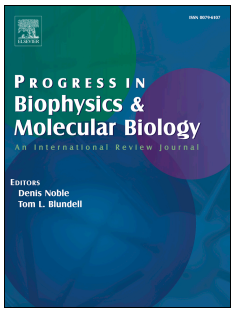
Accepted Manuscript



Sheaf theoretic formulation for consciousness and qualia and relationship to the idealism of non-dual philosophies

Menas Kafatos, Goro C. Kato

PII: S0079-6107(17)30120-7

DOI: 10.1016/j.pbiomolbio.2017.09.003

Reference: JPBM 1264

To appear in: *Progress in Biophysics and Molecular Biology*

Received Date: 30 May 2017

Revised Date: 1 September 2017

Accepted Date: 2 September 2017

Please cite this article as: Kafatos, M., Kato, G.C., Sheaf theoretic formulation for consciousness and qualia and relationship to the idealism of non-dual philosophies, *Progress in Biophysics and Molecular Biology* (2017), doi: 10.1016/j.pbiomolbio.2017.09.003.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Sheaf Theoretic Formulation for Consciousness and Qualia and Relationship to the Idealism of Non-dual Philosophies

Menas Kafatos[1,*], Goro C. Kato[2]

[1]*Fletcher Jones Endowed Professor of Computational Physics, Chapman University, Orange, CA 92866*
[2]*Department of Mathematics, California Polytechnic State University, San Luis Obispo, CA 93407*

ABSTRACT

Questions about the nature of reality, whether Consciousness is the fundamental reality in the universe, and what is Consciousness itself, have no answer in systems that assume an external reality independent of Consciousness. Ultimately, the ontological foundation of such systems is the absolute division of subject and object. We advocate instead what we consider to be an approach that is in agreement with the foundation of quantum reality, which is based on Rāmānuja's version of Vedanta philosophy and non-dual Kashmir Śaivism. Quantum mechanics opened the door to consciousness, *but* it cannot account for consciousness. However, the quantum measurement problem implies that we cannot remove subjective experience from the practice of science. It is then appropriate to seek mathematical formalisms for the workings of consciousness that don't rely on specific interpretations of quantum mechanics. Temporal topos provides such a framework. In the theory of temporal topos, which we outline here, the difference between a subject and an object involves the direction of a morphism in a category. We also note that in the dual category, the direction of the morphism is in the opposite direction compared with the original direction of the original category. The resulting formalism provides powerful ways to address consciousness and qualia, beyond attempts to account for consciousness through physical theories. We also discuss the implications of the mathematics presented here for the convergence of science and non-dualist philosophies, as an emerging science of Consciousness, that may bring out the underlying unity of physics, life and mind.

Keywords: Consciousness, t-topos, quantum mechanics, Vedanta, Kashmir Śaivism, qualia

*Corresponding Author
E-mail addresses: kafatos@chapman.edu (M.C. Kafatos), gkato@calpoly.edu (G.C. Kato)

Special issue on Integral Biomathics: The Necessary Conjunction of the Western and Eastern Thought Traditions for Exploring the Nature of Mind and Life

1. Introduction

Science presupposes that sentient scientists exist. Part of the sentience is an understanding on the foundations of science. Any scientific system of thought relies on the underlying ontological assumptions (or axioms) of such a system of thought, what is the nature

of underlying existence or being (Kafatos and Nadeau, 2000). Niels Bohr in the Copenhagen Interpretation of quantum mechanics (QM) argued that QM is silent on a possible underlying ontology and he instead opted for an epistemological approach, or how quantum mechanics is carried out in practice and what constitutes knowledge of the quantum world. Heisenberg, on the other hand, who along with Bohr was one of the chief architects of QM, held the view that ontology mattered and, therefore, even in standard QM one does not have unified views. Several interpretations of QM give identical results as standard QM (Wikipedia), however they differ in ontological assumptions. In this sense, ontology does matter as the different interpretations cannot all be identical.

The present work is the crossroad among philosophy, physics and pure mathematics, the latter providing the glue linking philosophical views of reality that include subjective and contemplative practices and pure physical theories that have little to do with the mind or its role beyond acknowledging its existence.

As such, we hold the view that ontology cannot provide a comprehensive account of the foundation of a system of thought, in this case QM and the theory of measurement, without accounting for the very awareness that is assumed in creating that ontology. As Max Planck explains, “I regard matter as derivative from consciousness. We cannot get behind consciousness. Everything that we talk about, everything that we regard as existing, postulates consciousness.” (from *The Observer* 25 January 1931).

This view of Planck and many of the founders of QM in the first decades of the twentieth century finds resonance with philosophical systems both in the East and the West, often termed idealism. In a recent published work, Theise and Kafatos (2016) outlined the unification in philosophy and science of what they term fundamental Awareness.

The mathematical formalism proposed here agrees with the unification approach, builds on a philosophical framework that examines the ontological assumptions of science, offering concrete steps that provide the foundation of scientific epistemological inquiry. In other words, unification can most naturally be approached by looking at mathematics to provide the bridge. The philosophical underpinnings sketched here are different from current science as practiced: They are in closer agreement with QM than what classical physics or Cartesian dualism (and we emphasize that classical physics is still at the core of the ontology assumed in science as practiced today) implicitly assumes.

We start with a single fundamental axiom drastically different from the (implied) metaphysical axioms of current so-called materialist science, which are accepted without a formal inquiry: Specifically, the unstated ontological assumptions or axioms of current science are that Reality is external, physical and independent of observation, that dualism between mind and matter is fundamental. In other words, the underlying ontology of how science is practiced today is that there is an external reality (matter) independent of observers (mind). However, QM has shown that this external, physical reality, which denies the role of conscious involvement, particularly the vexing measurement problem, simply doesn't work. Therefore, QM is fundamentally different than classical physics and all modern science (excluding QM) built on it as practiced today.

Rejecting *a priori* the implications of what quantum mechanics implies would completely stop the dialogue between science and philosophy/metaphysics. Doing this in order to remain within an outdated dualistic, external reality Cartesian physical model of the universe is not necessary, and in fact is not desirable. The value of controlling unrestricted subjectivity to conduct science and obtain objective scientific results is indisputable. Nevertheless, we have to

also understand the limits of the way science is being practiced today and the theory of knowledge itself or the epistemology of science.

Several works, in addition to t-topos theoretic methods (see Butterfield and Isham, 1999); and Mallios and Zafiris, 2016), have been proposed to study the foundations of quantum mechanics (and quantum gravity) in terms of categories and sheaves. Some of the motivating forces to adopt the notion of topos come from singularities, e.g., at the center of a black hole and the big bang singularity. Traditionally in physics we use the sets of real numbers $\mathbb{R}$ and complex numbers $\mathbb{C}$ with the Dedekind-Cantor type completeness of the systems causing various singularities as a consequence of mathematics based on $\mathbb{R}$ and $\mathbb{C}$, and hence result in no meaning in physics. For a general information for categories and sheaves, we recommend Gelfand and Manin (1996), and Kato (2006). Following the above arguments, we are proposing a new science in terms of categories and sheaves where from the outset, the observer will be considered integral to what is being observed, wherein the observer, the observed and the process of observation, form an undivided whole. In some sense, epistemology and ontology are intimately connected.

We posit that mathematics can approach foundational issues better than specific physical theories devised to study specific properties of physical systems. In other words, our approach can take us further than using physical theories which are generally developed to address dynamics of objects (see several references, of Kato, and Kafatos works). In other words, we view mathematics as more fundamental than physics to address ontological issues.

The observer-observed relationship is at the foundation of any system of thought. Any account of specific experiences of the physical world, the *qualia* that we examine below, are ultimately based on the most fundamental experience, namely the experience of the "other". Relationships between observers and observed fall more in the area of logic and cognition than in descriptions of physical dynamics. In the mathematical formalism of temporal topos (abbreviated as t-topos) as described below, observer and observed are naturally accounted for.

In the present work we use the equivalent terms "Fundamental Awareness", "Consciousness", and "Reality", realizing that terms such as consciousness, and reality are interpreted and defined differently in different fields. This unfortunately causes a lot of confusion and is a limitation of the ordinary language we use with very few words related to consciousness, meaning different things to different people. In the mathematical framework proposed here this is (partially) alleviated. The fundamental axiom takes all these terms, Fundamental Awareness, Consciousness and Reality, as equivalent. What we develop here is an axiomatic approach which encompasses the fundamental principles or natural laws and addresses some of the fundamental characteristics of Consciousness. The combined formalism suggested here assumes only one fundamental axiom. Statements or derivatives of that one axiom which are implied or follow directly from it are discussed as *notes*; whereas further clarifications of the axiom and of the notes that derive from it, are offered as *remarks*, which serve more as a clarifying role, in order to emphasize different aspects of the one Reality. Our approach as suggested here starts from Reality and the fundamental axiom and successively builds on them.

The present work can be seen as new foundational mathematical approach to modern science, showing how this implies forms of Idealism found in certain Hindu philosophies, supporting Hindu thought. Of course it would also apply to western Idealism and other eastern idealist philosophies. The interpretation of modern science, developed through category theory (a sheaf theoretical formulation), is closest to the Idealist philosophy of Rāmānuja (see for example Mishra, 2012), one of the most influential philosophers associated with the Vedanta school of

philosophy; as well as the vast non-dual system of Kashmir Śaivism (see for example Chatterji, 1986; Dyczkowski, 1992; Kafatos and Kafatou, 1991; Pandit, 1997; SenSharma, 2007; Swāmī Muktānanda, 1997; Swāmī Shāntānanda, 2003; Singh, 1980; Singh, 2006).

Rāmānuja's philosophical system was founded on qualified monism. His idealism asserts that there exists a plurality and distinction between the individual soul or Ātman and Brahman (the metaphysical, ultimate reality). He also affirmed that there is unity of all souls and that the individual soul has the potential to realize identity with the Brahman. Although in a sense all souls are essentially the ultimate reality, the unity in diversity (which is ultimately non-duality) needs to be realized. In this way, he differs from Ādi Shankara's Advaita (absolute monism) (see, e.g. Swāmī Prabhavānanda, Isherwood, 1975; Swāmī Vimuktānanda, 2005), which rejects qualified monism.

Śaivism is closer to Rāmānuja's idealism of qualified monism. It is a *Trika* (triadic) system, consisting of *Paramaśiva* or supreme Śiva, the Absolute, undifferentiated Being; *Śakti* (universal Energy), also known as Citi (universal Consciousness, as the creative power of the Absolute); and the individual soul. The triadic teaching holds that there is *no difference* between Śiva and Śakti/Citi, and in fact no difference between Consciousness, which is the One Paramaśiva/Citi, and the individual. The monism could be also viewed as a three-fold Reality, consisting of Consciousness, the universe, and the individual; or, alternatively, the object, the subject and the processes tying them together: Paramaśiva, the supreme Being is identical to supreme Consciousness, the Self of everything in the universe. Paramaśiva is the Absolute, undifferentiated universal Being, and as Brahman in Vedanta, is the underlying substratum of all existence. However, the world and multiplicity of objects and souls are also real (as they ultimately arise from Consciousness). As Citi unfolds the universe from herself onto herself, She (the Creatrix of everything) is the ultimate source of all manifestations, all objective existence, all experiences of the subjective selves and as such, also the source of the mind. Citi represents the immanent part of existence, while Paramaśiva the transcendent aspect of the same identical existence (cf. Kafatos and Chopra, 2014).

Śaivism as Rāmānuja's idealism, as well as Buddhist thought, Christian, Jewish and Sufi mystical explorations, and other philosophical traditions including Taoism and several philosophical systems of ancient Greece such as the philosophy of Plato, Heraclitus, Parmenides, the Neoplatonists, etc., as well as western Idealism since the Renaissance, share similar interpretations of reality. However, Śaivism and Rāmānuja's idealism, without being more privileged than other forms, are perhaps unique in the great care and methodical manner of description they provide, which finds resonance with modern implications of the quantum universe. As such, without attempting a complete review which would be beyond the aims of the present work, we present some of the statements of these two systems and find congruence not just with the implications of quantum theory but most importantly also with the formalism of the fundamental mathematical framework presented here: One important point to note is that these monistic systems *assign reality to everything* that exists. This is not the case with every idealist system. Śaivism as Rāmānuja's idealism do not deny the existence of the universe, but instead they consider the universe as real as the infinite Self, because in fact the universe arises from the Self. Countless or infinite numbers of universes and countless beings and objects are all emanations of the creative power of Citi as Śaivism emphasizes.

We offer here an interesting interpretation of modern science, showing the potential of our mathematical approach, and how the philosophical problems of science, e.g. accounting for qualia, could be overcome, from this perspective. Our approach provides a mathematical (and

therefore, ultimately, scientific approach, as all science is based on mathematics) to defend Idealism, providing the view that Idealism is not arbitrary. Our approach here is in agreement with the focus of the special edition.

2. Reality

As background to previous works and definitions (e.g. Struppa et al. 2002; Kafatos and Narasimhan, 2016), the systems of Vedanta (specifically Rāmānuja's) and Kashmir Śaivism are relevant to the Idealism that the mathematics is in agreement with. Here we present the following updated statements and formalisms:

> "Category theory was developed as a general framework for many fundamental concepts like sheaves, presheaves etc. in algebraic geometry and algebraic analysis". Initially sheaves, presheaves and functors were defined over a topological space to the category of sets or the category of abelian groups, but later generalized to the case where the target category can be an arbitrary category. Note that a sheaf is a special presheaf that satisfies the sheaf axiom, whose definition is given in Section 3. That is, a presheaf is a sheaf if global information (a section of a sheaf) can be uniquely determined when given local information can be pasted together. This point is emphasized in the discussion given in the qualia section. "Now with the advancement of quantum cosmology it is believed that these abstract mathematical objects may play a significant role in physics" (Struppa et al, 2002). For the sake of completeness let us review some of the basic notions from categories and sheaves as follows: Historically speaking, the concept of a sheaf was defined over a topological space. A contravariant functor is said to be a presheaf especially when the functor is defined on a site (a category with a Grothendieck topology) or on a topological space. This is further discussed in what will follow in this paper. Note that the concept of a Grothendieck topology was originally introduced in Algebraic Geometry by Alexandre Grothendieck around 1960 to overcome the difficulty of proving Andre Weil's conjectures on zeta functions determined by an algebraic variety over a finite field of characteristic prime $p>0$. The notion of a site is a generalization of a topological space, e.g., Euclidean space, so that sheaf theory can be developed over such a site (a category with a Grothendieck topology). For a general theory of a sheaf over a site, see Kato (2006, 2013), Kashiwara and Schapira (2006) or Gelfand and Manin (1996).

Moreover we note:

> "Various QM phenomena, which actually form subsets of the three Laws of Nature, can be discussed in the context of category theory, within universal Consciousness, as they apply to the physical world…If conscious entities are described as *presheaves* on *T* (where *T* is a site or a (general) topological space), their *complementarity* nature is embedded in the very way in which presheaves and sheaves are constructed. Interestingly enough, while both descriptions are adequate ones, on each given theorem, only one or the other representation is used in practice, in accordance with the principle of complementarity…" (Struppa et al., 2002; Kafatos and Narasimhan, 2016). For a more general and updated description of the above in terms of a general *t*-topos theoretic sheaf theory, see Kato (2017) or Kato (2013).

We are now ready to develop the *t*-topos approach to reality. We present elements of *t*-topos, referring to full treatments in numerous works of mathematical *t*-topos formalism developed elsewhere (e.g. Kato, 2004, 2005, 2013, 2017).

The most general definition of a presheaf is a contravariant functor from a category *C* to another category *D*. Traditionally, category *C* is the category induced by a topological space where morphsims are only inclusion maps, and the target category *D* is the category of sets, or the category of abelian groups. Since we need the notion of a presheaf over a site, we need a more general notion of a presheaf than a presheaf defined over a topological space. Recall also a contravariant functor *F* from category *C* to category *D* is an assignment from objects and morphisms in *C* to *D* as follows: for an object *X* in *C*, *FX* is an object of *D*. For a morphism *f* from *X* to *Y* in *C*, we have the induced morphism *Ff* from *FY* to *FX* in *D*, satisfying $F(g \circ f) = F(f) \circ F(g)$ as a morphism from *FZ* to *FX*, where *g* is a morphism from *Y* to Z. Lastly, for identity morphism *1* on *X*, *F1* is the identity morphism on *FX*.

Definition: A presheaf *m* is said to be a *t*-presheaf from a site *S* to a category when *m* is defined for objects of a subsite R_m of *S*, where a site *S* is a category *S* with a Grothendieck topology. See e.g., Gelfand and Manin (1996), Kashiwara and Schapira (2006) or Kato (2006, 2013) for the notion of a site and a sheaf over *S*.

See also Remark near the end of Section 2 for a logical solution to the above notion of the modified notion called a *t*-presheaf. In what will follow in this paper, a *t*-presheaf is said to be simply a presheaf defined on a *t*-site *S*.

As discussed above, central to our approach, is the relationship between subject and object: The only difference between the observer and the observed is in the direction of a morphism in a category (e.g., Kato, 2013). Since the spacetime sheaf $\omega = (\kappa, \tau)$ is a final object of the t-topos $\hat{S}$, for any object *m* of $\hat{S}$, there exists a unique morphism from the object to the spacetime sheaf. Even for a physical object, *t*-topos accounts for the relationship between the observed object and the observer. For example, for an electron (*t*-)presheaf *e* associated with an electron, when presheaf *e* associated with an electron is in an ur-particle state, by definition, there exists an object *V* in the t-site so that *e*(*V*) is defined. For this case, we say also that *e* is reified at *V*. When *e* is observed, presheaf *e* is necessarily in an ur-particle state. One can also say that in such an ur-particle state, a presheaf *e* collapses of the wave states at the *V*. As is often used in a categorical notion, an ur-wave state of presheaf *e* can be written as *e*(-). The effect of an electron on spacetime (sheaf) in the microcosm comes from the unique morphism $e \xrightarrow{\sigma_e} \omega$ in the following sense: Suppose that there exists *V* where *e* and ω are reifed. When $\omega(V)$ is observed by an observer *P*(*V*) by the morphism $\omega(V) \xrightarrow{S_V} P(V)$, then the composition $S_V \circ \sigma_V$ gives information on the ur-particle (see below) state of *e*(*V*) through measuring its effect S_V on $\omega(V)$.

We now present the foundations of *t*-topos as pertaining to Reality. Specifically, in:

Temporal Topos, the category $\hat{S}$ of presheaves on a temporal site *S* exists independently of the usual notion of time.

A more explicit definition of a temporal topos, as the category of contravariant functors, or rather contravariant *t*-functors from a *t*-site to a product category, will be given in what will follow. Note also that, via the Yoneda Lemma and its embedding, the target product category (considered as a site with a canonical topology) can be embedded to a topos.

Namely, for the (pre)sheaf τ associated with time, the classical notion of time *t* (or infinitesimal time period Δt) is expressed as the reified $\tau(V)$ for an object *V* of the temporal site *S*. See the comments on the usual notion of time *t* and the generalized time period $\tau(V)$ in the section on Qualia in what will follow. In temporal topos, the fundamental postulate states that we disregard whether the time associated (pre)sheaf τ is reified or not. As such, in what follows we assume the existence of the temporal topos $\hat{S}$.

The underlying basis of our formalism is expressed in the following Axiom, which we also state in t-topos formalism:

Axiom 1: *Fundamental Awareness or Consciousness is the total Reality.*

The Axiom is in total agreement with the first sūtra of the Śiva Sūtras (Dyczkowski, 1992; Singh, 2006). which states: "Consciousness is the Self". In other words, Reality, which is the universal Self, is identical to Consciousness.

Here we use the term "Fundamental" in the sense of unified (global) consciousness. In *t*-topos formalism, the concept of Fundamental Awareness is interpreted as the *t*-topos $\hat{S}$ itself where all the presheaves are un-reified. Our ontological temporal topos postulate states that a *t*-(temporal) topos exists independently from the usual notion of time. Mental and physical realities are formulated in terms of *t*-topos, i.e., via categories and sheaves. Therefore, restating the general statement of the above Axiom 1 in *t*-topos formalism, it takes the equivalent mathematical form, providing a mathematical formalism for the fundamental tenet of non-dual Idealism:

Axiom 2: *Category of all un-reified presheaves is total (un-reified) Reality.*

Recall that a (*t*-)presheaf *m* is reified when there exists an object *V* in the *t*-site *S* for which *m* is defied at *V*, and, *m* is said to be not reified or un-reified at *U* when *m* is not defined at *U*. Consequently, the total Reality consists of all the ur-wave state presheaves {*m*(-)}. We can also state that there many physical and mental realities but all are contained in the One, Reality, as we further explain below. The difference between the total un-reified Reality in Axiom 2 and the Reality that consists of reified presheaves is the following: The total reified Reality is potentially observable. However, un-reified Reality can be observed only by the mind.

Note that general term for a category of sheaves over a site is said to be a *topos*. We use a restricted notion of a topos, which we call Temporal Topos or simply a *t*-topos. Recall also that a site is a category with a Grothendieck topology. For more detail explanations and applications of a topos over a site, consult Kashiwara and Schapira (2006) or Kato (2006, 2013). In what will follow we develop concise description of the logical statements in terms of *t*-topos. As one can observe in what will follow, the most significant restriction is that in our *t*-topos theory, a (*t*-) presheaf in *t*-topos need not always be defined at an object of a site.

The following remarks apply as pertaining to the above Axiom:

Nothing exists which is not within Fundamental Awareness. That is, if anything exists as a reified presheaf, it is within reified Fundamental Awareness. Or, equivalently**:** There does not exist anything outside Fundamental Awareness.

Here "Nothing(ness)" can be identified with $\hat{S}$, the (un-reified) topos (or the "nothing" of Vilenkin, 1982). If we adapt this definition of "nothing" of Vilenkin as un-reified presheaf category $\hat{S}$, it follows that a universe emerges out of this "nothing". As was indicated in Kato

(2017), when all the presheaves are not reified, including space-time sheaf $\omega = (\kappa, \tau)$, then in such a state, spacetime cannot be observed.

We also remark that Awareness is all possibilities, including qualia, the qualities of experience (see below). All possibilities are presented by reified presheaves. We regard qualia as reified presheaves. This is the case when presheaves match the pairing partners from the *t*-site. We can call such a pair as a reified pair of a presheaf and a *t*-site object.

We further remark that:

The observable Universe is the totality of observable objects. Or, equivalently,

The observable Universe consists of reified presheaves.

We can also say that the observable Universe is the immanent (i.e. different manifestations) aspect of Awareness in the following sense:

The observable universe is reified aspect of *t*-topos, i.e., as stated earlier, reified objects (presheaves) of the *t*-topos.

An important point to make is that all potential manifestations of consciousness form the transcendent aspect of Awareness. Namely, all un-reified presheaves form the transcendent aspect of Awareness. Note that in the *t*-topos theory developed in Kato (2005, 2006, 2013) the concept of "enough presheaves" assumption was developed. Namely, there exists a presheaf for every particle (microcosm or macrocosm). That is, there are more presheaves in category *t*-topos which need not correspond to any particles. In this sense, *t*-topos has "enough presheaves".

Finally, Awareness is boundless in the sense that there are more presheaves than reified presheaves, without beginning or end, not subject to limitations of space or time.

Remark: In order to avoid logical problem, a referee kindly suggested the following, which we have accepted with deep appreciation. We will define a category *W* containing the temporal topos $\hat{S}$ as a full subcategory: The objects of *W* are pairs (*m*, *a*(*m*)) where m is a presheaf from S to the product category and *a*(*m*) is a subcategory of S. Namely, we interpret a reified presheaf as the restriction of an un-reifed presheaf to the subcategory *a*(*m*) of *S*. The morphisms from (m, a(m)) to (*m'*, *a*(*m'*)) in *W* are pairs (*j*, *i*) where *j* is the inclusion functor from *a*(*m*) to *a*(*m'*) and *i* is a natural tramsfomation from *m* to *m'*, i.e., a morphism of presheaves. Then category W contains both reified and un-reified presheaves. Hence objects in $\hat{S}$ are *t*-presheaves, which in this paper we abbreviate simply as presheaves over a *t*-site *S*.

3. Nature of Fundamental Awareness

If fundamental Awareness is the total Reality, then what is its nature? What are its main characteristics?

An important remark to make which ties the formalism here to Eastern systems of thought is that Reality is Consciousness and Completeness, or Being (Light) and Consciousness, in Śaivism (in Vedanta systems it is Being, Awareness and Completeness) of different types (Singh, 2006; Pandit, 1997; Kafatos and Kafatou, 1991). This Reality is the Light that illumines everything, and also consists of Awareness of everything that exists.

Or, equivalently, restating this general philosophical statement in *t*-topos, we note:

Reality consists of reifications of presheaves as objects of *t*-topos $\hat{S}$ defined on *t*-site objects, called generalized time periods. And,

Consciousness is self-interacting as both the subject and object of awareness. Consciousness is expressed in *t*-topos as follows: For a conscious entity we associate with it a sheaf *P* rather than a presheaf. This is because a conscious entity is capable of connecting local

information data to obtain global information. In terms of sheaf theory this simply means that the pair ($P(V)$, $P(g_i)$) is an equalizer in the following sense; if $p(\pi_i)(x_i) = p(\pi_j)(x_j)$ for x_i in $P(V_i)$ and x_j in $P(V_j)$ then there exists a unique x in $P(V)$ such that $P(g_i)(x)=x_i$ for all I,:

$$P(V) \xrightarrow{P(g_i)} \prod_{i,j} P(V_i) \underset{P(\pi_2)}{\overset{P(\pi_1)}{\rightrightarrows}} P(V_i \times V_j)$$

where π_k are projections from $V_i \times V_j$ to V_i and V_j, respectively, $k = 1,2$. Namely, a conscious entity can "paste" local "matching" section data to obtain the unique global section in the above sequence. For details, see Kato (2006). Self-interaction can be expressed as an endomorphism *P(V)* to *P(V).* That is, in terms of temporal topos, self-awareness is an endomorphism of the sheaf associated with a conscious entity over a generalized time period.

We make several further notes: The mind is of the same nature as Consciousness. And, (expressed in an equivalent form): The individual is essentially the same as Consciousness. These statements are in agreement with Rāmānuja's version of Vedanta philosophy and non-dual Kashmir Śaivism. As such, all observers, all experiencers, all individuals are none other than the Consciousness. All minds are ultimately the one Mind (Citi) (see for example Swāmī Muktānanda, 1997; and Swāmī Shāntānanda 2003).

All experiencers are immanent components of the transcendent Reality, which is universal, non-dual Awareness.

Focused attention of the observer can also turn back on itself, which is what is termed introspection (or meditation). This now has a mathematical equivalence in t-topos.

The individual is subjected to misunderstanding of his true nature of Reality and experiences dualism in different states. And,
(equivalent form) Human consciousness, the subconscious, different sleep states, awake state, are all aspects of Consciousness but are considered as separate from Consciousness. This is related to the veiling aspect of Fundamental Awareness.

The brain and the mind are similar types of complementarities to the universe and Consciousness.

4. Powers of Fundamental Awareness

One can inquire about the powers of Awareness, manifesting in the Universe. We note the following statements:

Fundamental Awareness possesses infinite powers, meaning it has no limitations, it can accomplish anything in the sense that there are enough un-reified presheaves with the potential to be reified.

In Śaivism three powers are primary (Dyczkowski, 1992; Pandit, 1997; SenSharma, 2007; Singh, 2006): Will; Knowledge (based on awareness of other and of itself); and, Action (Kafatos and Chopra, 2014; Kafatos and Kafatou, 1991). These are discussed in the papers by Kafatos (2015) where a Hilbert-like fundamental mathematics is applied to Will, Knowledge and Action.

The three powers also exist in the individual as they exist in Fundamental Awareness but are experienced in reduced or limited form.

The primary power is the complementary relationship in the unity awareness "I Am That" or "That Am I". The denial of "I Am That" yields veiling, wherein global reduces to the local.

And in the opposite sense, the denial of veiling yields Unity, which manifests in the "I Am That" relationships.

A separate universe is an illusion as the universe is essentially Consciousness. This is in agreement with Advaita (non-dualist) Vedanta but stated more clearly, and without confusion as to what "illusion" may imply, in Kashmir Śaivism. When objects, subjects and processes are experienced as not separate, all that remains is the Unity of Awareness. In this Unity, all is process, "everything flows" is the dynamical nature of Consciousness.

5. How the Universe Arises

If everything is Consciousness, the question naturally arises, how does the objectified universe with different objects and forms arise?

In t-topos, we note that**:** Self-interacting Consciousness projects the universe onto its own field of awareness.

In Kafatos and Chopra (2014) (see also Kafatos and Kafatou, 1991), it is stated:

> "How does the universe manifest? What is the source of the universe? The first sutra of the *Pratyabhijñā-hṛdayam*, "The Secret of Self Recognition", authored by Kṣemarāja (Singh, 1980) states: "Citi, supremely independent universal Consciousness, is the cause of the manifestation, maintenance, and reabsorption of the Universe". Alternatively, "The universe is the means to attain the realization of free universal Consciousness" (Swāmī Shāntānanda, 2003). The first aphorism gives the underlying cause of the changing universe, as universal Consciousness. Here the three cosmic actions which create, maintain and re-absorb all existence are attributed to Citi. In contrast to the way scientists view the universe as being caused and driven by the laws of Nature, the Pratyabhijñā-hṛdayam states that the cause is Consciousness itself. How does universal Consciousness unfold the universe? Sūtra No. 2 of the Pratyabhijñā-hṛdayam states: "By the power of her own will, she (Citi) unfolds the universe upon her own screen (i.e. in herself, as the basis of the universe)". Here Kṣemarāja describes the universe as being nothing other than the projection by Consciousness onto Consciousness. What appear as differences in the objectified world, are projected differences in the universal screen of Consciousness. But then the question would arise, what is the origin of the vast diversity of objectified existence? Sūtra No. 3 of the Pratyabhijñā-hṛdayam, explains: "That becomes diverse because of the division of reciprocally adapted objects and subjects". In other words, division in what appear as objects and subjects gives rise to all diversity".

As all is un-reified potential, Consciousness does not need anything external to project (form) the universe.

Moreover, Consciousness takes on limitations in order for manifestation of the objective universe to proceed from the transcendent to the immanent or from Fundamental Awareness to the individual mind or from global Mind, as many Buddhist schools would state, to local mind. Veiling is the root cause of the experience of limited existence (see for example Kak, Chopra and Kafatos, 2014). In quantum theory, veiling is responsible for inherent non-localities that are directly observed. The reader is directed to the works of Kafatos and Kak (2015) and references therein on the veiling in general which assumes specific definitions in general relativity and quantum mechanics as explained in Kafatos and Kak. Likewise, for fundamental Awareness,

veiling appears to reduce to a limited individual who is nonetheless similar to fundamental Awareness.

We remark the following equivalent forms given here: Veiling is characterized by limiting the field of Awareness to specific properties which characterize objects and qualia. L imitations give rise to space, time, limited desire, limited knowledge, limited action, and, therefore, limited existence. Veiling is non-localized, but once reified, limitation is induced. Limitations give rise to boundaries in the infinite field of Awareness. Projections onto Consciousness are experienced or reified as boundaries of Reality. Boundaries give rise to the objectified experience of existence of forms. These projections appear to bind Reality but don't change its essential transcendent, formless nature.

Finally, at the objectified levels of ordinary existence, veiling becomes veiled non-locality and cosmic censorship. In terms of *t*-topos, when a presheaf is not reified, it is even meaningless to ask where and when an entity, associated with the presheaf, exists. Such a presheaf exists in the category called *t*-topos without specified location and time.

6. Operational Principles and Quantum-like Processes

Consciousness operates through the *operational Principles* or *Laws of Nature*, namely Complementarity (or Integrated Polarity); Recursion (or Correspondence; i.e. expressed as similar patterns and laws across different ranges); and Flow (or Creative Interactivity) (Kafatos and Nadeau, 2000; Theise and Kafatos, 2013a, b).

We note that in the *t*-topos formulation complementarity can be understood as the *dual*, reified versus un-reified. Creative interactivity is understood as *morphism.* Namely, in terms of t-topos, when an entity *m* is observed (or measured) by another entity *P* (e.g., a human or a machine), there exists an observation morphism from $m(V)$ to $P(V)$ over an object (a generalized time period) of the t-site. If one prefers to express this morphism in a more precise way, i.e., relevant to relativity theory, we replace *V* by *V*' where a morphism from *V* to *V*' is a t-linear morphism (that is the particle ur-states $m(V)$ and $P(V')$ are in a t-light cone. For details, see Kato 2005 or 2013.)

There are no parts of the universe, no scientific fields, no processes that are not subject to the three Laws of Nature, Complementarity, i.e., the underlying presheaves $\{m\}_{m\in\hat{S}}$, Recursion, i.e., the discrete nature of *t*-site, and Flow, i.e., the process $\left\{m(V)\longrightarrow m'(V')\right\}_{\substack{m,m'\in\hat{S}\\V,V'\in S}}$.

As such, the Laws of Nature are the means of Awareness projecting "out" the Universe. They form what experiencers experience as "external reality". The so-called Universe and all its so-called objects arise from the split between objects and subjects, interacting with each other, according to the Operational Principles.

Studying the microcosm reveals the macrocosm and vice versa (Theise and Kafatos, 2013a, b). This can be formulated in terms of sheaves. From macrocosm to microcosm the process proceeds in a restriction, which is functorially induced by the presheaf for a morphism in the t-site, and from microcosm to macrocosm is described by the sheaf axiom as explained above. As discussed in previous works (see also Chopra and Kafatos, 2017) the Laws of Nature are most easily discernible in the scientific fields of quantum mechanics, relativity theory and quantum biology, including neuroscience. The extension of QM to other scientific fields, following the Operational Principles outlined here, can be formalized at mesoscales as *quantum-like* processes. Quantum-like are generalized processes and phenomena that apply beyond the

strictly microscale levels for which the original QM was developed. As such, QM reveals the underlying Operational Principles applying beyond the microscales of quanta as quantum-like processes.

7. Qualia

The so-called "hard problem" (Chalmers, 1995) of consciousness is a statement of what constitutes experience. Experiences in the world are termed *qualia* (Chopra and Kafatos, 2017). Qualia are the glue that holds the five senses (vision, audition, somatic sensation, gustation, olfaction) as well many other modalities important for our experiences, together and gives the appearance of an external reality. All experiences, whether of the body or the outside world, consists of qualia. Our world only exists because we perceive it and act as conscious agents. Thus, all interactions with the universe are experiential and subjective. What we call "objective" in science is that which we can measure within patterns of qualia dictated by mathematical laws. Quantum mechanics is a mathematical model for formalizing and measuring what are nothing other than experiences (compare with Bohr's, 1934 and 1958, view of reality). It's the map, not the territory (Chopra, Tanzi and Kafatos, 2014).

The field of pure awareness exists prior to qualia, while subjective experiences in Consciousness are qualia, which are sensations, images, feelings, thoughts (Siegel, 2016). Qualia are the experiential attributes of Consciousness. To clarify:

There is no possibility of proving anything existing outside of qualia. Qualia are distinct and are tied to the experiencing individuals. Space, time, particles, all objects are nothing other than qualia when they are reified, i.e. possible subjective experiences. Mathematics itself is the most refined form of qualia. Even our neuronal system is a product of a possibility in consciousness, which has evolved as a mode for interpreting consciousness from a perspective that makes humans unique, at least as currently understood or as it appears to be the case (see the work of Kato and Nishimura, 2013, and 2015). The underlying world is pure Consciousness, which has no qualities, being the pre-created state. Since this is also the ground state of existence, human awareness can explore it through an experience of the mind's silent source (Chopra, Tanzi and Kafatos, 2014). Experiences of the external world are mediated by the qualia of sensory awareness (including sight, sound, touch, taste, and smell) as consciousness interacts with itself (Chopra, Tanzi and Kafatos, 2014).

One may say that qualia are the reified Reality. Qualia appear on the boundary between the perceived and the actual (pure Consciousness) (Chopra, Tanzi and Kafatos, 2014; Chopra and Kafatos, 2017). *From the un-reified to the reified.* The process of consciousness interacting with itself is most obvious in humans as self-awareness imparting the sense of choice, purpose, and meaning (Chopra and Kafatos, 2017). Self-organization, which can occur with discrete systems as well, is based on continuous feedback loops (Theise and Kafatos, 2013a).

"Veiling" makes qualia appear as unreal or irrelevant and space, time and objects as real. However, it is the other way around. The so-called "measurement problem" of QM reveals the underlying conscious Awareness.

To proceed, we need the following definitions:

Ur-State: A presheaf *m* is said to be in an ur-particle state if there exists an object *V* of the *t*-site at which *m* is reified. And *m* is said to be in an ur-wave state when *m* is not reified with any object of the *t*-site.

Qualia: They can be defined in *t*-topos as: Qualia={reified presheaves}={$m(V)$: $m \in \hat{S}$, $V \in S$}

We note again that objects of the *t*-site S are said to be generalized time periods. The notion of a generalized time period, i.e., an object of *t*-site S is more fundamental than the usual time concept in the following sense. The usual concept of time is a reification of a time-associated presheaf τ defined on the *t*-site S. Namely, a generalized time period *V* is used as a parameter for the usual time concept. That is, the usual time *t* is controlled by generalized time *V*. Let *t* to be preceding *t'* in the usual sense. Namely, for $t \leq t'$, we write $t \to t'$. Let *V* and *V'* be the corresponding *t*-site objects (generalized time periods) to *t* and *t'*. The correspondence between them can be phrased as $t \sim \tau(V)$ and $t' \sim \tau(V')$. Note also that in the theory of *t*-topos, time, presheaf τ is assumed to be a sheaf so that the smoothness of (space-) time is a consequence of a sheaf property of exactness of the sequence mentioned above. Notice also that our approach toward time is not the Dedekind-Cantor type in the sense time *t* is an element of set $\boldsymbol{R}$ of real numbers. We consider the true nature of time is not a point on the real line $\boldsymbol{R}$, rather a period given by τ (*V*). We will use $\omega = (\kappa, \tau)$ as a pair of *t*-entangled sheaves of space-time. For more information on *t*-entanglement, see Kato (2013, 2017). By the definition of qualia, i.e., Qualia={reified presheaves}={*m(V): m*$\in \hat{S}$, *V*$\in S$}, it is the totality of all the (ur-) particle states of presheaves associated with particles.

For the sake of completeness let us recall the following: We let $\hat{S}$ be the category of presheaves over a site *S*. A presheaf is a contravariant functor from a site *S* to any category. In our *t*-topos approach, with a restricted notion of a site, which is called *t*-site *S*, a presheaf is nothing but a contravariant functor from *S* to a product category of categories of all the measurable physical entities. We can express such a presheaf as:

$$m : S \longrightarrow \prod_{\alpha \in A} C_\alpha$$

Or some prefer to write this category as $\left(\prod_{\alpha \in A} C_\alpha \right)^{S^{opp}}$. Consequently, for an object *V* (generalized time period), a presheaf *m* takes *V* to a reified state *m*(*V*) in the product category $\prod_{\alpha \in A} C_\alpha$.The projection $\pi_\alpha : \prod_{\alpha \in A} C_\alpha \longrightarrow C_\alpha$ takes $m(V)$ in $\prod_{\alpha \in A} C_\alpha$ to $m_\alpha(V)$ in C_α.

We remark here that the *t*-topos theoretic uncertainty principle comes from the notion of a micromorphism. Recall that our notion of a *t*-site is a restricted notion of a general site (i.e., a category with Grothendieck topology) where a presheaf need not be defined for all the objects of the *t*-site. Let us assume that a particle is measured twice at time *t* and time *s*, and let the corresponding generalized time periods be *V* and *U*. Then the corresponding morphism from *V* to *U* is said to be a *t*-linearly ordered morphism (or *t*-linear morphism). Suppose that a presheaf *m* is reified at an object *V* of a *t*-site. A morphism $\varphi : V \longrightarrow V'$ is said to be a *t*-linear micromorphism when φ is *t*-linear and φ cannot be properly factored. Namely, for a factorization of φ as $V \xrightarrow{\varphi_1} W \xrightarrow{\varphi_2} V'$, either φ_1 or φ_2 is an isomorphism in the *t*-site. If a particle associated presheaf *m* is reified at *V* for a micromorphism $\varphi : V \longrightarrow V'$, then presheaf *m*

cannot be in a ur-particle state after *V* till *V'*. That is, *m* has to be in a ur-wave state during the generalized time periods between *V* and *V'*. Our formulation from the microcosm to the macrocosm can be expressed in terms of morphisms. Namely, the difference between microcosm and macrocosm is the number of micromorphisms in a *t*-site. To be explicit, for a morphism $V \xrightarrow{\varphi} U$ in the *t*-site, suppose that φ can be factored as $\varphi = \varphi_n \circ \varphi_{n-1} \circ --- \circ \varphi_1$, where $V_{i-1} \xrightarrow{\varphi_i} V_i$ is a micromorphism. Whether $V \xrightarrow{\varphi} U$ is a macrocosm morphism or a microcosm morphism depends upon the positive integer *n* in the number of factorization of $V \xrightarrow{\varphi} U$.

A quantum jump is interpreted as the discontinuity of the morphisms in *t*-site. Namely, the corresponding states of a preseaf associated with a particle is controlled by finite series of morphisms in the *t*-site. In particular, for a micromorphism $V \longrightarrow V'$, there does not exist an ur-particle state (i.e., *m* is never reified) between the two (ur-)particles (see above) stated $m(V)$ and $m(V')$.

The presheaf theoretic aspect of the wave function in the Schrödinger equation can be interpreted as follows: The difference of the ur-particle states $m(U)$ and $m(V)$ of a presheaf *m* corresponding to a micromorphism $V \xrightarrow{\varphi} U$ depend upon the initial ur-particle state *m(V)* and $V \xrightarrow{\varphi} U$.

Recall that Self-observation consists of the following: Let *P* be a sheaf associated with a conscious entity. Self-observation is an endomorphism from *P*(*V*) to *P*(*V*), where *V* is an object of the *t*-site. Namely, self-observation is a morphism $P(V) \xrightarrow{\varphi_V} P(V)$. As noted earlier, notice that we assume a presheaf associated with a conscious entity is a sheaf.

An identity morphism $Id_{P(V)}$ is a special case of endomorphism in $End(P(V))$.

We recall the following:

(1): *T*-topos as un-reified stage of presheaves exists ("prior") as a preparation (foundation) leading to reified presheaves (i.e. qualia); subjective experience is a morphism from a reified presheaf to an observer (SIFT, Siegel, 2016). We can also account for self-observation

(2): Qualia appear on the boundary between the perceived and the actual.

Formal definitions of "veiling" and "measurement problem" are given here:

Veiling is the boundary process from un-reified to reified. Namely, veiling is "the concept " of a contravariant functor.

Measurement problem is veiling, i.e. for presheaves *m* and *P*, we formulate that *P* measures *m* in terms of morphisms as follows (for the relativistic formulation, see Kato, 2005): For the sake of simplicity, we formulate non-relativistic case. In this case, one may consider that *P* is the observer and *m* is the observed. First *m* is measured by *P* over an object *V* of the *t*-site and can be formulated

$$m(V) \xrightarrow{s_V} P(V)$$

Where the measurement (observation) s_V is a natural transformation from m to *P* evaluated over *V*. (Note that the case of relativistic formulation would become as follows. For a t-linear morphism $V \longrightarrow V'$ in the *t*-site, i.e., the ur-particle states of *m* and *P* over *V* and *V'* are mutually

in the t-light-cone, the measurement morphism becomes $m(V)\xrightarrow{s^V_{V'}}P(V')$, which is not canonically induced as a natural transformation anymore.) For a *t*-linear morphism $V\xrightarrow{\varphi}W$, the presheaf *m* induces $m(V)\xleftarrow{m(\varphi)}m(W)$. (Notice that the direction of the arrow is reversed due to the contravariantness of presheaf.) ur-particle state $m(V)$ over *V* in the *t*-site should be regarded as the preceding particle state of a particle, and the ur-particle state $m(W)$ is the future state. Notice that the diagram

$$\begin{array}{ccc} m(V) & \xleftarrow{m(\varphi)} & m(W) \\ \downarrow{\scriptstyle s_V} & & \\ P(V) & & \end{array}$$

indicates that the (non-relativistic) measurement $m(V)\xrightarrow{s_V}P(V)$ can be composed as $m(W)\xrightarrow{s_V\circ m(\varphi)}P(V)$ with the canonically induced $m(V)\xrightarrow{m(\varphi)}m(W)$ obtaining the information of the future ur-particle state $m(W)$. On the other hand, when $m(W)$ is measured, i.e. $m(W)\xrightarrow{s_W}P(W)$, the induced $m(\varphi)$ cannot be composed with the measurement morphism (the natural transformation over *V*) s_W. The situation can be expressed as the following diagram

$$\begin{array}{ccc} m(V) & \xleftarrow{m(\varphi)} & m(W) \\ & & \downarrow{\scriptstyle s_W} \\ & & P(W) \end{array}$$

indicating that measuring the ur-particle state of *m* by *P* over *W* gives no information of the temporal past ur-particle state of *m* over *V*. Note that in terms of t-site, *V* is the past state determing generalized time period with respect to *W*.

We note that the lack of information about a past time period by measuring something in a given time period corresponds to veiling.

It may be useful to make the following comments on the deterministic-classical formulation of measurements in terms of *t*-topos theory: For an object *V* defining the ur-particle state of *m*, there exists a *uniquely determined t-linear isomorphism* to an object *W* . In the classical world interpretation, measuring either the ur-particle state of *m* over *V* or *W*, makes no difference to determine either state, since the isormorphism has the (isomorphic) inverse

providing the each state over *V* or *W* symmetrically. This is the so called Laplace's world formula.

8. Conclusions and Future Work

The present paper outlines how some aspects of t-topos would link to the science of Fundamental Awareness, based on qualia. We have shown how the t-topos mathematics can be used to provide a mathematical formalism for what has been mostly described in the West as the philosophical system of Idealism or in the Eastern philosophies as Monism or Non-dualism. Monistic systems are valid practical systems of thought that address fundamental issues of existence and they can provide guiding insights for the development of the science of qualia, the system of thought which takes experience as fundamental aspect of our existence, the external universe and all its objects being experienced. Rāmānuja's version of Vedanta philosophy and particularly Kashmir Śaivism, for example, state that Consciousness dynamically emanates, sustains, re-absorbs, conceals and reveals everything that exists. These are known as the five Actions of Consciousness. It will be important to explore how the five-fold Acts working with the three Laws described here, give rise to the field of experiences, constituting all conscious processes. Do the five-fold Acts working with the three Laws give rise to the evolution of physical objects (such as planets, stars etc.) and biological structures (all species)? The experiencing individuals view reality in species-specific, planetary-specific and frame-specific ways, which can be further explored in mathematical formalism. What applies to our species as veiling may actually have cosmic implications: Veiled non-locality and cosmic censorship may yield understanding of the unification of general relativity, quantum theory, through consciousness (as pointed out by Kafatos and Kak, 2015).

The work presented here may provide a way for the convergence of science and non-dualist philosophies, as an emerging science of Consciousness. The exploration of the connection of Western idealist philosophies in addition to the idealist non-dualist Hindu philosophies is beyond the scale of the present work but would form a natural extension. We propose that a new science of Consciousness referred to in the present work and references given here would bring out the underlying unity of physics, life and mind. In some sense, the relevant mathematics presented here may be seen as a universal language of physics and metaphysics.

Another topic that should be explored in the future is how evolution fits in framework of Fundamental Awareness. It may be the case that evolution is the primal dynamical aspect of the self-aware universe. Such evolution must yield a universe that is extremely finely-tuned, as observed at many levels. Fine tuning exists at all levels of Reality. At the physical levels, fine tuning is often appears as randomness, which indicates that fine tuning and randomness are complementary constructs.

In building a better mathematical foundation of fundamental Awareness, it will be important to explore mathematical patterns across different scales: All so-called objects follow recursive mathematical vibrational relationships. For example, it will be important to explore mathematical vibrational relationships which generally follow Fibonacci and Golden ratio forms.

The mathematical approach outlined here will assist in developing the science of qualia, also known as observer-based science (Chopra and Kafatos, 2017). Qualia science aims at

crossing the boundary between the perceived and the actual. The perceptual world is what our nervous system (or the nervous systems of other species) experiences.

The future of qualia science will lead to the emergence of new, dynamic, and self-organizing networks of qualia that will reshape the universe as we know it. In the future, we will explore the evolution, in the sense that there is a possibility that as Consciousness interacts with itself, the resulting qualia self-organize (i.e., evolve). Another future topic of exploration is further developing the mathematical formalism of quantum-like processes, utilizing the operational Laws.

The *indirect* evidence for the conscious universe is the universality of the three operational Laws of Nature, Complementarity, Recursion and Flow. The "hard problem" (Chalmers, 1995) becomes the "impossible problem" of understanding qualia within physical theories. However, taking Awareness as the fundamental Reality, resolves the hard problem into a non-existing issue. The extremely fine-tuned laws of physics, and cosmological evolution, must impact what is assumed as random biological evolution, and are the hallmarks of the conscious universe. The alternative to what we are proposing is that, in terms of existence, we live in a highly improbable universe. And there is the theory of the multiverse, proposing 100^{500} universes or many more! We claim, if scientists take such theoretical ontologies seriously, then science has become metaphysical, and unmoored from human reason and experience. What we are proposing is more reasonable than the suggestion that out of an essentially infinite numbers of universes in the multiverse, we just happen to be the universe that won the lottery.

Our proposal of Consciousness or fundamental Awareness, put here in mathematical t-topos formalism, is the main driver for developing mathematically the initial stages of a new science of Consciousness. It will, therefore, form the core of the new expanded science.

References

Butterfield, J., Isham, C., 1999. Spacetime and the philosophical Challenge of Quantum Gravity, arXiv:gr-qr-qc/9903072v1.

Bohr, N., 1934. Atomic Theory and the Description of Nature, Cambridge University Press, Cambridge.

Bohr, N., 1958. Atomic Physics and Human Knowledge, Wiley, N.Y.

Chalmers, D., 1995. *Facing up* to the problem of consciousness. Journal of Consciousness Studies.
2 (3): 200–219.

Chatterji, J.C., 1986. Kashmir Śaivism, SUNY Press, N.Y.

Chopra, D., Kafatos, M.C., 2017. You Are the Universe, Harmony, N.Y.

Chopra, D., Tanzi, R., Kafatos, M.C., 2014. A Consciousness-based Science: From Quanta to Qualia: How a Paradigm Shift Turns Into Science, in: Chopra, D. (Edit), Brain, Mind, Cosmos: The Nature of Our Existence and the Universe, eBook, Deepak Chopra, Publisher, c/o Trident Media Group LLC, N.Y.

Dyczkowski, M.S.G., 1992. The Aphorisms of Śiva, SUNY Press, Albany, N.Y.

Gelfand, S. I., Manin, Yu. I., 1996. Methods of Homological Algebra, Springer-Verlag, N.Y.

Kafatos, M.C., 2015. Fundamental Mathematics of Consciousness. Cosmos and History: The Journal of Natural and Social Philosophy, 11(2), 175-188.
http://www.cosmosandhistory.org/index.php/journal

Kafatos, M.C., Chopra, D., 2014. The Time Machine of Consciousness. Cosmology of Time,

Quantum Physics of Time Travel (Guest Editors). Cosmology, 12 http://cosmology.com/Contents18.html

Kafatos M.C., Kafatou T., 1991. Looking in, Seeing out: Consciousness and Cosmos, Quest Books, Wheaton, IL.

Kafatos, M.C., Kak, S., 2015. Veiled Nonlocality and Cosmic Censorship. Physics Essays. 28,182 -187 http://physicsessays.org/browse-journal-2/product/1242-9-menas-c-kafatos-and-subhash-kak-veiled-nonlocality-cosmic-censorship-and-local-observations.

Kafatos, M.C., Narasimhan, A., 2016. Mathematical Frameworks for Consciousness. Cosmos and History: The Journal of Natural and Social Philosophy. 12, no. 2, 150-159.

Kak, S., Chopra, D., Kafatos, M.C., 2014. Perceived Reality, Quantum Mechanics, and Consciousness. Cosmology. 18, 231-245. http://cosmology.com/ConsciousTime107.html

Kashiwara, H., Schapira, P., 2006, Categories and Sheaves, Springer-Verlag, N.Y.

Kato, G., 2005. Elemental t.g. Principles of Relativistic t-Topos. Europhysics Letters. 71, No.2, July.

Kato, G., 2006. The Heart of Cohomology. Springer-Verlag, N.Y.

Kato, G., 2013. Elements of Temporal Topos. Abramis Academic.

Kato, G., 2017. Topos Theoretic Approach to Space and Time in monograph: Space Time and the Limits of Human Understanding, Springer.

Kato, G., Nishimura, K., 2013. Grasping a Concept as an Image or as a Word. Journal of Scientific Research and Reports. 2(2): 682-691, Article no. JSRR.2013.016, Science domain international.

Kato, G., Nishimura, K., 2015. What is a Thought Process, categorical sheaf-theoretic approach. Journal of Integrated Creative Studies, 1, No.1, 01503004, March.

Mallios, A. and Zafiris, E., 2016. Differential Sheaves and Connections: A Natural Approach to Physical Geometry, World Scientific, Singapore.

Mishra, P.P., 2012. Rāmānuja, in Encyclopedia of Global Religion. Editors: Mark Juergensmeyer & Wade Clark Roof.

Pandit, B.N., 1997. Aspects of Kashmir Śaivism, Utpal Publications, Santarasa Books, Boulder, CO.

Siegel, D. J., 2016. Mind: A Journey to the Heart of Being Human, Norton Series on Interpersonal Neurobiology, N.Y.

Struppa, D. C., Kafatos, M., Roy, S., Kato, G., Amoroso, R. L., 2002. Category Theory as the Language of Consciousness. Noetic Journal. 8(3): 271-281. And references therein.

SenSharma, D.B., 2007. Paramārthasāra ("The Essence of Supreme Truth") of Abhinavagupta (with the commentary of Yogaraja, translation), Muktabodha Indological Research Institute, New Delhi.

Swāmī Muktānanda,1997. Nothing Exists that is not Śiva, SYDA Foundation, South Fallsburg, N.Y.

Swāmī Prabhavānanda, Isherwood, C., 1975. Viveka Chudamani ("Crest-Jewel of Discrimination")

of Adi Śankarā (translation), Vedanta Press, Hollywood, CA.
Swāmī Shāntānanda, 2003. The Splendor of Recognition, Siddha Yoga, South Fallsburg, NY.
Swāmī Vimuktānanda, 2005. Aparokshānubhuti ("Self-Realization") of Adi Śankarā (translation),
Advaita Ashrama, Delhi.
Singh J., 1980. Pratyabhijñā-hṛdayam ("The Secret of Self-recognition"), Motilal Banarsidass, Delhi.
Singh J., 2006. Śiva Sūtras ("The Yoga of Supreme Identity"), Motilal Banarsidass, Delhi.
Theise, N.D., Kafatos, M.C. 2013a. Sentience Everywhere: Complexity Theory, Panpsychism & the Role of Sentience in Self-Organization of the Universe. Journal of Consciousness Exploration & Research. 4(4), 378-390.
Theise, N.D., Kafatos, M.C., 2013b. Complementarity in biological systems: a complexity view. Complexity. 18(6), 11-20.
Theise, N.D., Kafatos, M.C., 2016. Fundamental Awareness: A Framework for Integrating Science,
Philosophy and Metaphysics. Communicative & Integrative Biology. 9(3), 00-00 e1155010 (19 pages).
Vilenkin, 1982. Creation of universes from nothing. Physics Letters. 117B, No. 1, 2.

ACCEPTED MANUSCRIPT