Causality Then and Now: Al Ghazālī and Quantum Theory

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Are appearances deceiving? Do objects behave the way they do because God wills it? Are objects impermanent and do they only exist because they are continuously created by God? According to al Ghazālī, the answers to all of these questions are yes. Objects that appear to be permanent are not. Those relationships commonly referred to as causal are a result of God's habits rather than because one event inevitably leads to another. God creates everything in the universe continuously; if He ceased to create it, it would no longer exist.

These ideas seem oddly naive and unscientific to people living in the twentieth century. They seem at odds with the common conception of the physical world. Common sense says that the universe is made of real objects that persist in time. Furthermore, the behavior of these objects is reasonable, logical, and predictable. The belief that the universe is understandable via logic and reason harkens back to Newton's mechanical view of the universe and has provided one of the basic underpinnings of science for centuries. Although most people believe that the world is accurately described by this sort of mechanical model, the appropriateness of such a model has been called into question by recent scientific advances, and in particular, by quantum theory. This theory implies that the physical world is actually very different from what a mechanical model would predict.

Quantum theory seeks to explain the nature of physical entities and the way that they interact. It arose in the early part of the twentieth century in response to new scientific data that could not be incorporated successfully into the prevailing mechanical view of the universe. Due largely

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to the theory's abstract, mathematical nature, there has been great disagreement over its correct physical interpretation ever since it was first proposed. The most widely accepted is the Copenhagen Interpretation. Similarities between this interpretation of quantum theory and the thought of al Ghazālī will be the focus of this paper.

Initially, it might appear unlikely that there would be any significant similarities between the thought of al Ghazālī (eleventh century CE) and the ideas of quantum theory in the twentieth century. Although separated by culture as well as several centuries, many of the same ideas are incorporated into these two bodies of thought. Important similarities are seen in the role of causality in the natural world, the nature of physical objects, and the extent to which the behavior of objects is predictable.

Western thought has long made a distinction between the study of objects and the study of God. Science is the study of objects and of natural phenomena; the study of God more properly belongs to philosophy or theology. There is, however, an increasing awareness that this separation raises difficulties of its own. Although many scientists would prefer to restrict their research analysis to the study of the behavior of objects, quantum theory has caused many of them (as opposed to philosophers of science) to address questions about the metaphysics of science. The data supporting quantum theory is so strong that the theory cannot be ignored. Acceptance of the theory brings with it ideas that force many scientists to reexamine the ideas that underlie the scientific enterprise.

The fact that scientific advances and emerging theories are prompting scientists to look at the metaphysics of science makes it less surprising to find that both al Ghazālī and quantum theorists ask many of the same questions. This is not meant to imply that the questions asked are identical in tone or context, or that there was ever a question of influence in any shape or form. What concerned al Ghazālī and his contemporaries were such questions as: "What is the role of God in everyday events?" or "How is it possible for miracles to occur?" Quantum physicists, on the other hand, ask: "Is there a causal link between these two events?" or "To what extent is the behavior of physical objects predictable?" Even though the wording and the context of these questions are different, the underlying questions are similar. In both cases, the questions revolve around the causes behind events in the natural world and the extent to which these events are predictable. Both ask whether one event causes another or whether events occur due to some other, outside force.

The object of this paper is to investigate the similarities that one encounters between these two bodies of thought. The extent of the commonalities is striking. For example, both deny that the regularities in the behavior of objects should be attributed to the existence of causal laws.

Further, they agree that events in the world are not strictly predictable. Both accept the idea that unexpected, unpredictable things can and do occur. According to al Ghazālī's explanation, God is omnipotent and involved in the world at every moment and can, therefore, cause anything to happen. The Copenhagen Interpretation of quantum theory says that it is impossible to predict the exact behavior of an object based on physical laws. As a result, while one might expect a lead ball to fall when it is dropped, there is a definite possibility that the ball will rise instead.

The independent existence of real objects is doubted by both al Ghazālī and the Copenhagen Interpretation. It is useful, therefore, to consider what is meant by the term "object." In everyday language, "object" refers to something that takes up space and has a set of properties that enables one to differentiate it from its surroundings. For example, an object such as a lead ball has certain properties that govern its behavior. Furthermore, it is assumed that these properties persist and that the ball continues to behave according to the same set of laws over time. A lead ball falls when it is dropped because it is the nature of heavy objects to do so.

In order to more fully discuss the similarities to which I have referred, it is necessary for the reader to have some familiarity with al Ghazālī's ideas as well as with some of the basic ideas of quantum theory. Providing this background is the function of the next portion of this paper. The final portion highlights the similarities between al Ghazālī's ideas and the Copenhagen Interpretation of quantum theory.

Al Ghazālī

Abū Ḥamīd al Ghazālī (1058-1111 CE) was one of the most influential thinkers of medieval Islam. Among his many writings, the primary source of information on his ideas about the nature of the physical world is the *Tahāfut al Falāsifah* (The Incoherence of the Philosophers) (al Ghazālī 1958). Of particular importance to this discussion is Problem 17, entitled "Refutation of Their Belief in the Impossibility of a Departure from the Natural Course of Events." Here, he addresses such questions as: What is the role of God in everyday events?; How is it possible for miracles to occur?; and, Do objects have a nature that causes them to behave in certain ways?

This work was written to refute the claims of such philosophers as Ibn Sīnā (980-1037 CE, aka Avicenna) about how and why natural events occur (ibid.). At the time al Ghazālī wrote this book, Ibn Sīnā and others believed that the physical world contained real objects that were independent of one another. One event was thought to cause another, and objects were thought to possess an inherent "nature" that governed their behavior. These ideas were disputed by al Ghazālī, for he thought that such a completely causal world would limit the power of God. He was particularly concerned that the continuing interaction of God with everyday events be acknowledged.

God's central role in everyday events is clearly seen in al Ghazālī's idea of continuous creation or, in other words, that everything in the universe is created every moment. In order for an object to continue to exist, God must create it anew each moment. Objects, then, have nothing in their own nature that causes them to endure over time (Wolfson 1976). What we perceive as the continuing existence of an object is due to the fact that God has decided to create that object over and over again. For al Ghazālī, a ball of lead that is seen resting on a table for a period of time only appears to persist in that behavior. In fact, it is continuously recreated every moment by God.

If the physical universe is created anew each moment, why is there any uniformity to what is seen? Why is it that one particular object appears to persist over time? For al Ghazālī, these conditions arise because it is God's "custom" to do the same things over and over again. God could, for example, choose to have a lead ball exist at one moment and not at the next. But it is His custom, once an object has been created, to continue to create it over and over again. Thus it is not the independent existence of an object that causes it to persist. Rather, an object persists because it is God's custom to bring that same object into existence over and over again.

This idea of custom applies to the behavior, as well as to the existence, of objects. For example, a lead ball falls when it is released. For al Ghazālī, God is responsible for creating this succession of events: release of the ball and a subsequently falling ball. In addition, it is His custom to create the same sequence of events over and over again. According to Wolfson (1976), al Ghazālī believed that

> ever since the creation of the world, whenever God creates certain events in succession to other events, He creates in men the knowledge or the impression that, barring miracles, the same events will continue to be created by Him in the future in the same order of succession.

Thus it is possible for us to predict the usual behavior of objects because God "chooses" to do the same things over and over again. This should in no way be construed as limiting the choices that God has. He normally follows His custom, but there is nothing that requires that He do so (Mirza and Siddiqui 1986). Thus it is easy for al Ghazālī to explain miracles. Since God brings everything into existence, He can bring anything He chooses into existence at any time. He is just as able to bring about an unexpected event as He is to bring about an expected one. It is al Ghazālī's conviction that just as the lead ball will usually fall when released, God is perfectly capable of causing it to rise instead if He so chooses. God's power is without limit, and human beings should not presume to limit their conception of what God is able to do.

> Things to which God's power extends include mysterious and wonderful facts. We have not observed all those mysteries and wonders. How, then, can it be proper on our part to deny their possibility, or positively assert their impossibility? (al Ghazālī 1958)

An example used by al Ghazālī to illustrate the power of God is that of placing a piece of cotton in a fire (ibid.). It is God's custom to allow the cotton to burn when it comes into contact with fire. But, al Ghazālī argues, this does *not* mean that the fire causes the cotton to burn: it is God who is responsible for making the cotton burn when it is brought into the presence of fire. God is equally able to cause the cotton to *not* burn when in such a situation.

> We admit the possibility of a contact between the two which will not result in burning, as also we admit the possibility of the transformation of cotton into ashes without coming into contact with fire. (ibid.)

The fact that God seldom causes this to happen is a result of His habit and has nothing to do with the nature of the fire or the nature of the cotton or even with the nature of the interaction of fire with cotton.

It is God who is responsible for the resulting blackness of cotton when it comes into contact with fire. The fire is not the agent of the blackness. Fire and the burning of cotton arise together but, "observation only shows that one is with the other, not that it is by it and has no other causes than it" (ibid.). Therefore what we might perceive to be a causal connection is really only a correlation—"with" does not equal "by." In the words of al Ghazālī:

> . . . the connection between what are believed to be the cause and the effect is not necessary . . . . If one follows the other, it is because He has created them in that fashion, not because the connection in itself is necessary and indissoluble. (ibid.)

Correlations between events can be readily observed, but since it is not possible to actually observe causal relationships, al Ghazālī argues that we are not justified in supposing that they exist.

For al Ghazālī, then, the world and all events are created by God every moment. God has complete freedom to create whatever He wishes at any time. Any uniformity or regularity of objects or of behavior is due to the fact that it is God's custom to create the same things over and over again. Causality is not a principle that governs the world.

The Copenhagen Interpretation of Quantum Theory

In the early part of the twentieth century, in response to an increase in the number of conflicts between scientific data and the prevailing Newtonian view of the physical world, a new theory was developed. This new theory, known as quantum theory, describes the structure of the objects that make up the material world. In order to appreciate its significance, it is important to see how fundamentally different it is from a mechanical-Newtonian view. The world described by a mechanical model is composed of independently existing objects, each of which has a set of qualities that make that object what it is. The objects continue to exist over time based on their inherent properties. Objects persist until they undergo a change in response to the actions of an outside force. For example, a lead ball is an object and it continues to exist until it is destroyed by some outside force. It will fall when released because it is acted upon by an outside force (gravity). Furthermore, it is inherent in a lead ball to behave in this fashion.

In addition, a mechanical view assumes the existence of natural laws that can predict the behavior of objects. If a ball is dropped from a height of ten feet, not only is it certain that it will fall, it is also possible to predict exactly how fast it will be moving when it hits the ground and exactly where it will land. In such a world, there is no room for surprises or miracles, for every event has a rational explanation.

Quantum theory arose as scientific data accumulated that could not be explained by this mechanical model (Crease and Mann 1986). An illustrative case is the behavior of electrons. Present in all physical objects, they, along with protons and neutrons, are the three so-called fundamental particles that make up all physical objects. When first discovered in 1897, electrons were assumed to be very small particles (i.e., objects with a definite size and a definable location in space[1]). Upon further study, however, it was noted that although electrons sometimes behaved as if they were particles, at other times they behaved as if they were waves. As waves do not have a size or a position, a fundamental contradiction arose: how was it possible for an electron to be a particle and *have* a position and, at the same time, be a wave and *not have* a position?

A further complication became apparent when it was learned that the behavior of the electron (i.e., as a particle or as a wave) depended not on the electron itself, but on the actions of an observer. It was found that if an observer set up an experiment to study the wave properties of an electron, it would act like a wave. If, on the other hand, the experiment were set up to study particle properties, the electron would behave like a particle. Thus, in some sense, an electron's nature is dependent upon the actions of the observer.

Quantum theory was developed to address such problems. It is a highly abstract, mathematical theory that completely defines the behavior of such entities as electrons.[2] This theory has been widely accepted by scientists, for it is able to produce accurate predictions of behavior.[3] Ever since the development of quantum theory, however, arguments have raged over the correct physical interpretation of such an abstract theory. The most widely accepted (although by no means the only potential) interpretation is known as the Copenhagen Interpretation, so named in honor of one of its founders and proponents: Niels Bohr, the director of the Copenhagen Institute of Theoretical Physics.[4]

In quantum theory, the electron is formally and completely described by a wave function. This mathematical function precisely defines such properties of electrons as their energy. It does not, however, define the electron's exact location or its precise movements. According to quantum theory, it is not possible, even theoretically, to define these attributes. It is only possible to define the potential that an electron has of being found at a certain location.

To make matters even more confusing, it appears that the electron does not actually exist at any one location until an observer interacts with

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[1]Size and position are attributes that we typically associate with objects.

[2]It can also be applied to larger and more familiar objects, such as a lead ball, for this object is composed of electrons, protons, and neutrons.

[3]As will be described in the following paragraphs, these predictions are quite different in scope and meaning from the predictions produced by a mechanical-Newtonian model.

[4]Although many descriptions of the Copenhagen Interpretation exist, the reader is refered to Heisenberg (1958), chapter 3.

it. In other words, an electron is a particle that has a position only when an observer *determines* its position. Without this interaction, the electron does not have a position. Instead, it has the "potential" to behave in a number of different positions. It does not, however, exist at any one of these places until an observer interacts with it to determine its position. This is contrary to the behavior expected of particles. Quantum theory, when expanded to objects of familiar size, implies that objects have properties that are very different from what one might expect. For example, it implies that a lead ball, if left on a table when everyone leaves the room, does not exist in the way that one might expect. The lead ball has the potential to continue to exist on the table, but it also has the potential to exist in a number of other places as well. Further, it does not actually exist in any one place unless someone interacts with it (i.e., looks at it to see where it is).

This idea of potentials is crucial to quantum theory. To more fully understand this, it is useful to discuss the structure of an atom. Protons and neutrons reside in the nucleus at the center of an atom, while electrons are found outside this nucleus. Although it is impossible to predict exactly where outside the nucleus an electron will be found, it is known that the electron has a very high probability of being found close to the nucleus. It has a much lower, but still definable, probability of being found far from the nucleus. It is not possible to predict exactly where an electron will be found when an observer looks for it, because it has the potential to be anywhere in the universe. It is, however, possible to predict with a very high degree of accuracy the *probability* of finding an electron at any particular location (Heisenberg 1962). Although an electron has no definable location prior to an observer interacting with it, there is a high probability that when its location is determined, it will be very close to the nucleus. There is a much lower probability associated with finding the electron far from the nucleus.

To take a concrete example, consider a brick wall. This wall is a solid object made of atoms held together by the interactions of their electrons. If, at one instant of time, all of the electrons were exhibiting very improbable behavior (i.e., were far away from their nucleus), there would be nothing holding the wall together and it would therefore cease to exist. In other words, there is a high probability that the electrons will be close to the nucleus and that the wall will behave normally. If one attempts to walk through this wall, there is a very high probability that one will be stopped by the wall. However, there is still a small (but, according to quantum theory, real) probability that, when attempting to walk through a wall, all of the electrons will be behaving in such a way that one can walk through the wall unscathed.[5]

The concept of probability is related to one of the most surprising aspects of quantum theory: the Heisenberg Uncertainty Principle. Suggested by Heisenberg in 1927, it states that there is a mathematical limit to what can be known about an object, and that certain attributes of an electron are so fundamentally connected to one another that the knowledge of one affects knowledge of the other (Davies 1989). Two such attributes are position and momentum, the latter of which is based on the direction of motion and the velocity of a particle. According to the Uncertainty Principle, the more that is known about the momentum of a particle, the less it is possible to know about its position. For example, if the speed and direction (momentum) of an electron are precisely known, it is impossible to determine where the electron is located (Bohr 1934). If, on the other hand, the exact location of an electron is known, nothing whatsoever can be learned about its momentum.

What, then, is the nature of an object in a quantum world? An object, as described by quantum theory, does not have an existence independent of an observer's interaction with it. The set of qualities that adhere to an object depend on the way that an observer interacts with that object. In addition, it is not possible to predict exactly what an object will do in any given instance, but only to predict the probability of any particular occurrence. Furthermore, since one attribute seems to influence another, there is a strict limit to what can be known about an object. This Uncertainty Principle limits the individual's ability to understand the world rationally. Even though these ideas of quantum theory are not easy to accept, scientists have come to believe them because, when quantum theory is applied, it gives accurate, testable predictions about the probability of any occurrence.

Similarities

As can be seen from the foregoing, there are many similarities between the ideas of al Ghazālī and the Copenhagen Interpretation of quantum theory. For example, consider the nature of objects in the world. It was al Ghazālī's belief that all things are created by God and, in order for them to endure, it is necessary for God to create them continuously.

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[5]The mechanical-Newtonian model, in contrast, states very clearly that no matter how many times one walks into the wall, one will *never* walk through it unscathed. Quantum theory states that although the chances of doing so are exceedingly small, they are still real and, moreover, can be calculated exactly.

There are no attributes inherent in the objects themselves, for any qualities or attributes that might be associated with an object are only the result of God's actions. For example, a lead ball does not have an inherent property of "heaviness," for "heaviness" is not a result of the lead in the ball. Rather, it is the result of God causing the ball to fall when dropped and causing the concept of "heaviness" to arise in the mind of the individual observing the event. The presence of lead in the ball is *not* what causes the ball to fall; it is the action of God that causes the ball to act as it does. It is also the action of God that causes the individual to interpret this behavior as "heaviness."

Like al Ghazālī, the Copenhagen Interpretation questions whether objects have any inherent qualities. For example, an electron has neither meaningful size nor a position until an observer interacts with it. All it has is the abstract mathematical description known as a wave function. This defines the properties of an electron once it is interacted with, but it also implies that an electron has no inherent properties prior to this interaction. Since larger objects, such as lead balls, are made up of electrons (along with protons and neutrons), quantum theory implies that a lead ball has no inherent properties that cause it to act as it does. Any properties exhibited by a lead ball arise from the interaction of the lead ball and the observer and are not properties inherent in the lead ball itself.

This lack of properties adhering to objects calls into question the very existence of objects. It would be al Ghazālī's contention that objects have no existence independent of God because He is responsible for creating each object every moment. Were it not for God, the object would not exist at all. Similarly, the Copenhagen Interpretation says that an object has no existence independent of an observer. If no observer is present, the object has no attributes and cannot be said to exist.[6] For al Ghazālī, then, God is responsible for the existence of objects as well as for all of the properties that adhere to them. In quantum theory, it is the observer who causes the object to have specific properties. Although al Ghazālī sees the source of properties as the actions of God and quantum theory sees properties arising as a result of an interaction with an observer, the disagreement over exactly how properties arise is much less profound than the basic agreement that the properties are not inherent in the object itself.

Another area of agreement is found in the interpretations of causality and the predictability of events. If events in the world are causally connected, it is possible, if enough is known about initial conditions, to pre-

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[6]To say that an object exists but has no attributes contradicts the common understanding of the term "object" as described in the introduction to this paper.

dict the exact course of future events. However, both al Ghazālī and the Copenhagen Interpretation deny that events are causally connected to this extent. They also deny that events are completely predictable. In the words of al Ghazālī, causal relationships are impossible because God creates everything at every moment. Everything that happens depends on decisions made by God. There may be a correlation between two events, such as the presence of fire and the burning of cotton, but that correlation does not imply a causal relation. The Copenhagen Interpretation also questions the existence of causal links between events, based on the fact that objects in the world are made up of entities (i.e., electrons) that do not themselves behave according to cause/effect relationships. In the Copenhagen Interpretation, causal relationships are not meaningful at the subatomic level because there are no "objects" there in the normal sense of the term. Electrons have only the potential to do certain things and do not manifest any of these potentials unless interacted with. If objects have only potentials and no attributes, it is meaningless to say that the objects themselves can interact causally.

Although al Ghazālī and the Copenhagen Interpretation question causality, neither denies that regularities exist in nature. These regularities are, according to al Ghazālī, attributed to God's "custom" (Qur'an 33:62). It is God's custom to correlate the presence of fire with the burning of cotton. But since God is omnipotent, He could, if He chose, prevent the cotton from burning in the presence of fire. The probability of cotton not burning when placed in fire is small, because it is not God's custom to *not* allow it to burn in such a situation. The Copenhagen Interpretation also acknowledges that regularities are seen in the physical world. These regularities are due to the fact that some events have higher probabilities of occurring than others. Events are therefore predictable, but only in a general way. For example, an electron has a high probability of being found in a position close to the nucleus. This high probability is similar, in many respects, to al Ghazālī's concept of "custom." It is possible to predict where the electron will *probably* be found, but impossible to predict *exactly* where it will be found. Similarly, it is possible to predict that cotton will *probably* turn black when it is placed in fire, but it impossible to say that it will *always* turn black in the presence of fire.

If these ideas are applied to a large object such as a lead ball, we find that the lead ball will *tend* to fall when it is released. But there is also the probability that it will rise. The chances of the latter, as defined by quantum theory, are very small but are still definably real. It is not possible to predict exactly what the lead ball will do in any given instance: it might rise or it might fall. It is only possible to say that the probability of it falling is much higher than the probability of it rising.

If a quantum theorist and al Ghazālī were to see a lead ball being released and then rising instead of falling, there would be many similarities in their explanations. For al Ghazālī, it would have risen because God chose, in this case, not to follow His custom of making it fall. We seldom see this happen, because God normally *does* follow His custom. There is, however, nothing to insist that God must cause the ball to fall, for He has complete freedom to do whatever He wishes. A quantum theorist who witnessed the same event would painstakingly and exhaustively work to eliminate all other potential scientific explanations. Once this arduous task was completed and no rational explanation remained, the rising of the lead ball would be explained by stating that an event for which the probability is exceedingly small (but still real) had been seen.

Conclusion

Although separated by culture and by nearly ten centuries, the similarities between al Ghazālī and the Copenhagen Interpretation are remarkable. In both cases, and contrary to common sense, objects are viewed as having no inherent properties and no independent existence. In order for an object to exist, it must be brought into being either by God (al Ghazālī) or by an observer (the Copenhagen Interpretation).

In addition, the world is not entirely predictable. For al Ghazālī, God has the ability to make anything happen whenever He chooses. In general, the world functions in a predictable manner, but a miraculous event can occur at any moment. All it takes for a miracle to occur is for God to not follow His "custom." The quantum world is very similar. Lead balls fall when released because the probability of their behaving in that way is very high. It is, however, very possible that the lead ball may "miraculously" rise rather than fall when released. Although the probability of such an event is very small, such an event is, nonetheless, still possible.

Both al Ghazālī in the eleventh century and quantum theory in the twentieth century imply that the world is very different from what common sense would lead one to believe. The appearance of objects is deceiving. Objects do not have an independent existence, as one has come to expect. Objects are created each moment, either by God or by an act of observation. Furthermore, it is not possible, even in principle, to predict the exact behavior of objects, but only the probability of occurrences. Such a view of the physical world is, then, both new and old.

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