ATOMIC STRUCTURE AND ITS CONNECTION TO THE QURANIC VERSES' CONTEXT

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Abstract: The growth of science in the twenty-first century, particularly in chemistry, is critically dependent on the integration of science and the Qur'an. Since numerous verses in the Qur'an disclose the fundamental principles of chemistry, such as the size of an atom, the integration of science and the Qur'an is nothing new in modern science, especially chemistry. As a result, this article will go into further detail regarding the atomic structure's physical setting and how it relates to Qur'anic verses. Writing this paper involved conducting literature searches on both contemporary science and Qur'anic interpretations of atomic structure. The word "dzarrah" appears in QS Az-Zalzalah verses 7-8, An-Nisa verse 40, and Yunus verse 61, and is interpreted as the size of a mustard seed that the human intellect may yet attain. However, "dzarrah" is often frequently interpreted as atomic size, since the atomic radius of the smallest atom (Hydrogen) and biggest atom (Organesson) atoms are 1.2×10^{-10} m and 1.52×10^{-10} m, respectively, with 1 million being smaller than the radius of mustard seed (5×10^{-4} m). Thus, the word *dzarrah*, which is translated as the size of a mustard seed, is less proportional to describe a much smaller atomic size. This atomic scale later served as a precursor for new developments in chemical research, such as nanomaterials and quantum dots.
Keywords: atomic structure; *dzarrah*; atomic radius.

Abstrak: Integrasi sains dan Al-Qur'an menjadi dasar yang penting untuk pengembangan ilmu sains pada abad ke-21, khususnya dalam ilmu kimia. Integrasi sains dengan Al-Qur'an sebetulnya bukanlah hal baru dalam sains modern, khususnya kimia, karena ada banyak ayat-ayat Al-Qur'an yang mengungkapkan tentang konsep dasar kimia, misalnya ukuran atom. Oleh karena itu, artikel ini akan membahas secara lebih jelas tentang konteks materi struktur atom dan kaitannya dengan ayat-ayat Al-Qur'an. Metode penulisan artikel ini menggunakan kajian literatur, baik itu dari segi sains modern dan tafsir Al-Qur'an tentang struktur atom. Kata "*dzarrah*" muncul dalam QS Az-Zalzalah ayat 7-8, QS An-Nisa ayat 40, dan QS Yunus ayat 61, yang ditafsirkan seukuran biji sawi yang ukurannya masih dapat dijangkau oleh pikiran manusia. Namun, "dzarrah" juga kerap diterjemahkan seukuran atom, padahal jari-jari 1 atom paling kecil (Hidrogen) dan paling besar (Organesson) berturut-turut adalah $1{,}2 \times 10^{-10}$ m dan $1{,}52 \times 10^{-10}$ m, dimana 1 juta lebih kecil dari jari-jari biji sawi (5×10^{-4} m). Sehingga kata

dzarrah yang diterjemahkan sebagai ukuran biji sawi kurang proporsional untuk menggambarkan ukuran atom yang jauh lebih kecil. Ukuran atom ini kemudian menjadi cikal bakal perkembangan penelitian di bidang kimia, misalnya nanomaterial dan quantum dots.
Kata kunci: struktur atom; *dzarrah*; jari-jari atom.

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Introduction

The Qur'an serves as a manual for everyday living, including matters of science and technology. Verse indications for numerous things that will help humanity can be found in the Qur'an (As'ad et al., 2021; Mohammed et al., 2021; Putra & Hidayaturrahman, 2020). The advancement or revision of current theories (Darmalaksana, 2021; Kean Hua, 2016; Mujala et al., 2022; Mukri et al., 2019) as well as fresh findings (Alawiyah et al., 2021; Apriani et al., n.d.; Nurhaeni et al., 2021). For instance, we have learned that rainwater originates from seawater that evaporates, condenses into clouds, and then falls to the ground as rain. But it seems that God has clarified this in the Qur'an, which was written more than 1400 years ago:

أَلَمْ تَرَ أَنَّ ٱللَّهَ يُزْجِى سَحَابًا ثُمَّ يُؤَلِّفُ بَيْنَهُۥ ثُمَّ يَجْعَلُهُۥ رُكَامًا فَتَرَى ٱلْوَدْقَ يَخْرُجُ مِنْ خِلَٰلِهِۦ وَيُنَزِّلُ مِنَ ٱلسَّمَآءِ مِن جِبَالٍ فِيهَا مِنۢ بَرَدٍ فَيُصِيبُ بِهِۦ مَن يَشَآءُ وَيَصْرِفُهُۥ عَن مَّن يَشَآءُ يَكَادُ سَنَا بَرْقِهِۦ يَذْهَبُ بِٱلْأَبْصَٰرِ

Meaning: Do you not see how God marches the clouds, then gathers them between (parts), then makes them overlap, and then you see the rain coming out of its cracks? Allah also sent down (particles of) ice from the sky, that is, from clouds that resemble mountains, and then He put (particles of) ice on whomever He wanted- His and He turns away from whomever He wills. The vision was almost completely obscured by the cloud's lightning flare. (QS. An-Nur, 24:43).

According to the verse above, a person would better grasp that God is all about him, that God orchestrates all of the events in heaven and earth, and that God is in charge of everything when he learns more about the instances of science and creation around him. People who believe in Allah SWT recognize that their lives will undoubtedly be taken and that they will receive rewards for whatever they do in this world. Believers will have greater respect for Allah SWT's wisdom as they become more familiar with the numerous phenomena that surround them. This appreciation is a crucial step in realizing the limitless might and power that only

belongs to Allah SWT, which increases one's fear of Allah SWT's retribution in the hereafter.

Depending on how many protons, electrons, and neutrons each element contains, it has a varied atomic makeup. Atoms can form bonds with other atoms thanks to electrons. For instance, one oxygen atom and two hydrogen atoms combine to produce a water molecule. The bond formation is also controlled by the atom's size (diameter) and the distance between the atomic nuclei. When the diameter of the atom increases, the distance between the atomic nucleus and the outside electron increases, requiring a closer distance between the nucleus to establish chemical bonds (Kraka et al., 2016). The magnitude of the distance between the nuclei of the chemically linked atom impacts the length of the bond, with the bond being stronger and more stable at the lowest energy when the gap between the bound atomic nuclei is at its smallest. If the distance is too great, only the internuclear style occurs, and the intermolecular style is weaker than the chemical bond (Kaupp et al., 2017). For example, a molecule of water that has two bonds between oxygen atoms as a center atom with a hydrogen atom, where the length of bond between the atoms O and H is 96 pm. 2007 (Hocking). If the distance between the atomic nuclei H and O (binding length) is larger than 96 pm, the faces of the molecule will alter; for example, in solid phases such as ice crystals, the bond length is 98.8 pm. The length of the bond between H and O becomes shorter in the gas phase, which is 95 pm (Chowdhary & Ladanyi, 2009).

The size of an atom to something that we can physically see is just a few instances of the many other things that can be used as inspiration for contemplating Allah's creation in addition to the ones mentioned above. Because of the size of the atom, chemical material research has advanced to the nanoparticle level. After undergoing a chemical or physical procedure, a material can be reduced to the nano size. This process can also cause changes in the material's physical and chemical properties. This is evidence that every aspect of Allah's creation, down to the atomic level, has contributed significantly to the advancement of chemistry in the present-day scientific era. The author is then prompted by some of these answers to look up further Qur'anic verses that explore the place of science in Islam, particularly in the area of chemistry and the concept of atomic structure.

Relevance of Atomic Structure Theory to the Qur'an and Spirituality

Al-Qur'anic teachings of Allah SWT on the fundamentals of atomic structure

فَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُ وَمَن يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُ

Meaning: Therefore, whoever performs a nice deed equal to the weight of one atom will undoubtedly witness (the reward). And whoever commits a crime

as serious as an atom will undoubtedly face consequences (retribution). (QS. Az-Zalzalah, 99: 7-8).

The discussion about the concept of atoms in the Qur'an has been previously explained by Harun Yahya (2004) in his book entitled The Perfection of Atomic Creation. The above-mentioned words of Allah SWT are expounded by many commentators in their own Tafsirs, who state that both those who do good and those who commit bad will experience vengeance (Yahya, 2005). This is also applicable to the atomic size, which began to be envisaged by the human mind after the introduction of tools capable of measuring particle sizes down to the micrometer or even nanometer level. The scanning electron microscope (SEM) is commonly used to evaluate the size of pores in a material, such as the average diameter of the membrane pores PVDF-CA to determine the effect of cellulose acetate (CA) addition on the pores size of the PVDF membrane matrix (Reza et al., 2022). Furthermore, in nanomaterials technology, TEM (Transmission Electron Microscope) is used to investigate the structure of the nanomaterial, and microstructure, and to characterize the order of atoms in the material to the level of quantum dots (Bernal et al., 2015; Su, 2017).

Modern scientists concur that protons, which are positive charges, electrons, which are negative charges, and neutrons, which are neutral charges, make up the atomic structure. But it wasn't until John Dalton (1766–1844) revealed the findings of his investigation into the atom's structure as the tiniest particle of something that cannot be divided again that mankind as a whole came to understand its structure. More than ten centuries have passed since the Qur'an was revealed, in comparison. This is a resounding demonstration for each of us that the Al-Qur'an is a source of truth that emanates from the Almighty, or Allah SWT. It also serves as evidence for one of the miracles of our Prophet Muhammad SAW, which Allah SWT promised would endure forever until the Day of Judgment.

Some studies have suggested that the word *dzarrah*, which appears multiple times in the Qur'an, can be interpreted as the seed of mustard to analogously explain the size of the atom so that the human mind can imagine it (Azizah & Kisworo, 2020; Badlisyah & Munawwarah, 2017; Sabarni, 2019). Yet, the size of a mustard seed cannot correctly depict atomic size because the atom is much smaller than the mustard seed. This proves to people that the atomic size is much smaller, as is the jarrah, which is also much wiser than the size of the mustard seed. Even if we examine it closer, the size of the atomic particles that make up the atom, such as electrons, neutrons, and protons, is smaller than the atom itself. Technological developments have enabled the separation of some of the smallest particles, which are not only the constituent particles of the atom, but also the lightest neutrinos with their mass (less than 2.14×10^{-37} kg) (Pascoli et al., 2006), and the smaller quarks with a volume of only 10^{-18} m (Baron et al., 2010). These discoveries subsequently led to a revival of the *dzarrah* expression, which is commonly connected with atomic size.

That is, the interpretation can be updated to reflect technical advances, particularly in the field of materials and component particles.

Despite the fact that fresh scientific proof was discovered centuries after the Qur'an's revelation, as mentioned by Allah SWT in Surat Az-Zalzalah, 99: 7-8 above. However, according to Islamic teachings, all Muslims must believe in the Qur'an because it is one of the tenets of their faith, even though its contents have not been corroborated by science. For the establishment of shari'a law in Islam, the Al Quran, Hadith, Consensus, and the Qiyas of the Ulama become the primary sources of reference (Iqbal, 2021; Sriatun et al., 2018).

Although the term "*dzarrah*" is frequently connected with QS Az-Zalzalah verses 7-18, it also appears in QS An-Nisa verses 40.

إِنَّ ٱللَّهَ لَا يَظْلِمُ مِثْقَالَ ذَرَّةٍ وَإِن تَكُ حَسَنَةً يُضَٰعِفْهَا وَيُؤْتِ مِن لَّدُنْهُ أَجْرًا عَظِيمًا

> Meaning: Truly, Allah does not penalize a person even as much as a *dzarrah*; and if there is a good thing as a Jarrah, Allah will augment its riches and recompense it from Him. (Q.S. An-Nisaa, 4: 40).

Allah affirms in the Qur'an that all good and wicked activities, no matter how minor, have their own effects and will be rewarded by Allah. If this "*dzarrah*" is just interpreted by the size of such a small mustard seed, then knowing the scale of *dzarrah* that is more appropriate for the dimension of the contributing particle of the atom is a very obvious reminder for people not to conduct any bad deeds of any kind. Those who do little good will be rewarded handsomely.

Living in this world, which has its ups and downs like a bridge to the afterlife, is a difficulty that must be overcome in order to experience the endless life that is the afterlife. There are only two activities performed by mankind in this world: good and evil. Therefore, whether the reward is seen in this life or the hereafter, a person who performs even the smallest amount of good (*dzarrah*) in this world will undoubtedly see it. Similarly, if someone commits a transgression that is as serious as an atom (*dzarrah*), he will undoubtedly witness (retribution). Islam's teachings consistently emphasize doing good deeds, no matter how tiny, and refraining from doing negative deeds, no matter how small.

The Concept of Atomic Structure From a Scientific Perspective

In our daily lives, we frequently see things like seats, tables, plastic, glasses, clothes, houses, automobiles, and so forth. But have you ever considered that everything listed above is composed of atoms? Atoms are tiny particles that, even with the most sophisticated microscopes available today, cannot be seen with the human eye. All matter in the cosmos depends on the atom, which has a crucial role to play. Because of the atoms that make up the paper and the pen, you can write on

paper with a pen. In essence, the tiniest component known as an atom is where all of our daily actions begin (Atteya, 2021; Yankumara, 2020).

Before Joseph John Thomson (1856 - 1940 BC) and Ernest Rutherford (1871 - 1937 BC) discovered electrons and protons, respectively, as the components of atoms, John Dalton (1766 - 1844 BC) postulated atoms as the smallest particles of an element. Although there are still smaller particles than atoms, we may often state that an atom is the smallest particle of an element. However, the size of the atom is now a matter of debate. To find out the answer to that question, consider the following example: If you have one gram of iron metal (Fe; Ar = 56), that equates to one mole of iron, so you can calculate the number of iron atoms by multiplying that mole by Avogadro's number (1/56 x 6.02 x 1023), which gives you 1.075 x 1022 = 10,750,000,000,000,000,000,000 iron atoms.

The just-mentioned explanation demonstrates how tiny an atom is, making it impossible to observe it directly before contemporary times. What components are there in such a tiny atomic structure, one could wonder if the atomic theory is further explored. It turns out that although being quite little, the solar system that we observe in the cosmos as a whole is comparable in sophistication to the perfect, singular, and intricate system that exists inside the atom. Besides that, the product synthesized based on particle size as one of the atomic characters is recently used for many applications, such as quantum dots materials.

Quantum dots are one area where chemical research is currently being done. Many different quantum dots materials have been successfully produced, however, carbon quantum dots and functionalized carbon quantum dots are the most common (Alavi et al., 2021). In addition to carbon quantum dots, graphene quantum dots are used extensively in medicine (Riviere, 2008), one of which was to enhance photodynamic therapy in the treatment of cancer (Fan et al., 2019). This material has various benefits due to its small size, including reduced toxicity, greater environmental friendliness, low cost, and ease of usage (Lim et al., 2015). Based on these benefits, carbon quantum dots have been widely used in a variety of fields, including biosensors (Demchenko & Dekaliuk, 2013; Posthuma-Trumpie et al., 2012), chemical sensors for metal Hg^{2+} (Gonçalves et al., 2010; Y. Liu et al., 2012; Yan et al., 2014), nanomedicine (Bechet et al., 2008; Hsu et al., 2013), and catalysis (R. Liu et al., 2013; Yang et al., 2011).

The Atomic Composers: Protons, Electrons, and Neutrons

The atom is made up of three types of particles that make up atoms of various charges, with protons and neutrons, both positively charged and non-chargeable, forming the nucleus of the atom. Outside the nucleus of the atom, negatively charged electrons spread with decreasing density from the nucleus to the outer skin (Kwon et al., 2010). Similar to how the planet revolves on its axis and also rotates around the sun, the electron is a particle that rotates and rotates around the atomic nucleus. On the tracks, we refer to as orbits, this revolution, like the rotation of the

planets, appears to be continuous and extremely regular. The atomic scale and comparing the sizes of the sun and the earth, however, are highly dissimilar. If we extend the atom to the size of the earth, the electron will only be the size of an apple, allowing us to compare its size to that of the earth.

With a startlingly fast speed of 1,000 km/s, the electrons that encircle the atom's nucleus never collide. It is incredible that these identical electrons may rotate in their individual orbits; this is unquestionably the outcome of "deliberate creation." According to what Allah SWT says in His Word, it's unusual regularity and intricate balance are a perfect creation.

هُوَ ٱللَّهُ ٱلْخَٰلِقُ ٱلْبَارِئُ ٱلْمُصَوِّرُ لَهُ ٱلْأَسْمَآءُ ٱلْحُسْنَىٰ يُسَبِّحُ لَهُۥ مَا فِى ٱلسَّمَٰوَٰتِ وَٱلْأَرْضِ وَهُوَ ٱلْعَزِيزُ ٱلْحَكِيمُ

Meaning: Allah is the Creator, the Maker, the Shaper, and the Owner of Asma'ul Husna. What is in heaven and on earth, praise Him. He is also powerful and wise. (QS. Al-Hasyr 59:24)

Chemistry studies the structure of atoms only up to the level of the three particles that comprise the atom. When compared to the size of the atom's composing particle, the atom itself is not the smallest, but it is larger than the component particle. Yet, these size discrepancies are likewise not adequate to depict the size of atoms that people can imagine. Here is Allah's message in Surah Yunus verse 61 about the mention of the word "*dzarrah*," which the mufasirs later interpreted as an atom.

وَمَا تَكُونُ فِى شَأْنٍ وَمَا تَتْلُواْ مِنْهُ مِن قُرْءَانٍ وَلَا تَعْمَلُونَ مِنْ عَمَلٍ إِلَّا كُنَّا عَلَيْكُمْ شُهُودًا إِذْ تُفِيضُونَ فِيهِ وَمَا يَعْزُبُ عَن رَّبِّكَ مِن مِّثْقَالِ ذَرَّةٍ فِى ٱلْأَرْضِ وَلَا فِى ٱلسَّمَآءِ وَلَآ أَصْغَرَ مِن ذَٰلِكَ وَلَآ أَكْبَرَ إِلَّا فِى كِتَٰبٍ مُّبِينٍ

Meaning: You are not in a circumstance and do not read a verse from the Qur'an, nor do you perform any job, but We are witnesses to your actions. It is not from your Lord's knowledge even as much as a dwarf in the earth or in the skies. Even in a clear book, there is nothing smaller or greater than this. Lauh Mahfuzh. (Q.S. Yunus, 10: 61).

When fitted to the evolution of chemistry, the translation of the word "*dzarrah*" as the atomic size is actually more appropriate. With the advancement of material technology that could quantify the size of materials down to the nanoscale level, scientists had to reconvene with chemists to change the translation of "*dzarrah*" as an atom to explain its extremely small size. The word "dzarrah" appears in QS Az-Zalzalah verses 7-8, An-Nisa verse 40, and Yunus verse 61, and is interpreted as the size of a mustard seed that the human intellect may yet attain.

However, "dzarrah" is often frequently interpreted as atomic size, since the atomic radius of the smallest atom (Hydrogen) and biggest atom (Organesson) atoms are 1.2 x 10^{-10} m and 1.52 x 10^{-10} m, respectively, with 1 million being smaller (as illustrated in Figure 1) than the radius of mustard seed (5 x 10^{-4} m). The word *dzarrah* was considered to be the size of a mustard seed at the time, which is actually much greater than the atomic size. Mustard seeds have a mass of 1.4 - 1.7 x 10^{-3} grams, which is substantially more than the mass of the atom's constituent particles (electrons = 9.1 x 10^{-25} grams; protons = 1.67 x 10-21 g; neutron = 1.69 10^{-21} grams) (Rutherford, 2012; Vergara et al., 2018).

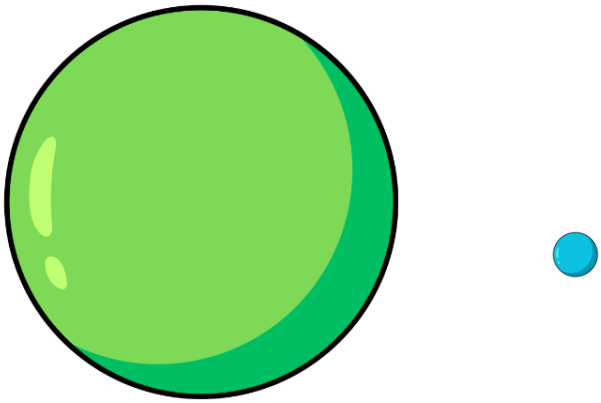

Figure 1. Graphical comparison of mustard seed (left) and atom's size (right.

Over the years, scientists have made every attempt to uncover the secret of this equilibrium established by Allah SWT, but they have only been successful in naming certain observed phenomena as the gravitational force, electromagnetic force, strong nuclear force, and weak nuclear force. However, nearly no one in our world gives the question "Why?" any thought. Why do these forces behave in a given manner and at a certain intensity? Why is there such a tremendous concord between the areas where these styles are governed, the laws they adhere to, and the intensity of these styles?

When faced with all of these issues, scientists are helpless because all they can do is speculate on the frequency of occurrences. However, their investigation reveals undeniable truths. Every location in the universe is evidence of the Owner of intelligence and will, who never leaves a particle unattended. All of these types are maintained in harmony by one force—Allah SWT, who possesses all dominion and strength. Only because of Allah SWT's will and care can the entire universe, from the tiniest atom to the limitless cosmos, continue to exist. He said as follows:

إِنَّ فِى ٱخْتِلَٰفِ ٱلَّيْلِ وَٱلنَّهَارِ وَمَا خَلَقَ ٱللَّهُ فِى ٱلسَّمَٰوَٰتِ وَٱلْأَرْضِ لَءَايَٰتٍ لِّقَوْمٍ يَتَّقُون

Meaning: There are undeniable signs (of God's power) for the pious in the alternation of night and day as well as in what God created in the heavens and on the earth. (QS. Yunus, 10:6).

Conclusion

In the development of chemistry, particularly for the growth of material chemistry research, the fusion of science and the Al-Qur'an is still comparatively young. Particle size, for instance, might be used as proof of the harmony between chemistry and the verses of the Qur'an, which have taught about the war of science, especially atoms, based on their physical attributes. The physical characteristics of the molecules or materials made up of these atoms are influenced by the atomic structure, which also confers distinctive features on the atoms that make up an element. Based on the literature review and *tafsir* of QS Az-Zalzalah verse 7 to 8, QS An-Nisa verse 40, and QS Yunus verse 60 revealed that the size of an atom is even smaller than the mustard seed particle. The atomic radius of the smallest (Hydrogen) and largest (Organesson) atoms are 1.2×10^{-10} m and 1.52×10^{-10} m, respectively, with 1 million being smaller than the radius of a mustard seed (5×10^{-4} m). As a result, the word dzarrah, which translates as mustard seed size, is less proportionate to express a much smaller atomic size. This demonstrates how current and relevant the Qur'anic verses are to scientific evidence, particularly the atomic structure or character seen in diverse chemical research discoveries.

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