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Clarification of the Field Concept for a New General System Theory

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Field is an essential concept for us to understand the physical phenomena in the universe. Since the field concept was proposed in electromagnetism during nineteenth century, the understanding of the field concept has experienced great changes. This paper re-examines the concept of field from its origin and evolution history, with the purpose of a better understanding of the concept in order to be used in our new general system theory to unify different theories. Our main conclusion is that the concept of field should not be regarded as an independent physical existence but a property of matter of both living and nonliving. Through a discussion on an isolated two-body system from the perspective of gravitational field, a psychic field is introduced to address the active force produced by living creatures with minds.

Keywords: field, electromagnetic field, gravitational field, psychic field, mind-body problem

Introduction

The concept of field is widely used in modern physics (Kibble, 1961; Itzykson & Zuber, 2005; Ryder, 2009; Griffiths, 2012; Schmitz, 2019) and it is an essential concept for us to understand the physical phenomena in the universe. Since the concept was first proposed with the development of electromagnetic theory during the nineteenth century (Thomson, 1851; Faraday 1855; Maxwell, 1864) and developed as the Einstein field equations first published in 1916 (Einstein, 1916), the understanding of the field concept has experienced great changes. Nowadays, field as a technical term is utilized in many different theories with different meanings (Kibble, 1961; Itzykson, 2005; Ryder, 2009; Griffiths, 2012; Schmitz, 2019), however, many people do not delve into the concept when using it, but just calculate according to the formula. In order to develop a unified theory based on general system theory (Bertalanffy, 1968; 1972), it is urgent to clarify this fundamental concept.

The purposes of this paper are to better understand the field concept, to clarify the meanings of field in different theories, to provide a clear interpretation of the concept, and to unify different theories on the field concept. To achieve these purposes, the origin and evolution history of the field concept are examined, an example of an isolated two-body system from the perspective of gravitational field is provided, and a psychic field to address the active force produced by a living body is introduced. It is argued that by assuming the

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existence of a psychic field for a living body due to the mind-body interaction, many anomalous phenomena such as out of body experience, near death experience, mediumship, children claiming to have memories of a previous life (Moreira-Almeida & Santana Santos, 2012) and parapsychological (psi) phenomena (Cardeña, 2018) can be explained.

The Origin of Field Concept

Action at a Distance

McMullin (2002) traced the origin of the field concept in physics. He suggested that the notion of an "area of influence" or "action at a distance" ought to qualify the beginning of the field concept which appeared as early as in Aristotle's time. "Action at a distance" is the concept that one object can interact with another object without physical contact but only through the empty space between them. Aristotle himself believed that a material body could not act where it was not present, but only through actual contact can action be transmitted between bodies. However, he also suggested that the migration of immaterial forms (species) could across the intervening space (McMullin, 2002).

In addition, early discussion of magnetic phenomena from the ancient Greek world and of the correlation between position of the moon in the sky and ebb and flow of the tides on the earth from the ancient Eastern world also suggested the idea of an "area of influence" or "action at a distance". By 1600, the idea of an influence in certain special cases extends outwards from a body into the space around it (McMullin, 2002), which are the basis of the introduction of the field concept from the observed behaviour of charged and magnetized bodies until the nineteenth century.

Thomson's Definition of Field Concept

The concept of field first appeared as a technical term in physics with clear definition in William Thomson's (Lord Kelvin) paper published in 1851 (Thomson, 1851), where he proposed a new definition on the theory of magnetic induction: "Any space at every point of which there is a finite magnetic force is called 'a field of magnetic force'; or, *magnetic* being understood, simply 'a field of force'; or, sometimes, 'a magnetic field'." From this definition, the term of field was originally used to describe the distribution of magnetic force at any point in space. In this definition, Thomson assumed the existence of a magnetic field, but did not address how the field comes from.

Then, what is the magnetic force at any point? The definition was also provided in the paper (Thomson, 1851): "It is the force which a magnet would exert on the north pole of an infinitely thin, uniformly and longitudinally magnetized bar of unit strength placed at that point, if it experienced no inductive action from the latter magnet." Therefore, the (magnetic) field defined by Thomson is produced by an object (a magnet) and used to describe its influence (force) on another object (a magnetized bar) placed at any point in space. By examining the definition more closely, there must be at least two objects, then the concept of field can be used to explain the non-contact force between these two objects and the force to explain the motion of them.

In addition, Thomson (1851) also defined the superposition of magnetic force at any point: "The total magnetic force at any point is the force which the north pole of a unit bar-magnet would experience from all magnets which exert any sensible action on it." In other words, the concept of field also satisfies the simple superposition principle, and the field in space is a superposition from all objects in the universe except the one

to be acted upon. For example, if we consider an isolated system of three magnetic objects, the force acted on one magnetic object is induced from the superposition fields of the other two magnetic objects.

Faraday's Field Concept

Gooding (1980) held that Thomson did not invent the idea of a magnetic field because Faraday had already taken an original approach in using and explaining this concept. But Thomson did help Faraday to draw this idea out of his own representation of the phenomena.

Faraday had introduced the term of field explicitly in the second of his papers on magnetism in 1845 (Faraday, 1855, p. 29). Although he did not provide a definition for this new term, it had a descriptive and operational use: it denoted the region near the magnetic poles, a reference frame against which the motions of sensors could be described (Gooding, 1980). Faraday defined matter as either the source of action or as a conductor which is able to influence the lines of action, while space was the absence of such powers (Gooding, 1980; Faraday, 1855, pp. 192-196).

Nersessian (1989) discussed Faraday's field concept in detail from what was Faraday's field concept to when Faraday had his field concept. She found that different scholars held different opinions even based on the same reference about Faraday. So it is actually a philosophical issue as well as an historical one. For example, as to when Faraday had his field concept, the positions divided into two camps. Some scholars, (e.g. Agassi, 1971; Berkson, 1974), considered that it was somewhere between 1821 and 1832 before or around his discovery of electromagnetic induction in 1831. Other scholars, (e.g., Gooding, 1978; 1980; 1981; Williams, 1975), believed that it should be around 1845-50 after Faraday had introduced the term of field. As to what Faraday's field concept is, Nersessian (1989) believed that the concept of lines of force proposed by Faraday played a crucial role in the construction of his field concept while Williams (1975) considered that the lines of force does not fit the criterion for field. But they (Agassi, 1971; Berkson, 1974; Williams, 1975; Gooding, 1978, 1980, 1981) all agreed that the field concept involved the notion of properties existing in space.

The authors agreed with Nersessian (1989) that the origin of field concept is a philosophical issue as well as an historical one. Through the above analysis, the authors believed that the field concept in modern science originates from Faraday, and the definition provided by Thomson (1851) could represent both Faraday and Thomson's attitude upon this concept since they had frequent correspondence about this concept during that period (Gooding, 1980).

The Evolution of Field Concept

Field Concept in Maxwell's Electromagnetism

By 1864, Maxwell took the term of field in the title of his groundbreaking paper of "A Dynamical Theory of the Electromagnetic Field" (Maxwell, 1864), which blended the electricity and magnetism into one: "The theory I propose may therefore be called a theory of the *Electromagnetic Field* because it has to do with the space in the neighbourhood of the electric or magnetic bodies, and it may be called a *Dynamical* Theory, because it assumes that in that space there is matter in motion, by which the observed electromagnetic phenomena are produced. The electromagnetic field is that part of space which contains and surrounds bodies in electric or magnetic conditions." Therefore, the electromagnetic field defined by Maxwell is produced by electric or magnetic bodies and is part of the space outside the bodies. Due to the existence of the body, other objects located in the field will be acted by that body, which is similar to Thomson's definition of the magnetic

field. Up to this point, it is clear that the magnetic field is created by a magnetic body in the empty space of the universe. If no magnetic body exists, then there is no magnetic field although the universe described by time and space exists. From these statements one can clearly see that Maxwell defined his concept of field based on his ontology of the world. At that time, the matter is the only existence in the universe. Maxwell did not address the origin of the universe.

Unlike Thomson's definition, Maxwell attributed the energy communicated between the two objects to the formerly existence in the medium of the space, that is, stored in the field (Maxwell, 1864). In addition, Maxwell (1864) also provided equations to calculate the energy of the field. From this perspective, Maxwell (1864) treated the concept of field just as a physical entity, which obviously deviated from Faraday's field concept and somewhat contrary to his own definition. As mentioned above, the field concept (Thomson, 1851) is originally used to describe the distribution of force in space, and such distribution of force is certainly not a physical entity. The introduction of energy concept is another big source of confusion in modern physics which will be discussed in another paper. But if we remember that at Thomson's time, people often thought that the universe is composed of ether (Newton, 1846; Maxwell, 2003) and thus his concept of energy can be regarded as a property of ether. Later, some people thought there is no need to introduce the concept of ether to explain the electromagnetic phenomena (e.g. Einstein, 1916).

In modern textbooks of electromagnetic field theory (Griffiths, 2012), the energy or energy density of the field is often directly used for calculation regardless of whether it is conceptually appropriate. Considering that the actual field is so complicated, which is the joint action of all the matters in the universe, the authors held that it is mathematically fine to do such calculation for convenience, but conceptually inappropriate to call it energy in field directly since the field itself is unable to store energy. Instead, energy is a property of matter, and it can only be stored in matter such as the electric or magnetic bodies. The electrostatic potential energy is stored in the charges and distance between them, and the electrodynamic or the magnetic potential energy in magnetized bodies and distance and orientation between them. Furthermore, even Maxwell assumed the existence of ether, the relation between ether and observed matter is unclear to him.

Field Concept in Newtonian Universal Gravitation

When Newton's law of universal gravitation was proposed in the *Principia* in 1687 (Newton, 1846), the term of field did not explicitly appear. However, since the concept of the field was proposed (Faraday, 1855; Thomson, 1851; Maxwell, 1864), it soon extended to the gravitational field. Many scholars believe that the law of universal gravitation reflects the nature of the field. Stein (1970) considered that the first physical field to be made the subject of a coherent theory was the Newtonian gravitational field.

According to Newton's law of universal gravitation (Newton, 1846), the attraction force F between two masses of M and m is

$$F = \frac{GMm}{r^2}, \tag{1}$$

where r is the distance between the centers of their masses and G is the gravitational constant. Here we adopt the original definition of field provided by Thomson (1851). Similar to the magnetic field, the gravitational field is used to explain the influences that a mass M extends into the space around itself, producing a force on another mass m. It is a vector field, and its direction is the same as the gravitational force that mass m would feel. The gravitational potential energy is stored in the massed bodies and distance between centers of them.

Field Concept in Einsteinian Relativistic Theory

In the general theory of relativity, the Einstein field equations are used to describe the gravitational force as a result of spacetime being curved by matter within it. The Einstein field equations are ten equations, contained in the form of a tensor equation (Einstein, 1916; Dirac, 1996):

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \kappa T_{\mu\nu}, \tag{2}$$

where $G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu}$ is the Einstein tensor that determined by the curvature of spacetime at a particular point in space and time, $R_{\mu\nu}$ is the Ricci curvature tensor, R is the scalar curvature, $g_{\mu\nu}$ is the metric tensor that specifies the spacetime geometry and is the solution to these equations, Λ is the cosmological constant, $\kappa = \frac{8\pi G}{c^4}$ is the Einstein gravitational constant, G is the Newtonian gravitational constant, c is the speed of light in vacuum, and $T_{\mu\nu}$ is the stress-energy tensor which represents the matter and is equated with the energy and momentum at the particular point in space and time. In this theory, actually many fundamental concepts such as matter, energy, time, and space have changed their original meanings and we do not agree with these new definitions. The same problem exists in quantum mechanics as pointed out by Oriols and Mompart (2019). So we stick to the classical definition of the field concept.

In Newton's law of universal gravitation, as shown in Eq. (1), mass is the source of gravitational force and field. The interaction between two massive bodies is instantaneous and no medium is required. In Einstein's relativistic theory, the above Einstein field equations as shown in Eq. (2) describe the gravitational force and field as a result of spacetime curvature, and the curvature is related to the distribution of matter within it. Here we will not discuss what spacetime is in Einstein's theory, but when compared to Newtonian gravitation, it is clear that Einstein's relativistic gravitation regards the spacetime as a medium and limits the speed of interaction between two massive bodies to the speed of light c in spacetime. Therefore, the gravitational field strength in Einstein's theory must be different from Newton's theory, but they both regard the field as a product of matter.

However, in terms of the definition of matter, Einstein is very different from Newton. In Newtonian ontology, matter is the only existence of the universe and mass is the fundamental property of matter, while position, velocity, acceleration, momentum, kinetic energy and potential energy are other properties of matter. Space and time are human constructs to describe the change and movement of matter. Space and time are not physical objects and the same as the concept of a field. However, in Einstein's ontology, matter, energy, field and spacetime are all fundamental physical existences, which is very different from the original materialism. Even with four physical existences, phenomena related to information cannot be explained and thus another fundamental existence of information is proposed by some philosophers or scientists (e.g., Gaiseanu, 2021). In order to explain the expansion of the universe, dark matter and dark energy have also been introduced (Nath, 2018). Whether a dark information is needed in the future is unclear. Thus, the ontology of the universe is blurred. From such an ontology, one cannot know what the fundamental existences are in the universe. In order to overcome this problem and utilize the general system theory (Bertalanffy, 1968) to unify different theories such as Newtonian mechanics, quantum mechanics and relativistic mechanics, a new ontology was proposed by Cui (2021a; 2021b). In the next section, we will introduce the concept of field based on this new ontology.

The Field Concept for a New General System Theory

We can conclude from the above analysis that the concept of field experienced great changes since its original birth from Faraday and Thomson. Although the concept of field is used in different theories, its meaning is not exactly the same. Cui (2021a; 2021b) proposed a unified ontology for the general system theory based on the clarification of some fundamental concepts including the field concept. Here we would like to further clarify the field concept in detail under the framework of Cui (2021a; 2021b).

The Introduction of Ontology for a New General System Theory

In Cui's (2021a; 2021b) ontology, every concept is a relative concept and in order to define a concept A, other concepts have to be referred. The minimum of the concepts for A is its complement, non-A in a two-valued logic system. This conclusion was derived from his first axiom (TOE-A1: the relativity of simultaneity axiom): "*There is no such thing as a perspective-independent existence. Every described existence is a relative existence since the concept of existence depends on other concepts, at least its opposite or complement*". Thus, if we want to define the existence of matter, the existence of non-matter has implicitly assumed. We can call this non-matter as mind. Note that our concept of mind is very different from the concept of mind in modern main-stream science that mind is specifically supported by brain as matter. Our concept of mind came from Buddhism and it is equivalent to alaya-vijnana (storehouse consciousness) in Buddhism (Harvey, 2013). The reason we redefine the concept of mind rather than use an unfamiliar concept of alaya-vijnana is to keep with the tradition of the mind-body problem. For large matter objects, since we can observe them, we can assign different names to different objects based on their differences. However, up to now we do not have the capability to distinguish different minds, so minds are just an ensemble of non-matter existence similar as ether is an ensemble of unobservable matter existence. For matter objects, we can decompose them into small particles such as molecules, atoms, protons, neutrons, electrons and even smaller subatomic particles. This process may be further down until the particles we cannot observe. If we call the ensemble of unobservable particles as ether, then matter objects is made of ether. Human beings can accumulate ether into observed particles or large objects and decompose large objects into small observed particles or even ether. Since mind is non-matter, we cannot observe it and thus it is hard for us to assign different names to each individual. The ensemble of minds and ether are the two fundamental substances in Cui's ontology. A body with a mind is called a living being which can make the active movement while a body without mind is called a lifeless object which can only be moved by the external force. Thus, he interprets all the quanta as living beings since they are moving all the time in relation to our observation. Of course, the minds for a quantum, for a plant, for an animal and for a person are very different, Cui did not assign different names for them due to the unobservability at this time (Cui, 2021a; 2021b).

Cui suggested that the field concept is used to explain the force phenomena (or action at a distance phenomenon) caused by objects in the universe rather than it is a new physical existence. Corresponding to the four basic forces of gravitation, electromagnetism, strong and weak interactions, there are also four basic fields in nature. That is to say, the original concept by Faraday and Thomson is adopted. However, these concepts are only suitable for lifeless objects but not living objects. Therefore, a new force field called psychic field is adopted which can be regarded as the generation of active force due to the mind-body interaction. The existence of psychic force and psychic field was first proposed in parapsychology (e.g., Radin, 2006; Moreira-Almeida & Santana Santos, 2012; Cardeña, 2018). The other four basic forces are correspondingly

called the passive forces. Details about the field concept and the fifth psychic field are given in these two references (Cui, 2021a; 2021b) and they are able to explain many anomalous phenomena. So here we would like to elaborate the field concept in the unified ontology of the general system theory from the perspective of gravitational field for simplicity. The same conclusion could be obtained by analyzing it from the perspective of other fields, so we will not repeat it here due to the length limit.

Field Concept From the Perspective of Newtonian Gravitational Field

Let us consider an isolated system of two bodies, and treat the mass M in Eq. (1) as the earth. Assuming that we human beings stand on a fixed point of the earth as an observer to study the movement of the mass m due to the gravitational attraction from the earth. Since the mass of us is negligible if compared to the earth, then the influence of us as an observer to the two-body isolated system can also be neglected. Now let us take the earth as the frame of reference, see Figure 1.

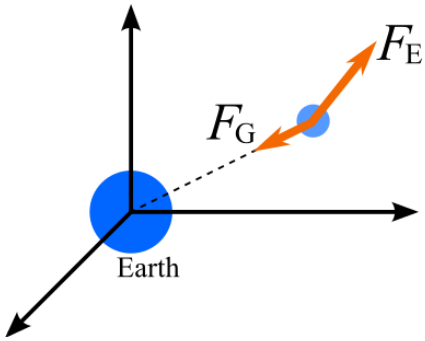

Figure 1. An illustration of two-body problem.

Note. One mass particle on an earth-fixed coordinate system, F_G: gravitational force, F_E: psychic force from the entanglement of two minds.

If the mass m is the moon of the earth, then the moon is located in the gravitational field of the earth and thus subjected to a gravitational force from the earth. Similarly, the earth is also located in the gravitational field of the moon and thus a gravitational force from the moon with the same magnitude but opposite direction. In the past, there is never a clear explanation why the centrifugal force exists between the earth and moon and keeps moon to rotate around the earth in a predictable trajectory. If we interpret both the earth and moon have minds and thus psychic force exists between these two objects, then the existence of centrifugal force can be explained. Of course, the minds of the earth and the moon are quite different from the minds of individual creatures.

If both mass M and mass m represent two living creatures such as two monkeys or two persons, then the psychic force between them is more complex. Every mind can change the magnitude and direction of the psychic force and it is hard to predict the trajectory of mass m in relation to the position of mass M. Furthermore, if the living object of mass m is a bird instead of a monkey or a person, then the bird is free to fly away from the Earth.

The classical field concept by Faraday alone is unable to explain them perfectly. By introducing the concept of psychic force and psychic field, these different action-at-a-distance phenomena can easily be explained. That is the main reason why Cui (2021a; 2021b) adopted the concept of psychic field to explain the active force existed for living creatures and this active force is created through the mind-body interaction.

In the above analysis, we considered the earth as a fixed origin of coordinates and only a two-body system of the earth and the mass *m*. In our general ontology, we can treat the two objects as two living beings, then there are two forces acted on the mass *m*, one is the gravitational force F_G towards the direction of earth center and the other is the psychic force F_E from the entanglement of two minds (Radin, 2006). The direction and magnitude can be changed by these two minds. Of course, how to measure the psychic force has not yet been solved and this may be a very challenging problem itself. It will be discussed in the next section, but this concept will leave enough room to explain the various phenomena we have observed. Even for the gravitational field, the actual situation is very complicated, there are so many massive bodies including both lifeless objects and living creatures in the universe and the motion of them is complex. For example, the moon moves around the earth, the earth moves around the sun, the sun moves around the center of the Milky Way along with the entire solar system, and the moon, earth and sun also rotate around its own axis. Each one is doing accelerated motion and each one will produce a gravitational field and at the same time located in the gravitational field of other massive bodies. The strength of the gravitational field at any point in space is the joint action of all the massive bodies in the universe. However, since the gravitational force is attenuated by the square of the distance as shown in Eq. (1), the contribution of the long-distance massive body to the field strength of a certain point in space is of course very small when compared to the short-distance massive body. Similar locality property exists for the other three types of passive forces of electromagnetic force, strong force and weak force.

The Psychic Field

Cui (2021b) defined any object of mass as matter and the thing enables a body of matter to possess the ability of active movement as mind. A body with mind is called a living creature while a body without mind is called a lifeless object. Then the difference between a stone and a monkey or bird is that the stone is a lifeless object without mind while the monkey or bird is a living creature with mind. A life with mind can generate active force to make itself move while a lifeless object can only be moved under the passive forces acted by other objects. In this case, the monkey or bird generates active force to make itself move on or around the earth while the stone can only move under the passive force of universal gravitation acted by the earth together with the push force from a living creature. Such active force by a life will create a psychic field around it just as similar as a gravitational force by a massive body will create a gravitational field around it. People may use the car example to refute the deduction here. A car without a mind can move. The cars can be easily explained in our new mind-mind model. In order for the cars to move at least the battery system is installed and someone is needed to start the engine. These are the functions of the mind in another living creature rather than the mind in the car. Any robot can also be explained in this way.

The differences between lives of the monkey and bird in this case exist in both the body and the mind within the body. The differences in their bodies are reflected in their different aerodynamic characteristics while the differences in their minds cannot be addressed at this moment because mind can only be understood as a concept for attributing uncertainly currently. That is to say, the psychic force and field are currently unmeasurable, but we know that they do exist based on the axiom of the relative existence of concepts (Cui, 2021a). It is the mind tells the monkey when to grab the branch to prevent itself from falling and the bird to fly away. Instead of declaring that the psychic force and field are unmeasurable similar as some overclaiming statements made in general relativistic theory (Einstein, 1916) or orthodox quantum mechanics (Oriols &

Mompart, 2019), Cui (2021b) suggested to be open-minded that human beings may be able to study the mind through methods such as meditation as indicated in Buddhism (Harvey, 2013). Of course, how to study the properties of mind, psychic force and field due to the mind-body interaction is not an easy task but it provides a room for us to extend the classical mechanics to solve modern problems encountered in the complex systems. Our purpose to update Bertalanffy's general system theory based on our new ontology is such an effort and the clarification of the field concept is just a small piece of work. Energy and information are another two important concepts to be clarified and they will be discussed in subsequent papers.

Conclusions

The main conclusions of this paper are summarized as follows:

1. The field should not be treated as a fundamental existence but a human constructed concept similar as time and space to explain the action at a distance (non-contact force) phenomenon. Each type of a force such as electromagnetic force, gravitational force, strong force and weak force can be explained by the corresponding field. All of them are produced by lifeless objects and they are passive forces.

2. Based on the axiom of the relative existence, a concept of non-matter called mind is introduced to define a living body. The interaction of mind-body can induce a psychic field around the living beings and if another living being is located in this field, a psychic force exists. This interaction can be called the entanglement of minds (Radin, 2006). This is an active force which can be used to explain all the active behaviour of living beings. When the mind is separated from the body, the life is dead and the body becomes a lifeless object.

3. The field concept originates from Faraday but it has changed its meanings many times and it is necessary to make a clarification in each particular theory. In our opinion, the original definition of the field by Faraday and Thomson should be kept. There is no need to add more fundamental existences such as field, energy, information, dark matter, dark energy to explain the newly observed phenomena. Only minds and ether are two fundamental existences from a two-valued logic category. Massive body is accumulated from ether by a life and a life is a body with mind while a body without mind is called a lifeless object. Energy is a property of matter while information is generated by mind and can be stored in matter and transmitted through the movement of matter.

4. A psychic field proposed in parapsychology is adopted to address the influence of mind (psychic force) on the body and space around the body. The authors are aware that the measurement of the psychic force is very challenging but it may be investigated through meditation. The concept itself leaves plenty of rooms to explain various anomalous phenomena (Moreira-Almeida & Santana Santos, 2012; Cardeña, 2018).

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