



Subjective Universe

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ABSTRACT

Ever since the deeply intuitive Bell inequalities argument and its subsequent experimental verification were presented, non-locality has been at the heart of quantum theory and clearly departs from its classical counterpart. On the other hand, a puzzling aspect of quantum entanglement is that it shows faster-than-light signaling between Alice and Bob to be impossible. In this article, we discuss that the compatibility between special relativity and quantum theory supports the acceptance of subjective reality over objective reality. Indeed, subjective reality derived from entanglement theory is consistent with a model of interwoven matter and mind relating to the non-computability of self-referential consciousness. This paper provides a relevant philosophical discussion of the preceding themes.

Key Words: reality, subjectivity, non-locality, entanglement

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Introduction

The French philosopher and mathematician René Descartes adopted methodological skepticism in the form of *suspicious reasoning*. Descartes was born in 1596 and studied law at the University of Poitiers. During his thirties and forties, he studied mainly in Holland and published a number of important books, including *Discourse on the Method of Rightly Conducting One's Reason and of Seeking Truth in the Sciences* (1637). Descartes' approach to seeking truth involved doubting everything to the most extreme extent possible, and he claimed that "doubt is the origin of wisdom". In particular, he considered that it is possible to manipulate mentality by treating physical objects as though they do not exist. By doubting every possibility, Descartes came to the conclusion that thought itself (i.e., rather than physical objects that can be seen or touched) must surely exist.

Albert Einstein is probably the most renowned person to have opposed quantum theory and, in particular, the Copenhagen interpretation of the theory. He was particularly displeased with the violation of causality that prevailed in science and

asserted that "God does not play dice". Indeed, Einstein appears to have been particularly dissatisfied with the role given to observation in the Copenhagen interpretation. While Schrödinger generally sided with Einstein, he acknowledged that, as science becomes more precise, subjective aspects may arise. However, this does not necessarily mean abandoning attempts to come up with an objective description of the Universe. Schrödinger argued that accepting subjective descriptions may be a compromise.

The Limits of Physics

In the case of quantum theory, at least in the standard Copenhagen interpretation, the physical system is represented mathematically using a state vector. The mathematical representation of the observer's frame of reference is called the observable, and quantum theory describes the way the observer and the object interact.

Although it may seem that the shift from an objective approach (as in Figure 1, Level I) to a subjective one (as in Level II) is somewhat abrupt, this change may have been rather inevitable, in the sense that, as science became more advanced and precise,

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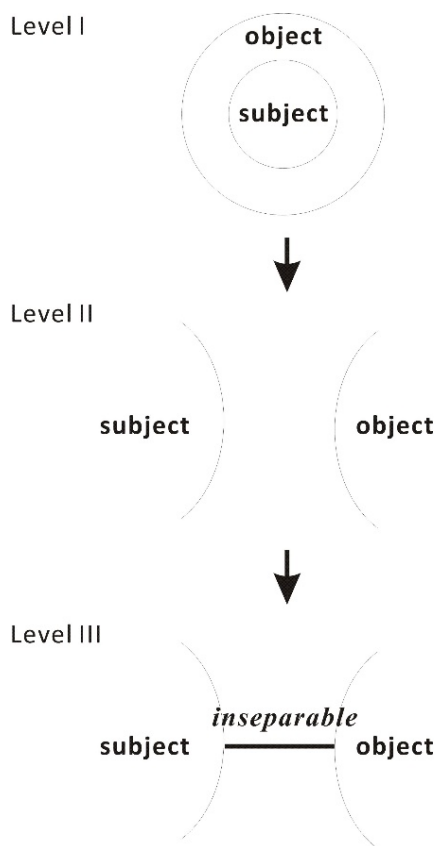


Figure 1. Level I: Classical Physics. Level II: Quantum Physics. Level III: Subjective Reality

it began to reveal the limits of objective knowledge. Niels Bohr commented as follows (Peterson, 1963):

“It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.”

The subjective limit applies not only to quantum theory, but to earlier physics also. Because science prior to quantum theory was not precise or advanced enough to reveal this subjectivity, subjective description was unnecessary. Indeed, quantum theory began to probe the limits of scientific investigation whereas, in the case of classical physics, the subjective limits were hidden or undiscovered.

Philosophy has a number of different branches: natural philosophy corresponds to physics, philosophy deals with morality and ethics, and metaphysics considers what goes beyond physics. In particular, epistemology concerns the fundamental study of knowledge; that is, what may be considered as true knowledge. The ancient Greek philosopher, Plato, believed that there are two worlds; namely, the ideal and physical ones. In particular, he considered that no trustworthy knowledge can be obtained from the imperfect physical world.

In physics, people often base mathematics on an ideal situation, such as a perfect circle. However, although mathematical ideal objects never exist in the physical world, the formulated rules based upon them are applied to the real imperfect world and yield useful predictions. Therefore, it seems that many scientific theories are based on the interplay between Plato’s two distinct worlds. Indeed, quantum objects, such as observables that are defined in an imaginary world of complex vector space, bear a resemblance to Plato’s ideal world. One of the pioneers of quantum theory and the Copenhagen interpretation, Heisenberg, remarked (Heisenberg, 1981):

“I think that modern physics has definitely decided in favor of Plato. In fact the smallest units of matter are not physical objects in the ordinary sense; they are forms, ideas which can be expressed unambiguously only in mathematical language.”

Aristotle’s ideas differed from those of his teacher, Plato: he considered only one world and tried to seek the meaning of that one world. In particular, he noted that the reality of a physical system may not consist simply of what it is made of. For instance, displaying the separate parts of a car is very different from displaying an entire car; that is, not only the material itself, but the structure or composition of the material, corresponds to a completely different reality. This may be interpreted as an inseparability between the physical system and conscious awareness that may be associated with metaphysical aspects. Plato and Aristotle were perhaps talking about different aspects of a single entity (Figure 2).

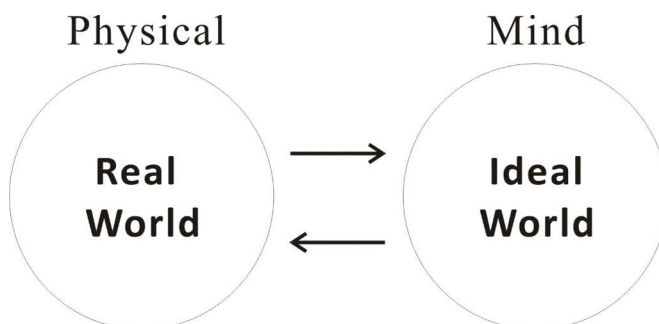


Figure 2. Interplay between the physical imperfect world and the mental ideal world.

Objective Reality vs. Subjective Reality

Quantum theory changed the scientific paradigm of two millennia from that of finding an objective reality (Level I, Figure 1) to that of studying the relationship between the observing party (i.e., the subject) and the observed or the object (Level II, Figure 1). Unlike



science, philosophers dealt with similar issues before quantum theory emerged. British empiricists tended to hold the opinion that knowledge results from experience or observation and, therefore, ought to be relative. John Locke believed that knowledge is obtained only through observation. He was a strong proponent of empiricism and did not believe in the innateness of knowledge; for example, he explained that sameness may mean rather different things to different individuals and asserted that scientific practice may lack innate knowledge. Locke argued that a person is born with a blank state of mind that experience fills; for example, people may have difficulty imagining a taste or smell that they have never experienced before. In particular, Locke argued that universal terms such as “whiteness” are constructed through repeated experience.

While debates between the rationalist and empiricist factions were ongoing, Immanuel Kant proposed another way of resolving the issue by arguing that objectivity and subjectivity may co-exist as far as human knowledge is concerned. Through careful and thorough analysis, he explained that absolute knowledge may be developed through reasoning, while relativism relates knowledge to observation. Like Kant’s argument, quantum theory and consciousness studies suggest that what we observe or experience is limited by subjectivity, and continuity, which we assert is the basis of a universal grammar, is associated with consciousness and shared between people (Song, 2019).

(Song, 2007) shows that the self-referential aspect of consciousness disrupts the symmetry allowed in quantum theory due to the separation between the observer and the object, as shown in Level II of Figure 1. Interestingly, a similar point regarding the self-referential predicament that exists in science has also been discussed by Max Planck (Planck, 1932):

“Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery that we are trying to solve.”

Due to the breakdown in the case of consciousness, it has been shown (Song, 2012; 2017) that the separation between the observer and the observed, as in Level II (Figure 1), is inadequate. In order to resolve this dilemma, the conscious mind of the observer and the object that is being observed must be inseparable, as shown in Level III (Figure 1).

In particular, with the introduction of cyclical time, it has been argued that the observed discrete physical Universe is filled with the continuous conscious mind of the observer that is generated by the reversal of quantum evolution (Figure 3). In other words, Level III in Figure 1 may be described as the interconnection between a physical system and conscious awareness; therefore, the objective and subjective realities may be described as follows:

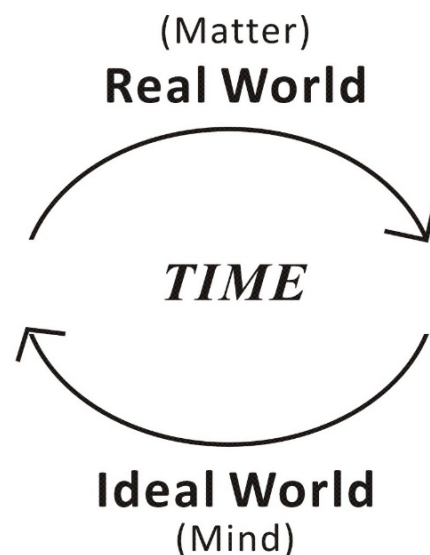


Figure 3. Subjective reality: matter and mind interwoven through cyclical time

Objective Reality: a physical system independent of the observer’s conscious awareness

Subjective Reality: a physical system dependent on the observer’s conscious awareness.

Non-locality and Reality

One of the most significant events in the history of modern physics took place in Brussels, Belgium, in 1927. The meeting was called the fifth Solvay conference, named after its founder, the Belgian businessman Ernest Solvay, and included some of the most profound thinkers of the time: Marie Curie, Max Planck, Hendrik Lorentz, Albert Einstein, and younger and upcoming scientists such as Niels Bohr, Erwin Schrödinger, Werner Heisenberg, Wolfgang Pauli, and others. At the conference, a famous debate about the nature of quantum theory took place. Einstein considered the probabilistic quantum theory to be incomplete, while Bohr described scientific endeavor as an interaction between an observing party and an observed object. Although these two scientific giants had contrasting views, it is known that they had an amicable relationship at a personal level.

In 1935, in order to show the incomplete nature of quantum theory, Einstein, Podolsky, and

Rosen used the strange theory of entanglement (Einstein *et al.*, 1935) (the term first used by Erwin Schrödinger in a letter to Einstein); indeed, quantum theory seemed to imply that two particles, or qubits, can be correlated, in such a way that they appear to be communicating instantaneously no matter how far apart they are, which would violate the laws of special relativity. (Also see (Korotkov *et al.*, 2006) and (Katz *et al.*, 2008) for undoing of a quantum measurement, thereby restoring an original unknown qubit.) Later Einstein called this peculiar aspect of entanglement “spooky action at a distance”.

In 1964, John Bell devised a brilliant method for determining the non-local nature of quantum theory (Bell, 1964). Subsequent experiments regarding Bell’s idea have been carried out (Aspect *et al.*, 1982) and have, indeed, confirmed the outcome predicted by quantum theory. This result suggests there is a faster-than-light influence between objects consisting of particles or qubits. This result surprised many people, including Bell himself, as the following comment implies (Farmelo, 2010):

“Bohr was inconsistent, unclear, willfully obscure and right. Einstein was consistent, clear, down-to-earth and wrong.”

While there is considered to be a superluminal aspect to quantum theory, this non-local aspect cannot be used for Alice to send information to Bob faster than the speed of light (Ghirardi *et al.*, 1980; Gisin, 1989; Scherer *et al.*, 1993; Bruss *et al.*, 2000). Indeed, various detailed studies regarding the non-local nature of entanglement and superluminal signaling strongly indicate the following two seemingly contradictory situations:

Case 1: Superluminal influence between qubits exists

Case 2: Superluminal communication between Alice and Bob does not exist.

Sometimes, it has been suggested that entanglement and special relativity are compatible due to there being no superluminal information transfer, as indicated in Case 2. However, various experiments have confirmed that the Case 1 phenomenon indeed takes place in nature, which certainly contradicts relativity.

In fact, the distinction between Cases 1 and 2 is shown even more vividly in the study of quantum cloning. If an unknown qubit can be cloned, it would

imply that superluminal signaling is possible, because Bob could clone qubit B and, with multiple copies, he would be able to distinguish the basis chosen by Alice. However, Wootters and Zurek have shown that quantum cloning is not possible (Wootters *et al.*, 1982).

On the other hand, although it has been shown that perfect cloning is not possible, it is still plausible to have imperfect or partial cloning (Bužek *et al.*, 1996). A question that was raised asked how, if partial cloning is possible, it can be used to only partially signal faster than the speed of light? Interestingly, this imperfect cloning has been shown to be insufficient for sending a signal; that is, the upper limit of partial cloning is also the lower limit at which any superluminal signaling can be achieved (Gisin, 1998). This relationship between cloning and signaling has also been applied to another type of cloning mechanism; namely, the probabilistic case, which clones perfectly, but with a probability of less than one (Duan *et al.*, 1998). Like deterministic imperfect cloning, probabilistic cloning has also been shown to be insufficient for sending a signal superluminally using entanglement (Hardy *et al.*, 1999).

Given two maximally entangled qubits, A and B, Alice measures her qubit, then qubit A communicates to qubit B how it should react. On the other hand, Bob, without knowing Alice’s choice, cannot know how qubit B reacts. Once Alice’s classical message reaches Bob, qubit B can be measured with certainty. If we consider subjective reality as a physical system, or an object, that is recognizable by the observer, as outlined in the previous section, Cases 1 and 2 may be re-written as follows:

Case 1’: Objective reality admits superluminality.

Case 2’: Subjective reality does not admit superluminality.

Therefore, if we accept the “no superluminal signaling” condition, objective reality should be abandoned and subjective reality ought to be taken as a correct description of nature. Moreover, this picture of subjective reality coincides with the conclusion derived from the completely different argument of the non-computability of self-referential consciousness.

In (Deutsch *et al.*, 2000), the local transfer of information has been discussed in terms of



Heisenberg’s formalism. If we accept the postulation that observables are an observer’s conscious reference frame, then entanglement corresponds to the correlation between the observer’s mental reference frames. Therefore, from a subjective reality perspective, entanglement is not a correlation between objects (i.e., qubits A and B—see Figure 4 (I)), but a correlation between Alice and Bob’s consciousness in a Dirac-type negative sea (Figure 4 (II)).



(I) Objective Reality



(II) Subjective Reality

Figure 4. (I) Objective reality suggests entanglement as a correlation between objects. (II) Subjective reality suggests that correlations exist between the subjects’ reference frames and that there is no superluminal influence between objects.

Remarks

In recent years, great efforts have been put to understand human cognitive processes. While these fascinating studies have indeed shed light on our understanding of the brain, a number of important unanswered questions still remain. The identification of observables in quantum theory, as an observer’s conscious reference frame, enables us to represent mind in terms of mathematical equations similar to state vectors’ mathematical representation of physical systems. Moreover, the non-computability of consciousness indicates that cognition is not a byproduct of a physical system, but is fundamentally different.

In this paper, we argued that subjective reality ought to be taken as a correct description of nature based on the compatibility between relativity and quantum theory. The inseparable relationship between an object and an observer’s consciousness is consistent with the same proposal derived from the non-computability of self-referential consciousness,

based on the asymmetry between the Schrödinger and Heisenberg pictures.

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