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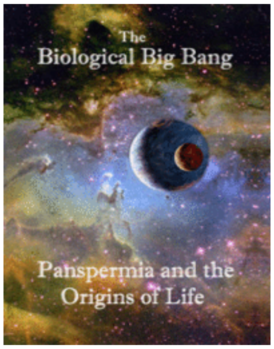

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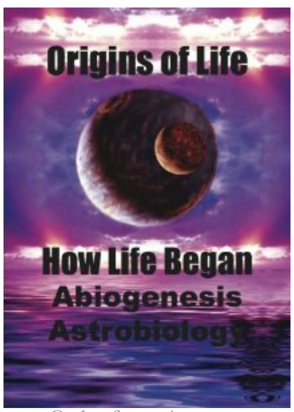

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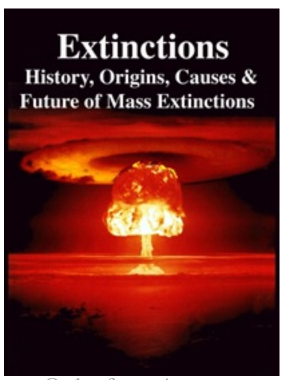

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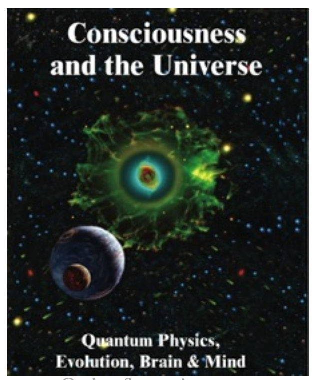

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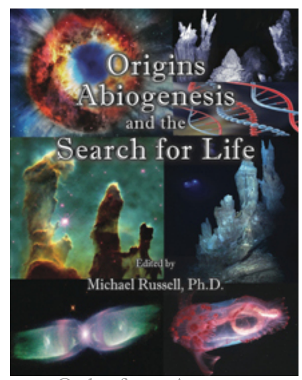

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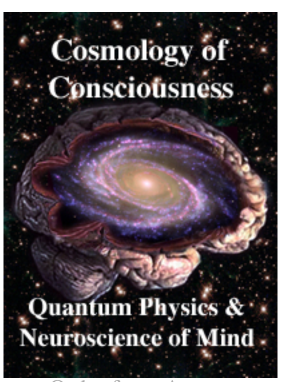

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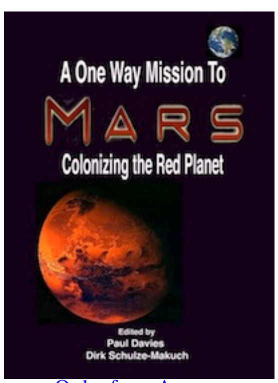

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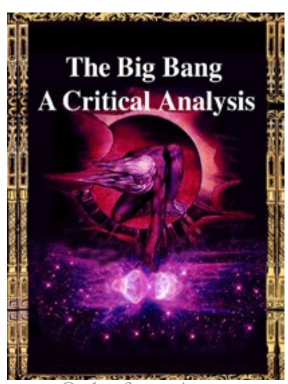

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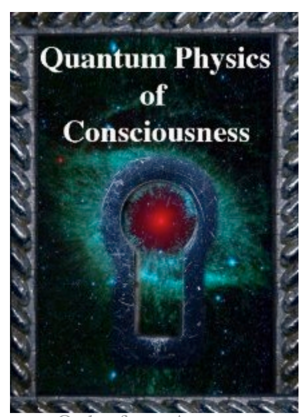

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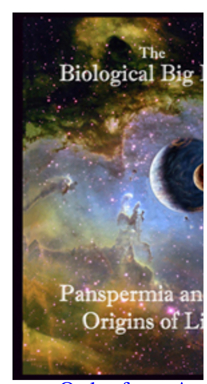

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Journal of Cosmology, 2011, Vol. 14.
JournalofCosmology.com, 2011

How Consciousness Becomes the Physical Universe

Menas Kafatos, Ph.D.[1], Rudolph E. Tanzi, Ph.D.[2], and Deepak Chopra, M.D.[3]

[1]Fletcher Jones Endowed Professor in Computational Physics, Schmid College of Science, Chapman University, One University Dr. Orange, California, 92866, U.S.A.

[2]Joseph P. and Rose F. Kennedy Professor of Neurology, Harvard Medical School Genetics and Aging Research Unit Massachusetts General Hospital/Harvard Medical School 114 16th Street Charlestown, MA 02129

[3]The Chopra Center for Wellbeing, 2013 Costa del Mar Rd. Carlsbad, CA 92009

Abstract

Issues related to consciousness in general and human mental processes in particular remain the most difficult problem in science. Progress has been made through the development of quantum theory, which, unlike classical physics, assigns a fundamental role to the act of observation. To arrive at the most critical aspects of consciousness, such as its characteristics and whether it plays an active role in the universe requires us to follow hopeful developments in the intersection of quantum theory, biology, neuroscience and the philosophy of mind. Developments in quantum theory aiming to unify all physical processes have opened the door to a profoundly new vision of the cosmos, where observer, observed, and the act of observation are interlocked. This hints at a science of wholeness, going beyond the purely physical emphasis of current science. Studying the universe as a mechanical conglomerate of parts will not solve the problem of consciousness, because in the quantum view, the parts cease to be measureable distinct entities. The interconnectedness of everything is particularly evident in the non-local interactions of the quantum universe. As such, the very large and the very small are also interconnected.

Consciousness and matter are not fundamentally distinct but rather are two complementary aspects of one reality, embracing the micro and macro worlds. This approach of starting from wholeness reveals a practical blueprint for addressing consciousness in more scientific terms.

KEY WORDS: Quantum Universe, perennial philosophy, consciousness, wholeness, Reality

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1. Introduction

We realize that the title of our paper is provocative. It is aimed at providing a theory of how the physical universe and conscious observers can be integrated. We will argue that the current state of affairs in addressing the multifaceted issue of consciousness requires such a theory if science is to evolve and encompass the phenomenon of consciousness. Traditionally, the underlying problem of consciousness has been excluded from science, on one of two grounds. Either it is taken as a given that it has no effect on experimental data, or if consciousness must be addressed, it is considered subjective and therefore unreliable as part of the scientific method. Therefore, our challenge is to include consciousness while still remaining within the methods of science.

Our starting point is physics, which recognizes three broad approaches to studying the physical universe: classical, relativistic, and quantum. Classical Newtonian physics is suitable for most everyday applications, yet its epistemology (method of acquiring knowledge) is limited -- it does not apply at the microscopic level and cannot be used for many cosmic processes. Between them, general relativity applies at the large scale of the universe and quantum theory at the microcosmic level. Despite all the attempts to unify general relativity with quantum theory, the goal is still unreached. Of the three broad approaches, quantum theory has clearly opened the door to the issue of consciousness in the measurement process, while relativity admits that observations from different moving frames would yield different values of quantities. Many of the early founders of quantum mechanics held the view that the participatory role of observation is fundamental and the underlying "stuff" of the cosmos is processes rather than the construct of some constant, underlying material substance.

However, quantum theory does not say anything specific about the nature of consciousness -- the whole issue is clouded by basic uncertainty over even how to define consciousness. A firm grasp of human mental processes still remains very elusive. We believe that this indicates a deeper problem which scientists in general are reluctant to address: objective science is based on the dichotomy between subject and object; it rests on the implicit assumption that Nature can be studied *ad infinitum* as an external objective reality. The role of the observer is, at best, secondary, if not entirely irrelevant.

2. Consciousness and Quantum Theory

In our view, it may well be that the subject-object dichotomy is false to begin with and that consciousness is primary in the cosmos, not just an epiphenomenon of physical processes in a nervous system. Accepting this assumption would turn an exceedingly difficult problem into a very simple one. We will sidestep any precise definition of consciousness, limiting ourselves for now to willful actions on the part of the observer. These actions, of course, are the outcome of specific choices in the mind of the observer. Although some mental actions could be automated, at some point the will of conscious observer(s) sets the whole mechanical aspects of observation in motion.

The issue of observation in QM is central, in the sense that objective reality cannot be disentangled from the act of observation, as the Copenhagen Interpretation (CI) clearly states (cf. Kafatos & Nadeau 2000; Kafatos 2009; Nadeau and Kafatos, 1999; Stapp 1979; Stapp 2004; Stapp 2007). In the words of John A. Wheeler (1981), we live in an *observer-participatory universe*. The vast majority of today's practicing physicists follow CI's practical prescriptions for quantum phenomena, while still clinging to classical beliefs in observer-independent local, external reality (Kafatos and Nadeau 2000). There is a critical gap between practice and underlying theory. In his Nobel Prize speech of 1932, Werner Heisenberg concluded that the atom "has no immediate and direct physical properties at all." If the universe's basic building block isn't physical, then the same must hold true in some way for the whole. The universe was doing a vanishing act in Heisenberg's day, and it certainly hasn't become more solid since.

This discrepancy between practice and theory must be confronted, because the consequences for the nature of reality are far-reaching (Kafatos and Nadeau, 2000). An impressive body of evidence has been building to suggest that reality is non-local and undivided. Non-locality is already a basic fact of nature, first implied by the Einstein-Podolsky-Rosen thought experiment (EPR, 1935), despite the original intent to refute it, and later explicitly formulated in Bell's Theorem (Bell, 1964) and its relationship to EPR – for further developments, see also experiments which favor QM over local realism, e.g. Aspect, Grangier, and Roger, 1982; Tittel, Brendel, Zbinden & Gisin, 1998. One can also cite the Aharonov-Bohm (1959) effect, and numerous other quantum phenomena.

Moreover, this is a reality where the mindful acts of observation play a crucial role at every level. Heisenberg again: "The atoms or elementary particles themselves . . . form a world of potentialities or possibilities rather than one of things or facts." He was led to a radical conclusion that underlies our own view in this paper: "What we observe is not nature itself, but nature exposed to our method of questioning." Reality, it seems, shifts according to the observer's conscious intent. There is no doubt that the original CI was subjective (Stapp, 2007). However, as Bohr (1934) and Heisenberg (1958) as well as the other developers of CI stated on many occasions, the view that emerged can be summarized as, "the purpose is not to disclose the real essence of phenomena but only to track down… relations between the multifold aspects of our experience" (Bohr, 1934). Stapp (2007) restates this view as "quantum theory is basically about relationships among conscious human experiences" (Stapp 2007). Einstein fought against what he considered the positivistic attitude of CI, which he took as equivalent to Berkeley's dictum *to be is to be perceived* (Einstein 1951), but he nevertheless admitted that QM is the only successful theory we have that describes our experiences of phenomena in the microcosm.

Quantum theory is not about the nature of reality, even though quantum physicists act as if that is the case. To escape philosophical complications, the original CI was pragmatic: it concerned itself with the epistemology of quantum world (how we experience quantum phenomena), leaving aside ontological questions about the ultimate nature of reality (Kafatos and Nadeau, 2000). The practical bent of CI should be kept in mind, particularly as there is a tendency on the part of many good physicists to slip back into issues that cannot be tested and therefore run counter to the basic tenets of scientific methodology.

To put specifics into the revised or extended CI, Stapp (2007) discusses John von Neumann's different types of processes. The quantum formalism eloquently formalized by von Neumann requires first the acquisition of knowledge about a quantum system (or probing action) as well as a mathematical formalism to describe the evolution of the system to a later time (usually the Schrödinger equation). There are two more processes that Stapp describes: one, according to statistical choices prescribed by QM, yields a specific outcome (or an intervention, a "choice on the part of nature" in Dirac's words); the second, which is primary, preceding even the acquisition of knowledge, involves a "free choice" on the part of the observer. This selection process is not and *cannot be* described by QM, or for that matter, from any "physically described part of reality" (Stapp, 2007).

These extensions (or clarifications) of the original orthodox CI yield a profoundly different way of looking at the physical universe and our role in it (Kafatos and Nadeau, 2000). Quantum theory today encompasses the interplay of the observer's free choices and nature's "choices" as to what constitute actual outcomes. This dance between the observer and nature gives practical meaning to the concept of the participatory role of the observer. (Henceforth we won't distinguish between the original CI and as it was extended by von Neumann—referring to both as orthodox quantum theory.) As Bohr (1958) emphasized, "freedom of experimentation" opens the floodgates of free will on the part of the observer. Nature responds in the statistical ways described by quantum formalism.

Kafatos and Nadeau (2000) and Nadeau and Kafatos (1999) give extended arguments about these metaphysically-based views of nature. CI points to the limits of physical theories, including itself. If any capriciousness is to be found, it should not be assigned to nature, rather to our mindset about how nature ought to work. As we shall see, there are credible ways to build on quantum formalism and what it suggests about the role of consciousness.

3. Quantum Mechanics and the Brain

It is essential that we avoid the mistake of rooting a physical universe in the physical brain, for both are equally rooted in the non-physical. For practical purposes, this means that the brain must acquire quantum status, just as the atoms that make it up have. The standard assumption in neuroscience is that consciousness is a byproduct of the operation of the human brain. The multitude of processes occurring in the brain covers a vast range of spatio-temporal domains, from the nanoscale to the everyday human scale (e.g. Bernroider and Roy, 2004). Even though they differ on certain issues, a number of scientists accept the applicability of QM at *some scales* in the brain (cf. Kafatos 2009).

For example, Penrose (1989, 1994) and Hameroff and Penrose (1996) postulate collapses occurring in microtubules induced by quantum gravity. In their view, quantum coherence operates across the entire brain. Stapp (2007) prefers a set of different classical brains that evolve according to the rules of QM, in accordance with the uncertainty principle. He contends that bringing in (the still not developed) quantum gravity needlessly complicates the picture.

In order for an integrative theory to emerge, the next step is to connect the quantum level of activity with higher levels. As a specific example of applying quantum-like processes at mesoscale levels, Roy and Kafatos (1999b) have examined the response and percept domains in the cerebellum. They have built a case that complementarity or quantum-like effects may be operating in brain processes. As is well known, complementarity is a cornerstone of orthodox quantum theory, primarily developed by Niels Bohr. Roy and Kafatos imagine a measurement process with a device that selects only one of the eigenstates of the observable A and rejects all others. This is what is meant by selective measurement in quantum mechanics. It is also called *filtration* because only one of the eigenstates filters through the process. In attempting to describe both motor function and cognitive activities, Roy and Kafatos (1999a) use statistical distance in setting up a formal Hilbert-space description in the brain, which illustrates our view that quantum formalism may be introduced for brain dynamics.

It is conceivable that the overall biological structures of the brain may require global relationships, which come down processes to global complementarity—every single process is subordinated to the whole. Not just single neurons but massive clusters and networks communicate all but instantaneously. One must also account for the extreme efficiency with which biological organisms operate in a holistic manner, which may only be possible by the use of quantum mechanical formalisms at biological, and neurophysiological relevant scales (cf. Frohlich, 1983; Roy and Kafatos, 2004; Bernroider and Roy, 2005; Davies, 2004, 2005; Stapp, 2004; Hameroff et. al., 2002; Hagan et. al., 2002; Hammeroff and Tuszynski, 2003; Rosa and Faber, 2004; Mesquita et. al., 2005; Hunter, 2006; Ceballos et al., 2007).

Stepping into the quantum world doesn't produce easy agreement, naturally. The issue of decoherence (whereby the collapse of the wave function brings a quantum system into relationship with the macro world of large-scale objects and events) is often brought up in arguing against relevant quantum processes in the brain. However, neuronal decoherence processes have only been calculated while assuming that ions, such as K+, are undergoing quantum Brownian motion (e.g. Tegmark, 2000). As such, arguments about decoherence (Tegmark, 2000) assume that the system in question is in thermal equilibrium with its environment, which is not typically the case for bio-molecular dynamics (e.g. Frohlich, 1986; Pokony and Wu, 1998; Mesquita et. al., 2005).

In fact, quantum states can be pumped like a laser, as Frohlich originally proposed for biomolecules (applicable to membrane proteins, and tubulins in microtubules, see also work by Anirban, present volume). Also, experiments and theoretical work indicate that the ions themselves do not move freely within the ion-channel filter, but rather their states are pre-selected, leading to possible protection of quantum coherence within the ion channel for a time scale on the order of 10-3 seconds at 300K, ~ time scale of ion-channel opening and closing (e.g. Bernroider and Roy, 2005). Similar timescales apply to microtubular structures as pointed out by Hameroff and his co-workers. Moreover, progress in the last several years in high-resolution atomic X-ray spectroscopy from MacKinnon's group (Jang et al. 2003) and molecular dynamics simulations (cf. Monroe 2002) have shown that the molecular organization in ion channels allows for "pre-organized" correlations, or ion trappings within the selectivity filter of K+ channels. This occurs with five sets of four carbonyl oxygens acting as filters with the K+ ion, bound by eight oxygens, coordinated electrostatic interactions (Bernroider and Roy 2005). Therefore, quantum entangled states of between two subsystems of the channel filter result.

Beyond the brain, evidence has mounted for quantum coherence in biological systems at high temperatures, whereas in the past coherence was thought to apply to systems near absolute zero. For proteins supporting photosynthesis (Engel, et.al., 2007), solar photons on plant cells are converted to quantum electron states which propagate or travel through the relevant protein by all possible quantum paths, in reaching the part of the cell needed for conversion of energy to chemical energy. As such, new quantum ideas and laboratory evidence applicable to the fields of molecular cell biology and biophysics will have a profound impact in modeling and understanding the process of coherence within neuro-molecular systems.

4. Bridging the Gap: A Consciousness Model

Our purpose here is not to settle these technical issues – or the many others that have arisen as theorists attempt to link quantum processes to the field of biology – but to propose that technical considerations are secondary. What is primary is to have a reliable model against which experiments can offer challenges. Such a model isn't available as long as we fail to account for the disappearance of the material universe implied by quantum theory. This disappearance is real. There is at bottom no strictly mechanistic, physical foundation for the cosmos. The situation is far more radical than most practicing scientists suppose. Whatever is the fundamental source of creation, it itself must be uncreated. Otherwise, there is a hidden creator lying in the background, and then we must ask who or what created that.

What does it mean to be uncreated? The source of reality must be self-sufficient, capable of engendering complex systems on the micro and macro scale, self-regulating, and holistic. Nothing can exist outside its influence. Ultimately, the uncreated source must also turn into the physical universe, not simply oversee it as God or the gods do in conventional religion. We feel that only consciousness fits the bill, for as a prima facie truth, no experience takes place outside consciousness, which means that if there is a reality existing beyond our awareness (counting mathematics and the laws of physics as 1 part of our conscious experience), we will never be able to know it. The fact that consciousness is inseparable from cognition, perception, observation, and measurement is undeniable; therefore, this is the starting point for new insights into the nature of reality.

What is the nature of consciousness in our model? We take it as a field phenomenon, analogous to but preceding the quantum field. This field is characterized by generalized principles already described by quantum physics: complementarity, non-locality, scale-invariance and undivided wholeness. But there is a radical difference between this field and all others: we cannot define it from the outside. To extend Wheeler's reasoning, consciousness includes us human observers. We are part of a feedback loop that links our conscious acts to the conscious response of the field. In keeping with Heisenberg's implication, the universe presents the face that the observer is looking for, and when she looks for a different face, the universe changes its mask.

Consciousness includes human mental processes, but it is not just a human attribute. Existing outside space and time, it was "there" "before" those two words had any meaning. In essence, space and time are conceptual artifacts that sprang from primordial consciousness. The reason that the human mind meshes with nature, mathematics, and the fundamental forces described by physics, is no accident: we mesh because we are a product of the same conceptual expansion by which primordial consciousness turned into the physical world. The difficulty with using basic terms like "concept" and "physical" is that we are accustomed to setting mind apart from matter; therefore, thinking about an atom isn't the same as an atom. Ideas are not substances. But if elementary particles and all matter made of them aren't substances, either, the playing field has been leveled. Quantum theory gives us a model that applies everywhere, not just at the micro level. The real question, then, isn't how to salvage our everyday perception of a solid, tangible world but how to explore the mysterious edge where micro processes are transformed into macro processes, in other words, how Nature gets from microcosm to macrocosm. There, where consciousness acquires the nature of a substance, we must learn how to unify two apparent realities into one. We can begin to tear down walls, integrating objects, events, perceptions, thoughts, and mathematics under the same tent: all can be traced back to the same source.

Physics can serve a pivotal role in transitioning to this new model, because the entire biosphere operates under the same generalized principles we described from the quantum perspective, as does the universe itself. This simple unifying approach must be taken, we realize, as a basic ontological assumption, since it cannot be proven in an objective sense. We cannot extract consciousness from the physical universe, despite the fervent hope of materialists and reductionists. They are forced into a logical paradox, in fact, for either the molecules that make up the brain are inherently conscious (a conclusion to be abhorred in materialism), or a process must be located and described by which those molecules invent consciousness -such a process has not and never will be specified. It amounts to saying that table salt, once it enters the body, finds a way to dissolve in the blood, enter the brain, and in so doing learns to think, feel, and reason.

Our approach, positing consciousness as more fundamental than anything physical, is the most reasonable alternative: Trying to account for mind as arising from physical systems in the end leads (at best) to a claim that mathematics is the underlying "stuff" of the universe (or many universes, if you are of that persuasion). No one from any quarter is proposing a workable material substratum to the universe; therefore, it seems untenable to mount a rearguard defense for materialism itself. As we foresee it, the future development of science will still retain the objectivity of present-day science in a more sophisticated and evolved form. An evolved theory of the role of the observer will be generalized to include physical, biological, and most importantly, awareness aspects of existence. In that sense, we believe the ontology of science will be undivided wholeness at every level. Rather than addressing consciousness from the outside and trying to devise a theory of everything on that basis, a successful Theory Of Everything (TOE) will emerge by taking wholeness as the starting point and fitting the parts into it rather than vice versa. Obviously any TOE must include consciousness as an aspect of "everything," but just as obviously current attempts at a TOE ignore this and have inevitably fallen into ontological traps.

The time has come to escape those traps. An integrated approach will one day prevail. When it does, science will become much stronger and develop to the next levels of understanding Nature, to everyone’s lasting benefit.

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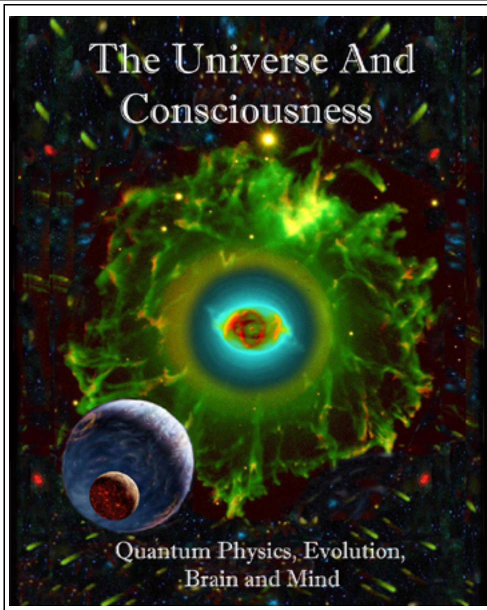

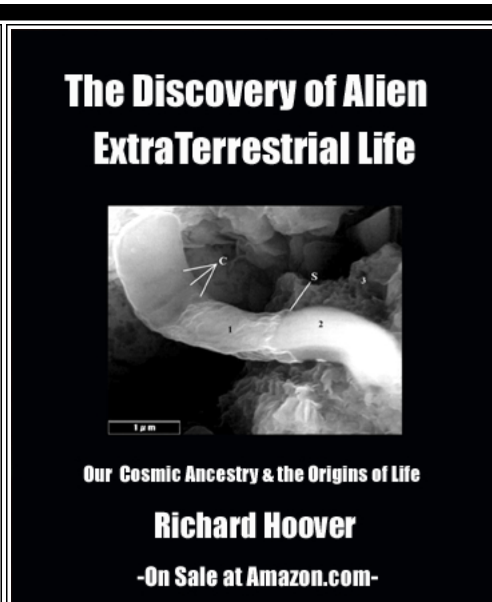

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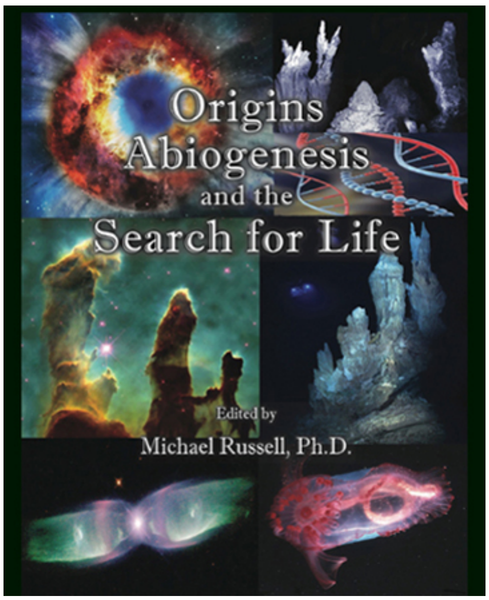

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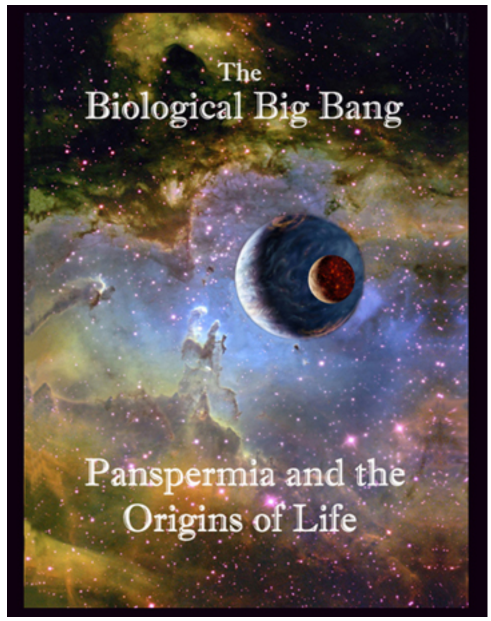

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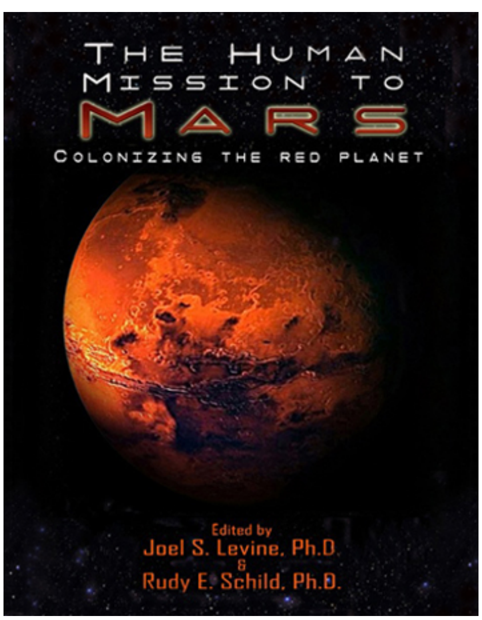

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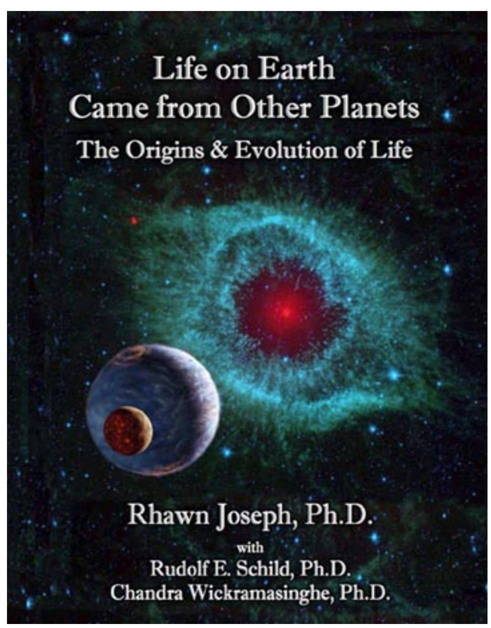

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