

The Problem of Conscious Observation in Relativistic Description

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ABSTRACT

The role of the conscious observer in Relativity theory is investigated with a view to unifying it with quantum theory on the basis of consciousness. It is argued that contrary to popular belief, the relativistic observer is not merely the reference frame i.e. the scaffolding of meter-sticks and clocks, but is also conscious. This fact has remained hidden for long, since classical measurements have been taken to end with the interaction of the system with the *apparata*, whether any conscious observer subsequently reads the resulting pointer state of the apparatus or not. However, Quantum theory demands that the measurement process be carried to its logical conclusion by the observation of the results and this must also be described by the theory. The aim in this article is to scrutinize the role of the conscious observer hidden in relativity theory so that a new basis for unification of quantum theory with relativity emerges from it. Generalized definitions in Relativity are provided and the eight specific bases of relativity, four each for the objective and the subjective categories, are delineated.

Key Words: consciousness, conscious observer, quantum measurements, subjective relativity, objective relativity, theory of perception

DOI Number: 10.14704/nq.2014.12.4.755

NeuroQuantology 2014; 4: 417-423

I. Introduction

It is a widely accepted scientific as well as common-sense assumption that there is an *objective world* which exists independently of the existence of observers (Tegmark, 2008; Hut *et al.*, 2006), although at the same time, it is also an equally widely accepted and well-known fact that different observers, humans or

otherwise, perceive this *objective world* differently depending on various factors that go into the make-up of the observer, the observed system and the process of observation (Wheeler, 1978). While this dichotomy could be easily ignored in the classical science era, it has become increasingly difficult to shove it aside after the advent of the theory of relativity and quantum theory (Zeh, 2000), which form the twin pillars of modern physics.

In the currently accepted scientific worldview, we understand space-time structure through the general theory of relativity (GTR) and the interacting fields of matter-energy inhabiting space-time through quantum field theory (QFT). Logically, this should have led us

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 19 May 2014; **Accepted:** 9 Sept 2014

eISSN 1303-5150



to rest happily contented, with nothing more left to understand. But, unfortunately for us, we can't, by our very make-up as human beings, rest content with two distinct theories providing us the 'complete' understanding of the so-called *objective world* of space-time-fields. Instead, we want them to fuse into one final theory of quantum-gravity, popularly called a theory of everything (TOE). Now, what the possible parameters and the probable structure of such a TOE could be are not so easy to define or delineate, but we do have some candidate theories like string theories and M-theory for it. At the same time we should not forget the fact that so many times in the history of science, deep-thinking and well-meaning scientists have very sincerely and boldly declared the end of science but every time science itself has unfailingly proved them wrong by throwing up new surprises and has moved forward.

As things stand today, a theory of quantum-gravity can claim to be a truly final one only on the basis of another *ad hoc* reductionist assumption that *consciousness is not a phenomenon fundamentally different from matter* and that *it arose from the latter* in the course of the inorganic evolution of the universe when matter became sufficiently complex and self-organized and found itself in an environment conducive for its manifestation (Tegmark, 2014). This assumption is untenable since the fundamental characteristic of consciousness- *the ability to know*- is quite absurd a property to endow matter with, which can only interact with another, but can never know another, much less itself. On the contrary, it is *consciousness alone* that manifests in us as the individual mind which *knows, thinks, feels, wills, organizes, compares, performs measurements and logical analyses, draws inferences, proposes hypotheses, builds theories and makes testable predictions* using the *material* instruments at its disposal like the senses, the nervous system and the brain. Thus, following the current objective science approach, we can at best have a final theory of matter-energy-fields only, constructed by mind(s) that have not been factored into the theory as essential ingredients of Reality as a whole.

Unless and until we address this glaring loophole in the final TOE, we are surely going to find history repeating itself in an eventual and inevitable abandonment of the same in favor of something stringier than string theory and

more mysterious than M-theory. In a recent work, Quantum theory was given a psychophysical interpretation wherein the conscious observer enters as an equal participant alongside the observed system in determining the outcome of quantum measurements. Most of us are afraid of talking about the conscious observer because we don't know how to address the issue of consciousness within science. We ask, "*Can one mathematically represent consciousness, or the observer, or one is just talking in the air? What is consciousness made up of and what are its defining characteristics? How is it related to matter, energy or fields or even space-time?*" These are some of the questions that we would expect a practicing scientist to skeptically ask following the objective science paradigm. Interestingly enough, there can be perfectly acceptable scientific answers to all of these and within the framework of quantum theory some of these have already been addressed in the literature (Pradhan, 2010).

In this work we aim to investigate the problem of conscious observation in relativity theory so that it can be unified with quantum theory, taking the observer also into account. Contrary to our apprehensions, the problematic conscious observer may actually provide us the solution to the problem of finding the long-sought after theory of quantum-gravity or TOE! In section-II we give the generalized definitions in the theory of relativity and attempt to delineate the bases of both subjective and objective relativity. We discuss the theory of perception in section-III and quantum measurements in section-IV and conclude in section-V with a discussion of the main results and future directions.

II. Generalized Definitions in Relativity

Relativity: *If observers O_1 and O_2 measure an observable Q for a system S to have values q_1 and q_2 respectively with $q_1 \neq q_2$, then there obtains relativity between them with regard to the observable Q .*

Observable: An *observable* is any property of the system under observation.

It may represent: (a) any objective *physical quantity* like energy etc. in physics, (b) any of the *qualia* (secondary qualities) like color etc. in cognitive sciences (c) the contextual *meaning* of a word or phrase in a context in literature

studies (d) it may even be some *characteristic* or nature of a living system (e.g. a human being) about which different observers have their different ideas, attitudes and opinions.

In the specific case of physical observables, we can represent them by real numbers in the classical domain and by Hermitian operators in the quantum domain as the case may be. The other three kinds are beyond the scope of the present work although the framework developed applies equally well to such observables also.

Observation: The process of *observation* consists in the flow of information from the system to the observer through the chosen apparatus followed by the rise of knowledge of the observable upon inspection of the apparatus by the observer.

This definition is in keeping with the requirements of quantum theory of measurements.

Observer: The *observer* is the one who observes i.e. the *individual knower* of the observable.

Although the conscious observer is generally identified as the physical body (of the observer) that houses the sense organs, the nervous system, the brain, and also presumably, the 'cognizing mind', or more precisely, the 'abstract ego' of von Neumann (von Neumann, 1955), we shall take this last, the *abstract ego* or the *conscious knowing subject* as the true observer, that actually cognizes the *brain state* or the *neural correlate* formed during the process of observation, as a concept or idea coming out of many intermediate percepts.

Note that in the above definitions, we have deviated from the widely accepted classical notion in relativity (Resnick, 1990; Klajnand Smolic, 2013) that the *reference frame itself is the observer* or even the much-debated position in some interpretations of quantum theory (Rovelli, 1996) that *the measuring instrument itself is the observer*, since quantum theory requires, at least in some of the interpretations, that the measurement process be *completed* by the acquisition of knowledge of the result through observation by the conscious observer (von Neumann, 1955; Pradhan, 2012). The reason for both the above untenable positions is not so much the *love for* the so called *objectivity* of science but is due actually to our

lack of any scientifically acceptable treatment of *subjectivity* or the phenomenon of consciousness.

We now proceed to delineate the sources of relativity on the basis of the above generalized definitions. Relativity may occur at the objective (observational) level and/or the subjective (observer) level, with various sublevels contributing to each of them as discussed below.

(a) Objective Relativity: The relativity arising out of differences in the process of observation by fully identical observers is *objective relativity*.

- **Systemic Relativity:** *No two systems are absolutely identical* although we usually assume that measurements made on the same system at different space-time locations are made on identical systems. Each system has a distinct history of its own right up to the time of a measurement and thus, the presumed identically is lost. Repeated measurements on the same system are, truly speaking, not performed on the same system but on different systems, each having undergone different measurement histories and each measurement having had its impact on the future evolution of the system. Further, the system may be in a superposition or it may be in an entanglement with another system or with its environment or it may even be entangled with the rest of the universe. Thus, this is the most fundamental kind of objective relativity which is usually ignored in practice.
- **Environmental Relativity:** *No system is absolutely isolated* and thus there is relativity owing to the environment(s) in which the system is placed and through which the signals from the system to the Instrument and from the instrument to the observer pass. All kinds of optical illusions are ordinary examples of *environmental relativity*. In quantum mechanics, *environment induced decoherence* due to coupling of the system with different environments leading to the realization of different quantum states is a well-known example.

- **Instrumental Relativity:** *No instrument is absolutely perfect* and thus there is relativity owing to the differences in the instruments employed for the purpose of measurement. Examples in classical physics include relativity arising due to differences in the least counts and resolving powers etc. of the measuring instruments. Further, a *direct* measurement of an observable may lead to a value different from that obtained in an *indirect* estimation i.e., through measurement of another related observable. In quantum theory, *quantum contextuality* is an example of *Instrumental Relativity*.
- **Frame Relativity:** *No preferred reference frame exists* and this is what we ordinarily understand by the word *relativity* in Physics. Frame relativity is classical relativity arising from the differences in the coordinate frames used for the observations. The values of an observable obtained in two such frames may be related to each other by translations, rotations and boosts (Lorentz transformations in special relativity) or by general coordinate transformations (general relativity).

These four kinds of relativity exhaust all possibilities from objective sources and are depicted in Figure 1. All these are independent causes of objective relativity and may coexist in any given situation.

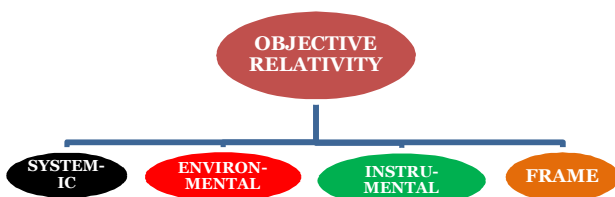


Figure 1. Sources of Objective Relativity.

It is to be noted that sometimes the instrument and the frame may be included in the environment and thus the resulting relativity may be classified as environmental in such cases, but this is not possible in general. Similarly, sometimes frame relativity may be an alternative to systemic relativity (e.g. in the case of translations or rotations), but that does not

take away the validity of classifying them as two different types of objective relativity.

While objective relativity is the everyday stuff of science, subjective relativity requires us to have a reasonable theory of perception, of which we give only an outline here in Section-III.

We now proceed to delineate the four primary sources of *subjective relativity*.

(b) Subjective Relativity: If there is no objective relativity due to complete identicality of the processes of observation of the *same system*, then the relativity coming purely from the differences between the observers themselves is *subjective relativity*.

It turns out that like the four sources of objective relativity, we can have the following four sources of subjective relativity.

- **Sensory Relativity:** If the relativity arises due to the differences in the constitution of the sense organs, then it is *sensory relativity*. An example is that between the colors perceived by a color blind person and a person with normal color vision.
- **Brain-state Relativity:** If the sense organs are identical but the same sensory signals excite different neural correlates (NCs) or brain states due to structural and/or functional differences of the brains (and/or the nervous systems) for some reason, it is then a case of *brain-state relativity*.
- **Perceptual Relativity:** If the senses as well as the brain states of the two observers are identical, and yet there is a difference in percepts (e.g. due to difference in attention) it is then *Perceptual Relativity*.
- **Conceptual Relativity:** If up to the percepts everything is identical but the resulting concepts are different (e.g. owing to differences in memory contents and additional analytical processes responsible for concept formation), then we have the *deepest* kind of relativity called *conceptual relativity*. This is essentially the same as the *conceptual relativity* discussed by Putnam (1988).

These four kinds of subjective relativity actually occur in a *nested* manner since all the information content of the various signals from



the observed object must first get to the brain through the avenues of the sense organs and then the *ego* must cognize the brain-state or neural correlate for the knowledge to rise. The knowledge of the observable is finally a concept (idea) and thus *any relativity, whether objective or subjective, must finally manifest as a conceptual relativity*. This is depicted in Figure 2 with the sequential arrows signifying the *flow of information* till the cognition process is complete.

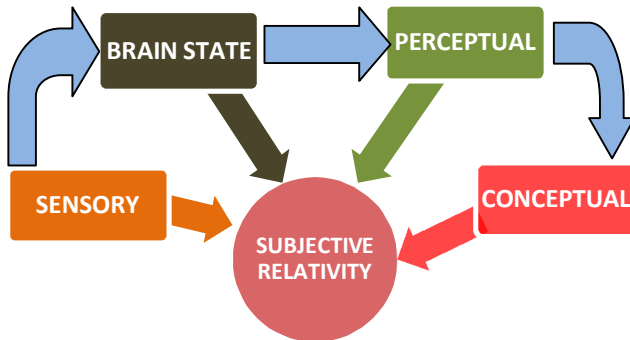


Figure 2. Sources of Subjective Relativity.

It is to be noted that any objective relativity must, of necessity, be recorded differently by at least two different observers or by the same observer at different times, first at the sensory levels, and then, it must manifest itself finally as different concepts, which are then cognized by their respective egos as being different outcomes.

III. Brief Outline of a Theory of Perception

To appreciate better the subjective causes of relativity, we have to have at least a plausible model of the process of perception by an observer from the instant of reception of the signal by the respective sense organs to the rise of knowledge of the observable in the conscious mind. As discussed in detail by Pradhan (2012), the sensory impression is transmitted through the nerve channels to the respective areas in the brain where a *neural correlate* (NC) is formed which is called a *brain state* corresponding to the object. This brain state is interpreted by the observer's *abstract ego* as the object existing outside through the de-excitation of the NC and following up to the object via advanced waves.

To elucidate the possible mechanism of interpretation of the brain state by the *abstract ego* we have to accept the fact that there must be a *percept* formed before it becomes a *concept* (idea). The *percept*, so to say, is the intermediate link between the *brain state* that is purely *physical* (material) and the *concept* that is purely *psychological* (mental) in character. Obviously the percept has to be the *electromagnetic field pattern* generated by the de-excitation of the brain state to the normal (ground) state of the brain. We remark that the Conscious Electromagnetic Information (CEMI) field proposed by McFadden (2002) pertains to this percept in our model. This percept or field pattern then becomes a concept when it is cognized by the conscious mind by first *identifying itself with the percept*, and then, taking recourse to the following *four-fold interpretative process*:

- **Differentiation:** considering the structural parts of the system (internal differentiation) and the distinctive features of the system that differentiate it from the rest (external differentiation).
- **Integration:** considering the system as a *structural* and *functional* whole leading to *gestalt formation*.
- **Comparison:** structural and functional matching with other similar as well as dissimilar concepts stored in the memory depending on its relation and interaction with them.
- **Categorization:** placing into a category like living or non-living etc.

In cognitive sciences, the cognition process is described as having three broad stages namely, *selection*, *organization* and *interpretation*. The above four are the essential steps at the stage of *interpretation*. The process of *cognition* (*i. e.* determinate perception) of an observable by an observer becomes *truly* complete only after the fourth stage *i.e.* after its classification, which renders it fit to be sent to the memory for storage. Especially, the role of *comparison* as a *sine qua non* in the cognitive process is extremely important in the formation, storage and recall of concepts, so essential to complete the subjective part of the process of measurement.

IV. Relativity and Quantum Measurements

While subjective relativity is obviously really very hard to deal with scientifically at the present moment, it turns out that even the more familiar objective relativity is not subject-less or subject-independent as is assumed classically in the objective science paradigm. Rather, the relative nature of quantum measurements forces us to accept the role of the conscious observer or the observing subject in the choice of the system, the instrument *i.e.* the observable, the environment and the reference frame for the observation which are all primary sources of objective relativity as has already been discussed.

In cases, where a quantum state can be assigned to the system, let $|\alpha^{(1)}\rangle$ and $|\alpha^{(2)}\rangle$ be the states assigned by observers O_1 and O_2 respectively, then there will be cases where a map \mathbf{M} exists between them such that,

$$|\alpha^{(2)}\rangle = \mathbf{M}|\alpha^{(1)}\rangle \quad (1)$$

Then, for purposes of comparison, the operators \mathbf{Q}_1 and \mathbf{Q}_2 corresponding to the observable \mathbf{Q} , as measured by O_1 and O_2 respectively, will be related by the transformation:

$$\mathbf{Q}_2 = \mathbf{M}\mathbf{Q}_1\mathbf{M}^\dagger \quad (2)$$

We note that in the well-known cases of objective frame relativity in quantum mechanics involving various continuous symmetries like translations and rotations etc, \mathbf{M} will be unitary, while this will not be the case in general.

According to the psychophysical interpretation, the physical states represented by kets $|\alpha^{(1)}\rangle$ and $|\alpha^{(2)}\rangle$ have their psychic counterparts in the minds of observers O_1 and O_2 respectively, and are therefore related by the psychic counterpart (*adjoint*) of eq. (1):

$$\langle \alpha^{(2)} | = \langle \alpha^{(1)} | \mathbf{M}^\dagger \quad (3)$$

This relation is the equation for conceptual relativity between O_1 and O_2 that must obtain if there is objective relativity between them. Correspondingly, we see that the psychic counterpart of the transformation equation for the observables is:

$$\mathbf{Q}_2^\dagger = \mathbf{M}\mathbf{Q}_1^\dagger\mathbf{M}^\dagger \quad (4)$$

This is identical with Eq.(2), due to the hermiticity of the operators \mathbf{Q}_1 and \mathbf{Q}_2 , assuring

us that the objective relativity obtaining between the observables in the physical domain must match the corresponding conceptual relativity between O_1 and O_2 in the psychic domain.

This gives us a novel psychophysical understanding of the meaning of the hermiticity of operators representing physical observables and the significance of their real eigenvalues in quantum measurements: “*While in general, there need not be an objective counterpart for every subjective perception; the real eigenvalues are those for which there are such objective counterparts.*”

Similarly, the identical of Eq. (2) and Eq. (4) also expresses a *real fact of relativity*, the existence of a *real transformation* having objective validity that is also subjectively perceived. It is to be noted that the states $|\alpha^{(1)}\rangle$ and $|\alpha^{(2)}\rangle$ and the operator \mathbf{M} are themselves different in the subjective and the objective domains *i.e.* are not self-adjoint, and therefore, neither the states nor the transforming operator \mathbf{M} can be physical observables, although they exist as physical objective *quantities* having valid mathematical representations and have their distinct conceptual subjective counterparts. In other words, *for something to be an objective physical observable, the essential condition then is that it must be self-adjoint i.e. must have the same corresponding subjective counterpart.* Here, the distinction between a *physical quantity* and a *physical observable* comes out very clearly *i.e.* not all physical quantities can be physical observables.

V. Discussion and Conclusion

We have showed how the conscious subjective observer can be incorporated in Relativity theory with a view to finding a common ground for its unification with quantum theory by appealing to quantum measurements. The emergence of the conscious observer in quantum theory of measurements is therefore not something to be worried about. Rather, we should gladly welcome its appearance, since it has always been part and parcel of the scientific approach but has been consistently ignored in the name of objectivity. However, the truth must ultimately prevail over all our attempts to sweep it under the carpet. Moreover, the bold acceptance of the conscious observer into the fold of mainstream science lends it greater credibility and completeness and opens up new



vistas and frontiers of research towards integrating the third category, namely, *conscious experience*, with *theories* and *experiments* that we already have as the two traditional pillars of science, the empirical-rational approach to the understanding of reality that appears as the phenomenal universe to us. Of course, we are as yet far from having any complete understanding of the mind-brain connection or the hard problem of consciousness, but we believe that by gradually incorporating the conscious observer into the well-known theories like quantum mechanics and relativity theory which do provide some room for such incorporation, we are making progress in the right direction, and may be, that day will come sooner rather than later, when consciousness and the experience of the conscious observer would become the everyday stuff of science and we would be knocking at the doors of the truly final and all-encompassing theory of everything, incorporating consciousness in quantum gravity or the other way around!

Acknowledgements

The author wishes to gratefully acknowledge encouraging discussions with S. P. Priyananda, L. P. Singh, and D. Dash.

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