

Al-Ghazâlî's Concept of Causality and Quantum Physics: Finding a Point of Relevance

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Abstract

Al-Ghazâlî views the connection between what is believed to be natural cause and effect is not necessary. For him, God is the Agent in every event. He is the determining factor. As a result, a natural event cannot be seen with certainty, in other words it is probabilistic. On the other hand, quantum physics developed in the early 20th century, which tries to explain the microscopic world is only able to predict events probabilistically. So it can be said that quantum physics that emerged at the beginning of the 20th century supports and affirms the views of al-Ghazâlî formulated in the 11th century at least in terms of probability. In addition, the many strange and complicated things that have not been well explained in the atomic world should be an indication that a more in-depth and thorough study of the universe leads to an increasingly "visible" Entity that is Almighty, namely God—where He has made nature as the *âyat* (signs) of His existence. Furthermore, from this study of al-Ghazâlî's concept of causality and quantum physics, it can be understood that there are differences that become the end of the problem, namely metaphysical beliefs. So that an important effort

that must be made to build Islamic science is to form an intellectual commitment based on metaphysical beliefs originating from Revelation.

Keywords: Al-Ghazâlî, Quantum Physics, Causality, Probabilistic, Relevance.

Abstrak

Al-Ghazâlî memandang hubungan antara apa yang diyakini sebagai sebab alami dan akibat adalah tidak mesti. Baginya, Tuhanlah Agen dalam setiap peristiwa. Dialah yang menjadi faktor penentu. Akibatnya sebuah peristiwa alam tidak bisa dipandang secara pasti, dengan kata lain bersifat probabilistik. Di sisi lain, fisika kuantum yang dikembangkan pada awal abad ke-20, yang mencoba menjelaskan dunia mikroskopik hanya mampu memprediksi peristiwa secara probabilistik. Sehingga bisa dikatakan bahwa fisika kuantum yang muncul pada awal abad ke-20 mendukung dan mengafirmasi pandangan al-Ghazâlî yang dirumuskan pada abad ke-11 setidaknya dalam aspek probabilitasnya. Selain itu, banyaknya hal aneh dan rumit yang belum bisa ter jelaskan dengan baik dalam dunia atomik harusnya bisa menjadi indikasi bahwa pengkajian yang semakin mendalam dan teliti tentang alam semesta menghantarkan kepada semakin “tampak”nya suatu Entitas yang Maha Mengatur, yakni Tuhan—di mana Dia telah menjadikan alam sebagai *âyat* (tanda-tanda) eksistensi-Nya. Lebih jauh lagi, dari kajian konsep kausalitas al-Ghazâlî dan fisika kuantum ini, dapat dipahami bahwa ada perbedaan yang menjadi ujung permasalahan, yaitu keyakinan metafisika. Sehingga usaha penting yang harus dilakukan untuk membangun sains Islam adalah membentuk komitmen intelektual dengan basis keyakinan metafisika yang bersumber dari Wahyu.

Kata Kunci: Al-Ghazâlî, Fisika Kuantum, Kausalitas, Probabilistik, Relevansi.

Introduction

Contemporary science evolved and developed from a philosophy which from the very beginning asserted that the existence of all things is related to one another, has no beginning and no end. The world is seen as something that stands alone, eternal, and moves by itself according to its own laws.¹ The metaphysical, spiritual, qualitative, and aesthetic aspects of the universe are ignored, belittled

¹ S.M.N. al-Attas *Prolegomena to the Metaphysics of Islam: an Exposition of the Fundamental elements of the Worldview of Islam*, (Kuala Lumpur: ISTAC, 1995), 115.

or even denied.² Reality has been reduced to only the realms that can be sensed,³ while the reality and existence of God is abolished.⁴ Or if some still believe in a god, then that god is just filling in the blanks in their scientific explanations—until better data or new theories deem external influences unnecessary.⁵ So it is not surprising that a popular Western physicist, Stephen Hawking, issued the sentence “it possible to replace religion and metaphysics with a mathematical theory that encodes all the laws of nature”.⁶

However, the development of modern science developed by the West is not fully in line with their philosophy which excludes metaphysical aspects, especially God. Nidhal Guessoum in his book *Islam's Quantum Question: Reconciling Muslim Tradition and Modern Science*, explained that modern science has brought at least three major theories that have had a significant influence on mankind's conception and belief in God: Darwin's theory of evolution;⁷ Big Bang theory⁸ which explains how the universe; and quantum theory which explains microscopic world.⁹ Of these three theories, we choose to discuss quantum theory and its influence on our conception of God. It is because of the importance of this theory in the development of modern science and technology and its positive implications for the belief in the existence of God based on various books and articles that we have explored.¹⁰

² Osman Bakar, *Tauhid dan Sains*, (Pustaka Hidayah: Bandung, 1994), 75.

³ Sayyed Hossein Nasr, *The Need for a Sacred Science*, (United Kingdom: Curzon Press, 1995), 5.

⁴ S.M.N. al-Attas, *Prolegomena...*, 115.

⁵ IAN G. Barbour, *Issues in Science and Religion*, (New Jersey: Prentice-Hall, 1966), 1.

⁶ Peter Coles, *Hawking and the Mind of God*, (United Kingdom: Icon Books, 2000), 67.

⁷ The theory proposed by Charles Darwin in the book *On the Origin of Species* (1859), which postulates that today's species arose from simpler ancestral types through a process of natural selection that led to the emergence of diversity in populations. Elizabeth A. Martin, *Kamus Sains*, (Yogyakarta: Pustaka Pelajar, 2012), 185, translated from *A Dictionary of Science* by Ahmad Lintang Lazuardi.

⁸ The cosmological theory which states that all matter and energy in the universe originated in a state of extraordinary density and temperature which then exploded instantly. Elizabeth A. Martin, *Kamus Sains...*, 1082.

⁹ Nidhal Guessoum, *Islam's Quantum Question: Reconciling Muslim Tradition and Modern Science*, (New York: I.B. Tauris, 2011), 40.

¹⁰ Some of them: Ian G. Barbour, *When Science Meets Religion*; Wolfgang Smith, *Quantum Enigma: Finding the Hidden Key*; A.M. Hamza, *A Reflection of Quantum Mechanics: an Islamic Perspective*; Shahidan Radiman, *Sufism and Quantum Knowledge: some Convergence*; and Torla bin Haji Hassan, *Modern Physics versus Islam*.

Quantum physics which began to be developed at the beginning of the 20th century has destroyed the world view of classical physics¹¹ which sees nature as a machine, namely mechanistic-deterministic.¹² In quantum physics, events are considered to be indeterministic or probabilistic. This is based on the discovery of strange phenomena in the atomic world that are no longer in accordance with the fundamental concepts in classical physics. It finally forces us to reunderstand reality and the principle of causality¹³ that has been understood so rigidly. Many events in the microscopic world cannot be explained properly so that some scientists associate them with metaphysical things, including God.

On the other hand, al-Ghazâlî¹⁴ (1058-1111 AD), who was one of the great Muslim scholars of the 11th century, had formulated a concept on how to see nature processes occur, which was based on an Islamic worldview whose source was Revelation. In the concept that he built, the aspect of God becomes the central and determining factor. All natural processes that occur are seen as His actions. So what is usually believed to be natural cause and effect is not necessary.¹⁵ As a result, an event can only be seen as probabilistic.

In this article, we try to describe how the concept of al-Ghazâlî causality is understood and can be the basis for developing knowledge, especially natural sciences as well as examining the development journey of quantum theory so that it can be accepted and used today, especially its probabilistic view. After that, it is discussed what and what kind of relevance is between the concept of al-Ghazâlî and the basic concepts in quantum theory. We also discuss how the position of relevance based on our (Muslim)

¹¹ Classical physics was theoretical physics until the 19th century, before the advent of quantum theory (1900) and special relativity (formulated by A. Einstein in 1905). This theory can still be applied with great precision to large-scale phenomena that do not involve relative motion at very high speeds, 299. Elizabeth A. Martin, *Kamus Sains*,....

¹² See Fritjof Capra, *The Turning Point: Science, Society, and the Rising Culture*, (New York: Bantam Books, 1983), 85.

¹³ The general principle of causality used science today, "*The same cause or set of causes always produces the same effect or effects (other things being equal) and the cause(s) temporally precedes, or is simultaneous with, its effect(s).*" Peter J. Riggs, *Quantum Causality: Conceptual Issues in the Causal Theory of Quantum Mechanics*, (New York: Springer), 6.

¹⁴ His full name is al-Imâm Hujjatul Islâm Zaynuddîn Abû Hâmid bin Muhammad bin Muhammad bin Ahmad at-Tûsi at-Tabarâni asy-Syâfi'î al-Ghazâlî.

¹⁵ See Al-Ghazâlî, *The Incoherence of Philosophers (Tahâfut al-Falâsifah)* (Provo: Brigham Young University Press, 2000), parallel English-Arabic text translated by Michael E. Marmura, 166. It will be discussed in more detail in the Al-Ghazâlî's Concept of Causality section.

worldview. This last discussion is missed in some very related previous scientific articles that we have found.¹⁶

Al-Ghazâlî's Concept of Causality

The concept of the elements of reality,¹⁷ especially the concept of God, has influenced al-Ghazâlî's concept of causality. He views that in the causal connection in the phenomenal world, God is the determining factor.¹⁸ Causality is only a part of God's continual act of creation and annihilation (*dawâm al-tajaddud wa dawâm al-in'idâm*).¹⁹

The discussion on the causality of al-Ghazâlî is mainly contained in his book *Tahâfut al-Falâsifah (The Incoherence of Philosophers)* the seventeenth discussion. He states:

«الاقتران بين ما يعتقد في العادة سببًا ، وبين ما يعتقد مسببًا ، ليس ضروريًا عندنا ، بل كل شيئين ، ليس هذا ذاك ، ولا ذاك هذا ، ولا إثبات أحدهما ، متضمنًا لإثبات الآخر ، ولا نفيه متضمنًا لنفي الآخر ، فليس من ضرورة وجود أحدهما ، وجود الآخر ، ولا من ضرورة عدم أحدهما ، عدم الآخر ، ... ، فإن اقتراها لما سبق من تقدير الله سبحانه ، بخلقها على التساوق ولا لكونه ضروريًا في نفسه ، غير قابل للفرق ...»²⁰

¹⁶ One of the articles that the authors found that saw the relevance between al-Ghazâlî and quantum physics was written by Karen Harding entitled 'Causality Then and Now: Al-Ghazâlî and Quantum Theory', *The American Journal of Islamic Social Sciences* 10: 2, (1993). Another one was written by Ümit Yoksuloglu Devji in his thesis entitled 'Al-Ghazâlî and Quantum Physics: A Comparative Analysis of the Seventeenth Discussion of Tahâfut al-Falâsifa and Contemporary Quantum Theory', (Montreal: McGill University, 2003). However, the authors of these two writings do not relate their discussion with worldview (especially worldview of Islam) and the challenges of contemporary thought. In our article, we try to fill this emptiness by retracing the two kinds of school of thought so that it can be seen, where the position of these similarities is based on the Islamic worldview. By knowing the position of these similarities, it is hoped that Muslims can respond these similarities wisely and fairly.

¹⁷ The elements of reality mentioned by Sulayman Dunyâ, namely an explanation of God, about nature, humanity, and prophethood. See Sulayman Dunyâ, *al-Haqîqah Fi Nazari al-Ghazâlî* (Cairo: Dar al-Ma'ârif, without year), 149-408, see Hamid Fahmy Z., *Kausalitas: Hukum Alam atau Tuhan: Membaca Pemikiran Religio-Saintifik Al-Ghazâlî*, (Ponorogo: UNIDA Press, 2018), 103.

¹⁸ Hamid Fahmy Zarkasyi, *Kausalitas:...*, 238.

¹⁹ Al-Ghazâlî, *al-Iqtisâd fi al-I'tiqâd*, Abu al-A'la (ed.), 40. See Hamid Fahmy Zarkasyi, *Kausalitas:...*, 238.

²⁰ Al-Ghazâlî, *Tahâfut al-Falâsifah*, 4th ed., (Cairo: Dâr al-Ma'ârif, 4th ed., without

From this quote, two sides of al-Ghazâlî's argument can be drawn, namely the theological argument and the empirical argument. In his theological argument, al-Ghazâlî emphasizes that in every event, the perpetrator is God²¹ — where the perpetrator (*fâ'il*) for al-Ghazâlî has three criteria: *First*, the perpetrator must have a will (*murîd*) to act; *Second*, the perpetrator must have free choice (*mukhtâr*); *Third*, the perpetrator must have knowledge (*'âlim*) about what he wants.²²

Meanwhile, from the empirical argument, three points can be drawn: 1) every two things are separate; 2) ontologically, one affirmation or negation has no implications to affirmation or negation of others; and 3) ontologically too, the existence or non-existence of something has no implications for the existence or non-existence of others.²³ In other words, the connection of one thing "with" another is different from that of being caused "by" something else.

To make the explanation clearer, al-Ghazâlî then gives an example, namely the phenomenon of the burning of cotton when in contact with fire. Al-Ghazâlî believes that contact of fire with cotton does not always burn the cotton. Or the transformation of cotton into ashes can happen without burning first.²⁴ For him there is no evidence that fire causes combustion or that the cause of the appearance of ash is fire that meets cotton. He states:

”وليس لهم دليل ، الا مشاهدة حصول الاحتراق منذ ملاقة النار ، والمشاهدة تدل على الحصول عندها ، ولا تدل على الحصول بها ، وانه لا علة له سواها ،...“²⁵

In this case Al-Ghazâlî believes that the “the perpetrator of burning” is God, not fire. Or the transformation that occurs from cotton to ashes when cotton comes into contact with fire, the reality and the truth is the annihilation of cotton and the creation of ash at the moment when cotton comes into contact with fire which done by God.

Al-Ghazâlî understands the consequences of this concept. So that in the following pages he gives answers to various statements that may be put forward by philosophers who disagree with him. One statement

year), 239.

²¹ Hamid Fahmy Zarkasyi, 'Epistemological Implication of Al-Ghazzâlî's Account of Causality', *Intellectual Discourse*, Vol. 26, No. 1, (2018), 53.

²² Al-Ghazâlî, *The Incoherence...*, 55.

²³ Hamid Fahmy Zarkasyi, *Epistemological Implication...*, 55.

²⁴ Al-Ghazâlî, *The Incoherence...*, 166-167.

²⁵ Al-Ghazâlî, *Tahafut al-Falasifah*, 240.

that may have relevance to the quantum view to be discussed next is found on page 243-244 of the *Tahâfut*:

«ومن وضع كتبا في بيته ، فليجوز أن يكون قد انقلب عند رجوعه إلى بيته ،
غلامًا أمرد ، عقلا متصرفًا ، أو انقلب حيوانًا .
ولو ترك غلامًا في بيته ، فليجوز انقلابه كلبًا ، و ترك الرماد ، فليجوز انقلابه مسكًا
، وانقلاب الحجر ذهبًا ، والذهب حجرًا ...»²⁶

The statement of possibility as stated above is justified by al-Ghazâlî. However, he comments that although it is possible but Allah swt. has given the knowledge that He does not do such things, although it is possible.²⁷ It means that although it is possible, the fact is that we never find such strange things. In other words, not everything that is possible is actualized by Him.²⁸ With a view like this, we can still place God as the Most Willing and Powerful, but also understand that in this nature God creates *sunnatullâh* that seems clear and cannot be avoided.

So it should be underlined that al-Ghazâlî clearly does not deny that there is a connection between a cause and an effect; but he just reject the 'necessity' of thus connection.²⁹ He believes that there is a consistent cause and effect connection or a strict pattern of regularity between cause and effect that is seen as a habit of God. And that doesn't preclude God's free will. He may wish to do something out of His habit anytime. So that the occurrence of miracles and wonders is actually just an event where God does or actualizes a possibility outside of His habit.³⁰ So like Prophet Ibrahim not being burned by fire (cause without effect), the birth of the Prophet Isa without a father

²⁶ Al-Ghazâlî, *Tahafut al-Falasifah*, 243-244. As far as our analysis, there is a relevance where from all possible circumstances or events, God chooses one circumstance so that humans only observe an event that is not random and can be understood in this universe. This will happen later in the quantum world, although the interpretation of the state is slightly different. In the quantum world it is believed that an object can have several states at the same time which is called the *principle of superposition*. However, when measurement are made, only one particular state will be obtained. For al-Ghazâlî, the choice of the state to be observed is determined by God, while for quantum physicists it assumed that the actualization of a certain state is determined by nature itself and is influenced by the observational behaviour of a subject. See The Schrödinger Equation and His "Cat" section.

²⁷ Al-Ghazâlî, *The Incoherence...*, 170.

²⁸ Frank Griffel, *Al-Ghazâlî's Philosophical Theology*, (New York: Oxford University Press, 2009), 154.

²⁹ Frank Griffel, *Al-Ghazâlî's Philosophical...*, 149.

³⁰ Hamid Fahmy Zarkasyi, *Kausalitas:...*, 274.

(effect without cause) or *Ashâbul-Kahfi* sleeping for hundreds of years are things that may happen and are clearly acceptable.

Logical and Ontological Causality

Al-Ghazâlî has a basis for denying a necessary causal connection in objective reality as previously explained. However, he acknowledges causality in human logic.³¹ Certainty in the mind is only an impression that is acquired unconsciously through the “course of habit” observed by the senses.³² From this it can be understood that al-Ghazâlî is not at all against there is a knowledge that can be obtained from observing the universe, but it must be realized that its certainty has certain limits according to its reality, both this universe which is the object of knowledge and human mind as the instrument of that knowledge. Through this explanation of logical and ontological causality, it is seen that al-Ghazâlî wants to place the reality of nature and knowledge about it in its main place and function, namely a contingent reality but at the same time a sign that will lead to His Reality.

For example in *al-Iqtisâd*, al-Ghazâlî makes the causal argument as one of the rationale for the existence of God. He conveys:

« قانون السببية : ان الشيء الساكن لا يتحرك الا بمحرك يحركه . وان المعدوم لا يوجد الا بموجود يوجدده . وان تعطيل قانون السببية تعطيل لاحكام العقل ومبادئه . انه لكل سبب مسبب، ولكل حادثة سبب، وكذلك خلق لانسان والكون وكل ما في الوجود لا بد له من سبب او صانع...»³³

This quote shows that al-Ghazâlî recognizes the certainty of causality in mind. The principle of causality embedded in the mind is proof that the mind is always looking for a cause or effect from what is captured by the senses. This principle, if integrated with belief in the principle of uncertain causality in the universe or knowledge of contingent natural reality, then the mind is directed to find the main cause of the existence of all things that are visible to the senses or experienced. It as a fact that many things happen in the universe and in our lives without any explainable cause that we often call ‘coincidence’

³¹ *Ibid*, 315.

³² *Ibid*, 290.

³³ Al-Ghazâlî, *al-Iqtisâd fi al-I'tiqâd*, (Lebanon: Bîrût, 2003), 35.

events³⁴—or conversely, so many factors are beyond our reach that the certainty of an event is impossible.³⁵ So that conclusion of mind for the existence of a substance that is the Absolute Cause or in al-Ghazâlî's terms the Perpetrator is a necessity.

Significance of Al-Ghazâlî's Concept of Causality

Another important thing that can be seen from the concept al-Ghazâlî's causality is that this concept presents a high sense of religiosity and divinity. Al-Ghazâlî seems to position that the knowledge of nature should not exclude supernatural causes.³⁶ In other words, he wants in the observation of every process of the universe that God is included. So that science can finally be seen as a knowledge that studies the habits of God's actions which are then formulated into a theory or law that is considered reasonable, if not necessarily, at least the habit pattern is stable, unchanging, and permanent.³⁷ So that every scientific activity can be a remembrance of God activity (*ẓikr*)³⁸—not just a research activity looking for endless mysteries and unclear goals like what is happening in Western society today.³⁹ This way of thinking is very important and should be built into Muslim research activities and programs. This concept also if properly understood, will not at all reduce our understanding and appreciation of order and pattern of nature arranged by God; not as alleged by some circles.⁴⁰

³⁴ See Mohsen Gharaviyan, *Pengantar Memahami Buku Daras Filsafat Islam: Penjelasan untuk Mendekati Analisis Teori Filsafat Islam*, (Jakarta: Sadra Press, 2011), 161.

³⁵ See also explanation of al-Ghazâlî in *The Incoherence...*, 167. See also Mohammed Basil Altaie, 'Causality: An Islamic Perspective', published in *God, Nature and the Cause: Essays in Islam and Science Islamic Analytic Theology Series*, (USA: Kalam Research and Media, 2016), 57.

³⁶ Hamid Fahmy Zarkasyi, *Epistemological Implication...*, 152.

³⁷ Frank Griffel, *Al-Ghazâlî's Theological...*, 177.

³⁸ In *Ihyâ'* volume 4, al-Ghazâlî mentions that a person needs both divine knowledge and rational knowledge to attain closeness to God. So, rational knowledge of external reality is a ladder that functions to get close to God because the reality that appears in the universe is actually a verse for people who think. This has been very clearly explained in many verses of the Qur'an. See Al-Ghazâlî, *Ihyâ' al-'Ulûm al-Dîn*, volume 4, (Cairo: Lajnah al-Thaqâfah al-Islâmiyyah, 1356 H), 1372. See Hamid Fahmy Zarkasyi, *Kausalitas...*, 193.

³⁹ Al-Attas states in his book *Prolegomena...*, 88, the search for knowledge in Western society is like a person struggling to push a rock up a hill, but when he reaches the top of the hill he rolls it down again.

⁴⁰ Like what Ibn Rushd allaged in *Tahâfut al-Tahâfut*. See Hamid Fahmy Zarkasyi's book entitled *Kausalitas: Hukum Alam atau Tuhan* for interesting discussion, 278-292.

From Classic to Quantum

At the end of the nineteenth century, physics consisting of classical mechanics, electromagnetic theory, and thermodynamics was believed to have provided a basic picture of the universe.⁴¹ However, at the turn of twentieth century, classical physics, began to get serious challenges to explain two domains, namely the relativistic domain and the microscopic domain. In 1905, Einstein's theory showed that classical mechanics was no longer valid at very high speeds (close to the speed of light). Then in the atomic world, classical physics was not able to provide a good explanation of the phenomena found at that time.⁴² Finally the basic concepts of the Newtonian worldview: views of absolute space and time, elementary solid particles, rigid causality in physical phenomena, and ideals of an objective picture of nature have been shattered by these two theories.⁴³ However, here we will only focus on problems in the atomic world.

Some phenomena in the atomic world that could not be explained by classical physics, namely black body radiation, the photoelectric effect, the Compton effect, and atomic stability⁴⁴ had forced physicists to seek new ideas to explain these phenomena.

The first breakthrough came in 1900 when Max Planck introduced the concept of *quantum energy*.⁴⁵ Planck found that energy from heat radiation does not emit continuously but appears in the form of "energy packets" which Einstein later called *quanta*.⁴⁶ Planck's idea is able to accurately explain black body radiation which is one of the quantum phenomena. From here began to emerge other new breakthroughs and solutions to various phenomena in the atom that could not be explained at the time—starting from the explanation of the photoelectric effect by Einstein in 1905, the Hydrogen atom model that was able to explain atomic stability, which was introduced by

⁴¹ Nouredine Zettili, *Quantum Mechanics: Concepts and Applications*, (United Kingdom: John Wiley & Sons, 2009), 1.

⁴² *Ibid.*

⁴³ Fritjof Capra, *The Tao of Physics: an Exploration of the Parallels between Modern Physics and Eastern Mysticism*, 5th ed., (Boston: Shambala, 2013), no page number.

⁴⁴ Discussion about these quantum phenomena are generally available in many quantum learning books. One of them is Nouredine Zettili's book entitled *Quantum Mechanics Concepts and Applications*.

⁴⁵ Nouredine Zettili, *Quantum Mechanics...*, 2.

⁴⁶ Fritjof Capra, *The Tao..*, no page number. See also Peter Coles, *Stephen Hawking and...*, in the Key Ideas section, 70.

Niels Bohr in 1913 and the confirmation of X-ray photons that behaved like particles with momentum $\frac{h\nu}{c}$ ⁴⁷ by Compton in 1923. These three breakthroughs confirm that on a microscopic scale waves can behave like particles.⁴⁸ In 1923 also de Broglie postulated that not only waves behave like particles, but also vice versa, particles can behave like waves. This concept was only confirmed experimentally in 1927 by Davisson and Germer; they showed that forms of interference, a property of waves, could be obtained with material particles such as electrons. Finally it is clear that on a microscopic scale, classical physics fails not only quantitatively but even qualitatively and conceptually.⁴⁹



Figure 1. Wave-particle duality

The following will discuss the basic concepts in quantum physics in order to clarify how the development of the formulation of quantum theory so that finally some views that are no longer in accordance with the views in classical physics must be recognized and accepted.

Heisenberg's Uncertainty Principle

The experimental proof of the wave property of particles in 1927 inspired Heisenberg to postulate the uncertain nature of the world of microphysics.⁵⁰ In the same year he formulated an uncertainty principle known as *Heisenberg's uncertainty principle*. In its original form, Heisenberg stated "if the *x*-component of the momentum of a particle is measured with an uncertainty Δp_x , then its *x*-position cannot, at the same time, be measured accurately than $\Delta x = \hbar/(2\Delta p_x)$ ",⁵¹ or can be expressed by $\Delta x \Delta p_x \geq \hbar/2$ —where Δx and Δp_x denote the uncertainty of position

⁴⁷ $h = 6,626 \times 10^{-34} \text{ J s}$ is Planck constant, $c \approx 3 \times 10^8 \text{ m/s}$ is light velocity in vacuum, and ν is X-ray frequency.

⁴⁸ Nouredine Zettili, *Quantum Mechanics...*, 2.

⁴⁹ *Ibid.*

⁵⁰ *Ibid.*, 28.

⁵¹ *Ibid.* Δx and Δp denote uncertainty of position and momentum, respectively. Then $\hbar = h/2\pi$, where h is Planck constant. Where $p = mv$, with v is particle velocity.

and momentum in the direction of x , respectively.

The uncertainty of the position Δx equal to zero means that the position of the particle is known to be at a certain point, while the uncertainty of momentum Δp_x equal to zero means that the momentum of the particles has a certain and definite value. The Heisenberg's uncertainty principle clearly prohibits zero values for Δx and Δp_x . This means, the particle is never at rest in a certain position or in other words the particle is always in motion.⁵² In a very dynamic world, it is very difficult to determine which is cause and which is effect, as in the macroscopic world. Heisenberg's uncertainty principle finally makes us realize that we cannot avoid the inaccuracies of the description of mechanics as well as the classical principle of causality.⁵³ Wheeler in his book *Quantum Theory and Measurement* states:

“[As] the statistical character of quantum theory is so closely linked to the inexactness of all perceptions, one might be led to the presumption that behind the perceived statistical world there still hides a “real” world in which causality holds. But such speculations seem to us, to say it explicitly, fruitless and senseless...quantum mechanics establishes the final failure of causality.”⁵⁴

Schrödinger Equation and His ‘Cat’

In quantum mechanics, the state of a particle is described by a wave function $\psi(x, t)$ that represents the de Broglie wave of the particle.⁵⁵ The wave function can be found using the Schrödinger equation.

The Schrödinger equation was proposed by an Austrian physicist, Erwin Schrödinger, in 1925 and published in 1926. The Schrödinger equation plays a logically analogous role to Newton's second

⁵² Agus Purwanto, *Ayat-ayat Semesta: Sisi-sisi Lain Al-Qur'an yang Terlupakan*, (Bandung: Mizan, 2015), 324-325.

⁵³ Paul S. Eipstein, 'The Reality Problem in Quantum Mechanics', *American Journal of Physics*, Vol. 13, No.3, (1952), 127.

⁵⁴ John Archibald Wheeler and Wojciech Hubert Zurek, *Quantum Theory and Measurement* (Princeton: Princeton University Press, 1983), 139. See Mohammed Basil Altaie, 'Causality: An Islamic...', 76.

⁵⁵ Nouredine Zettili, *Quantum Mechanics...*, 30.

law. Suppose that given the initial conditions $\psi(x, 0)$, the Schrödinger equation determines $\psi(x, t)$ for the future time—just as Newton's laws can determine the position of a particle in the future $x(t)$.⁵⁶ The time independent Schrödinger equation can be expressed as:

$$\left(-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} + V(x) \right) \psi(x) = E\psi(x)$$

Here we can comment that the laws of physics in quantum theory are deterministic while the phenomena described are probabilistic.⁵⁷ This means that the laws of physics are different from the laws of nature. The laws of physics are construction of mind, which are formulated according to the capacity of logic. While the laws of nature represent natural phenomena.⁵⁸ This means that here logical certainty must be recognized, but ontological certainty does not. This basic principle has been realized by al-Ghazâlî as described in the section on Logical and Ontological Causality.

Another important contribution of Schrödinger was a thought experiment which he proposed in 1935. This experiment is known as the *Schrödinger cat*. Here he told about a cat which is a macroscopic object to illustrate the strange interpretation of the reality of the quantum world when referring to the reality understood in the macroscopic world.⁵⁹ He experimented as follows:

“Imagine a cat locked up in a room of steel together with the following hellish machine (which has to be secured from direct attack by the cat): A tiny amount of radioactive material is placed inside a Geiger counter⁶⁰, so tiny that during one hour perhaps one of its atoms decays, but equally likely none. If it does decay then the counter is triggered and activates, via a relays, a little hammer which breaks a container of prussic acid. After this system has been left alone for one hour, one can say that the cat is still alive provided no atom has decayed in the mean time. The first decay of an atom would have poisoned the cat. In terms of the ψ -function of the

⁵⁶ David J. Griffith, *Introduction to Quantum Mechanics* second edition, (USA: Pearson, 2005), 1.

⁵⁷ See Probabilistic Interpretation section which discussed after this section.

⁵⁸ See Mohammed Basil Altaie, 'Causality: An Islamic...', 71.

⁵⁹ Bruce Rosenblum and Fred Kuttner, *Quantum Enigma: Physics Encounters Consciousness*, second edition, (New York: Oxford University Press, 2011), 155.

⁶⁰ An instrument which can detect radiation.

entire system this is expressed as a mixture of a living and a dead cat."⁶¹

The cat-in-a-box wave function has a schematic form

$$\psi = \frac{1}{\sqrt{2}}(\psi_{\text{alive}} + \psi_{\text{dead}})$$

So in the quantum interpretation, before the measurement, the cat in the box cannot be considered alive *or* dead, but in a linear combination of the two states. In other words, cats are seen as dead *and* alive at the same time. This principle is known as the *principle of superposition*. In the macroscopic world, this does feel strange, but in the microscopic world this interpretation is used.⁶²

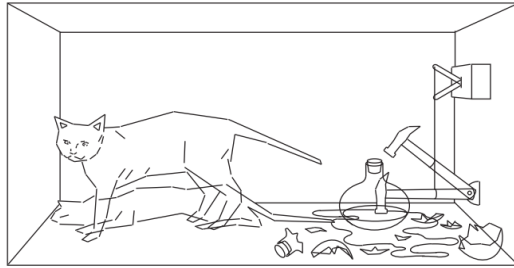


Figure 2. Schrödinger's cat thought experiment⁶³

Probabilistic Interpretation

The wave function obtained from the Schrödinger equation is purely a mathematical statement, not directly related to something that

⁶¹ E. Schrödinger, 'The present status of quantum mechanics, *Die Naturwissenschaften*', Vol. 23, Issue 48, (1935), 9.

⁶² David J. Griffith, *Introduction to Quantum...*, 382. There is a difference between classical logic and quantum logic. In classical logic, if we were told that Bill with red hair was at home or at a bar, we automatically thought we would be able to find a Bill with red hair at home or at a bar. In the 1930s, people began to realize that matter in the quantum world was different. An electron can not only be 'here' and 'not here', but can also be in possible states which are a superposition of 'here' and 'not here'. The consequence is the existence of a new form of logic called quantum logic. Often called three-value logic, because in addition to 'true' and 'false' also probabilistic answers 'maybe'. See John Polkinghorne, *Quantum Theory: A Very Short Introduction*, (New York: University Press, 2002), 38.

Here we can also comment that there is a strange state that is possible for quantum, but what is actualized when an observation has occurred is only a state that can be accepted by sense—in this case the state of life *or* death of a cat, not the state of life *and* death of the cat.

⁶³ Picture source: Christopher C. Gerry & Kimberley M. Bruno, *The Quantum Divide: Why Schrödinger's Cat is Either Dead or Alive*, (Oxford: Oxford University Press, 2013), 151.

can be observed.⁶⁴ It wasn't until 1927 that a German physicist, Max Born, proposed a statistical interpretation of the wave function which said that $|\psi(x, t)|^2$ gives the *probability* of finding a particle at a point x , at time t —or more precisely $|\psi(x, t)|^2 dx$ equal to the probability of finding a particle between x and $(x + dx)$, at time t .⁶⁵ So, it is Born's interpretation that connects quantum theory which describes abstract mathematical objects with the world of experimentation.⁶⁶

EPR (Einstein-Podolsky-Rosen) Paradox and Bell's Theorem

In its development, not all physicists agree with the nature of uncertainty or probabilistic interpretations in quantum theory. One of the objections came from Einstein, Podolsky, and Rosen.⁶⁷ In 1935, they published an article arguing that quantum mechanics does not provide a complete picture of physical reality: the wave function does not represent the whole picture—there is another quantity that must be added to the wave function to get a complete picture of the system. Therefore, they proposed another quantity called the “hidden variable”. It is so named because it is not known how to calculate and measure it.⁶⁸ In addition, the article contains a refutation of the doctrine that physical properties generally have no objective reality independent of the act of observation.⁶⁹ EPR rely on two assumptions: physical quantities have a value before being measured (realism) and there is no effect that propagates faster than the speed of light which is called the *principle of locality*.⁷⁰

Only 29 years later, in 1964 John S. Bell formulated a theorem proving that the theory of local hidden variables is incompatible with

⁶⁴ Phillip Ball, 'Mysterious Quantum Rule Reconstructed From Scratch', *Quantamagazine*, February 13, 2019, <https://www.quantamagazine.org/the-born-rule-has-been-derived-from-simple-physical-principles-20190213/>, accessed on November 18, 2020.

⁶⁵ David J. Griffith, *Introduction to Quantum...*, 2.

⁶⁶ Phillip Ball, 'Mysterious Quantum...'

⁶⁷ A. Einstein, B. Podolsky, and N. Rosen, 'Can Quantum-Mechanical Description of Physical Reality be Considered Complete?', *Phys. Rev.*, Vol. No. 10, (1935), 777. Einstein belongs to the group of physicists who maintain the view on classical physics which views that uncertainty is caused by human ignorance at this time. This group believes that certain laws do exist and will eventually be discovered. See Ian G. Barbour, *Issues in Science...*, 229.

⁶⁸ David J. Griffith, *Introduction to Quantum...*, 376.

⁶⁹ N. David Mermin, 'Is The Moon When Nobody Looks? Reality and the Quantum Theory', *Physics Today*, Vol. 38, No. 4, (1985), 38.

⁷⁰ David J. Griffith, *Introduction to Quantum...*, 375-376.

quantum mechanics.⁷¹ This was shown by the non-fulfillment of *Bell's inequality*. The inequality was then tested by many experiments between the years 1960-1970. The test results agreed with quantum mechanics and clearly did not agree with Bell's inequality.⁷² This theorem is a solid proof that stops the debate about the principle of locality that Einstein and other realists have defended. Henry Stepp, a Berkeley physicist, argued that Bell's theorem was the greatest discovery in science.⁷³ Finally, the probabilistic view of the atomic world is getting stronger because of the recognition of undetected external factors that can intervene in the occurrence of an event.

Quantum and God

The oddities in the quantum world have invited discussion not only among scientists, but also theologians.⁷⁴ Many of the scientists who still hold firmly to their religion associate quantum with mystical, metaphysical things, including God. One example is William Pollard. He is a physicist as well as a priest. Pollard proposes that atomic uncertainty is the realm in which God determines His destiny in governing the world. According to him, it is God who determines which conditions will be realized from the various possible conditions that can occur. This is because he sees that scientists cannot find a natural cause in the choice between quantum alternatives, so he views the selection that occurs as an act of God.⁷⁵

The same thing was formulated by Wolfgang Smith⁷⁶ which he discussed in many of his books, one of which was in *The Quantum Enigma: Finding the Hidden Key*. He stated that this uncertainty in quantum can only be explained in the realm of metaphysics.⁷⁷ Smith viewed that quantum theory has shown us that there is a primary

⁷¹ *Ibid*, 376.

⁷² *Ibid*, 379.

⁷³ Wolfgang Smith, *The Wisdom of Ancient Cosmology: Contemporary Science in Light of Tradition*, (Oakton: Foundation for Traditional Studies, 2004), 74.

⁷⁴ See A. M. Hamza, 'A Reflection on Quantum Mechanics: An Islamic Perspective', *Researchgate*, 5.

⁷⁵ Ian G. Barbour, *When Science Meets Religion*, (HarperCollins, 2000), without page number.

⁷⁶ Wolfgang Smith was a mathematician, physicist, Roman Catholic, and member of the Traditional School.

⁷⁷ Wolfgang Smith, *The Quantum Enigma: Finding the Hidden Key*, third edition (Hillsdale: Sophia Perennis, 2005), 98.

causality or what he also called *vertical causality*. The concept departs from the advice contained in Christian holy book. He believed that it was God who created everything at this time. In that his book, Smith quoted Meister Eckhart,⁷⁸ namely, “*God makes the world and all things in the present now*”.⁷⁹ From this principle was born the view that the process that occurs is not temporal but God created the whole including time. This he adapted to what was stated by St. Augustine,⁸⁰ “*Beyond all doubt, the world was not made in time, but with time*”.⁸¹

Regardless of the various concepts they propose, the point to be highlighted here is that quantum theory shows the way for the explanation and “visibility” of a higher Entity, namely God as Reality and Existence which is denied in contemporary scientific discourse.⁸²

Discussion on Relevance

From the explanation above, a general relevance can be drawn,⁸³ namely that both al-Ghazâlî and quantum theory view that an event that occurs in the universe is probabilistic. So that we cannot predict exactly an event; all possibilities have a chance to happen. So the concept of a causal connection which is rigid and necessary in nature is invalid according to both views. Certainty is only a construction of mind that works as it is and has the ability to understand a phenomenon or pattern in the universe within a certain limit. In other words, humans always have limits that can not be exceeded in knowing something.⁸⁴

⁷⁸ Meister Eckhart is a Christian theologian and mystic. He was one of the most famous mystical figures in the medieval church.

⁷⁹ Wolfgang Smith, *The Quantum Enigma:...*, 113.

⁸⁰ St. Augustine is perhaps the most significant Christian thinker after St. Paul. He adapted Classical thought to Christian teaching and created a powerful theological system of lasting influence. He also shaped the practice of biblical exegesis and helped lay the foundation for much of medieval and modern Christian thought. Excerpted from James O'Donnel, “St. Augustine”, *Britannica*, <https://www.britannica.com/biography/Saint-Augustine>, accessed on November 06, 2022.

⁸¹ Wolfgang Smith, *The Quantum Enigma:...*, 111.

⁸² See al-Attas, *Prolegomena...*, 115.

⁸³ Here we emphasize the most basic relevance. In the further research we can trace and discuss in more detail how the points of continued relevance between al-Ghazâlî's view and quantum physics have actually been touched on in several parts, such as the relevance in the logical and ontological certainty and the actualization of possibilities that God does with how the effects of measurement in quantum mechanics cause various states that may collapse to one particular state.

⁸⁴ See Ahmed Mabrouk, *Quantum Physics and the Boundaries of Human Perception*, TAFHIM: IKIM Journal of Islam and the Contemporary World 13 No.1, (2020), 23-55.

Then the principle of nonlocality reinforces the probabilistic nature of the universe. This principle has implications for the acceptance of external influences which can affect a system—no matter how far they are. And it is impossible for all these external factors to be known. We argue that this principle should be applicable in the macroscopic world because a necessary cause-and-effect process can only occur in a completely closed system. However, in the real world, we are not dealing with a completely closed world, so there is always the possibility of a different effect due to the reduction or addition of causes.⁸⁵ It means that we can also see an event that occurs in the macroscopic world in a holistic way like the quantum world view, so that it appears that an event that occurs is not something that is absolutely certain, but every possible event has a certain probability.⁸⁶

However, it should be realized that there is a fundamental difference between al-Ghazâlî's view and the quantum view accepted by most scientist today, namely in the view of nature of indeterminacy. Al-Ghazâlî from the beginning believed that nature or universe is a creature that does not have any will and that the provisions or determination are essentially in the Creator (God). He is the Absolute Existence. While the scientiests who formulated the quantum theory, indetermination is seen as an objective property of nature that has nothing to do with God's intervention.⁸⁷ So, for them it nature that determines how events occur with the probabilistic nature inherent in it. Again, here we (Muslims) and the West clash on metaphysical beliefs. Related to this, in the book *Tinjauan Ringkas Peri Ilmu dan Pandangan Alam*, al-Attas states:

“However this similarity, which seems obvious, is only about the external faces, and does not eliminate the deep differences that arise from some important differences in our worldviews and our beliefs about ultimate nature of Reality. Our commitment to *Tanzil* as a true source of knowledge about the reality and truth of creation and its Creator, provide us with a basis for establishing a metaphysical framework in which we can make a description of our philosophy of science as integrated system...”⁸⁸.

⁸⁵ See Mohammed Basil Altaie, 'Causality: an Islamic...', 77.

⁸⁶ Fritjof Capra, *The Turning...*, 78.

⁸⁷ See Ian G. Barbour, *Issues in Religion...*, 303.

⁸⁸ S.M.N. al-Attas, *Tinjauan ringkas Peri Ilmu dan Pandangan Alam*, (Kuala Lumpur: Ta'dib International; 2019), 6.

Conclusion

Quantum theory which began to be developed in the early 20th century AD can be said to affirm and strengthen the concept of al-Ghazâlî causality which was built almost 10 centuries earlier, namely in the 11th century AD.⁸⁹ The view of rigid causal connection has proven to be not comprehensive and can no longer be a basis for explaining more complex natural phenomena. Uncertainty must finally be accepted as a fundamental principle in seeing events or phenomena in the universe. In this point, our study complements and strengthens the similar previous studies.

The more in-depth and through search by Western societies does not make things seem any clearer and does not actually support their philosophy of science. However, it leads to something increasingly uncertain which eventually requires metaphysics to explain. This shows that the feeling of a supernatural existence, especially God, is a natural tendency (*fiṭrah*) that cannot be denied.⁹⁰ Finally, this search for relevance is an attempt to explain and re-awaken that there is a Real Existence on which contingent existence rests its existence.

From an epistemological perspective, this study of the al-Ghazâlî's concept of causality and quantum physics is expected to provide an awareness that Muslims have great scholars who have formulated key concepts derived from the metaphysical beliefs in Islam itself which we can adjust and rearrange to build a more complete concept or theory to offer solutions to various problems of contemporary science today. Because after all, the compatibility between our views and modern science is only in external aspects. Although at least this opens the way for us to explain a reality and truth that is the belief of Muslims. Finally, to build an Islamic Science, Muslim scientists need to form an intellectual commitment together to build science with a metaphysical basis that comes from Revelation.⁹¹]

⁸⁹ See Karen Harding, *Causality Then...*, 176.

⁹⁰ See al-Ghazâlî, *al-Iqtisâd...*, 34. Here al-Ghazâlî explains that among the arguments of mind to show the existence of God is the argument of creation or *fiṭrah*.

⁹¹ See Imre Lakatos, *Scientific Research Programmes* volume 1, (Cambridge: Cambridge University Press, 1978), Mohammad Muslih, *Pengembangan Sains dalam Perspektif Metodologi Program Riset Lakatosian: Survei Kritis atas Karya Dosen UIN Malang dan UIN Yogya*, (Yogyakarta: State Islamic University Sunan Kalijaga Yogyakarta, 2017), Aldi Pradana and Yongki Sutoyo, 'Worldview Islam sebagai Basis Pengembangan Ilmu Fisika', *Tsaqâfah*, Vol. 15, No. 2, (Gontor: Universitas Darussalam Gontor, 2019), 187-214.

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