

Science and Metaphysics in the Three Religions of the Book

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Abstract: The three religions of the Book trace their origins back to the same Abrahamic experience, but only one, Christianity, developed a metaphysical framework consistent with that of modern science. Both Judaism and Islam during their formative years, and continuously up to modern times, considered Greek philosophy and science alien wisdom, jeopardizing their sacred scriptures. The different path followed by Christianity is due to the influence of Hellenistic thought during Christianity's early formative period. Both Judaism and Islam were spared the direct mediation of Greek culture and ideas because both Judaism and Islam developed geographically and linguistically isolated from the Greek influences during the reception of their scriptures.

Are there cognitive effects of religion and metaphysics on the development of modern science? I think the answer is, yes. The task of arriving at this conclusion is daunting and the answers suggested here can only be a first approximation.

At the outset I remind the reader that before there were Christians or Muslims, and perhaps before there were Jews, there were Greeks. The New Testament of the Christian Bible says, "In the beginning was

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the *Logos*" (the Greek term for "word," "reason," or "indwelling spirit"). So it is fitting for our context to say, "in the beginning were the Greeks." Of course archaeological remains would give priority to the Jews, but that is another story.

As all believers in the Abrahamic tradition know, the Greeks produced a philosophy and a culture—a broad and deep intellectual orientation—that was at once profoundly attractive, deeply subversive, and remarkably tenacious. Despite the desire of some of our contemporaries to relegate the Greeks to the dead past of Western patriarchy, no account of the historical record from the emergence of "high culture" to the present is complete until it has taken into account the profound intellectual effects that Greek culture has had on all aspects of Western culture and indeed, the global situation. Consequently the uniquely Greek idiom of philosophizing is a major point of reference. Nevertheless, the focus of this paper is on the development of the three religions of the Book, beginning about the time of Philo, that is, the first century before Christianity.

I should point out that some scholars would argue for a clear distinction between "religion" on the one hand, and "metaphysics" on the other. For present purposes I can only say that I agree with those who recognize that the line between the two is exceedingly fine. Whether or not we can determine that a particular item of belief belongs to the realm of "religion" or "metaphysics," it is clear that the development of modern science was greatly influenced by non-demonstrable assumptions that would ordinarily be labelled, "metaphysical." Although I focus here on metaphysical beliefs, nothing I say in this essay is meant to exclude the broader cultural, economic, legal and institutional factors that should be considered while investigating the reasons for the rise or (retardation) of modern science in any cultural setting, as I have done elsewhere.¹

Some Metaphysical Commitments

I want to focus initially on three particular sets of metaphysical beliefs. For in my view modern science could not have arisen were it not for the gradual and increasingly articulate evolution of the following three metaphysical assumptions:

First, it had to be believed that nature is a rational order, that is to say, an all-encompassing, coherent, orderly, and predictable domain. Without this axiomatic belief concerning the natural world, we could neither scientifically understand it nor explain it.

Second, scientific reasoning is predicated on the belief that human beings are endowed with reason and have the intellectual capacity to understand the workings of nature. Of course, particular theories may be wrong at any moment in time, but the assumption is that gradually over time nature will yield up its secrets to rational inquiry.

Thirdly, it has to be taken for granted that it is permissible, and even mandatory, for men and women, using their powers of reason, to question all forms of truth claims, including religious, political, ethical, and even science's own claims. This is a very important consideration because it is by no means assured that the intellectual elite of any particular society or civilization will agree that it is permissible for ordinary mortals—especially lay persons—to speak out, to challenge and upset traditional understandings, based on scientific findings, and above all, to disturb revealed truths stated in sacred books. It is not even certain today in many parts of the globe that public information which describes the collective state of well-being (or ill-health) can be publicly viewed or discussed. In many societies today all sorts of social statistics, economic results, and public health reports, are classified as state secrets, and cannot be published or discussed without obtaining official permission, or risk criminal sanctions, especially in Asia and the Middle East.

From this point of view, the rise of early modern science concerns the rise and institutionalization of these three enormously empowering principles. In the present discussion I shall focus mostly on the first two assumptions—that nature is a rational, coherent, and orderly domain, and that human beings have the capacity to understand that order, unaided by scripture. The question then becomes one of identifying some of the early manifestations of these metaphysical assumptions and how they were received by the three religions of the book.

The Greek & Hellenic Heritage

As we know, the period leading up to the beginnings of Christianity was one in which Hellenic culture reigned supreme throughout the settled communities surrounding the Mediterranean. Alexander the Great's conquest in the 4th century B.C. resulted in the sudden spread of Hellenic culture over a vast region of Asia and the Middle East. At the center of that culture we find not only Aristotle's great organon of natural philosophy, but also the equally persuasive works of Plato (d. 347 BC).

As a result of Alexander's expansion of the Greek oecumene, it is said that 70 new Greek cities were founded across the Middle East and elsewhere in the path of his conquest.² Undoubtedly the most significant of the new Greek cities was Alexandria, founded in 332 BC on the coast of Egypt. Indeed Alexandria's cultural life, based on the language, law, and philosophical culture of Greece during the last two centuries before Christ, rivalled that of Athens. During this period the Greek language had in fact become the "lingua franca" throughout this vast stretch of what was called the "inhabited world." As one classical scholar puts it, "Greek might take a man from Marseilles to India, from the Caspian to the Cataracts."³ Hence the schools and academies of that time were wholly framed by Greek learning, and deeply embedded in the works of Plato and Aristotle, their followers and commentators: Stoics, Sceptics, Cynics, Neoplatonists, and many others. What developed out of this was not always a literal restatement of what Plato and Aristotle taught; nevertheless, it represented in some ways a radical departure from the various indigenous cultures, especially Semitic, that had flourished outside the Greek cultural ambience. In the end, the intellectual idioms of Plato and Aristotle became the conceptual hinges on which the Western scientific tradition turned thereafter.

It has been recognized for some time that Plato's little classic, the *Timaeus*, is not only one of Plato's most influential books, but also one of the most concise statements of the classical Greek scientific heritage, above all, as an exposition of cosmology, physics, physiology, and the idea of cosmic creation.⁴

At the center of Plato's dialogue is the notion that the cosmos and the world in which we dwell was created by design, through the persuasion of "intelligence," shaping the material of the world. In Plato's words,

The generation of this cosmos came about through a combination of necessity and intelligence, the two commingled. Intelligence controlling necessity persuaded her to lead towards the best the greater part of the things coming into being; and in this way this universe was constructed from the beginning, through necessity yielding to intelligent persuasion. (*Timaeus*, 48a)

There is embedded in this powerful extract from the *Timaeus* an enormous amount of metaphysical presupposition. The whole cosmic creation (and smaller world in which we dwell) is said to be the product of (1) creation, (2) by a (divine) intelligence or Demiurge,

and (3) necessity. Throughout this creation "necessity" and "causation" are at work, making the whole into a balanced unity. In other places Plato speaks of "Reason" as the guiding principle. However, the text also says, "If, then, we are really to tell how it came into being on this principle, we must bring in also the Errant Cause—in what manner its nature is to cause motions." (48b).

Thus, the purposeful designer of the cosmos also had to deal with chance and fortuitous circumstance. Nevertheless, throughout the discussion reference is made to "rational design" and purposefully rational motivation behind the creation of this universe and all the acts of the creatures in it. It is a creation with purpose and hence design. Likewise, man is said to be part of this rational creation. The creator bestowed upon man the faculty of sight and this in turn allowed him to observe and study the workings of nature, especially the movements of the sun, moon, and celestial bodies. This in turn led man to discover the concepts of time as well as number. From all this we get philosophy, that blessing "than which no greater boon has ever come or shall come to mortal man as a gift from heaven." (*Timaeus*, 47b). Furthermore, by observing the more perfect motions of the heavens we, like them, may so order our own existence into a more perfect pattern of life. (47b-c). In other words, man is given the gifts of sight and intelligence which allow him to understand the workings of the natural world in all its manifestations, giving us philosophy, perhaps even divine wisdom. This very contemplation of nature (philosophy, to reiterate), is the greatest good that heaven could bestow on humankind.

In this discourse Plato has created the image of a rationally ordered world, an organic living whole, which was later interpreted as a "world machine," regulated by reason and necessity, though as noted, Plato allows for chance, which is the outcome of those fortuitous combinations of the workings of the separate "powers." The study and contemplation of this whole is not only permissible, it is the highest form of human activity that the world intelligence has created, and through us this rational contemplation is carried on.

This bare bones sketch of Plato's great work reveals the presence of nearly all of the metaphysical elements that I suggested earlier must be present if modern science is to rise and flourish: an orderly world, governed by chance and law in precarious balance, and the encouragement of man to study it. Yet from a sociological point of view, such ideas as these, which lie at the heart of natural science, have not been universally accepted. But if modern science is to

flourish, then some version of such ideas must be institutionally available. So let us turn to the encounter of Judaism and Hellenism and to the reception and transformation of these ideas in the other religious traditions.

Athens versus Jerusalem?

When Hellenism began its spread across the Middle East in the time of Alexander, Judaism was full blown, though it was still evolving. During the Hellenistic phase of Greek cultural expansion in the last three centuries before Christ, the Greek language, as noted earlier, became dominant throughout the region. Accordingly, the Jewish sacred scriptures (the Torah) were translated into Greek, from which we get the Pentateuch—the so-called Five Books of Moses in Greek translation. This was the edition of the Bible that was most commonly studied and read around the time of the birth of Christ.

Given this cultural situation, it should not be surprising to find a powerful encounter between the metaphysical presuppositions of Greek philosophy and the theological ones of Judaism of this period. In fact we find just such an encounter in the life and writings of Philo of Alexandria, also known as Philo the Jew.

Remarkably, Philo lived at the very moment of the birth of Christianity, from about 15 BC to 50 AD. What is interesting for us is the use that Philo made of Greek modes of thought in his interpretation of the Books of Moses—the Torah for Jews and the Pentateuch for Christians. What classical scholars have long known is that Philo created a synthesis of Greek philosophy and Judaism, producing what some would call "Jewish philosophy." But more importantly Philo fused the ideas of Judaic law and natural law into one entity. This claim of a new synthesis has been the subject of some controversy. Some scholars have said that the articulation of the idea of natural law was a Stoic idea (found already in the writings of Cicero and Antiochus of Ascalon) more than a generation before Philo, while others claim that Philo produced an original fusion of the Greek concepts of *nomos* and *physis*.⁵

However, at this point in time it is fair to say that while there are earlier formulations of the natural law theory, especially among the Stoics, Philo's writings do indeed achieve the fusion of Mosaic law and the law of nature by means of allegory. For example, Philo writes:

This world is the great city and it has a single constitution and law, which is the reason in nature. (*Jos.* 29-31) Since every well ordered state has a constitution, the world-citizen enjoyed the same constitution as did the whole world... this constitution is the right reason of nature more properly called an ordinance seeing that it is divine law. (*Opifex:* 143-4)⁶

Central to this understanding is the idea that a single universal law governs the universe and that this law or reason is inherent in nature. Thus nature, both man, animals and the cosmos itself, is regulated by the logos, by right reason which is the divine indwelling in nature.⁷

Furthermore, scholars agree that in his exegetical studies of the Mosaic Scriptures Philo used the *Timaeus* of Plato as the framework of his enterprise thereby rising to an allegorical and philosophical form of interpretation very different from the exegetical work of Talmudic scholars.⁸ Philo incorporates Plato's arguments that I set out above, that the world is regulated by natural law, that there is virtue in studying nature, and the idea that philosophy is not only good, but is the rightful gift of God to man.

In a word, Philo approached the sacred Jewish scriptures as a believing Jew but at the same time he used the philosophical apparatus of Plato and the *Timaeus*, to elucidate the Scriptures, thereby fusing Judaic belief with an implicit permission, even injunction, to undertake philosophical exegesis. According to Philo's account, philosophy as understood by Plato and Aristotle had really been invented by God through Moses, and therefore, there was no reason to deprive Jews of this great intellectual blessing. But neither Philo's contemporary co-religionists in Alexandria or Palestine, nor later generations of Jews were receptive to his innovation. Rabbis remained wary of the dangers of indulging in philosophical speculation. Had this not been so, Maimonides, twelve centuries later, would not have adopted such a cryptic and convoluted style of exposition when he wrote the *Guide of the Perplexed*, nor would his writings have provoked such controversy.

Put in slightly different terms, Judaic thought was to remain transfixed by the Torah, the oral tradition of the Mishnah, and the great compilations of commentaries known at the Talmud. Accordingly, theology as an enterprise in its own right, and natural philosophy, were considered (throughout the period we are dealing with) as extraneous additions that bordered on the impious. Within the Jewish community philosophical speculation remained dangerous.

On another level, one can see the split between Judaism and Christianity as the difference between those God-fearing individuals who preferred the letter of the law as opposed to those who looked to the spirit of the law. As was to be the case later in Islam, the sacred law—the Halakhah in Judaism and the Sharī'ah in Islam—was to be the controlling intellectual center of Jewish thought.⁹ Indeed, the tension between the particularism of Jewish law versus the norms of the larger society was to be the defining problem of the Judaic community for the next millennium and a half. Jews were forced to ask themselves why they were chosen to receive the Torah, and then on the other hand, if, out of a spirit of ecumenism, they neglected to follow the law but instead joined the universal community, how could they still be called Jews?

Seen in this light the Christians truly had a new message (Gospel): they were released from strict observance of the law, and were told to substitute universal love, not an eye for an eye, but a brotherly ethic of turning the other cheek.

In the end Philo's influence was primarily felt by Christians, especially the early Church Fathers who preserved his writings. Apparently they had greater freedom for philosophical speculation since they were bound not by the literalism of legislation in the Holy Book, but by the spirit of their New Gospel.

In the meantime, Philo's work became unknown in the Jewish community, not to be recovered until the sixteenth century.¹⁰ In a word, the attempt to fuse traditional Jewish thought with metaphysical speculation derived from Athens during this period, was a failure. This brings us to the advent of Christianity

Christianity and Greek Philosophy

Given the preceding excursion into Greek philosophy and the Hellenistic modes of thought, it requires a considerable transposition of mind to enter into the simple, non-Greek mindset of the Jewish carpenter's son who came to be known as Jesus Christ. For it is quite certain that Jesus himself was a person deeply immersed in local Hebraic culture, not Greek learning. Furthermore, by the time of Christ, the Romans had taken over the Holy Land and begun the great transformation to Roman cultural patterns.

Yet, as we know, the Gospel record of the life and times of Christ was written in Greek, and contains an abundance of Greek metaphysical concepts. The earliest extant records of the life and

religious message of the Jewish cum Christian prophet from Nazareth were given to posterity first in Greek, later in Latin, and then after fierce battles, translated into English and other vernacular languages. Thus, those who we may call the "mediatorial elite" of Christianity were Greek speakers struggling to capture the message of a religious leader who spoke another tongue. The important point, however, is that they were fully shaped by Greek philosophical habits of thought.

In the classic 19th century study by Edwin Hatch, *The Influence of Greek Ideas on Christianity*,¹¹ we hear the lament that from the beginning Christian intellectuals, due to their exposure to Greek thought, increasingly applied Greek philosophical forms to Christian thought and sentiments. This entailed the formal use of definitions, the effort to create universal statements and the attempt to cast the whole complex of definitions and propositions into a formal system of ideas, something that seems unlikely to have been uppermost in the mind of the historical Jesus and his immediate followers.

Furthermore, Edwin Hatch argues, these Christian formalizers wanted to create a uniform system of beliefs shared by all members of the community, wherever it might be located. And while we can see that this encouraged a universalizing impulse within the Christian community, it also led to the production of universally proclaimed creeds and officially mandated statements of belief (dogmas), such as the Nicene Creed. It also took the form of replacing untutored faith by a set of abstract propositions which were then taught more or less by rote, as in catechism. In the long run, simple faith in the life and message of Christ was replaced by formal dogma and the very reading of the Scriptures was put exclusively in the hands of the clergy. However, revolts against this priestly monopoly began in the Middle Ages, reaching a culmination in the 16th century with the Reformation. In addition, in the late 19th century, German scholars, among others, began a search for both "the historical Jesus" and a more authentic description of the "Primitive Church." This is seen in the writings of Harnack and his followers, as well as Ernst Troeltsch.

Thus from the outset the Christian worldview was deeply impregnated by Greek philosophical assumptions. In general (but not without exception), the Patristic Fathers had a high regard for the idea of natural law.¹² At the same time, just as they adhered to the creation story of Genesis, they tended to infuse it with Platonic ideas that filtered through from the *Timaeus* as well as from Philo. The creator/Demiurge of Plato was replaced by the Judeo-Christian God,

but the ubiquitous Logos (indwelling reason) was ever present. And while the Christian fathers appeared to be prepared to accept the philosophical principle of natural necessity, they had to work out the problem of free will and God's omnipotence. Christian thinkers insisted both that men have free will and that God transcends nature, even controlling it. But taking up these questions served to push Christian theologians deeper into the Greek philosophical literature in search of defensive ideas supplied by Greek philosophers.¹³

In sum, the worldview of early Christianity is so infused with Greek habits of thought that it is fair to say it was unusually well prepared to entertain the idea of cosmic self-regulation governed by the laws of nature. It took until the middle ages for all of these elements supportive of scientific thought to come together, not least because the Hellenistic world was in a great transition from the Greek language and modes of thought to that of the Romans, which were then to be displaced by Islamic culture in the 7th century.. From then onwards the Biblical lands and much of the formerly Hellenic world was transformed into an Arabic speaking civilization committed to a new religious orientation. Consequently, from the 9th until the 12th century, the only work of Plato available in Latin translation and commentary was the *Timaeus*. But before tracing that development, I turn to the case of Islam.

Islam and the Straight Path

The prophet Mohammad was born in 570 AD in Makkah, at a time when the Roman Empire was in decline. It is highly significant that the Arabian Peninsula had remained virtually untouched by either Hellenic or Roman culture during the preceding centuries. Makkah was an important urban trading center halfway down the peninsula, and thus was not totally isolated from outside currents. Still the Arabic language was little known outside the Arabian Peninsula, though it was close to Hebrew in its basic structure.

The holy book of Islam, the Qurʾān, is frequently characterized by Muslims as the final and complete revelation of the word of God, bringing to completion the Abrahamic prophetic tradition. Furthermore, the Qurʾān is described even by Muslims today as a complete book of truth, a copy of the heavenly speech of God, beyond comparison with any other source of knowledge. In other words, it is not meant to be a source of philosophical speculation nor are any of its allusions to natural events meant to be subjected to elucidation by contemporary scientific knowledge or philosophical exegesis. Rather

modern science is said to confirm the truth of the Qur'ān.¹⁴ Even at the beginning of the 20th century the Muslim community would not allow the publication of an annotated edition of the Qur'ān in Arabic accompanied by a commentary containing the modern scientific point of view.¹⁵

Thus the Qur'ān contains many reminders that it is "an explanation of all things" (12:111), though a scientific terminology is absent.¹⁶ If we look for metaphysical images and presuppositions in the Qur'ān that might guide scientific inquiry, they would be entirely different from those accustomed to Greek philosophy. They tend to be concrete images rather than generalized propositions. The idea of the "logos" as creative intelligence embedded in the structure of the universe or in the human actor, is absent. While God is said to have created the world in six days following the Genesis story, the world continues to be governed by God's uninterrupted control of all events. Secondly, God and man are utterly different from each other. The Judeo-Christian idea that God created man in his own image is replaced by the belief that man and God share no qualities or attributes. God is all powerful, all knowing, and actively creative, but humankind shares none of these attributes. Indeed, it is a form of blasphemy for anyone to claim any of God's attributes, and it heresy (*shirk*) to "associate" anything with God, or to imagine God having a peer. This declaration, that "God has no partners," in fact became a matter of formal dogma in later centuries reflected in various Islamic creeds.¹⁷ In short, the creative spark, i.e., reason or inner light, that Christian theology (no doubt influenced by Plato) invested in mankind is absent in Islamic thought.¹⁸ Likewise the idea of natural necessity or laws of nature governing either the human realm or the natural world is opposed. For example, the Qur'ān says,

It was Allah who made the heavens and the earth. He sends down the rain from the sky with which He brings forth fruits for your sustenance. He drives the ships which by His leave sail the ocean in your service. (14:32)

Thus God's agency is a constant, ongoing controlling force in nature:

Your Lord is Allah, and who in six days created the heavens and the earth and then ascended His Throne. He throws the veil of night over the day. (7: 54)

Passages such as these have been referred to as "sign-passages" (*Ayāt*), and they seem to fulfil several functions.¹⁹ On the one hand.

many such passages refer to natural phenomena which reveal the active powers of God, either creating or controlling nature, frequently for man's benefit. On the other hand, sign passages reveal the activities of the prophet, seeming to confirm the truth of his message.

In the context of scientific inquiry and the possibilities of natural necessity, there are numerous verses that clearly reserve to God all the powers that would otherwise belong to natural processes in and of themselves. Similarly, another Surah affirms that if God but wished it, it would be done, as in Surah 40:68: "When he wills a thing he simply says to it, "Be, and it is." Likewise, Surah 34:9 reads,

We could if we please, cause the earth to swallow them up, or cause clouds to fall upon them a deluge. In that, verily, is a sign for every servant of ours who turns to us.

This line of thought seems to be inhibitive with regard to the possibility of a natural world governed by autonomous forces of nature. Indeed, over the course of time, this issue of natural causation versus God's complete omnipotence developed into a major confrontation between Greek-inspired Muslim philosophers and those who took a more literalist view of the powers of God. Thus the great al-Ghazālī (d. 1111) argued that:

the natural sciences are objectionable because they do not recognize that nature is in subjection to God most high, not acting of itself but serving as an instrument in the hands of the creator. Sun, moon, stars and elements are in subjection to His command. There is none of them whose activity is produced by or proceeds from its own essence.²⁰

Before taking up that controversy let me also note the numerous Qur'anic passages that warn against conjecture and speculation, and which could be taken as a repudiation of philosophical inquiry in the Aristotelian mode. For example, Surah 53: 28 asserts: "They engage only in conjecture and conjecture is of no avail with the real." Likewise a Qur'anic verse says:

These are nothing but names which you have devised—you and your fathers. For which God has sent down no authority (whatever). They follow nothing but conjecture and what their own souls desire. (53:23)

To this passage the commentary of Abdullah Yusuf Ali says, "Conjecture is a dangerous thing in speaking of divine things."²¹ These passages seem to warn against the philosophical life that is so vividly affirmed by Plato and adopted by Philo of Alexandria as a gift of God.

Accordingly, when Islam spread out of the Arabian Peninsula (in both directions across the Middle East), it encountered a radically different cultural ambiance. Finding themselves in a vastly richer cultural setting than that of Makkah, the intellectual leaders of the expanding Islamic civilization encouraged the translation into Arabic of the great corpus of the "foreign" or "ancient" sciences which existed in libraries and private collections throughout the region. In addition, efforts were made to assimilate the store of scientific works from India.

But this appropriation of foreign cultural capital was also selective as should be expected. For example, Philo of Alexandria was not translated, and though Galen's epitome of the *Timaeus* was rendered into Arabic, actual discussions of the *Timaeus* and its rational image of the cosmos and man's place in it, are unknown among Muslim philosophers and theologians.²²

Nevertheless, Islamic followers of Aristotle did emerge in the person of such formidable intellects as al-Kindī (c. 800-70), al-Fārābī (d. 950), al-Rāzī, (d. 923 or 932), Ibn Sīnā (d. 1037), and al-Birūnī (d. 1048). The importing of Hellenistic thought appears to have occurred in two waves, the first taking place in the mid-8th century, and the second in the mid-tenth century. The earlier phase of assimilation was one largely of translation and one in which Neo-Platonic thought was very strong. Later the individuals named above became active and aggressive champions of Aristotle.

It must be said, however, that the guardians of orthodoxy within Islam strenuously opposed Aristotelian philosophy and its metaphysics of natural necessity. From the 9th century onwards, the *mutakallimūn* (Muslim theologians) became committed to what has been called Islamic occasionalism.²³ According to this view, the basic building blocks of nature are indivisible "atoms," but it went a step further by asserting that each moment of time is but an accidental arrangement of events. For Islamic atomists, each moment of existence was but the occasion of God's active creation of the world. God created the world anew each moment, and nothing can subsist more than "two moments" without God's power, according to this view.

This doctrine had been in gestation from Islam's beginnings in the 7th and 8th centuries (the first two of the Islamic era). In later phases it was used to counteract the writings of Islamic philosophers who adopted the position according to which nature is a rational and autonomous domain functioning according to the laws of its own

essential nature. It was the 9th century theologian al-Ash'arī (873-935) who solidified the atomist/occasionalist view in which all existence is composed of "atoms" and "accidents," each of which lasts only a moment, and then disappears. Furthermore, these atoms were but a "substrate" of metaphysical potentiality, which was given existence moment by moment by an external agent, that is, by God. God, as eternal creator, at every moment of time, recreated the world (the accidents of existence) thereby giving it pattern and persistence. In a word, Islamic atomistic occasionalism was designed specifically to guard against natural necessity and to preserve the complete omnipotence of God. This resulted in the denial of natural causality and applied equally to the acts of men.

For Ash'arī and his school, "the acts of man are created [by God] and ... a single act comes from two agents, of whom one God, creates it, while the other, man, "acquires" it (*iktasabu-hu*)..."²⁴ Islamic theologians were compelled to assert the omnipotence of God behind each and every human act, but at the same time they could not abandon the idea of human agency (free will), so they retained the idea that human agency was also involved. Hence Ash'arī insisted that the individual has the ability to act only "by virtue of a capacity which is distinct from him."²⁵

By the 10th century Ash'arī's atomism had become the dominant orthodoxy with the result that other great philosophers such as Ibn Sīnā felt compelled to take occasionalist assumptions into account, though in his case it was done very cautiously.²⁶ Indeed, Ibn Sīnā and the other Muslim Aristotelians did not think highly of these people, the *mutakallimūn*.

This unfolding conflict between Greek modes of philosophizing and Muslim orthodoxy came to a head in the 12th century with the work of al-Ghazālī (1058-1111), that philosophically inclined devout believer who flourished in Baghdad at the time when Peter Abelard was taking a different path in Paris.

Al-Ghazālī's motivation for attacking the philosophers was no doubt complex. On one level, he sought to protect ordinary believers from the corrosive effects of philosophical speculation which was something that Ibn Sīnā had also been concerned about. On the other level, al-Ghazālī was driven by a strong desire to achieve a level of religious certainty within which there could be no doubt or uncertainty. He had been smitten by the allure of demonstrative argument, and when he

elevated such logical-rhetorical skills to the position of final arbiter of all claims to knowledge, it did not leave much to believe in. That is to say, from a strictly logical point of view, the proof of any argument is always in doubt unless the syllogism is a strictly deductive claim, as in: "All men are mortal, Aristotle is a man, therefore Aristotle is mortal." Inductive arguments, on the other hand, which use empirical observation, rely on the "inductive leap" in order to get from particulars to the general, and hence cannot claim apodictic truth. This outcome drove al-Ghazālī into fideism, the position according to which one believes solely on the basis of faith, without rational argument. Unsurprisingly, al-Ghazālī fideism led directly to his efforts to strengthen his position by adopting the mysticism of the *ṣūfis*.²⁷

Al-Ghazālī's anti-naturalistic views became deeply ingrained in Islamic thought and continue to surface in contemporary discussions throughout the Muslim world. His famous book condemning philosophers was a wide-ranging inquiry that drew upon logic and mathematics as it considered the fundamental issues of natural causation. But it was no "mere" philosophical exercise. As al-Ghazālī wrote in his autobiographical *Deliverance from Error*, the errors of the philosophers "are combined under twenty heads, on three of which they must be reckoned infidels and on seventeen heretics."²⁸

Virtually from the outset when Muslim intellectuals encountered the Greek philosophical corpus, they perceived its dangers to the new faith. Orthodox religious leaders viewed the study of Greek natural philosophy as the first step toward impiety. Hence al-Ghazālī was just the most philosophically informed and perhaps most brilliant Muslim intellectual who took it upon himself to set the record straight insofar as the Islamic faith was concerned. Al-Ghazālī's ringing rebuttal of natural causality reads as follows:

According to us the connection between what is usually believed to be a cause and what is believed to be an effect is not a necessary connection; each of the two things has its own individuality and is not the other, and neither the affirmation nor the negation, neither the existence nor the non-existence of the one is implied in the affirmation, negation, existence, and non-existence of the other—e.g., the satisfaction of thirst does not imply drinking, nor satiety eating, nor burning contact with fire, nor light sunrise, nor decapitation death, nor recovery the drinking of medicine, nor evacuation the taking of purgative, and so on for all the empirical connections existing in medicine, astronomy, the sciences, and the crafts. For the connection of these things is based on a prior power

of God to create them in successive order, though not because this connection is necessary in itself and cannot be disjointed—on the contrary, it is in God's power to create satiety without eating, and death without decapitation, and to let life persist notwithstanding the decapitation, and so on with respect to all connections.²⁹

By this means al-Ghazālī dealt a severe blow to the study of philosophy and the natural sciences in the Islamic world. As a recent translator of the Persian version of al-Ghazālī's *Revivification of the Religious Sciences* put it, "there is little doubt in the court of Muslim popular opinion that [al-Ghazālī's critique of the philosophers] prevailed, forever altering the intellectual climate of the Islamic world."³⁰

Nevertheless, al-Ghazālī's attack on philosophy had a paradoxical effect. On one side, al-Ghazālī's condemnation of natural philosophy entailed a legal condemnation of those philosophers who held various naturalistic views. His wide-ranging arguments were "not [mere] rhetorical utterances, but a legal pronouncement" punishable by death.³¹ Consequently those who espoused al-Ghazālī's condemned theses were condemned as heretics with the legal consequence that their lives were in danger and their houses and property could be confiscated—though this is not known to have happened. On the other, al-Ghazālī's clarity of exposition of Aristotelian modes of philosophy led later theologians (*mutakallimūn*) to adopt philosophical modes of argument, albeit, for the purpose of denying philosophy's claims. In the end, al-Ghazālī's argument prevailed while the rebuttal by Ibn Rushd (Averroes, d. 1198) a generation later fell entirely on deaf ears in the Muslim world, while Medieval Christians embraced it.

Given the limitations of this presentation, I must forgo an adequate discussion of the many epistemological ramifications of this line of thought within Islam. But it is important to say that during the period from the 9th century until about the 13th century, scientific creativity within the Islamic world did occur, though the innovations for which Muslims are known did not encroach on basic metaphysical assumptions of the Muslim worldview. Apart from assuming the uniformity of nature and its patterned regularity, none of the advances in mathematics, astronomy, optics, and medicine entailed metaphysical assumptions counter to the Islamic worldview. The path to the discovery of the lesser circulation of the blood (from the heart to the lungs) by Ibn al-Nafis (d. 1288) and Ibn al-Quff's (1233-86) description of the stages of human embryonic development may have

entailed forbidden human dissection, but no controversy about this has been reported. In the longer run, al-Nafis' discovery seems to have been lost to the Muslim community and only in the late 17th century was the bodily circulation of blood in humans as understood by William Harvey introduced into the Muslim world.³² At the same time, it should be observed that while Arabic-Islamic science was fully technically prepared to make the great leap from the geocentric worldview to the new astronomic system first set out by Copernicus, no such innovation occurred in the Muslim world.

Still it should be remembered that the writings of gifted Muslim scientists and philosophers such as al-Fārābī, Ibn Sīnā and al-Birūnī, give ample evidence of their commitment to Islam. Some of them, for example, al-Birūnī, were explicit in linking their scientific work with Qur'anic injunctions, and the Qur'anic "sign passages" mentioned earlier. But by casting doubt on certain fundamental tenets of Islam, such as the divine creation and the resurrection of the dead, their writings were called into question. Thus those Muslim scholars of jurisprudence who took a literalist view of the Qur'ān aligned themselves with the scientific folklore evolving from pre-Islamic times, and consequently ignored the real advances being made in astronomy, time-keeping, and planetary topography (e.g. the direction of the *qiblah*). For example, the Qur'ān refers to the movements of the moon as a time keeping sign and thus the scripturalists insisted on preserving the lunar calendar and visual sighting of the moon for ritual purposes, when those based on modern astronomy would be far more satisfactory.

In short, by the 14th century, Islamic intellectual culture had lost its curiosity, and a reactionary attitude came to dominate virtually all fields. From then onwards, all innovations had to be filtered through the excessively conservative views of the religious scholars. Moreover, the ban on Arabic printing, except for a brief respite between 1728 and 1745, continued into the early 19th century. In the area of medicine, the Ottoman Turks only began to develop a modern medical vocabulary in Turkish in about 1826 with the work of Sanizade (1769-1826), who had set about translating Europe medical treatises into Turkish for the first time.³³

Europe on the Eve of Modernity

I come now to another major shift in the civilizational ascendancies of the Middle East and Europe. By the 12th century the metaphysical charge encouraging natural philosophy within the Muslim world had

been neutralized. The religious and legal scholars had thoroughly routed the Greek idea of an autonomous world-system governed by natural law. Likewise, the idea that man possesses that spark of divine intelligence enabling him to decipher the mysteries of nature had been denied. According to Islamic orthodoxy, God is the only creator. Furthermore, as we saw in al-Ghazālī's attack on Greek natural philosophy—that blessing, in Plato's words, "than which no greater boon has ever come or shall come to mortal man as a gift from heaven"—was dismissed. As A.I. Sabra has shown for the 14th century, *kalām* (Islamic theology) had indeed overcome philosophy and the latter was disparaged while Islamic occasionalism remained intact.³⁴

In Western Europe, however, a new surge of creativity burst forth. Beginning with the religious scholars of Chartres and then enveloping all of Western Europe, these scholars saw ubiquitous signs of reason and rationality, of orderly nature, of harmonious divine creation, everywhere. The message of cosmic unity and orderly intelligent creation made available by Chalcidius's translation of the *Timaeus* was now fully incorporated in Christian thought. People like Hugh of St. Victor (d. 1141), William of Conches (d. 1154), Thierry of Chartres (d. 1148), and many others saw evidences of God's harmonious creation fully in line with Plato's system of nature, indeed saw nature as a system of causal necessity. As William of Conches' commentary on the *Timaeus* reads:

Having shown that nothing exists without a cause, Plato now narrows the discussion to the derivation of effect from efficient cause. It must be recognized that every work is the work of the Creator or of Nature, or the work of a human artisan imitating nature. The work of the Creator is the first creation without pre-existing material, for example, the creation of the elements or spirits, or it is the things we see happen contrary to the accustomed course of nature, as the virgin birth, and the like. The work of nature is to bring forth like things from like through seeds or offshoots, for nature is an energy inherent in things and making like from like.³⁵

From top to bottom the world system was seen as a fully articulated mechanism willed by God. The metaphor of a world machine, (*machina mundi*) is found in the writings of a great variety of 12th and 13th century scholars. For example, Robert Grosseteste asserted that, "The world machine most evidently speaks of the eternal art by which it has been made..."³⁶ In his work on *The Sphere*, Grosseteste used this metaphor three times in the first thirteen lines of his treatise.³⁷

Similarly the metaphor of the world machine is found in the writings of Alan of Lille, Hugh of St. Victor, Bernard Sylvester, Sacrobosco and no doubt others. For them, as for Hugh of St. Victor (d. 1141), there were two "books of nature"—a visible and an invisible one—and whether one was referring to the visible or invisible world, there seems to be significant order, a universal machine:

The ordered disposition of things from top to bottom in the network of this universe ... is so arranged that, among all the things that exist, nothing is unconnected or separable by nature, or external." Furthermore, "[t]he visible world is this machine, this universe, that we see with our bodily eyes.³⁸

Likewise Sacrobosco cites with approval a passage from Dionysius the Areopagite: "Either the God of nature suffers, or the mechanism of the universe is dissolved."³⁹

While this enthusiasm for naturalistic images cropped up in many places, some did take objection to it. But defenders of the naturalistic view among the clergy were well represented and even made a distinction between the natural and the supernatural. Thus a certain Andrew of St. Victor, argued that in the interpretation of Scripture one should first consider all naturalistic possibilities before offering miracles as explanations. The interpreter, he wrote, "should realize this: in expounding Scripture, when the event described admits of no naturalistic explanation, then and only then should we have recourse to miracles."⁴⁰ In this Andrew was apparently following St. Augustine.

In this manner the medieval Christians reclaimed the Old Testament notion that humankind was created in the image of God. But now that image was reinforced with the Greek idea that man and nature were fully rational orders of existence. Not only was nature a fully rational unity, but man as a part of it was a fully rational creature. Both continentals and Englishmen like Adelard of Bath (fl. 1116-42) put forth optimistic peans extolling the rationality of mankind:

Although man is not armed by nature nor is [he] naturally swiftest in flight, yet he has that which is better by far and worth more—that is, reason. For by possession of this function he exceeds the beasts to such a degree that he subdues them.... You see, therefore, how much the gift of reason surpasses mere physical equipment.⁴¹

With the arrival of the newly translated "natural books" of Aristotle, this neo-Platonic enthusiasm for naturalistic inquiry was given another powerful boost. Soon they were put at the center of the university curriculum, in Paris formally by statute in 1255. From there

they reigned supreme for the next 400 years. Moreover, the teachings of Aristotle were linked to the so-called *questio* literature. That is, philosophy was taught in a format that began by asking a question: "let us inquire whether." For example, "let us inquire whether the world is round... whether the earth moves... whether it is possible that other worlds exist,...whether the existence of a vacuum is possible," etc.⁴² These inquiries took the form of arguing, in Abelard's memorable phrase, *Sic et Non* [Yes and No], for and against various answers to puzzling questions. While they did not often arrive at novel conclusions, they did proclaim the acceptability of publicly asking such questions and engaging in formal controversy. In that regard they institutionalized a form of public inquiry that lies at the heart of the scientific enterprise from that day to this.

In the area of cosmology alone, Professor Grant has catalogued 400 questions that were raised regarding the celestial bodies, their composition and motions. This generated 1,176 known responses, and these were by no means slavish replies, by 52 or more investigators.⁴³

In short, the medieval universities institutionalized a mode of philosophical inquiry that laid the foundations for the emergence of modern science. The curriculum was a unique fusion of Christian theology and Greek metaphysics, and it was just this educational foundation that was experienced in the universities by Copernicus and Galileo a century or two later. Just as William of Conches in the 12th century affirmed that it not the task of the Bible to teach us about nature, so too, Galileo wrote about four and half centuries later, "the intention of the Holy Ghost is to teach us how one goes to heaven, not how the heavens go."⁴⁴

Faith and Reason

But let me add a few concluding words regarding the fate of philosophy and science in Judaism during this period. The battle between faith and reason clearly has a long history and has taken many forms. If we look back to Philo of Alexandria with whom I began this discussion, we see a prescient vision of the unity between reason and religion. For Philo the revealed law of Moses was in harmony with natural law and universal principles. The five books of Moses revealed to Philo not just the sacred word, but the superiority of Moses as a philosopher. This theme—that Judaism was the superior religion and perfect philosophy—became a major theme in Jewish circles throughout all succeeding centuries, even into the 18th century. Had Philo's synthesis been taken up by the Judaic community following his

death, no doubt scientific history would have been different, as it accepted philosophy as a legitimate enterprise fully consistent with Scripture. As it is, the Jewish community was to engage in periodic internal conflicts over the appropriate role of reason in religious affairs for the next seventeen hundred years. Every rationalist attempt at fusing philosophy and Scripture was met by an equally strong anti-rationalist parry that virtually deadlocked the community. Only with the emancipation of Jews in Europe—in Germany in particular in the late 18th century—was the struggle to achieve an acceptable balance between the claims of reason and those of revealed law able to reach acceptable definition

In the meantime, during the period I have been discussing there was only one truly outstanding Jewish scientist, namely, Levi ben Gerson (Gersonides) who lived in Southern France in the Provence, and died in 1344. Gerson contributed a variety of innovations in astronomy, including unique astronomical instruments. He proposed a realist theory of astronomy, which is to say he believed that physical observations ought to correspond to mathematical models and worked toward that goal. At the same time Gerson composed commentaries on the Bible and related discussions of religious topics.⁴⁵ Nevertheless, Gerson stands as a lone exception during the whole intervening period of Arabic-Islamic ascendancy up to the 14th century. As one scholar put it, "there are no Jewish counterparts to such scientific geniuses as ...al-Birūnī, Ibn al-Haytham, and Thābit Ibn Qurra in the Arabic culture, or Robert Grosseteste, Roger Bacon, and Nicole Oremes in the Latin [culture]."⁴⁶ There were, of course, other scientists and notable intellectuals in the Jewish communities spread out as they were during this time, but they were not able to make contributions to scientific progress equivalent to those mentioned.

While it is appropriate to mention the name of the great Maimonides, it must be said that the writings of Maimonides served more to split the Jewish community than to energize it for scientific inquiry. For example, one result of his writings was an attempt to restrict the study and teaching of philosophy and the natural sciences until the age of 25 in the Jewish communities in southern France and Spain.⁴⁷ While Maimonides encouraged the study of the natural sciences, some have criticized him for intimately linking this with the achievement of religious piety, for it suggested that philosophy had no independent role to play. Furthermore, Maimonides, following ancient tradition, treated the study of the sciences as an esoteric enterprise

reserved for the privileged few and transmitted only through private instruction.

As late as the 14th century observers in the Jewish community noted how different the educational practice was in the Christian and Jewish communities. A late 14th century physician from Provence, Leon Joseph of Carcassone, lamented that in comparison to the Jewish community, [the Christians'] exchanges on these sciences is unceasing, and they miss nothing of what is worth investigating. Instead, they leave out nothing when it is a question of debating the truth and even the falsehood of a [proposition]. Through their vigorous scrutinizing questions and answers by way of disputation ... and by explaining everything through two contrary [opinions] they have the truth emerge from the center [of the contradiction] as a lily among the thorns.⁴⁸

Thus the unresolved conflicts between faith and reason in the Jewish community persisted. By the mid 15th century the scholastic question and answer method of presenting arguments had been adopted by leading Jewish scholars.⁴⁹ It also seems fair to say that Greek modes of philosophical inquiry were deeply embedded in Jewish thought by this period, and that they could not be rooted out, even if the Jewish community had attempted to do so. When the Iberian Jewish community revived in the Ottoman empire after being driven out of Spain at the end of the 15th century, it soon recovered and began teaching both the secular sciences and the traditional religious sciences.⁵⁰ But here again the role of philosophy as a handmaiden to religious enlightenment became dominant with the corresponding decline in naturalistic inquiry. Only with the so-called Jewish enlightenment (*Haskalah*) in the 18th century, did Jewish creativity begin to make its mark on modern science

Notes

1. Toby E. Huff, *The Rise of Early Modern Science: Islam, China and the West* (New York: Cambridge University Press, 1993).
2. Roy B. Chamberlain and Herman Feldman, *The Dartmouth Bible. An Abridgment of the King James Version, with Aids to Its Understanding as History, Literature and as a Source of Religious Experience* (Boston: Houghton Mifflin, 2nd, revised and enlarged, 1961), p. 732a.
3. William W. Tarn and G. T. Griffith, *Hellenistic Civilization* (London: Edward Arnold and Publishers, 1966) 3rd ed. p. 3.
4. In this discussion I draw on the very useful exposition of the *Timaeus* by Glenn R. Morrow, "Necessity and Persuasion in Plato's TIMAEUS," in

Studies in Plato's Metaphysics, ed. R. E. Allen (London: Routledge and Kegan Paul, 1965), pp. 421-37.

5. Ernst Troeltsch, *The Social Teachings of the Christian Churches* (New York: Harper Torch Books, 1960) vol. 1: 150f; Helmut Koester, "Nomos and Phyeos: The Concept of Natural Law in Greek Thought," in *Religions in Antiquity: Essays in Memory of E. R. Goodenough*, ed. Jacob Neusner (Leiden: E. J Brill, 1968), pp. 521-541; Richard A. Horsely, "The Law of Nature in Philo and Cicero," *Harvard Theological Review* 7 (1978): 35-59; and David Runia, *Philo of Alexandria and the Timaeus of Plato* (Leiden: E. J. Brill, 1986), among others.

6. As cited in Horsley, "The Law of Nature," p. 37f.

7. It has been pointed out by Biblical scholars that the word Logos appears more than thirteen hundred times in Philo's allegorical interpretations of Old Testament passages; *Interpreter's Bible* (Nashville, Tn: Abingdon Press, 1995) 7: 442a.

8. This is most convincingly shown by the masterful study of David Runia, *Philo of Alexandria and the Timaeus of Plato* (Leiden: E. J. Brill, 1986).

9. On the lack of Jewish philosophy in the Greek mold until the medieval period, see Dan Cohn-Sherbok *Jewish Philosophy*; and Daniel Frank, "What is Jewish Philosophy" in *History of Jewish Philosophy*: 1-10; and the essays in *Philosophy of the Middle Ages*, eds. Arthur Hyman and J.J. Walsh (Indianapolis: Hackett, 1973), 337ff.

10. David Winston, "Introduction" to *Philo of Alexandria* (New York: Paulist Press, 1981), p.36; and see Gregory E. Sterling, "Jewish Self-Identify in Alexandria," *The Studia Philonica Annual* 7 (1995), 1-18, at 17.

11. Edwin Hatch, *The Influence of Greek Ideas on Christianity* (Gloucester, Ma: Peter Smith, 1970, reprinted from 1888).

12. Robert M. Grant, *Miracles and Natural Law in Graeco-Roman and Early Christian Thought* (Amsterdam: North-Holland Publishing, 1952), and Edwin Hatch, *Influence of Greek Ideas*, and D. Runia, *Philo in Early Christian Literature* (Van Gorcum, Essen: Fortress Press, Minneapolis, 1993), as well as Troeltsch, *Social Teachings* I, esp. pp. 144f, 158-161; and p. 188n69.

13. Robert M, Grant, *Miracles*, p. 266 and passim.

14. For another view see M. Bucaille, *The Bible The Quran and Science* (Paris: Seghers, 1978); on which see Leif Stenberg, *The Islamization of Science. Four Muslim Positions Developing and Islamic Modernity* (Lund: Nova Press, 1996), chapter 5.

15. H.A.R. Gibb relates the case of an Egyptian *shaihk*, Muhammad Abu Zaid, who in 1930, published an edition of the Qur'an with annotations, criticizing the old commentaries and interpreting supernatural references in simple naturalistic ways. Although the purpose of the work was to encourage the younger generation to study the Qur'an, the police confiscated the book, and an injunction was secured to prevent the writer from preaching or holding

religious meetings. H.A.R. Gibb, *Modern Trends in Islam* (Chicago: University of Chicago Press, 1947), p. 54. More recently the Syrian engineer Shahrur, published a large exegetical study of the Qur'ān (*The Book and the Quran: A Contemporary Interpretation*, 1990). The study has been condemned by many Muslims, banned in several Muslim countries, provoked death threats, but sold surreptitiously in thousands of copies. Dale F. Eickelman, "Inside the Islamic Reformation," *Wilson Quarterly* 22 (Winter, 1998)2: 80-89. Also see Eickelman, "Islamic Liberalism Strikes Back" (A review of *The Book and the Quran: A Contemporary Reading*), *MESA Bulletin* #27 (1993): 163-168. For the spirit of Shahrur's enterprise, see his brief sketch, "The Divine Text and Pluralism in Muslim Societies," *Muslim Political Reports* (New York: Council on Foreign Relations) #14 (July/August) 1997: 3ff

16. I have primarily used the translation of Abdullah Yusuf Ali but also consulted the translations of N.J. Dawood, M.H. Shakir, and Zafrullah Khan for all of these passages.

17. See J. Wensinck, *The Muslim Creed* (Cambridge: Cambridge University Press, 1932); and W.M. Watt, trans., *Islamic Creeds: A Selection* (Edinburgh: Edinburgh University Press, 1994).

18. This a complex subject, on which see Falzur Rahman, *Prophecy in Islam* (Leiden: E.J. Brill, 1958); and the discussion in the Introduction to *The Guide of the Perplexed* vol. 1, by Shlomko Pines (University of Chicago Press, 1963).

19. See W.M. Watt, *Bell's Introduction to the Quran* (Edinburgh: University of Edinburgh University. Press, 1970, revised and enlarged), pp. 121-127.

20. *The Faith and Practice of al-Ghazali*, edited and trans. by W. M. Watt (Lahore: Sh. Muhammad Ashraf, 1953), p. 37.

21. *The Qur'ān: Text, Translation and Commentary* (Elmhurst, New York: Thrice Quran, 1987), p. 1446, note 5098.

22. In his study of Ibn Sīnā, L. E. discusses an argument regarding creation and causality that appears to be grounded in the causal logic of the *Timaeus*. But it could as easily be grounded in Aristotle, and no evidence is presented that Ibn Sīnā (or al-Ghazālī) actually studied or discussed the *Timaeus* or its Galenic epitome. See Goodman, *Avicenna* (New York: Routledge, 1992), 49f.

23. See S. Pines, *Studies in Islamic Atomism*, trans., Michael Schwarz (Jerusalem: Magnes Press, 1936/1997); W. Montgomery Watt, *The Formative Period of Islam* (Edinburgh: Edinburgh University); as well as Majid Fakhry, *Islamic Occasionalism, and its Critique by Averroes and Aquinas* (London: Allen & Unwin, 1958).

24. In Watt, *The Formative Period of Islam*, 192.

25. Richard McCarthy, ed. trans., *The Theology of Ash'ari* (Beirut: Imprimerie Catholique, 1953), chapter 6, 76ff.

26. See Michael Mamura, "Avicenna and the Kalam," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 7 (1991): 172-206.
27. Al-Ghazālī's struggles are revealed in his autobiography, see Watt, *The Faith and Practice of al-Ghazali*.
28. *Ibid.*, p. 37.
29. As cited in Averroes, *Tahafut al-Tahafut* [The Incoherence of the Incoherence], trans. Simon van den Berg (London: Luzac, 1954), 316 and al-Ghazālī's, *The Incoherence of the Philosophers*, trans. M. Mamura, 170.
30. Al-Ghazālī, *The Alchemy of Happiness*, ed. trans. Daniel L. Elton (Armonk, New York: M.E. Sharpe Inc, 1991), p. xxv.
31. Cf. M. Marmura, "Some Remarks on Averroes's Statements on the Soul," in *Averroes and the Enlightenment*, eds., Moura Wahba and Mona Abousenna (Amherst, New York: Prometheus Books, 1996), 279-291, at p. 280; who follows George Hourani, ed. trans., *Averroes on the Harmony of Religion and Philosophy* (London: Luzac, reprinted 1976), esp. 19 and 29.
32. See Niyazi Berkes, *The Development of Secularism in Turkey* (Montreal: McGill University Press, 1964).
33. Lewis, *The Emergence of Modern Turkey*, 84f.
34. A.I. Sabra, "Science and Philosophy in Medieval Theology: The Evidence of the Fourteenth Century," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* (1994) 9: 1-42.
35. As cited in Chenu, *Nature, Man, and Society* (Chicago: University of Chicago Press, 1968), 41.
36. As cited in Servius Gieben, "Traces of Word in Nature According to Robert Grosseteste," *Franciscan Studies* 24 (1964): 144-158, at p. 144.
37. Lynn White, Jr., *Medieval Technology and Social Change* (New York: Oxford University Press, 1962), 174.
38. As cited in Chenu, *Nature, Man, and Society*, 7n10.
39. In E. Grant, *A Source Book In Medieval Science* (Cambridge: Harvard University Press, 1974), 451.
40. As cited in Chenu, *Nature, Man, and Society*, 17n35.
41. As cited in Tina Stiefel, "Science, Reason and Faith in the Twelfth Century: The Cosmologists's Attack on Tradition," *Journal of European Studies* 6 (1976): 1-16 at p. 3.
42. For a lucid exposition of this literature and its use see Edward Grant, *The Foundations of Modern Science in the Middle Ages* (New York: Cambridge University Press 1996), 127ff.
43. E. Grant, *Planets, Stars, and Orbs. The Medieval Cosmos, 1200-1687* (Cambridge University Press, 1994).
44. Maurice Finocchiaro, ed., *The Galileo Affair* (Berkeley: University of California Press, 1989), 96.
45. Among his many publications on this subject, see Bernard Goldstein, "The Physical Astronomy of Levi Ben Gerson," *Perspectives on Science* 5 (1997)1:1-30; *idem*, *The Astronomy of Levi Ben Gerson (1288-1344)*. A

Critical Edition of Chapters 1-20 with Translation and Commentary (New York: Springer-Verlag, 1985); and Seymour Feldman, "Levi ben Gershom (Gersonides)," *History of Jewish Philosophy*, eds. D. Frank and O. Leaman (New York: Routledge, 1997), 379-398.

46. Gad Freudenthal, "Science in the Medieval Jewish Culture of Southern France," *History of Science* 33 (1995): 23-58, at p. 29.

47. Idit Dobbs-Weinstein, "The Maimonidean Controversy," *History of Jewish Philosophy*: 331-49, at p. 333; and Daniel Silver, *Maimonidean Criticism and the Maimonidean Controversy 1180-1240* (Leiden: E.J. Brill, 1965), pp. 41-48 and 148ff.

48. As cited in Freudenthal, "Science in Medieval Jewish Culture," p. 46f.

49. Hava Tirosh-Rothschild, "The Eve of Modernity," *History of Jewish Philosophy* at p. 505.

50. *Ibid.*, p. 530.

Note: For some comments on this article and a rejoinder by the author, see the forthcoming issue.