of natural and biological science. Indeed, at least one project among philosophers in Islamic lands was to reconcile, or at least adjudicate between, the best natural philosophy of the time as presented in Aristotle and the best medical theory of the time as seen in Galen. So, for example, from the point of view of natural philosophy, one challenge that medicine posed for philosophers in the Islamic world was to situate Galen's physiognomy within Aristotle's physics and show how a thing's underlying elemental mixture or temperament was related to its nature. This challenge, one might add, called for a reassessment of Galen's own philosophical assumptions. The one-time head of the teaching hospital in Baghdad, Abū Bakr Muḥammad ar-Rāzī, is credited with being the unsurpassed physician of Islam; he was among the first to rise to this challenge.²¹ While certainly indebted to Galen, ar-Rāzī's own close observations, emendations, and advancements went well beyond Galen in virtually all areas of medical learning and practice, such as anatomy, diagnosis, and pharmacology, and it was in light of his own independent speculation that ar-Rāzī wrote his *Doubts Concerning Galen*.²² Despite ar-Rāzī's rightly earned renown, it was Avicenna's *Canon* that would become the culmination of Arabic medicine; for in it not only did Avicenna present Galen's and ar-Rāzī's voluminous medical writings in a synoptic form, but he also attempted to provide for the science of medicine a theoretical basis that was grounded in Aristotelian natural philosophy.

Astronomy provided yet another discipline where advancements both in the later Greek and Arabic worlds went beyond Aristotle. Most notably, Aristotle had argued that the motions of the heavens accounted for changes in the elemental mixtures themselves and even suggested an astronomical model based on the system of Eudoxus (ca. 400–347 BCE), the best astronomer of his time. Unfortunately, Eudoxus's theory of rotating concentric spheres with Earth at the center was, within a generation of Aristotle, seen to be empirically inadequate. It was ultimately replaced by Ptolemy's (ca. 85–165 CE) astronomical system, with its appeal to eccentric and deferent-epicycle models.²³ Thus one issue facing philosophers in the Islamic world was how the physical principles and celestial motions assumed by Ptolemy's system (which were quite different from those assumed by Aristotle) could be incorporated into an Aristotelian natural philosophy with its explanation of changes in elemental mixtures, where those elemental mixtures in their turn determined a thing's specific nature and particular temperament—and all this while remaining sensitive to the conviction that God must be the ultimate cause of the natures that are impressed upon matter.

NATURE IN THE EARLY EASTERN ISLAMIC WORLD

The first Arabic philosopher to attempt this synthesis was al-Kindī, who, unlike most of his Aristotelian predecessors and successors, argued that God created the world along with all of its various motions from nothing and did so at some first moment in time in the finite past. Clearly, then, for al-Kindī, God, who created the existence of all things *ex nihilo*, is the cause of the absolute existence of natures. Al-Kindī added, however, that God uses the motion of the heavens in the generation and corruption of the individual instances of those natures thereafter. Al-Kindī's general strategy was something like this: the different motions of the elements—whether away or toward the center of the universe, that is the center of Earth itself, as well as the relative speeds away or toward the center—determine their natures. Heat is the cause of something's moving away from the center, while cold causes motion toward the center, whereas the dryer an element is the faster it moves and the wetter it is the slower it moves.²⁴ So, for example, the nature of the element fire is a combination of hot and dry, and as such fire naturally moves upward quickly. These motions, which again are linked to the qualities that determine the natures of the elements, are themselves affected by the size, speed, and proximity of the celestial bodies moving over them. In a popular survey of Ptolemaic astronomy and Galenic medicine, al-Kindī observed the following:

We see that the body of every animal comes to have a humor commensurate with its elemental mixture. Thus humors follow upon the proximity and distance from us of the [celestial] individuals and how high or low, or fast or slow they are as well as whether they are in conjunction or opposition. Moreover, [our humor] is proportionate to the elemental mixtures of our bodies at the time that the semen is produced as well as when it settles in the wombs.²⁵

Following Ptolemy, he then went on to describe the providential design of the heavens and their motions—including the sun's eccentric motion along the elliptic, as well as the various planetary motions produced by the combined effects of eccentrics, deferents, and epicycles. The myriad varying celestial motions, al-Kindī insisted, function together to give rise to numerous combined motions here on Earth, which themselves give rise to the various elemental and humoral mixtures of Aristotelian physics and Galenic medicine so as to account for the different specific natures that we find in the world as well as the particular temperaments of individuals. In summary, then, for al-Kindī, God is the proximate cause

of the existence of the heavens and their motions, creating them from nothing at some first moment of time, while their motions, in turn, are the proximate causes of the generation and corruption of natures here on Earth.

Many subsequent Arabic-speaking philosophers would accept, at least in outline, this synthesis of Aristotle, Galen, and Ptolemy, but with one major alteration. Al-Kindī's account seemingly had the celestial motions educe natures out of an underlying elemental mixture by affecting certain basic qualities in the elements—a feature that is in fact in keeping with Aristotle's own account of elemental change. Consequently, this account makes it appear as if accidental qualitative changes in the matter causally explain the existence of the various species forms, and yet for most later thinkers the causal explanation was just the reverse: form explains the actualized existence of matter, and species forms are causally prior to accidental forms.²⁶ Hence al-Fārābī maintained:

It would seem that the existence of forms is the primary aim, but since they subsist only in a given subject, matter was made a subject for bearing forms. For this reason, as long as forms do not exist, the existence of matter is in vain, but no natural being is in vain. Therefore, matter cannot exist devoid of a given form. Matter, then, is a principle and cause solely by way of being the subject for bearing the form; it is not an agent, nor an end, nor something that can exist independently of some form. Matter and form are both called "nature," although form is more aptly named such.²⁷

If matter alone cannot explain the existence of natures, understood as forms, whereas the celestial motions merely produce accidental qualitative changes in matter, then the question becomes "From whence do the natures or species forms arise and what impresses them into matter?" The question does not concern the ultimate cause of the absolute existence of natures, which all took to be God, but instead is "What causes the particular existence of a given nature in some bit of matter at a precise time?"

Although al-Fārābī suggested that natures temporally come to be in matter as a result of the "Active Intellect,"²⁸ which is the immaterial substance associated with the mover of the moon, Avicenna explicitly said as much and integrated this element into his overall theory of generation and corruption.²⁹ Avicenna summarized his account thus:

There is a single account about all of that, namely that through the mixture of the compound body it was prepared to receive a certain disposition or form or specific property [in other words, the natures] and that comes to be

in it as a result of an emanation from nothing other than the Giver of Forms and Powers. They emanate from it on account of its goodness and because it does not stint on providing [forms or natures] to whatever is deservingly prepared.³⁰

To be more specific, according to Avicenna every natural substance has an elemental disposition suitable to the nature informing it, where this elemental disposition is determined by how hot, cold, wet, or dry the substance is. Moreover, as in al-Kindī's system, elemental dispositions are constantly undergoing alteration as a result of the motions of the heavenly bodies. When, in a given natural substance, the alteration of its elemental disposition is significant enough, the matter is no longer suitable to the nature informing it, and so the matter receives a new nature that better accords with its new elemental disposition. Again it is the motions of the heavenly bodies that are the causes for the changes in a material substance's elemental dispositions. However, as such, the heavenly bodies are only preparatory or auxiliary causes for the occurrence of the new nature. The cause that imparts the new nature, that is, the new form, is "The Giver of Forms," which Avicenna identified, following al-Fārābī, with the last of the separate substances or Intellects, namely, the so-called "Active Intellect." The Giver of Forms, then, causes the suitable elemental disposition to receive the new form by emanating the appropriate form or nature into the prepared matter.³¹

Avicenna's conception of the role of the Giver of Forms in the temporal coming to be of natures and their concomitant actions would basically become the standard theory for later Muslim philosophers working in the east.³² So, for example, as-Suhrawardī (ca. 1154–1191 CE) embraced Avicenna's account, albeit recast in his preferred light imagery, and as such the theory became a mainstay of later Illuminationist philosophy in the Islamic east. (One should be careful, however, not to confuse the Illuminationist philosophy mentioned here with the tradition, frequently associated with the work of Ibn al-Haytham, that treats theoretical optics in the medieval Arabic-speaking world.)³³ As-Suhrawardī wrote, "Lights become the cause of motions and heat, where both motion and heat obviously belong to light, not that they are its cause, rather, they prepare the recipient so that it [a light] occurs in it from the dominating light that emanates through its substance onto the recipients properly prepared for it."³⁴ Here "light" is a trope for "form" or "nature," and "dominating light" is as-Suhrawardī's terminology for a separate, immaterial substance, such as al-Fārābī's "Active Intellect" or Avicenna's "Giver of Forms." Thus we see as-Suhrawardī in effect repeating the Avicennan position that cer-

tain accidental changes in motion and heat prepare matter such that it is impressed with a nature or form by a separate, immaterial substance.

NATURE IN THE LATER WESTERN ISLAMIC WORLD

There is evidence that the idea of a separate substance's impressing natures into matter reached philosophers working in the Islamic Empire in Spain at a fairly early date. In his *Inquiry into the Active Intellect*, the first major Iberian Peripatetic, Ibn Bājja, asserted the following:

The bodies subject to generation and corruption are subordinate to bodies that move circularly insofar as these are neither generated nor corrupted, where the former is like the elements. The elements, taken in their entirety, are not subject to generation, while their particular instances, namely the species of things existing materially, are generable. When we consider their particular instances, namely, the things subject to generation, it follows necessarily that there is a form that is not in a matter at all [namely, the Active Intellect], but which is intimately related to material forms and is a cause of their existence.³⁵

Here we see all the salient features of Avicenna's theory of the Giver of Forms—that the elements are subject to the motion of the celestial bodies, but that the cause of the existence of a particular species, or nature, in the matter, is due to a separate immaterial substance, identified, following al-Fārābī, with the Active Intellect.

Despite hints of this theory in the later western Islamic world, it never really seemed to capture the imagination of the Spanish Muslim philosophers, who on the whole preferred a theory of nature and the generation of natural things more closely aligned with the historical Aristotle. Thus even though Ibn Bājja, in his commentary on Aristotle's *Physics*, asserted that generation is the most significant part of the science of physics, there was no immediately apparent reference in that work to the role of the Active Intellect in generation as is suggested in his *Inquiry into the Active Intellect*.³⁶ Similarly, Ibn Ṭufayl, in his only extant philosophical work, *Ḥayy ibn Yaqzān*, said nothing about a possible role of either the Active Intellect or the Giver of Forms in generation, even though he had much to say about generation and the role of the celestial motions in the formation of elemental mixtures and readily admitted that the philosophy of Avicenna had influenced his own philosophical thought. Finally, although Averroës would mention Avicenna and al-Fārābī by name, noting the role that they had assigned to the Giver of Forms (that is, the Active Intellect) in generation, he did so only

to indicate what he considered to be an aberration of the moderns which, he claimed, belied a fundamental misunderstanding of Aristotle's position. (We shall return to Averroës' criticism of Avicenna and al-Fārābī shortly.)

In general the Andalusian Peripatetics seemed happier to explain the emergence of natures either, as in the case of the elements and nonliving things, in terms of qualitative changes brought about by celestial motions, or, as in the case of living things, through the activity of seeds and semen on a recipient matter. In Averroës' commentary on Galen's *Elements*, he wrote of the simple bodies:

It has become clear in the science of physics that every body is a composite of matter and form. The matter of the simple bodies is their common component that exists only in potency, as will become clear, while their forms are the four simple qualities, which are at the extreme. (I mean the two of them that are active and passive, for example, the hot and dry that are in fire and the cold and wet that are in water.)³⁷

Averroës identified the basic primary qualities, hot, cold, dry, and wet with the elemental forms or natures themselves, by which he probably meant that different natures are to be associated with different ratios between hot and cold and wet and dry. Consequently, as a result of the motions of the heavenly bodies, there would be changes in these primary qualities and their ratios, which in turn would explain the emergence of a new form or nature in a particular instance.³⁸ Thus, concluded Averroës, there is no reason to appeal to a separate substance that gives forms.

Similarly, according to these western Arabic-speaking philosophers, the species form or nature arises in living things when something possessing an active principle, namely, a specific type of semen or seed, brings about a change in the matter. Ibn Bājja gave a series of examples to make this point—"the embryo does not result from the [menstrual] blood until the semen unites with it . . . and the plant does not come from the mixture of water and earth until the seed unites with them."³⁹ On this point, Averroës wholly concurred. For these philosophers, one did not need to posit some separate, immaterial substance that impresses natures onto the prepared matter; rather, the seeds and semen that are part of our physical world can impart their own nature to a suitably disposed material when they come into direct contact with it.

Averroës further argued that the introduction of the Giver of Forms indicated a fundamental misunderstanding of the relation between matter and form; for if the matter's being prepared were different from the form impressed onto it, then one must assume that matter and form would be

really distinct, when in fact they are merely conceptually different. For example, if one considers an actually existing bed, one might conceive of the shape of the bed as different from the stuff that has that shape, but the shape and stuff of the bed are not really distinct such that there could be both a subsisting shape and subsisting matter. Yet, objected Averroës, such an opinion seems to be exactly what is assumed when one maintains that the Giver of Forms has certain forms that it impresses into prepared matter.

In the end, Averroës complained that both al-Fārābī and Avicenna had been misled about the generation or temporal coming-to-be of natures “because it was an opinion very much like the account upon which the practitioners of *kalām* in our religion rely, namely that the agent of all [generated] things is one and that some of the [generated] things do not bring about an effect in others.”⁴⁰ This criticism is interesting. One of its key complaints concerns the assumption that there must be some single efficient cause of all things—that is, that there is one agent who generated all things, a premise that Averroës would in fact deny. In denying the need for such an agent, Averroës in effect was rejecting the Ammonian interpretation of Aristotle, which made God both a final and efficient cause of everything in the universe. This, as we have seen, was the very issue that motivated earlier eastern accounts of nature. In fact Averroës considered it an open interpretative question within Islam whether God is the efficient, rather than just the final, cause of all things.⁴¹ Indeed, Averroës himself sided with Aristotle on this point, maintaining that certain substances other than God, such as the heavenly bodies, are eternal and so do not need an efficient cause; rather, God is precisely the final cause of the world’s existence and as such brings about celestial motions, which, as we have seen, were for Averroës the causes of elemental changes here in our world.⁴²

Here, then, we see that the discussion concerning nature within the *falsafa* tradition, which had its origins in Aristotle, was affected by later developments within the Greek intellectual tradition, underwent significant modifications at the hands of Arabic-speaking philosophers in the east, finally to come full circle in the thought of Averroës, who reestablished Aristotle’s account of nature and natural change.

NATURE IN *KALĀM*

Whereas the cast of players in the *falsafa* tradition might disagree about whether the nature arose from within or without a natural thing, they all agreed that once existing in such a thing, the nature is a cause and

principle of that thing's actions and motions. In contrast, the dominant position in *kalām* came to be that while a thing's true nature (*ḥaqīqa*) came directly from God (or perhaps through the intermediacy of an angel), such a nature had no causal efficacy considered in itself, and indeed God was the true and only cause of all things—both the cause of existence itself as well as any particular actions and motions or changes. This position, which culminated in a type of occasionalism, was not a matter of blind religious faith but was the conclusion of a series of arguments.

Before turning to those arguments, however, we should briefly consider sources for *kalām* conceptions of nature. Whereas the *falsafa* tradition was clearly indebted to Aristotle and his later Neoplatonic commentators for its understanding of nature, the sources for early *kalām* conceptions of nature are more obscure. Certainly many of the “theological” issues treated by practitioners of *kalām* had been part of the philosophical and theological systems of the Greek world. Moreover, there is evidence that part of the impetus for the early Greco-Arabic translation movement of Greek philosophical and scientific works was to provide factual information, particularly concerning natural philosophy, for theological debates between Muslim and Christian theologians.⁴³ Consequently, it is not surprising that at least one significant early *mutakallim* (a practitioner of *kalām*, plural, *mutakallimūn*), al-Jubbā'ī, wrote a treatise discussing and refuting arguments from Aristotle's corpus on natural philosophy.⁴⁴ Thus it seems likely that those working in the *falsafa* and the *kalām* traditions were in part drawing upon the same body of literature, except that whereas the former more openly embraced Greek learning, the latter seem to have been more hostile toward it. Perhaps one source for this difference in orientation toward Greek science was the Arabic language itself, or more particularly its grammar. Many *mutakallimūn* were leery of the new Greek science precisely because of its heavy reliance on Aristotelian logic, which they took to be nothing more than thinly disguised Greek grammar.⁴⁵ It was common to question whether Greek grammatical categories could provide a better way of conceptualizing the world than the categories that Arabic grammarians used, especially, it was argued, since the philosophizing was taking place in the Arabic language itself.

It may have been these linguistic concerns that motivated those working in the *kalām* tradition to adopt “true nature” (*ḥaqīqa*) for their notion of nature; for *ḥaqīqa* can simply mean the proper or strict sense or use of a word, and so a *ḥaqīqa* can be merely that which fixes the referent of some term without having any deeper metaphysical implications beyond this linguistic role. Thus Abū Rashīd (who flourished during the first half of the eleventh century CE) wrote of a thing's true nature:

The thing itself inevitably is specified by a certain description by which it is distinguished from other [things], where that description inevitably has a characteristic by which [the thing] is known⁴⁶ and that characteristic is, as it were, its true nature (*ḥaqīqa*) and a necessary condition of [the thing's] existence.⁴⁷

Here the emphasis is on a certain characterization or description by which one can pick out or identify a thing. Thus *ḥaqīqa*, far from identifying the causal principle of something's proper actions as it does in the *falsafa* tradition, indicates in the *kalām* tradition the feature(s) by which we sensibly recognize something and fix a referent in the language.

This is not say that theories of causal interaction among physical things were absent within the *kalām* tradition. They were not. Some of the earliest *kalām* thinkers maintained a theory by which one thing might "be engendered" (*tawallud*) by another and so caused. For example, the movement of the hand engenders the movement of the ring on the hand. A response to the theory of engenderment came at the hands of no less than al-Ghazālī (1058–1111 CE) himself. Al-Ghazālī's significance in the Islamic intellectual tradition cannot be understated. He was born in Ṭūs in the province of Khurasan in northeastern Iran and taught in both Baghdad and Nīshapūr. Among his intellectual accomplishments are his legitimization of Aristotelian logic among the *mutakallimūn*, his trenchant critique of *falsafa*, and his integration of Sufism, *kalām*, and even elements of *falsafa* into a systematic whole. When responding to the theory of engenderment, he presented what would become the dominant opinion within *kalām*, pointing out that such a theory, while perhaps capturing the imagination, lacked philosophical precision.

Now in our opinion what is known concerning the expression "to be engendered" is that some body emerges from inside of another body, as the fetus emerges from the mother's belly and plants from the belly of the Earth. This is absurd with respect to accidents, since the motion of the hand has neither an inside such that from it the motion of the ring emerges nor is it something containing things such that from it part of what is in it emerges. So if the motion of the ring is not concealed in the very motion of the hand, then what is the meaning of its being engendered by it?⁴⁸

In addition, this early *kalām* causal theory of engenderment seemed liable to the same type of criticism that *kalām* opponents of Aristotelian natural causation would raise, to which we shall now turn.

Aristotle and most (although not all) of those working within the

falsafa tradition took the existence of natures, understood as causes of species-specific actions and motions, as virtually self evident and not in need of proof.⁴⁹ Aristotle wrote, “Trying to prove that there is nature is ridiculous; for it is obvious that there are many such things, whereas proving obvious things through what is not obvious belongs to one who is incapable of distinguishing between what is known in itself and what is not.”⁵⁰ We have seen al-Kindī appealing to the regular movements of the elements, whether away from or toward the center, as witness to the existence of natures, and other philosophers point to the regularity of fire burning, alcohol’s intoxicating, and the like as evidence that these physical things have certain innate causal powers, which the philosophers identified with those things’ natures.

The first in a chain of *kalām* arguments directed against philosophers’ conception of natures was intended to undermine the claim that the existence of natures, understood as internal causes, is self-evident. One *mutakallim* who argued against the purported self-evident status of natures was al-Bāqillānī (d. 1013). A near contemporary of Avicenna, and for much of his adult life a resident of Baghdad, he was also one of the first to systematize and popularize the newly emerging Ash‘arite *kalām*, which took a more traditionally Islamic approach to theological and philosophical issues. Al-Bāqillānī observed:

Concerning what [the philosophers] are in such a stir, namely that they know by sense perception and necessarily that burning occurs from fire’s heat and intoxication from excessive drink, it is tremendous ignorance. That is because that which we observe and perceive sensibly when one drinks and the fire comes into contact is only a change of the body’s state from what it was, namely, one’s being intoxicated or burnt, no more. As for the knowledge that this newly occurring state is from the action of whatever, [such a causal relation] is not observed; rather it is something grasped through rigorous inquiry and examination.⁵¹

In other words, although we observe the constant conjunction of two types of events—whether fire’s contacting cotton and the cotton’s burning or intoxication following excessive drinking—one does not observe the causal connection or mechanism that explains such regularities. Based solely on sense perception, one could equally explain the regularity of our observations by appealing to a custom or habit on the part of God to bring about one type of event on the occasion of another type of event. For example, it might be that when fire is placed in contact with cotton, God, not the fire, causes the burning of the cotton. Both

interpretations—whether the natural causation of *falsafa* or the occasionalism of *kalām*—are underdetermined, should one appeal solely to sense perception.

A second in the chain of *kalām* arguments against Aristotelian natures was intended to show that in fact natures taken alone could not be causally efficacious. Again let us consider an argument derived from al-Bāqallānī.⁵² We observe around us the temporal succession of various and different events. If this temporal succession of events is due solely to natures, then the nature might be either eternal or temporal. Now since nature does not act by choice but always acts in the same way, if it were eternal, then from all eternity there would have been the same actions and the same events. Thus one could not explain the variety and differences of temporal events. If the natures that cause the temporal succession of various and different events are themselves temporal, that is to say, various and different natures arise and so produce various and different events, then there must be a cause for the temporal origination of those new natures. Consequently one can again ask about the origination of the new nature: “Is it caused by a nature and if so is that nature eternal or temporal?” Here one finds oneself once again facing the initial question. Clearly, then, if every cause acts through a nature, one is on the road to infinite regress. The adherents of *kalām* denied the possibility of an infinite series absolutely, whether an infinite series extending into the past or an infinite series of presently existing natural causes. Thus the purported series of natural causes must terminate with God. Of course, one could say that God acts through a finite series of intermediary natural causes, but why complicate matters when the earlier argument had shown that there is no empirical reason for assuming causal relations between various observable events? Simplicity, then, would suggest that one needs only a single cause. According to this account it is God, rather than the natures of things, that causally determines everything in the world at every instant. The origins of Islamic occasionalism—the view that reserves all causality for God and God alone—may well have had its origins in *kalām* critiques of Aristotelian natures.⁵³

CONCLUSION

In Islamic occasionalism, one sees an extreme response to a question that first arose in the late Hellenistic world and then influenced discussions of the understanding of nature in the medieval Arabic-speaking world: “What is God’s causal relation to the natural world?” Among those work-

ing in the *falsafa* tradition, the answer initially seems to have been that God created natures and matter, impressing the one into the other. Here God is the efficient cause of the natural world's existence. Subsequent thinkers, most notably Avicenna, relegated the task of impressing natures into prepared matter to an immaterial substance below God, identified with the Active Intellect or Giver of Forms. For certain later Muslim philosophers, such as Averroës, God apparently stands to the world only as its final cause, not its efficient cause, and so the issue of making natures that come from without and are then subsequently impressed into matter fell by the wayside. Indeed, when one turns to the Latin West and its reception of Arabic philosophy, in a real sense it was Averroës who led the way on this point—not in restricting God's role to final causation alone (for many Latin scholastics saw God as both final and efficient cause), but in rejecting the need for a separate substance (al-Fārābī's and Avicenna's Active Intellect or Giver of Forms) to explain how natures are impressed in matter. Thus, at least by the time of Thomas Aquinas (1225–1274 CE), Avicenna's Giver of Forms seemed to play no significant role in physics, and the Active Intellect had come to be identified with an internal cognitive faculty belonging individually to each human. In short, the Active Intellect was no longer considered a separate substance, as philosophers working in the Islamic world had commonly held.

In stark contrast to those working in the *falsafa* tradition, practitioners of *kalām* developed an occasionalistic outlook on the world, which simply did away with the intermediacy of natures and made God the direct efficient cause of all actions in the world. While none of the theological treatises of the *mutakallimūn*, in which they themselves laid out these arguments, made it into Latin translations, their thought was nonetheless known to Latin scholastics indirectly. Moses Maimonides (1135–1204 CE), for instance, mentioned *kalām* positions in his *Guide of the Perplexed*,⁵⁴ and Averroës incorporated into his *The Incoherence of the Incoherence* virtually the whole of al-Ghazālī's *The Incoherence of the Philosophers*, in which al-Ghazālī approvingly mentioned *kalām* theories.⁵⁵ Both Averroës' and Maimonides' works were in turn translated into Latin and played significant roles in the development of Latin scholasticism. Despite the relatively early presence of *kalām* theories available in Latin (even if at one remove), it would be difficult to trace direct lines of influence to similar views in Europe, such as seventeenth-century occasionalism and David Hume's criticism of causation in the early modern period.⁵⁶ Still, there are certain marked notes of agreement between the two groups. For example, both linked occasionalism with their anti-Aristotelian polemics, and attacked the causal theory that underwrote Aristotelian science.⁵⁷ Ironically,

while in the West these very points of similarity were seen as part of a scientific outlook that helped bring about the European scientific revolution, their success in the Islamic context, with the accompanying critique of natures taken as causal principles, has been seen (rightly or wrongly) as contributing to the decline of Islamic science.

NOTES

1. Aristotle, *Physics* II.1.192b21–23.
2. Ibid; Arabic in *Aristuṭṭālīs, at-Ṭabīʿī*, ed. Abdurrahman Badawi, 2 vols. (Cairo: General Egyptian Book Organization, 1964–65).
3. Al-Kindī, *Rasāʿil al-Kindī al-Falsafīya*, ed. Muhammad Abu Rida, (Cairo: Dār al-Fikr al-ʿArabī, 1953), 1:165.
4. Al-Fārābī, *Falsafat Aristuṭṭālīs*, ed. Muhsin Mahdi (Beirut: Dār Majallat Shiʿr, 1961), 89; English translation in *Philosophy of Plato and Aristotle*, trans. Muhsin Mahdi (Ithaca, NY: Cornell University Press, 2002), 128.
5. ʿUyūn al-masāʿil, in *Alfārābī's Philosophische Abhandlungen*, ed. Friedrich Deiterici (Leiden: E. J. Brill, 1890), 60.
6. Yaḥyá ibn ʿAdī, *Maqālāt Yaḥyá ibn ʿAdī al-falsafīya*, ed. Sahban Khalifat (Amman: Publications of the University of Jordan, 1988), 269–70.
7. In Aristotle, *Aristuṭṭālīs, at-Ṭabīʿī ad 192b21–23*.
8. Avicenna, *The Physics of The Healing*, ed. and trans. Jon McGinnis (Provo, UT: Brigham Young University Press, 2009), I.5 (3), 39.
9. Ibn Bājjā, *Sharḥ as-Samāʿ at-ṭabīʿī Aristuṭṭālīs*, ed. Majid Fakhry (Beirut: Dār an-Nahār li-n-Nashr, 1973), 24.
10. Ibn Ṭufayl, *Hayy Ben Yaqdhân, roman philosophique d'Ibn Thofaïl*, ed. Léon Gauthier (Beirut: Imprimerie Catholique, 1936), 85, English translation in *Hayy Ibn Yaqzân*, trans. Lenn Goodman (New York: Twayne Publishers, 1972), 132.
11. Averroës, *al-Jawāmiʿ fī l-falsafa Kitāb as-samāʿ at-ṭabīʿī*, ed. Josep Puig (Madrid: Instituto Hispano-Arabe de Cultura, Consejo Superior de Investigaciones Científicas, 1983), 19–20; Long Commentary on the *Physics* (Venice: *apud Junctas*, 1562), 48C–49K (repr. Frankfurt: Minerva, 1962).
12. For general accounts of theories of causation in the Islamic middle ages see Taneli Kukkonen, “Causality and Cosmology, the Arabic Debate,” in Eevan Martikainen, ed., *Infinity, Causality and Determinism: Cosmological Enterprises and their Preconditions* (Frankfurt: Peter Lang, 2002), 19–43; and Thérèse-Anne Druart, “Metaphysics,” in *The Cambridge Companion to Arabic Philosophy*, ed. Peter Adamson and Richard C. Taylor (Cambridge: Cambridge University Press, 2005), 327–48.
13. Al-Kindī, *Fī l-ibāna ʿan anna ṭabīʿat al-falak mukhālafa li-ṭabāʿī al-ʿanāṣir al-arbaʿa*, in al-Kindī, *Rasāʿil*, 2:40 (henceforth *Ṭabīʿat al-falak*) (emphasis added).
14. Ar-Rāzī, *Maqāla fīmā baʿd at-ṭabīʿa*, in *Rasāʿil Falsafīya*, ed. Paul Kraus (Cairo: Universitatis Fouadi I Litterarum Facultatis Publicationum, 1939), 116 (repr. Frankfurt:

Institut für Geschichte der arabisch-islamischen Wissenschaften, 1999) (emphasis added). This text, while I believe it is an authentic work by ar-Rāzī, is almost certainly not his *Maqāla fīmā ba'd aṭ-ṭabī'a*, but from his *Fī l-madkhal ilā l-'ilm aṭ-ṭabī'ī* [Introduction to Physics], which also went under the title *Sam' al-kiyān* [Auscultatio physica].

15. Aristotle, *Physics* II.1.193a9–b21.

16. See for example *Physics* VIII.1, where Aristotle argued that the motion of the heavens could not have begun at some first moment of time; *De caelo* I.11–12, where he argued that the heavens must be ungenerated and necessary; and finally *Metaphysics* Z.8, where he argued that form and matter absolutely do not come to be, but only particular instances of forms in matter come to be.

17. See Aristotle, *Physics* VIII.5 and *Metaphysics* Λ.7.

18. For the reception of Aristotle's *Physics* (with a particular emphasis on the role of the Neoplatonist John Philoponus's *Physics* commentary) see Paul Lettinck, *Aristotle's Physics and Its Reception in the Arabic World* (Leiden: E. J. Brill, 1994).

19. For discussions of Ammonius's influence on philosophy in the Islamic Middle Ages, see Robert Wisnovsky, *Avicenna's Metaphysics in Context* (Ithaca, NY: Cornell University Press, 2003), part 1; and Amos Bertolacci, "Between Ammonius and Avicenna: al-Fārābī's treatise *On the Goals of Aristotle's Metaphysics*," in *The Reception of Aristotle's Metaphysics in Avicenna's Kitāb al-Šifā': A Milestone of Western Metaphysical Thought* (Leiden: E. J. Brill, 2006), 65–110.

20. For a discussion of Aristotle's account of mixtures and various classical, medieval, and contemporary interpretations of Aristotle's account, see Rega Wood and Michael Weisberg, "Interpreting Aristotle on Mixture: Problems about Elemental Composition from Philoponus to Cooper," *Studies in History and Philosophy of Science* 35 (2004): 681–706.

21. For a discussion of ar-Rāzī's intellectual influence in the medieval Islamic world, see Lenn E. Goodman, "Muḥammad ibn Zakariyyā' al-Rāzī" in *History of Islamic Philosophy*, ed. Seyyed Hossein Nasr and Oliver Leaman (London and New York: Routledge 1996), 198–215.

22. See, ar-Rāzī, *Kitāb ash-shukūk 'alā Jālīnūs* [Doubts Concerning Galen], ed. Mahdi Muhaqqiq (Tehran: al-Ma'had al-'alī al-'ālamī li-l-fikr wa-l-ḥadāra l-Islāmīya, 1993).

23. For a general discussion of the relation between Aristotle's physics and Ptolemy's astronomy and the challenges it presented to Arabic-speaking philosophers and astronomers, see George Saliba, "Aristotelian Cosmology and Arabic Astronomy," in *De Zénon d'Élée à Poincaré, Recueil d'études en hommage à Roshdi Rashed*, ed. Régis Morelon and Ahmad Hasnawi (Leuven: Peeters, 2004), 251–68.

24. Al-Kindī, *Ṭabī'at al-falak*, 40–44.

25. Al-Kindī, *Fī ibāna 'an al-'illa l-fā'ila l-qarība lil-kawn wa-l-fasād*, in al-Kindī, *Rasā'il*, 1:226.

26. See Abraham D. Stone, "Avicenna's Theory of Primary Mixture," *Arabic Sciences and Philosophy* 18 (2008): 99–119, for a discussion of the Greek origins of this problem and Avicenna's theory of the Giver of Forms as a solution to it.

27. Al-Fārābī, *Mabādī' al-mawjūdāt*, in Fauzi Najjar, ed., *as-Siyāsa al-madaniya al-mulaqqab bi-mabādī' al-mawjūdāt* (Beirut: Imprimerie Catholique, 1964), 36–37.

28. See al-Fārābī, *Falsafat Aristuṭālīs*, 129–130 and *Mabādī' al-mawjūdāt*, 54–55.

29. See Avicenna, *al-Kawn wa-l-fasād*, ed. Mahmud Qasim (Cairo: General

Egyptian Book Organization, 1969), XIV; and *The Metaphysics of The Healing*, ed. and trans. Michael E. Marmura (Provo, UT: Brigham Young University Press, 2005), IX.5, for discussions of the role of the “Giver of Forms” (wāhib al-ṣuwar) in the processes of generation and corruption.

30. Avicenna, *al-Af'āl wa-l-infi'ālāt*, ed. Mahmud Qasim (Cairo: General Egyptian Book Organization, 1969), II.1, 256.

31. The most extensive discussion of Avicenna theory of the “Giver of Forms” is Jules L. Janssens, “The Notions of *Wāhib al-Ṣuwar* (Giver of Forms) and *Wāhib al-'aql* (Bestower of Intelligence) in Ibn Sīnā,” in *Intellect et Imagination dans la Philosophie Médiévale*, ed. Maria Cândida Pacheco and José Francisco Meirinhos (Turnhout, Belgium: Brepols, 2006), 1:551–62.

32. There is even reason to believe that the great critic of *falsafa*, al-Ghazālī, may have incorporated Avicenna’s theory into *kalām*, albeit with significant modifications; see Jon McGinnis, “Occasionalism, Natural Causation and Science in al-Ghazālī,” in *Arabic Theology, Arabic Philosophy, from the Many to the One: Essays in Celebration of Richard M. Frank*, ed. James E. Montgomery (Leuven: Peeters, 2006), 441–63.

33. It is worth noting that Illuminationist philosophy seems not to have made it into Latin and so had no real influence on Latin philosophy and science. For a discussion of Arabic optical theories that would be influential on the Latin *perspectiva* tradition, see David C. Lindberg, *Theories of Vision from al-Kindī to Kepler* (Chicago: University of Chicago Press, 1976).

34. Arabic in Suhrawardī, *The Philosophy of Illumination*, ed. and trans. John Walbridge and Hossein Ziai (Provo, UT: Brigham Young University Press, 1999), 129.

35. Ibn Bājja, *al-Wuqūf ‘alā l-‘aql al-fa’āl*, in *Rasā’il ibn Bājja al-ilāhiya*, ed. Majid Fakhry (Beirut: Dār an-Nahār li-n-Nashr, 1968), 107; French translation in Thérèse-Anne Druart, “Le Traité d’Avenpace sur ‘Les choses au moyen desquelles on peut connaître l’intellect agent,’” *Bulletin de Philosophie Médiévale* 22 (1980): 73–77.

36. Ibn Bājja, *Sharḥ as-Samā’ aṭ-Ṭabī’ī*, 23.

37. Averroës, *Talkhīṣ kitāb al-uṣṭūqissāt li-Jālīnūs*, ed. George Anawati and Sa’id Zayed (Cairo: The General Egyptian Book Organization, 1987), 55.

38. See Averroës’ middle commentary on *Generation and Corruption*, *Commentarium medium in Aristotelis de generatione et corruptione libros*, ed. Francis Fobes (Cambridge, MA: The Medieval Academy of America, 1956), book II, para. 56, 146–48; English translation in *Averroës on Aristotle’s De Generatione et Corruptione*, *Middle Commentary and Epitome*, trans. Samuel Kurland (Cambridge, MA: The Medieval Academy of America, 1958), 101–2.

39. Ibn Bājja, *Sharḥ as-Samā’ aṭ-Ṭabī’ī*, 27; cf. Averroës’ long commentary on the *Metaphysics* Z.9 (comment 31), *Tafsīr mā ba’d aṭ-Ṭabī’īyāt*, ed. Maurice Bouyges, 3 vols. (Beirut: Imprimerie Catholique, 1938–1952), 878–886.

40. Averroës, *Tafsīr mā ba’d aṭ-Ṭabī’īyāt*, 885.

41. See, e.g., his *Decisive Treatise*, trans. Charles E. Butterworth (Provo, UT: Brigham Young University Press, 2001), 16 (21).

42. See Averroës’ long commentary on the *Metaphysics* Λ.6 (comments 29–36), *Tafsīr mā ba’d aṭ-Ṭabī’īyāt*; English translation in Charles Genequand, *Ibn Rushd’s Metaphysics* (Leiden: E. J. Brill, 1986), 134–50.

43. See Dimitri Gutas, *Greek Thought, Arabic Culture: The Graeco-Arabic Translation*

Movement in Baghdad and Early 'Abbāsīd Society (2nd-4th/8th-10th centuries) (London: Routledge, 1998), 72–73.

44. See F. E. Peters, *Aristoteles Arabus: The Oriental Translations of Commentaries on the Aristotelian Corpus* (Leiden: E. J. Brill, 1968), 35–36.

45. For at least one historical account of this complaint, see David S. Margoliouth, “The Discussion between Abū Bishr Mattā and Abū Sa’īd as-Sīrāfī on the Merits of Logic and Grammar,” *Journal for the Royal Asiatic Society* (1905): 79–129.

46. *Yazharu*, literally, “[the thing] becomes apparent.”

47. Arabic in Richard M. Frank, *Beings and their Attributes, the Teaching of the Basrian School of the Mu’tazila in the Classical Period* (Albany: State University of New York Press, 1978), 80n3.

48. Al-Ghazālī, *Iqtī’ād ft l-i’tiqād*, ed. ‘Abdallah Muhammad al-Khalili (Beirut: Dār al-kutub al’ilmīya, 2004), 59; English translation in Michael E. Marmura, “Ghazali’s Chapter on Divine Power in the Iqtī’ād,” *Arabic Science and Philosophy* 4 (1994): 312.

49. Dissenters included ar-Rāzī in his *Maqāla fīmā ba’d aṭ-ṭabī’a*, 116, who maintained natures are neither immediately perceptible, even if their purported actions might be, nor is their existence a first principle of the intellect; and Avicenna in his *The Physics of The Healing*, I.5 (4), 40, who argued that although the natural philosopher must accept the existence of natures as one of his first principles, that existence could be demonstrated in first philosophy.

50. Aristotle, *Physics* II.1.193a3–6.

51. Al-Bāqillānī, *Tamhīd*, ed. Richard McCarthy (Beirut: Librairie Orientale, 1957), 43 (77); al-Ghazālī provides a similar argument in his *The Incoherence of the Philosophers*, ed. and trans. by Michael E. Marmura (Provo, UT: Brigham Young University Press, 1997), 171 (discussion 17).

52. Al-Bāqillānī, *Tamhīd*, 34–37 (59–65).

53. For discussions of Islamic occasionalism, see Majid Fakhry, *Islamic Occasionalism, and Its Critique by Averroës and Aquinas* (London: George Allen & Unwin, Ltd, 1958).

54. See Moses Maimonides, *Guide of the Perplexed*, part I, chapter 73.

55. See Averroës, *Destructio Destructionum Philosophia Algazelis*, ed. Beatrice H. Zedler (Milwaukee: Marquette University Press, 1961).

56. One might also note the atomism of Nicholas of Autrecourt in the Middle Ages. Unfortunately, *kalām* atomism was not discussed in this study. A brief survey of it is available in the Stanford Encyclopedia of Philosophy (<http://plato.stanford.edu/entries/arabic-islamic-natural/>), and a more extensive study is offered by Alnoor Dhannani, *The Physical Theory of Kalām, Atoms, Space, and Void in Barisan Mu’tazilī Cosmology* (Leiden: E. J. Brill, 1994); and again in Abdelhamid I. Sabra, “*Kalām* Atomism as an Alternative Philosophy to Hellenizing *Falsafa*,” in *Arabic Theology, Arabic Philosophy, from the Many to the One*, 199–272. As for a discussion of *kalām* influences on Nicholas of Autrecourt, see Zénon Kaluza, “Nicolas d’Autrecourt et la tradition de la philosophie grecque et arabe,” in *Perspectives arabes et médiévales sur la tradition scientifique et philosophique grecque*, ed. Ahmad Hasnawai, Abdelal Elamrani-Jamal, and Maroun Aouad (Leuven: Peeters, 1997), 365–93.

57. It is worth noting, however, that unlike later European occasionalists, Muslim theologians did not altogether deny real qualities, nor did they adopt a mechanical

outlook to replace Aristotelian forms as a causal explanation. So, for example, they would affirm that the wine is red because of the accident of redness in it; however, God is the cause of the redness in the wine as well of our perceiving the wine as red. For a discussion of causal explanations in medieval Latin and early modern thought, see Steven Nadler, "Doctrines of Explanation in Late Scholasticism and in the Mechanical Philosophy," in *The Cambridge History of Seventeenth-Century Philosophy*, ed. Daniel Garber and Michael Ayers (Cambridge: Cambridge University Press, 1998), 513–52.