Continuous Re-Creation: From Kalam Atomism to Contemporary Cosmology*

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Garden-variety (or ordinary) objects or bodies are seemingly the most concrete physical entities around us. However, throughout history people have attempted to uncover the reality which lies behind these appearances. In this context the atomistic view, which claims that bodies are composed of discrete units that cannot be divided into smaller parts, was one of the main solutions developed in ancient times regarding this phenomenon.[1] Pre-Socratic philosophers, such as Leucippus (480–420 BC) and Democritus (460–370 BC), propounded this idea in order to reconcile the principle of the unity and immutability of being with the multiplicity and the mutability of the visible world.[2] Aristotle (384–322 BC) rejected this view, claiming that accepting objects as discontinuous and discrete requires that the notions of space and time associated with objects should also be discrete in nature, which makes motion and extension or magnitude impossible.[3] In the Hellenistic period philosophers such as Epicurus (342–270 BC) and Lucretius (95–51 BC) attempted to defend atomism again.[4] However, the dominant view in the West, especially during the Middle Ages, was the Aristotelian theory of bodies as continuous and potentially divisible ad infinitum.[5]

After the Ancient Greeks Islamic theologians (*mutakallimun*) became the champions of atomism.[6] The *mutakallimun*, on the basis of the principle of finitude of events (itself based on the impossibility of an actual infinite), defended the view that not only matter but also the entire universe, including space, time, and motion, consists of finite units.[7] Such an atomistic model of the universe had, in turn, important implications for Islamic theological concepts. At first, during the absorption of atomism from ancient cultures, the *mutakallimun* gave it a shape according to their theological considerations but, thereafter, it gradually affected their theological views. In this context, the continuous re-creation and the rejection of natural causality were both theological theories that were developed as a consequence of the atomistic worldview.[8] So, unlike the Christian West, which declared this theory heretical due to its materialist basis,[9] the Islamic theologians made this theory the basis of the occasionalist relationship between God and the universe, in which God is the only efficient cause, and constantly re-creates the universe at every moment.[10]

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1 Jennifer Trusted, *Mystery of Matter* (London: Macmillan, 1999), 12.

2 W. K. C. Guthrie, *A History of Greek Philosophy: The Pre-Socratic Tradition from Parmenides to Democritus* (Cambridge: Cambridge University Press, 2003), 2:389ff.; David Furley, *The Greek Cosmologists: The Formation of the Atomic Theory and its Earliest Critics* (Cambridge: Cambridge University Press, 1997), 115; Samuel Sambursky, *The Physical World of the Greeks* (Princeton: Princeton University Press, 1987), 105.

3 On Aristotle's defense that space and time can be divided into indefinitely, see Max Jammer, *Concepts of Space: The History of Theories of Space in Physics* (Dover Publications: New York, 1993), 17; David Furley, "Aristotle and the Atomist on Infinity", in *Cosmic*

In Islamic thought, the theory of atomism was not a marginal view held by only a few individuals and groups; rather, it was adopted as official doctrine by the majority of Muslim theologians and became a predominant model for explaining reality from the ninth to the twelfth century.[11] As it was widely discussed and accepted, it gained a coherent structure and became a comprehensive model of the universe. However, in the period after al-Ghazali (1058–1111), it began to decline due to Aristotelian and Neo-Platonist theses defended by Peripatetics (*Mashsha'un*), and the rise of mysticism that challenged rationalist and materialist views of the world. In fact, while not abandoned completely, it would not hold a central position in Islamic theology after the twelfth century.[12] However, the Islamic theologians who inherited this tradition from the ancient world not only protected this theory, but also promoted its revival in the West.[13]

The cosmological paradigm shift, which began with the scientific revolution in seventeenth-century Europe, led Western thinkers to search for alternative natural philosophies to that of Aristotle. In this context, philosophers such as Giordano Bruno (1548–1600), Francis Bacon (1561–1626), and Daniel Sennert (1572–1637) showed a renewed interest in old atomistic views.[14] The French priest and astronomer Pierre Gassendi (1592–1655) attempted a reconciliation of Epicurean atomism with Christianity.[15] Also, leading influential natural philosophers at the time, such as Galileo Galilei (1564–1642), Isaac Newton (1642–1727), Robert Boyle (1629–98), John Locke (1632–1704), and W. Charleton (1620–1707) championed philosophical and theological atomism in various domains.[16]

In the eighteenth century, scientists such as Joseph Black (1728–99), CW Scheele (1742–86), John Priestly (1733-1804), and Henry Cavendish (1731–1810) proved through their experimental research that air, which was accepted as an element by Aristotle, is actually a compound consisting of oxygen and nitrogen. Later on, the French scientist Antoine Lavoisier (1743–94) demonstrated that water is not an element but consists of two separate components, hydrogen and oxygen.[17] Soon the combustion theory (phlogiston), based on the doctrine of the four elements, was also shown to be false; it was further proven that fire was a form of energy and soil was composed of many different elements. So the doctrine of the four elements, which had prevailed in the West for more than two thousand years, was invalidated[18].

In 1808, the British chemist and physicist John Dalton (1766–1844) took the first steps on the road towards scientific atomism by assuming that all elements consist of indivisible atoms identical in weight and characteristics.[19] Then came the Italian chemist Amedeo Avogadro's (1776–1856) studies on the molecular structure of gases which states that under the same pressure and warmness gases consist of the same amount of molecules; this was in turn followed by the Russian chemist Dmitry Mendeleyev's (1834–1907) arrangement of the periodic table in 1868. Eventually, the opinion that atoms bear all the chemical characteristics of a given element, and are not further chemically reducible to another element, became fixed and common.[20]

Despite these developments in the area of chemistry, an uncertainty still prevailed in physics. Even in the early 1900s famous physicists such as Wilhelm Ostwald (1853–1932) and Ernst Mach (1838–1916), who were influenced by positivism, were skeptical of the existence of

Problems (New York: Cambridge University Press, 1989), 103ff.; Leslie Jaye Kavanaugh, *The Architectonic of Philosophy: Plato, Aristotle, Leibniz* (Amsterdam: Amsterdam University Press, 2007), 94–6; Alan Chalmers, *The Scientist's Atom and the Philosopher's Stone: How Science Succeeded and Philosophy Failed to Gain Knowledge of Atoms* (New York: Springer, 2009), 34; A. Cornelus Benjamin, "Ideas of Time in the History of Philosophy", in *The Voices of Time*, ed. J.T. Fraser (New York: Braziller, 1966), 12–15.

4 Epicurus, *Letters and Sayings of Epicurus,* trans. Odysseus Makridis (New York: Barnes & Noble Books, 2005), 1–29; Lucretius, *The Nature of The Universe*, trans. R. E. Latham (Harmondsworth: Penguin Books, 1951); Pierre-Marie Morel, "Epicurean Atomism", in *The Cambridge Companion to Epicureanism*, ed. James Warren (Cambridge: Cambridge University Press, 2009), 65.

5 Norris S. Hetherington, "Aristotle's Cosmology", in *Encyclopedia of Cosmology*, ed. Norris S. Hetherington (New York: Garland Pub., 1993), 19–20; Andrew G. Van Melsen, *From Atomos to Atom* (Pittsburgh: Duquesne University Press, 1952), 49ff.

6 Andrew Pyle, *Atomism and Its Critics* (Bristol: Thoemmes Press, 1997), 210–11.

7 The most important characteristic of kalam atomism is that it offers a comprehensive model of the universe. In this context, Islamic theologians claim that not only atoms, but also their interactions (*ekvan*), attributes (*aʿraz*), space, time and motion, that is, the universe as a whole, consists of finite units. Regarding this subject see Mehmet Bulgen, "Klasik Donem Kelam Atomculugunun Gunumuz Kozmolojisi Açısından Degerlendirilmesi" (PhD diss., Marmara University, 2013), 157.

8 In fact, early Muʿtazili theologians, who introduced atomism into Islamic theology, were not strictly occasionlist and tried to develop different concepts such as the conjugation (*iqtiran*), generation (*tawlid*), dependence (*iʿtimad*), custom (*ʿada*) in order to explain causal relations between different natural phenomena. However, atomism does not provide an appropriate basis for such conceptualization, therefore the system had rapidly evolved into occasionalism. The main reason for this is that atomism depends on the discontinuity principle, and makes everything in the universe disconnected and disjointed, including matter, space,

atoms.[21] According to them, the atom, though it does not actually exist, can be used as a hypothesis for the explanation of macroscopic phenomena more successfully than other theories.[22]

However, the subsequent twenty years witnessed radical discoveries about the structure of matter. In their research, physicists such as Joseph J. Thomson (1856–1940), Ernest Rutherford (1871–1937), and James Chadwick (1891–1974) did not only prove experimentally the existence of the atom, but also demonstrated that it consists of a nucleus and revolving electrons and that this nucleus contains smaller units called protons and neutrons.[23] Ongoing studies showed that the atom, which is indivisible in chemical reactions, could be disintegrated physically in a nuclear reaction.

However, in the more advanced studies of the atomic structure of matter, philosophical atomism, which defended the discontinuity, made a significant gain. In 1901 the German physicist Max Planck (1858–1947) discovered that radiation absorbed and emitted a discrete form of energy packs which he called quanta.[24] Immediately after this Albert Einstein (1879–1955) used Planck's theory in other experimental phenomenon, in which certain metals are exposed to light electron emissions seen on them (the photoelectric effect).[25] It did not take too long to understand that the assumption of discontinuity would be needed in the explanation of other problems in atomic structure. The Danish physicist Niels Bohr (1885–1962) discovered that the angular momentum of an electron could be related to fixed units or discrete energy packets. Accordingly, he fixed the trajectory of an electron orbiting around the nucleus of an atom, with discrete integers called principal quantum numbers and in the sequence of natural numbers (1, 2, 3, and so on).[26] Further studies on the structure of the atom provided more quantum numbers that describe specific situations such as energy, position, spin and angular momentum found in an atom. Thus, the geometric status based on real numbers in relation to the substance of nature was replaced by the arithmetic status based on integers.[27]

As a result, today quantum mechanics is the final point that human knowledge has been able to reach in the adventure of long-term research into understanding the nature of matter and the fundamental forces that govern the universe. Many technological inventions that changed our lives in the twentieth century are based on this theory.

However, in spite of the micro-level discontinuity today, the continuity in space and time continues. The main reason for this is the theory of general relativity, which describes the rules of gravity, and ties together space and time in a nonlinear manner known as the space-time continuum.[28] But to consider matter and forces at the micro level as discontinuous, and space-time as continuous at the macro level, seems contradictory, as Aristotle would have said, for these terms (magnitudes, space, time and motion) are inextricably linked. Therefore, if one of them is continuous, the others should also be continuous.

In the past, Aristotle specified that space and time are continuous in structure, and in this context he claimed that bodies should be divided potentially forever.[29] Islamic theologians defended the position that bodies are composed of discrete units instead of continuous ones; in the same way, they held that space and time should also be the same in structure.[30] Thus, both Aristotle and Islamic theologians—although they disagree on whether bodies are continuous or discontinuous—shared the same view that the universe as a

time, and motion. Osman Bakar, "The Atomistic Conception of Nature in Ashᶜarite Theology", in *The History and Philosophy of Islamic Science* (Cambridge: Islamic Texts Society, 1999), 91; see also M.B. Altaie, "Daqiq al-Kalam: The Islamic Approach to Natural Philosophy", 6, a paper delivered at the Institute of Arab and Islamic Studies, University of Exeter, UK, 26 January 2005.

[9] Josef van Ess, "Muᶜtazilite Atomism", in *The Flowering of Muslim Theology*, trans. Jane Marie Todd (Cambridge, MA: Harvard University Press, 2006), 79–115. For example, Dante sends atomic philosophers such as Democritus and Epicurus to the bottom of the layers of hell; see Joseph Anthony Mazzeo, "Dante and Epicurus", in *Comparative Literature* 10 (Spring 1958), 106–20.

[10] Majid Fakhry, *Islamic Occasionalism* (London: Allen & Unwin, 1958), 23; Duncan B. Macdonald, "Continuous Re-Creation and Atomic Time in Muslim Scholastic Theology", *The Muslim World* 18, no. 1 (1928): 6–28.

[11] There are a lot of classical and modern works on kalam atomism, but the most important classical works are: Ebu Reşid en-Nisaburi (d. 415/1024), *el-Mesail fi'l-hilaf beyne'l-Basriyyin ve'l-Bagdadiyyin*; Ibn Metteveyh (d. 469/1075[?]) *et-Tezkire fî ahkami'l-cevahir ve'l-a'raz*; Musa bin Meymun (Maimonides) (d. 601/1204) *Delaletü'l-Hairin*; Ebu'l-Mu'in en-Nesefi (d. 508/1115). Modern studies on kalam atomism include: Shlomo Pines, *Beitrage zur islamischen Atomenlehre* (Berlin: Graefenhainichen, 1936); Harry Austryn Wolfson, *The Philosophy of the Kalam* (Cambridge, MA: Harvard University Press, 1976); Alnoor Dhanani, *The Physical Theory of Kalam* (Leiden: E.J. Brill, 1994); Husam al-Alousi, *The Problem of Creation in Islamic Thought* (Baghdad: National Printing and Publishing, 1965); Muna Ahmed Muhammed Ebu Zeyd, *et-Tasavvuru'z-zerri fi'l-fikri'l-felsefiyyi'l-İslami* (Beirut, 1994); Richard Sorabji, *Time, Creation and the Continuum* (Chicago: University of Chicago Press, 2006); M. B. Altaie, *Daqiq al-kalam* (Jordan, 2010); Otto Pretzl, "Die fruhislamische Atomenlehre", *Der Islam* 19 (1931): 117–30; Richard M. Frank, "Bodies and Atoms: The Ashcarite Analysis", in *Islamic Theology and Philosophy*, ed. Michael E. Marmura (Albany: State University of New York Press, 1984); A. I. Sabra, "Kalam Atomism as an Alternative Philosophy to Hellenizing Falsafa", in *Arabic Theology, Arabic Philosophy*, ed. James E. Montgomery (Leuven: Peeters, 2006), 199–271;

whole, including bodies, space, time, and motion, should be isomorphic in structure, as the twelfth-century philosopher Maimonides (d. 601/1204) articulated:

> This is their [*mutakallimun*/Islamic theologians'] statement that time consists of moments (*anat*). They mean that there are many units of time that are indivisible because of the shortness of their duration. This premise is also necessary for them because of the first premise [namely, the premise that atoms are the smallest constituents of matter]. That is to say, they must have seen Aristotle's demonstrations in which he had demonstrated that distance, time, and motion are all three equivalent with respect to existence, meaning that the relationship of each of them to the other is in the same proportion. Hence, they knew necessarily that if time were continuous and capable of infinite division, then it follows that the part that they considered indivisible must likewise be capable of infinite division. Similarly, if distance were presumed to be continuous, then the division of moments of time, which they had presumed to be indivisible, also follows, as Aristotle had explained in his *Physics*. For this reason they presumed that distances were not continuous but were composed from parts that had reached the utmost limit of division. Likewise, time reaches a limit, namely the moments, beyond which further division is impossible. An example of this is that one hour consists of sixty minutes, and a minute consists of sixty seconds, and a second consists of sixty thirds. This, in their view, reaches a limit parts which are either tenths for instance, or even smaller then them, which are in no sense divisible, and which do not, like distance, admit of further division.[31]

So, according to the data of the current scientific cosmology, who is right? Aristotle, who said, "Space and time can be divided infinitely," or the Islamic theologians who defended the argument that space, time, and matter—in other words the universe as a whole—is finite?

Unfortunately, modern cosmology cannot yet give a definite answer to this question. However, in the last century Einstein was able to connect space and time to each other (the space-time continuum). However, as we have seen in quantum mechanics, micro-level matter (fermions) and discontinuous forces (bosons) were not included in this composition. The continuity-discontinuity conflict that exists between general relativity and quantum mechanics is the most important dilemma faced by modern scientific cosmology today.[32] For this reason, there is as yet no comprehensive model for the universe. For example, the continuity of general relativity theory, which foresees that space-time can be divided indefinitely, has led to the possibility of multiple situations being created endlessly in the universe. These circumstances can be called singularity, and, ultimately cannot be explained.[33]

Physicists in the early days of quantum theory hoped that the gravitational field could be quantized, just like the quantized electromagnetic field. For example, Einstein argued that gravity and electromagnetism known to exist in his own time were the only major basic

Tzvi Langermann, "Islamic Atomism and the Galenic Tradition", *History of Science* 47 (2009), 277–95.

[12] See Alnoor Dhanani, "Atomism in Islamic Thought", in *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. Helaine Selin (The Netherlands: Kluwer Academic Publishers, 1997), 139–43.

[13] Taufik Ibrahim K., "Ancient Heritage in Kalam Philosophy", in *Values in Islamic Culture and the Experience of History*, ed. N. S. Kirabaev (Washington, DC: Council for Research in Values and Philosophy, 2002), 99–134.

[14] Robert H. Kargon, "Atomism in the Seventeeth Centurty", in *Dictionary of the History of Ideas*, ed. Philip P. Wiener (New York: Charles Scribner's Sons, 1973), 1:132–41; John Henry, "Matter", in *Encyclopedia of the Scientific Revolution*, ed. Wilbur Applebaum (New York: Garland, 2000), 621.

[15] Lynn Sumida Joy, *Gassendi the Atomist: Advocate of History in an Age of Science* (New York: Cambridge University Press, 1987), 180; Lauge Olaf Nielsen, "A Seventeenth-Century Physician on God and Atoms", in *Memory of Jan Pinborg*, ed. Norman Kretzmann (The Netherlands: Kluwer, 1988), 297–369. For Epicurean atomism as the source of the birth of modern atomism in Gassendi's footsteps, see John Masson, *The Atomic Theory of Lucretius Contrasted With Modern Doctrines* (London: G. Bell, 1884), 5.

[16] James A. Altena, "Revival of Corpuscular Theories During the Seventeenth Century", in *Science and Its Times*, ed. Neil Schlager (Detroit: Gale Group, 2000), 3:354; Bernard Pullman, *The Atom in the History of Human Thought* (New York: Oxford University Press, 124); John W. Clarke, "Atomism", in The Continuum *Encyclopedia of British Philosophy*, ed. Anthony Grayling et al. (Bristol: Theommes Continuum, 2006), 154. In his book *Opticks*, Newton's definition of material particles was as follows: "It seems probable to me that God, in the beginning, formed matter in solid, massy, hard, impenetrable, movable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them; and that those primitive particles, being solids, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break in pieces; no mundane power being able

principles, since strong and weak forces were not yet discovered.[34] By the 1970s physicists were able to collect three of the four forces (strong, weak, electromagnetic) under the umbrella of standard model, and they showed that two of these (the weak and electromagnetic) are actually coming from the same source (electroweak force).[35] However, regarding the merging of general relativity with the standard model of quantum theory under the name of quantum gravity, then they are faced with significant challenges. Hence, despite a century of work, the issue has yet to be resolved.[36]

The main reason for the failure of the unification is the formulation of general relativity theory with differential equations based on continuity and determinism.[37] In this context, general relativity assumes that space-time is divisible continuously; on the other hand, quantum theory did not allow infinite division, and claims that before approaching Planck scale space-time should turn out a discontinuous (discrete) structure.[38]

Many physicists maintain that the main problem with this issue is general relativity's ignorance of the effects of quantum. Accordingly, while relativity theory's space-time can be curved under the influence of massive objects, when it comes to the subatomic objects it acts almost indifferently like Newton's absolute space and time.[39] However, while forces and substances were quantized in subatomic scale, the continuity of gravitation (space-time) is a contradiction and, to solve the conflict between general relativity and quantum physics, cosmologists need a quantum theory of gravity.[40]

Scientists for a long time assumed that merging would reveal, as in other forces, that gravity by its nature is atomic and that it is carried by graviton called messenger particles.[41] However, while other forces are considered to be acting in the space and time arena, gravity itself is space-time. Quantizing gravity means, therefore, quantizing space-time, due to the fact that they have the same value.[42]

The most important theory developed regarding this unification is string theory (M-theory at present), and the lesser-known approach is called loop quantum gravitation.[43] They both very strongly suggest that space-time must be in discreet and discontinuous architecture, namely, it is likely to be composed of individual units that cannot be subdivided.[44]

If we delve more into the issue of discrete space-time, quantum theory, which postulates that continuity, which is based on fields and waves, cannot be true, tries to relate each field and wave by particles (gluon, photon, boson).[45] Therefore, quantum theory attempts to explain gravitational field by reducing the particles in the Planck scale (for space 10^{-35} meters, and for the time to 10^{-43} seconds),[46] and accordingly asserts that there are gravitons so-called spin-2 particles connected with space-time.[47] However, the problem is that until now they cannot be observed.[48]

It is no surprise that the subatomic structure of time-space has been overlooked in the macrocosm. Even protons, neutrons and other particles forming tiny quarks (10^{-18} m), are too large to feel these particles, which consist in the Planck scale (10-35 m). If we make a comparison of the size of the proton (10^{-15} m) colliding at CERN, the size of the graviton (10^{-35} m) versus a proton is like the size of proton against the size of the sun in value.[49]

to divide what God himself intended to be indivisible." Newton, *Opticks* (London: W. and J. Innys, 1718), 375.

17 David Philip Miller, *Discovering Water* (Burlington, VT: Ashgate, 2004), 27ff; Andrew Ede, *The Chemical Element: A Historical Perspective* (Westport, CT: Greenwood Press, 2006), 54–5; Pullman, *The Atom in the History of Human Thought*, 18.

18 John Read, "Chemistry", in *What Is Science?*, ed. James R. Newman (New York: Simon and Schuster, 1955), 164–6.

19 John Dalton described the indestructible character of atoms as follows: "Chemical analysis and synthesis go no farther than to the separation of particles one from another, and to their reunion. No new creation or destruction of matter is within the reach of chemical agency. We might as well attempt to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen. All the changes we can produce consist in separating particles that are in a state of cohesion or combination, and joining those that were previously at a distance." *A New System of Chemical Philosophy* (Manchester: Bickerstaff, 1808), 143, 212.

20 Alan Chalmers, "Atomism from the 17th to the 20th Century", in *The Stanford Encyclopedia of Philosophy Winter 2010 Edition*, ed. Edward N. Zalta, <http://plato.stanford.edu/archives/win2010/entries/atomism-modern>.

21 Kent A. Peacock, *The Quantum Revolution* (Westport, CT: Greenwood Press, 2008), 7.

22 Helge Kragh, "Particle Science", in *Companion to the History of Modern Science*, ed. G. N. Cantor (London: Routledge, 1990), 665; W. Demtroder, *Atoms, Molecules, and Photons* (Berlin: Springer, 2006), 7.

23 Dennis Chamberland, "Atomic Nucleus", "Quantum Chromodynamics", in *Science and Scientists*, ed. Salem Press (Pasadena, CA: 2006), I, 42, 819.

24 Planck introduced the concept of the quantum to understand the emission of radiation from heated objects, known as black-body radiation, which refers to an ideal body or surface that absorbs all radiant energy without any reflection. His hypothesis was that energy is radiated only in quanta of energy hn, where n is the frequency and h is the quantum action, now known as Planck's constant. The new

To think that the structure of space and time consists of particles is actually contrary to macrophysics. When we look at the universe in our daily life, we are caught up in the illusion that space is continuous. To understand the discrete structure of space, the computer or the television screen are often quoted as an example. When we look from a distance, we see a perfectly continuous picture. However, when we look closer, we realize that they are only discrete points of pixels; there is no signal between two points. The same can be applied to unified theories' claim that space is discrete, particulate and quantized in 10^{-35} meters scale.[50]

If theories such as loop quantum gravity are true then, not only the shortest length (Planck scale), but also the shortest time is possible.[51] In cinema, the film appears streaming continuously and uninterruptedly, but the fact is that it is being shown at 24 frames per second, just like our universe is also moving frame by frame in a discontinuous manner. However, these frames are repeated on a massive scale such as 10^{-43} times per second (Planck time).[52]

How can space attain the atomizing structure in quantum physics? This can be demonstrated by another example. If we select an A point in a 0 position, and if we relate his position with 0 and if we detect an exact opposite B point one meter away, and we continue to divide these units in each time 10 times smaller, we will never find the infinite small structure, because if we repeat this process thirty-five times, we reach 10^{-35} meters, and this what is known as Planck distance. However, when we go to this point exactly, we encounter a strange situation—objects begin to move not in a continuous manner, but actually in discrete jumps at 1.6×10^{-35} m intervals.[53]

However, this is not the same as the jump leap we encounter in daily life, due to the fact that it is impossible for an object to be in the position between the two Planck distances, or pass through, because, there is no space between two neighboring points separated by the Planck distance. If there were space, there would be no point in saying that space is discontinuous, i.e., discrete; otherwise space would be permanently adjacent. Therefore, that area is the field of absence/nonexistence. In this case, the particle moves by leaping to the next Planck distance and ceases to exist, and then exists again.[54]

In quantum physics, the explanation of motion in Planck level is consistent with the opinions of the classical *mutakallimun* who adopted atomism. For example, al-Ghazali (d. 555/1111) explains the movement in the following way:

> The doctrine may be explained by considering the case of motion. The states that follow each other through continuous periods of time are described as movements only because they alternate by continuously originating anew and continuously ceasing to exist. . . . The essence of motion is inconceivable without also conceiving nonexistence to follow existence.[55]

Al-Ghazali's views on motion are quite similar to quantum physics' approach to movement.[56] Quantum physics' understanding of movement makes it easier to understand why Islamic theologians called movement as a coming into existence from nothing (*al-kawn*).

Planck's Law matched the observations very well at both high and low frequencies, so he won the 1919 Nobel Prize for Physics for his discovery of energy quanta. For detailed information see <http://nobelprize.org/nobel_prizes/physics/laureates/1918>.

25 Albert Einstein used Planck's concept of the quantum to explain the photoelectric effect that is an experimentally observed phenomenon in which electrons are emitted from metal surfaces when radiation falls on these surfaces. Einstein assumed that a single quantum of radiant energy ejects a single electron from the metal. The energy of the quantum is proportional to the frequency, and so the energy of the electron depends on the frequency. It was for this discovery, not relativity, that Einstein was awarded the 1921 Nobel Prize for Physics. About this see Scott A. Davis, "Quantum Mechanic", in *Science and Scientists*, 824.

26 Asher Peres, *Quantum Theory: Concepts And Methods* (Dordrecht: Kluwer Academic Publishers, 1993), 18, 20.

27 M. B. Altaie, "The Scientific Value of Dakik al-Kalam", *Journal of Islamic Thought and Creativity* 4 (1994), 11–12.

28 Brian Greene, *The Elegant Universe* (New York: W. W. Norton, 2003) 231; in fact, Einstein's general theory of relativity belongs to the nineteenth century rather than the twentieth, because the key concept of twentieth-century physics is discontinuity and probability; and the relativity theory, which is strongly attached to continuity and determinism, is a field theory. Carlo Rovelli, *Quantum Gravity* (Cambridge: Cambridge University Press, 2004), 3; Heinz R. Pagels, *The Cosmic Code* (New York: Simon and Schuster, 1982), 20.

29 Aristotle in part VI of *Physics* argues that magnitude, time and motion are concepts so intimately related that if one of these is assumed to be discontinuous, the others must be discontinuous (*Physics*, 231a18–19, 231a18–22). Aristotle finds atomism contrary to space-related axioms the then current of geometry, and claims that to accept this view would mean to deny the mathematics (*De Caelo*, I.5 271 b10–13; III.4 303 a20–3).

30 Dhanani, *Physical Theory of Kalam*, 132.

31 Moses Maimonides, *Dalalat al-ha'irin*, ed. Huseyin Atay (Ankara: Üniversitesi Besımevi, 1972) 201–2; Maimonides, *The Guide of the Perplexed*, trans. Shlomo Pines

According to the *mutakallimun*, as substances move they move through spaces similar to their scale.[57] But the space is also discontinuous as substance, i.e. becomes discrete for entering into absence, transition from one space to another becomes possible by extinction in the previous space first, then with existence in the next space. The difference is that, although the theologians say that these smallest units have an amount, they do not put a precise criterion such as the Planck length. However, in kalam atomism, a discrete scale of space, time and substance is determined in relation to each other. This is similar to interrelated determination of Planck constant, Planck energy, Planck distance and Planck time.[58]

So, if space-time is quantized, in other words, if it is found that its structure is discontinuous, discrete and intermittent, what happens?

If we adopt the idea that space-time consists of tiny building blocks such as discrete-time and discrete space, then our understanding of the universe also needs to be changed dramatically, such that it will potentially lead to a resurgence in the contemporary relevance of important philosophical and theological reflections that Islamic theologians defended in the past, such as continuous recreation and occasionalist theological approaches.

In other words, the formation of space from small particles will mean that there are gaps between the parts where space exist; or rather, there are absences or voids (lack of spaces) in between them. In the same way, if time has a granular structure, that is, if it consists of very small time intervals acting as building blocks (in the manner of Planck time 10^{-45} sec), then it could be interpreted as the experience of successive instants of a time-timeless process (which is the discontinuity of time). If time consists of small segments, then there must be periods of timeless gaps in the transition from one time-moment to another. Otherwise, if time slices (moments) are whole and do not have gaps between them, such moments are not truly intermittent or discontinuous. Since space, time and matter are not independent of each other, between each period of time i.e., in the time of timelessness, the universe must cease to exist and in the next time-moment begin to exist again, like the light of a lamp flashing.

It seems to me that this scenario inevitably brings about the need to address the following questions:

1. At the time of extinction, how will all the information from the previous accumulated moments of the universe be transported to the next moment?
2. If there is an existence and nonexistence process in the universe due to the discreteness of time, then when the universe ceases to exist, what is it that brings it into existence again?

Both questions cannot be answered by either something in the universe or with the universe as a whole, because the universe as a whole and everything in it will have already vanished with the vanishing of the time-moment.

A nonexistent thing cannot create itself from nothing which means that, at the time of nonexistence, there must be an entity that will transfer all the knowledge of the universe to the next moment in a systematic way, thus re-creating it as a new whole. And that entity, which is outside of the universe, I conclude is God.

(Chicago: University of Chicago Press, 1999), 1:196.

32 Samuel Sambursky, *Physical Thought from the Presocratics to the Quantum Physicists* (New York: Pica Press, 1974) 28–9.

33 Greene, *Elegant Universe*, 129; John Gribbin, *In Search of the the Multiverse* (London: Allen Lane, 2009), 115.

34 J. Bernard Cohen, *Revolution in Science* (Cambridge, MA: Harvard University Press, 1985), 438; Greene, *Elegant Universe*, 15.

35 Gribbin, *In Search of the Multiverse*, 117, 118; Greene, *Elegant Universe*, 123.

36 Ian Marshall, Danah Zohar, and F. David Peat, *Who's Afraid of Schrodinger's Cat?* (New York: Morrow, 1997), 290–2.

37 Lee Smolin, "Atoms of Space and Time", *Scientific American* 290, no. 1 (January 2004), 66.

38 Rovelli, *Quantum Gravity*, 3–4; for quantum physics' claim that space-time is also in a particulate structure and cannot be divided see Gribbin, *In Search of the Multiverse,* 118.

39 Jeremy Butterfield, "On Time in Quantum Physics", in *A Companion to the Philosophy of Time,* ed. Heather Dyke and Adrian Bardon (Malden, MA: Wiley-Blackwell, 2013), 226; Tim Maudlin, *Philosophy of Physics* (Princeton: Princeton University Press, 2012), 160.

40 Igor S. Makarov, *A Theory of Ether, Particles and Atoms* (Manchester: Open University Press, 2008), 2; Simon Raggett, *Consciousness, Biology and Fundamental Physics* (Bloomington, IN: Authorhouse, 2012), 27; another reason for contradiction is that the uncertainty principle, prevailing in the micro world, prevents us from knowing precisely the position and motion of any particle. This means that the universe is entirely indeterminate; whereas general relativity, as in Newtonian physics, is a classical theory connected to determinism. John D. Barrow and Joseph Silk, *The Left Hand of Creation* (New York: Basic Books, 1983), 60; for the continuity-discontinuity difference on movement in Newtonian physics and quantum mechanics, see Fred Alan Wolf, *Taking the Quantum Leap* (San Francisco: Harper & Row, 1981), 3, 13.

41 Lee Smolin, *Three Roads to Quantum Gravity* (New York: Basic Books, 2001), 148; Robert P. Crease and Charles C. Mann, *The Second Creation* (New York: Macmillan, 1986), 413.

To sum up, after introducing the general character of atomism, including today's quantum physics, it will not be difficult to understand why Islamic theologians have adopted an occasionalist God-universe relationship that entails continuous re-creation and a denial of causality. Since atomism makes everything in the universe discontinuous and fragmented, including space-time, substance and movement, the *mutakallimun* had to resort to an immediate and exclusive cause (i.e., God) to explain the existence of the universe. Accordingly, the universe had a first moment of creation, then continuous re-creations at every subsequent moment in time. In this way, the universe's existence is like the blinking of a light—it exists successively for the duration of only a moment.

In this article, therefore, my main idea is quite different from William Lane Craig's Kalam Cosmological Argument, which aims to establish the temporal beginning of the universe in the finite past. However, I argue that the universe was not only created at some time in the past, but is also being continuously re-created at every subsequent moment of time, according to contemporary unified theories such as string theory and quantum loop gravity.

If we consider the classical *mutakallimun*'s atomistic theories, which form the basis of their *huduth* argument, then we can admit that the universe, after having ceased to exist at one moment, will require the presence of some causal power to re-create it. This is because a completely destroyed thing (i.e., the universe), cannot bring itself into existence again from nothing. Therefore, the continued existence of the universe can only be possible if some entity outside it, an entity outside all material spatio-temporal reality (i.e., the totality of the universe), creates it again. And this entity we call God.

[42] Jean-Paul van Bendegem, "The Possibility of Discrete Time", in *Oxford Handbook of Philosophy of Time*, ed. Craig Callender (Oxford: Oxford University Press, 2011), 145.

[43] Instead of a continuous space time, which can be divided indefinitely as in general relativity, string theory and loop quantum gravity, tells us that space-time has a discrete structure, that it's made of individual units which cannot be subdivided. See Salvator Cannavo, *Quantum Theory* (Albany, NY: SUNY Press, 2009), 116.

[44] See Micheal Lockwood, *The Labyrinth of Time* (Oxford: Oxford University Press, 2007), 333; George Johnson, "How Is the Universe Built? Grain by Grain" (*New York Times*, December 7, 1999); Samuel Mongeau, "Atoms of Time", *Ampersand Journal* VI (2014), 6–9.

[45] For example, in quantum theory there are photon particles for electromagnetic waves, gluons for strong force, W and Z bosons for weak force.

[46] E. J. Zimmerman, "Time and Quantum Theory", in *The Voices of Time*, ed. J. T. Fraser (New York: Braziller, 1966), 495; George Gamow, *Gravity* (New York: Dover Publications, 2002), 142, 143; Gribbin, *In Search of the Multiverse*, 118.

[47] Chris Isham, "Quantum Gravity", in *The New Physics*, ed. Paul Davies (Cambridge: Cambridge University Press, 2000), 82, 83; Brian Greene, *The Hidden Reality* (New York: Alfred A. Knopf, 2011), 87; Marshall, Zohar, and Peat, *Who's Afraid of Schrodinger's Cat?*, 290–2; Johnson, "How Is the Universe Built?".

[48] Smolin, *Three Roads to Quantum Gravity*, 150; Leon M. Lederman and David N. Schramm, *From Quarks to the Cosmos* (New York: Scientific American Library, 1989), 185.

[49] Planck length (10–35 m) is one hundred billion times smaller from a point (10–19 m) and can be observed experimentally by the LHC at CERN today. If an atom magnified up to the universe, the Planck distance could be up to a tree in the universe. Greene, *Hidden Reality*, 90.

[50] Heinz R. Pagels, *The Cosmic Code* (New York: Simon and Schuster, 1989), 26.

[51] Lee Smolin, "Atoms of Space and Time", *Scientific American* (January 2004), 68.

[52] Dave Goldberg and Jeff Blomquist, *A User's Guide to the Universe* (Hoboken, NJ: Wiley, 2010), 227.

[53] Jim Elvidge, *The Universe Solved!* (Alternative Theories Press, 2007), 32.

[54] Remember the television and computer screen examples.

[55] Abu Hamid al-Ghazali, *Moderation in Belief*, trans. Aladdin M. Yaqub (Chicago: University Of Chicago Press, 2013), 44; see also Abdu-r-Rahman Abu Zayd, *al-Ghazali on Divine Predicates and Their Properties* (Lahore: Sh. Muhammad Ashraf, 1990), 21.

[56] For al-Ghazali's occasionalism, see also Omar Edward Moad, "Al-Ghazali's Occasionalism and the Natures of Creatures", *International Journal for Philosophy of Religion* 58 (2005): 95–101; for al-Ghazali versus quantum physics see, K. Harding, "Causality Then and Now", *American Journal of Islamic Social Sciences* 10, no. 2 (Summer 1993): 165–77; Umit Yoksuloglu Devji, "Al-Ghazali and Quantum Physics" (PhD diss., McGill University, 2003); Mehdi Golshani, "Quantum Theory, Causality, and Islamic Thought", in *The Routledge Companion to Religion and Science*, ed. James W. Haag, Gregory R. Peterson, and Michael L. Spezio (New York: Routledge, 2012), 188; here Golshani points out the similarity between the Ashʿari occasionalist view and quantum mechanics that both deny any necessary connection between cause and effect.

[57] Alnoor Dhanani, "Problems in Eleventh-Century Kalam Physics", *Bulletin of the Royal Institute for Inter-Faith Studies* 4 (January 2002), 78.

[58] For the interrelated evaluation of space, time, and motion in quantum physics, see B. K. Ridley, *Time, Space and Things* (New York: Penguin, 1976), 55, 64ff.