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Substantial Motion: from Mulla Sadra's Philosophy to Physics

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Abstract

Substantial motion is Mulla Sadra's philosophical innovation in material existence. Since the four fundamental interactions are the major topics of physics, in this comparative study, substantial motion is tested based on physical achievements. The study aimed to find answers to the following questions: do the achievements made in physics strengthen or weaken the theory of substantial motion? If science strengthens it, which physical interactions are examples of substantial motion? Based on the results of the physics, how can some of the accidental changes be considered as Substantial motion? Mulla Sadra proved that material existence has a constant inherent fluidity. Three centuries later, quantum physics proved the dynamism within matter. Mulla Sadra showed that accidental motion is the cause of substantial motion. Similarly, science confirmed that any change in the properties of an object results from the internal interactions of the matter and the object. Furthermore, any motion in an object occurs along with the exchange of the particles carrying force. Accordingly, internal transformations in the matter including the intermolecular, intramolecular, atomic, and subatomic (at elementary particles and quarks level) are subsets of the substantial motion.

Keywords: *Substantial Motion; Matter; Forms; Electromagnetic Force; Weak Nuclear Force; Strong Nuclear Force*

Introduction

Mulla Sadra (Sadr ad-Dīn Shirazi), a seventeen-century Muslim philosopher, founded a philosophical school known as "transcendent wisdom", which, after four centuries, is still the most prominent school of thought in Islamic philosophy such that famous contemporary philosophers such as Allameh Tabataba'i, Allameh Ja'fari, and Imam Khomeini are the commentators of it. Although they may question some issues, they have not exited from the field of transcendental wisdom.

Although many books and articles have recently been written on various topics of transcendent wisdom, Mulla Sadra is still unknown to many contemporary philosophers of the world. This is due to the language barrier. Some of Sadra's successors and scholars in Islamic philosophy, who have written various books and articles in Persian, have not been able to transfer the complicated concepts of transcendent wisdom to other languages, and General translators also cannot afford specialized translation due to their unfamiliarity with philosophy. One of the scholars who has taken an effective step in

explaining Islamic philosophy is the French scholar Henry Corbin. After learning Persian, he traveled to Iran and became acquainted with Allameh Tabataba'i and benefited from his presence .

It can be said that Henry Carbin made great efforts to introduce Islamic philosophy and mysticism in his works such as "*The Voyage and the Messenger: Iran and Philosophy*" and "*The Man of Light in Iranian Sufism*".

This article is aimed at acquainting researchers with one of the topics of transcendent wisdom called substantial motion.

"It has become commonplace to credit Mulla Sadra with a significant innovation in Islamic philosophy, that of 'substantial "(Burrell, 2009). Pondering this well, we find that what makes the present essay analytical and different from descriptive research is its comparison with the physical results of quantum relativity. Since physics also deals with understanding the motions and the forces deriving things to move, it is possible to compare the findings of the two fields. Although physics and philosophy have two completely different methods, physicists use mathematical equations and experimental data, and philosophers use rational principles, differences in methods do not mean differences in results. All sciences in their full aspects move towards the truth.

Overall, philosophical methods will be faster in achieving facts than the experimental and empirical methods, though experimental methods gain more details

The main problem the present study sought to solve was to see if the achievements of physics strengthen or weaken the theory of the substantial motion or have no effect on it. Furthermore in the case of the convergence of physics and philosophy, what the instances of substance and the substantial motions are.

1.The Prior Principles of Substantial Motion

Before discussing the substantial motion, it is necessary to present the hypotheses which are the starting point for the discussion. In fact, presenting the hypotheses clarifies the context and provides the ground for a comparative study.

1.1.The First Principle

The present study was conducted based on the principle of the analytical composition of matter and Form. This theory was primarily proposed by Aristotle and, later, was explained and revised by Ave Sina and Mulla Sadra. According to this principle, every object consists of a matter which is related to its potentiality and a form which is related to its actualities. Today, the ability or the potential of transformation is discussed under the title of "Gene" in genetic science. When Aristotle proposed the theory of matter and form, he thought that the surface of the object is cohesive having no components. This was because when one touched an object, he found it cohesive and unified. However, advances in science led to the discovery of the particles. Accordingly, some contemporary scholars argue that by the advancement of the sciences and accepting that the principle of the composition of matter and form is violated: "principally Mulla Sadra's view of the things as a substance which doesn't consist of parts and has a unity is nothing but a popular illusion" (Yasrebi, 2000. P. 152). In response, it is said that the composition of matter and form is based on subjective analysis, which can never be violated by the empirical sciences. Analytically, the matter is related to the potentiality of the object and the form refers to its actuality. The principle of matter and form is so evident that it has general and daily use. Generally, the objects are valued and priced based on their matter. For example, two bracelets which have similar form but different matters (materials) - one is gold and the other one is made of titanium- have very different prices. On the contrary, aesthetic judgment is based on the form of the objects, although sometimes selecting the material appropriate for the form is also effective in aesthetic judgment. Two

similar bracelets made of different materials may be priced very differently. Therefore, the theory of matter and form which is based on philosophy has daily use and is not violated by physics, and is still valid. In other words, although advances in physics proved that an object is a substance which consists of components, this does not mean that the theory of matter and form is violated and that the individual unity of being is valid through the bonding unity of the parts. That is, although an apple is made of components, it is considered one apple because of the bonding unity of its parts.

1.2.The Second Principle

According to Mulla Sadra, "Substance is a being existing in itself; accident is a being existing in another as its subject." (Mulla Sadra, 1989, V. 1, p. 275). The accident exists in the substance. In other words, the substance serves as the subject of accidents. In Aristotle's ten categories, the first category is the substance which is followed by accidents such as quantity and quality.

What is the place of matter and form in this dual division of substance and accident?

Mulla Sadra considered the union composition of matter and form (Mulla Sadra, 1989, V. 4, P. 34). According to the theory of union composition, the composition of the body from matter and form is of analysis of the mind, and matter and form are not two separate substances. Thus, the body is the substance in terms of the composition of matter and form (Tabataba'i, 1953, V. 4, p. 178).

2. The Substantial Motion

Mulla Sadra was the first who proved the substantial motion based on proof. To prove the substantial motion, he argued that Aristotle's ten categories and such accidents as quality, quantity, and relatives do not exist independently. In fact, they exist in substances. Motion is also an existence. If the motion occurs in the accidents, the motion will definitely occur in the substance, too, because the accident depends on the substance in order to exist. In the logic of analogy, this can be described as follows:

Every *accident* to exist is subject to substance.

The motion is related to how existence occurs.

So, every *accident*al motion to exist is subject to substantial motion

Therefore, motion in accident implies motion in the substance.

According to Mulla Sadra, every material being is temporal and has a temporal dimension, and time is based on motion, and that the motion of the object is existential. Therefore, every material being has a gradual and moving existence in every being that has a temporal dimension (Mulla Sadra, 1989, V. III, pp. 126-127). In other words, every temporal object is an inherently moving object.

As the substance can be understood by the intellect, and what is experienced is an accident of the object, in the same vein, substantial motion can be proved through argument. A point to be considered is that accidental motion is not always apparent and that an object may seem to be fixed for years. That's why Mulla Sadra distinguished two types of substantial motions:

1. The Permanent inherent motion of the object upon which the temporality of the object depends.

2. The temporary or "unnecessary" motions that the object sometimes has including moving from one place to another place, transforming into another thing, and growth and development (Mulla Sadra, 1989, V.3, p. 62).

In moving from a sperm to a complete human, a temporary substantial motion occurs. In this process, a solid sperm transforms into proliferating cells and move to the vegetable stage. It continues to grow until the fetus develops motion and emotion and reaches the animal stage. By evolution and development of the brain, it reaches the human stage.

Another example of temporary substantial motion is an apple which transforms from a small green apple into a big red one. In this motion, in such accidents as the size (quantity) and color (quality), the substance of the apple is moving. This is because accidents are present in the substance.

"In apparent contradiction to the dicta of Aristotle, where the change pertaining to a mutable thing cannot attend its very essence, so it must be 'accidental'. Mulla Sadra finds essences themselves to be subject to change and makes that point central to his metaphysical inquiry" (Burrell, 2009, p. 1).

The most important question posed about the substantial motion and made the earlier scholars such as Ave Sinan and the proponents of his philosophy refuse to accept the substantial motion is the issue of "the survival of subject in the substantive movement" (Ave Sina, 1982, 123-126). The problem they mentioned was that in motion, there is a need for a fixed subject and that substance does not have the subject. Therefore, the motion in the substance means a moving subject, which is impossible.

In response, Mulla Sadra stated that motion is gradual, connected in which the connectedness of the motion leads to a moving individual unity (Mulla Sadra, 1989, V. III, p. 96). For example, what makes the red apple to be considered the same very green apple is the fact that motion in the apple is always cohesive. It can be said that this is the apple which has had a gradual substantial motion.

Motahari argues that in substantial motion, "there is no need for a fixed subject for the object to move" (Motahari, 1982, V. 2, pp. 51-52). His opinion is quite logical since in cases where an object transforms into two or more objects or, conversely, two objects change into one, the survival of the fixed subject is not valid and the solution to the problem is the connectedness in motion. For example, in the motion of the chlorine and sodium and their conversion to salt, the connection in this chemical conversion makes us consider chlorine and sodium as the raw materials of the salt.

3. *Types of Force and Interaction in Physics*

In physics, motion is caused by force. All of the known forces of the universe are classified into four fundamental interactions. The strong and the weak forces act only at very short distances and are responsible for the interactions between subatomic particles including nucleons and compound nuclei. The electromagnetic force acts between electric charges, and the gravitational force acts between the masses (Feynman, 2011; Braibant 2011). It should be mentioned that in quantum mechanics, physicists often use the terms "force" and "interaction" interchangeably.

3.1. The Electromagnetic Force

The magnetic *force* acts between moving *charged particles*. The motion of the electron around the nucleus results from the electromagnetic force.

The electromagnetic force, carried by the photon (γ) creates electric and magnetic fields, which are responsible for the attraction between orbital electrons and atomic nuclei which hold atoms together, as well as chemical bonding (Behroun, 1996, 261). Therefore, the rotation of electrons around the nucleus is formed by the exchange of photon particles, and this rotation around the nucleus is not just spatial motion.

3.2. The Strong Nuclear Force

In addition to the electromagnetic force between the charged particles, there is a force which binds neutrons and protons to create atomic nucleus, which is called "strong nuclear force" (Han, 1999. P. 150). This force is the strongest force known in the whole universe. However, in terms of the radius of the effect, it is the most limited force.

The strong nuclear force acts to hold all the protons and neutrons close together, while the electromagnetic force acts to push protons further apart. So these two forces produce opposite effects in the nucleus (Schwartz, 2000, p. 19).

The strong interaction is carried by a particle which is called the gluon and is responsible for quarks binding together to form hadrons, such as protons and neutrons. As a residual effect, it creates a nuclear force that binds the latter particles to form atomic nuclei (Behroun, 1996, p. 262).

3.3. The Weak Nuclear Force

The weak interaction is carried by particles called W+, W−, and Z0, bosons and also acts on the nucleus of atoms, mediating radioactive decay (Han, 1999, 162). One of the weak interactions is Beta-decay. Beta-decay occurs when, in a nucleus with too many protons or too many neutrons, one of the protons or neutrons is transformed into another as follows:

$$(1) \qquad n \Rightarrow p + e + \upsilon_e$$

Where,

n: neutron

p: proton

e: electron

v_e: Electron neutrino

The neutron is built from one up quark and two down quarks (*n~udd*), while the proton is built from two up quarks and one down quark (p ~ udu). Therefore, if we describe the beta-decay based on the quark model it will be (Feynman, 2000, p. 145):

$$(2) \qquad udd \Rightarrow udu + e + \upsilon_e$$

Therefore, beta-decay occurs at the subatomic level (quarks).

3.4. The Gravitational Force

The gravitational force is the cause of the tension between the masses. This force is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

$$(3) \qquad F = \frac{G \times m_1 m_2}{r^2}$$

Where,

m_1, m_2: the mass of each object

r: the distance between the centers of gravity of the objects

G: universal gravitational permanent

F: gravitational force between the two objects (Vasilyev, 1980, p. 84).

According to Newton, the propagation of gravitational force is instantaneous and does not need time. In 1915, Einstein took a fundamental step in explaining the force of gravity by introducing general

relativity. According to this theory, space is a function of the presents of objects which have gravitational mass (Gott, Strauss, & Tyson, 1982, p. 45).

In general relativity, the effects of gravitation are ascribed to space-time curvature instead of a force (Randall, 2009). The higher the density of the matter, the greater the curvature of space will be. The gravitational forces depend on the curvature of space and the speed of objects. According to the theory of general relativity, Newton's view that the effect of gravity is instantaneous is rejected. It is followed that the effect of gravity moves from one object to another object at a limited speed (equal to the speed of light). Einstein proposed that space-time is curved by matter and that free-falling objects are moving along locally straight paths in curved space-time. These straight paths are called geodesics. Like Newton's first law of motion, Einstein's theory states that if a force is applied on an object, it would deviate from a geodesic. The geodesic paths for space-time are calculated from the metric tensor (Collier, 2012). The modern quantum mechanical view of the fundamental forces other than gravity is that particles of matter (fermions) do not directly interact with each other, but rather carry a charge, and exchange virtual particles (gauge bosons), which are the interaction carriers or force mediators. The exchange of gauge bosons always carries energy and momentum between the fermions thereby changing their speed and direction.

Moreover, it is hypothesized that gravitational interactions are mediated by a yet-undiscovered elementary particle, dubbed the graviton (parker, 1995, 193).

4. A comparative Study of Motion in Physics and Substantive Motion in Philosophy

According to Mulla Sadra, "Substance is a being existing in itself" (Mulla Sadra, 1989, V. I, p. 275). The accident is a being existing in another as its subject. Therefore, everything in nature that exists in the form of solid, liquid, or gas is an instance of the substance.

Mulla Sadra believes that the temporality of the objects is based on the fluid material existence. The inherent and permanent motion which is not separated from the substance of the object means that the dynamic system within the object has been formed based on intra-atomic forces which are interpreted as the nature of the matter by Mulla Sadra. Moreover, he distinguishes this motion from the motion which has an external cause. That is, sometimes the motion of an object is related to its nature. For example, the upward motion of fire and its internal heat which are due to its nature. Sometimes the motion is caused by an internal force, like a stone thrown by another person (Mulla Sadra, 1982, 230). In explaining the permanent motion of an object, Mulla Sadra considers it to be of the first type. In other words, the permanent motion of an object is caused by its nature. Physics also proves that the cause of the motion inside the atom is external, rather it is related to the forces between the particles of the atom. Therefore, any transformation and permanent intra-atomic motion resulting from the object's nature- or in physics, motions in molecular, atomic, and subatomic levels- is an instance of substantial motion some of which include:

What are the instances of substantial motion?

If we consider the instance of the substance as an object composed of the matter and form, the internal changes of the object including intermolecular, and even subatomic (at elementary particles and quarks level), changes are instances of the substantial motion. Any interaction and motion that occurs at the molecular, atomic, and subatomic levels is an instance of substantial motion, some of which are as follows:

a. The motion of the electron around the atom is an instance of a permanent substantial motion.

b. The attraction of the nucleons within the nucleus due to the continuous emission of the exchange particles of the strong nuclear force (i.e., gluons) is also an instance of the permanent substantial motion.

c. The weak interactions (weak nuclear force) which lead to the transformation of the subatomic particles are temporary substantial motion.

On the other hand, there are some cases which cannot be viewed as substantial motion. Therefore, quantum mechanics which combines the properties of the wave-particle for a particle separated from the classic mechanics (Behroun, 1996).

5. Physic-Based Explanation of Some of the Accidental Motions to Substantial Motion

In addition to the Permanent intra-atomic motion, every object has some temporary unnecessary motions. In some cases, the change in the matter of the object is obvious. When the smell of the meat changes, we throw it away because we view this change as a sign of spoiled meat and substantial motion. However, in some cases, the explanation of the substantial motion seems too difficult. Here are a few cases:

1) When we pour water from one container to another container (the mass of the water does not change), is this a substantial motion?

In this case, the type and mass of the matter have not changed, but the arrangement of the water molecules and the intermolecular cohesion within the matter have changed, which can be interpreted as substantial motion. It is important to note that the object is not a container full of balls, in which when the arrangement of the balls changes, the container does not change, rather, in this example, there is an interaction between the balls and the whole set. Even when a ball is separated from the container, there is still a connection between the separated ball and other balls and their physical properties exchange. In philosophical terms, the composition of the object of quantum particles is a real unified composition, not a concrete one. "The phenomenon of the Quantum entanglement" provides a holistic structure for the physical world which completely contrasts with the reductionist views of the critics of western philosophy, by which the composite systems can be decomposed into their components (Isham,2003, p. 190).

2) How can the phenomenon of the metal expansion resulting from the heat be related to the change within the matter and the substantial motion?

In the expansion phenomenon, the number of the molecules and their mass do not change, but heating increases the movement and speed of the molecules within the metal. This change happens in the quantity and size of the metal. Thus, in the expansion phenomenon, the motion generated in the molecules of the matter is an instance of the substantial motion of the metal. It should be noted that in some cases, the substantial motion of the object is reversible. In the last cases, there is a reversibility.

3) When we move a ball from one point to another point in the room, there is a change in the category of accident of the place and the position of the ball. In terms of the apparent senses, this displacement does not show the motion within the matter. How can the change in place and position be related to the substantial motion?

According to the theory of general gravity, the special motion of an object results in curvature in space-time. According to the quantum of the Gravitational force, a change in the position of the object occurs along with the exchange of the quantum particles (graviton) with the surrounding objects. Accordingly, even a change in the position of an object, which is one of the categories of the relative accident, leads to a change in the space around the object and the exchange particle, though not noticeable.

Conclusion

Although the substantial motion was the philosophical approach of Mulla Sadra, three centuries later the achievements of quantum and General relativity confirmed it. Using rational arguments, Mulla Sadra proved that material existence is a fluid existence and that fluidity and motion are inherent, if they are removed from the object, there will be no material existence. In addition, physics approved that there is a dynamic world within the atom. If the dynamic world changes into a static world, the atom will be disintegrated. Mulla Sadra considered fluid material existence as the basis of the temporality of the objects. Motion and fluidity are inherent and permanent and are not separate from the substance of the object.

The present study showed that any change and cohesive motion at molecular, atomic, and subatomic levels is an example of substantial motion. Therefore, the motion of the electrons in their orbits around the nucleus is an instance of the inherent substantial motion.

The attraction of the nucleons in the nucleus of the atom by the strong nuclear force and the exchange of the gluon particles between the nucleons are also instances of the inherent substantial motion.

In addition to the dynamic system, objects have temporary changes at molecular, atomic, and subatomic levels such that sometimes, the type, number, and arrangement of the molecules change. Sometimes, the speed of the motion and intermolecular movements change (e.g., expansion and contraction of metals). The entanglement and intermolecular interaction are instances of substantial motion. According to the theory of general relativity in physics, the special motion of the object changes the curvature of the space around it, and the gravitational force of the object changes according to the objects surrounding it, which can be interpreted as substantial motion, especially given the fact that gravitational interactions are mediated by graviton.

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