Quantum Reality and the Consciousness of the Universe

QUANTUM REALITY, THE EMERGENCE OF COMPLEX ORDER FROM VIRTUAL STATES, AND THE IMPORTANCE OF CONSCIOUSNESS IN THE UNIVERSE

by Lothar Schäfer

Abstract. I review some characteristic aspects of quantum reality and make the connection to Pierre Teilhard de Chardin's vision and a generally new quantum perspective of biological evolution. The quantum phenomena make it possible to conclude that the basis of the material world is nonmaterial; that the nature of reality is that of an indivisible wholeness; and that elementary particles possess aspects of consciousness in a rudimentary way. The quantum perspective of evolution makes it possible to conclude that the emergence of complex order in the biosphere is not from nothing (*ex nihilo*) but by the actualization of virtual quantum states—that is, by actualizing empty states which are part of the mathematical structure of material systems, representing a logical order that is not real in a material sense but, predetermined by system conditions, has the potential to become real in quantum jumps. I show how the existence of virtual states makes it possible to suggest that a transcendent reality underlies the visible order of the world and is immanent to it; and constantly new forms evolve from it.

Keywords: cosmic consciousness; emergence of complexity; quantum perspective of evolution; quantum reality; Pierre Teilhard de Chardin; transcendent order; virtual state actualization; virtual states.

Lothar Schäfer is Edgar Wertheim Distinguished Professor of Physical Chemistry at the University of Arkansas, Fayetteville, AR 72701; e-mail schafer@uark.edu.

[*Zygon*, vol. 41, no. 3 (September 2006).]
 ISSN 0591-2385

Until recently, it has been difficult for many to accept science as a source of knowledge about the world and to have any hope for the future of humanity as a species endowed with the gift of leading a life with values. Since the seventeenth century the ruling scientific outlook (one that is still taught in our schools today) was that of the classical physics of Isaac Newton and the Age of the Enlightenment. It is the doctrine that everything in the universe can be explained in terms of moving material particles—that the universe is clockwork, closed, and entirely predictable on the basis of unchanging laws. "Permanent matter in motion," wrote Rupert Sheldrake (1988, 47), "governed by permanent non-material laws." That worldview gave rise to the naive realism of mechanist materialism, which claims that all aspects of human beings—our loves, hopes, creativity, and spirituality—are nothing but accidental by-products of the properties and actions of matter. When Darwin combined that same materialism with the laws of chance and natural selection, claiming to have found a comprehensive mechanism for the evolution of life and our existence, it seemed to many, especially those with a background in science, that the universe was a place without hope, with no room for the spiritual and God. As Jacques Monod, recipient of the 1965 Nobel prize in medicine, wrote: "Man must at last wake out of his millenary dream and discover his total solitude, his fundamental isolation. He must realize that, like a gypsy, he lives on the boundary of an alien world; a world that is deaf to his music, and as indifferent to his hopes as it is to his suffering or his crimes" (1972, 160).

Now this older scientific doctrine is being challenged on the basis of discoveries made by quantum physicists during the past century. In its place, a new scientific understanding has arisen that points to transcendent aspects of physical reality, and thus of human nature itself, providing new hope that a life with values is not in conflict with our science. In the course of the twentieth century, physicists discovered that physical reality is different than we had thought. At the foundation of ordinary things we find entities—atoms, molecules, elementary particles—existing in a kind of reality that is different than the reality of the objects that they form. In a way these quantum entities, of which we and everything around us are made, are not quite real but are "standing in the middle between the idea of an event and the actual event, a strange kind of physical reality just in the middle between possibility and reality," as Werner Heisenberg wrote ([1958] 1962, 41). Specifically, elementary particles can exist in states in which they have no definite position in space. That is, they are practically nowhere; they display aspects of consciousness in a rudimentary way; and they are able to act on each other without any delay over long distances. Physical reality is not what it looks like, and the microscopic constituents of things are not just miniaturized editions of the ordinary objects of our conscious experience but are different in essence. These discoveries must affect our views of human nature and, particularly, of our spiritual nature.

As a consequence, from a tradition in our culture that is characterized by conflict between science and religion, we are now able to enter an era of congruence and wholeness when it is meaningful to assume that physical reality is part of a divine reality and when what we know about the world is not in conflict with what we hope for.

The European Idealist philosophers of the late eighteenth and early nineteenth centuries wanted to bridge the diverging positions of empiricism and idealism and tried to unite object and subject by assigning all power to reason as the source of reality (see, for example, Bubner 1978). The Idealist program can now be resumed and pursued on the basis of quantum reality, proposing that the background of reality is mindlike and that it is the source of our metaphysical convictions.

Some Characteristic Aspects of Quantum Reality

The Basis of the Material World is Nonmaterial. Electrons are tiny material particles with a diameter of less than a billion-billionth of a meter. They are true elementary particles in that they cannot be broken up into even smaller pieces of matter. Whenever we see an electron, it always appears as a localized event, such as a tiny flash on a television screen or a small dot on a photographic film.

In contrast, when an electron is left alone, it will evolve in a wavelike state that is extended through arbitrarily large areas of space and corresponds to a superposition of simultaneous possibilities or tendencies for the particle to be found at different locations in space. This is the wave-particle duality: a quantum entity observed, a particle; not observed, a wave. *Single particle interference* is the observable phenomenon that reveals this duality.

Similarly, in Erwin Schrödinger's Quantum Mechanics—currently the only effective theory that makes it possible to calculate the properties of molecules—the electrons in atoms are not tiny particles, little balls of matter, but are standing waves, wave functions, numerical patterns, or mathematical forms. We owe to Max Born the discovery that the nature of these waves is that of *probability waves*.

Probabilities are dimensionless numbers, ratios of numbers. Thus, probability waves are empty; they carry no mass or energy, just information on numerical relations. Yet, all visible order in the universe is determined by the rules of their interference. Interference of the wave functions of atoms, for example, determines what kind of molecules can form and what kind of chemistry is possible. Interference of the wave functions of molecules determines what intermolecular interactions are possible, including those which, in living cells, are the basis of life.

In this way we find numerical relations at the foundation of reality—nonmaterial principles on which the order of the world is based. Reality is

based on phenomena that transcend the monist materialist views of classical physics, which claimed that all phenomena can be reduced to the motion of solid material particles. The basis of the material world is nonmaterial.

In modern science, this discovery was a surprise, but new it is not. Pythagoras already thought that "all things are numbers" (Russell [1946] 1979, 54), that "the entire cosmos is harmony and number" (Hirschberger 1976, 1:25), where harmony rests, as in music, on the ratios of numbers. (And what are probabilities? Ratios of numbers!) Similarly, Augustine wrote in his *Confessions* (see, for example, Augustinus 1989, 169): "The older I got, the more despicable became the emptiness of my thought, because I could think of no entity in any other way than as bodily visible." And Nicolas da Cusa is credited with the statement "Number was the first model of things in the mind of the Creator."

The universe, once closed by Newton's materialism, has opened again. The classical universe was closed—a self-sustained, predictable machine. Cracks have opened to a different type of reality, and the world of mass-energy is no longer completely sealed.

The Nature of Reality Is That of an Indivisible Wholeness. We speak of the nonlocality or nonseparability of reality, because two quantum particles that at one time interact and then move away from each other can stay connected and act as though they were one thing regardless of the distance between them.

In the commonsense reality of our consciousness, no signal, no influence is able to move at a speed faster than the speed of light. For example, if one intends to cause an effect somewhere else and far away, one has to wait at least as long as it takes for a light signal to get there. Commonsense reality is a local reality; physical forces are contact forces.

In contrast, in the quantum world, elementary particles can act without any delay on each other, no matter how far apart they are. Experiments testing Bell's Theorem and their interpretations (Bell 1965; 1988; Aspect et al. 1981; 1982; Clauser and Shimony 1978; Freedman and Clauser 1972; d'Espagnat 1983;) have shown that, under certain conditions, decisions made by an experimenter in one laboratory can have an instantaneous effect on the results of an experiment in another laboratory a long distance away.

This is the nonlocality of the quantum world. M. Kafatos and R. Nadeau (1990) have drawn a remarkable conclusion from this phenomenon: If reality is nonlocal, the nature of the universe is that of an undivided wholeness. Because our consciousness has emerged from this wholeness and is part of it, it is possible to conclude that an element of consciousness is active in the universe. Cosmic consciousness?

Quantum Entities Possess Aspects of Consciousness in a Rudimentary Way. The frequent references to the presence of mind, or to mindlike aspects,

are a fascinating phenomenon in twentieth-century physics. Whenever we want to physically affect a thing, we have to spend some energy to do so. For example, to move an object from one place to another we have to push it—that is, impart some energy to it. Just thinking about such an action will not get it done.

Quantum entities, again, are different. Under certain conditions these systems change their behavior when what we know about them changes. For example, in particle interference experiments *which-way information* destroys coherence, that is, the ability to interfere. Thus, quantum systems are sensitive to gradients of information.

In the ordinary world of our conscious experience, the only thing that we know which can react to the flow of information is a mind. In this sense we can say that at the foundation of ordinary things we find entities with mindlike properties.

"It is not unreasonable to imagine," wrote John A. Wheeler and Kenneth Ford, "that information sits at the core of physics, just as it sits at the core of a computer. Information may not be just what we *learn* about the world. It may be what *makes* the world" (Wheeler and Ford 1998, 340). And Norbert Wiener, founder of Cybernetics, emphasized that "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day. . . . The mechanical brain does not secrete thought 'as the liver does bile', as the earlier materialists claimed, nor does it put it out in the form of energy, as the muscle puts out its activity" (Wiener 1961, 132).

Considering the mindlike aspects of quantum reality already in the 1930s, Arthur S. Eddington wrote: "The universe is of the nature of 'a thought or sensation in a universal Mind'" (1939, 151). "To put the conclusions crudely—the stuff of the world is mind-stuff. As is often the way with crude statements, I shall have to explain that by 'mind' I do not here exactly mean mind and by 'stuff' I do not at all mean stuff. Still this is as near as we can get to the idea in a simple phrase" (1929, 276). And James Jeans, distinguished astrophysicist:

> The universe begins to look more like a great thought than like a great machine. Mind no longer appears as an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather to hail it as the creator and governor of the realm of matter—not of course our individual minds, but the mind in which the atoms out of which our individual minds have grown exist as thoughts. . . . We discover that the universe shews evidence of a designing or controlling power that has something in common with our own individual minds. (1931, 158)

The mindlike properties of quantum entities come in many phenomena to the fore.

- The nonmaterial probability waves are closer to the nature of a thought than that of a thing.

- Occupied orbital avoidance—the limited capacity of electronic states in atoms and molecules to store electrons—is the basis of the Periodic Table and of the laws of chemistry. It is the result not of any mechanical force that we know but of the symmetry of the wave functions of electrons. Wave functions are mere lists of numbers. Thus, a mental principle of something immaterial—the symmetry of numbers—is the basis of the visible order of the world. "There is indeed something quasi-mental, non-physical about it," Henry Margenau wrote (1984, 16).
- When a quantum system makes a transition from one state to another in a quantum jump, it does so spontaneously and seemingly without any cause. Again, a mind is the only thing that we know that can act in this way.

The Quantum Perspective of Biological Evolution

Given the orthodox views of current mainstream biology, the discovery of the quantum phenomena necessitates a critical reappraisal of our views of life and its origins. We are not living inside a giant machine, as modern science claimed; we have to view ourselves as acting within the framework of an interconnected kind of reality that is as metaphysical as it is physical, and mindlike. It seems safe to think that, if the universe were nothing but what the mechanists and materialists say it is, we would not have evolved from it.

The basis of life is molecular. Molecules are quantum systems and exist in quantum states. All that a molecule can do is to jump from one state to another. Quantum jumps are spontaneous, caused by nothing and ruled by probabilities. In processes ruled by probabilities, one can never be sure of the outcome of a specific event.

For a comprehensive view of evolution, these simple quantum conditions of molecules must be taken into account.

The Importance of Virtual States for the Emergence of Complex Order in the Universe. In the center of all processes of emergence are *virtual states*. The concept derives from quantum chemistry, where virtual states denote unoccupied and empty but predetermined molecular states.

Every molecule contains not only the state that it occupies when it is observed but countless other, invisible states that are not real in a material sense, because they are empty. Quantum chemists call empty states virtual because they virtually exist, but not really. Virtual states are mathematical forms, probability functions, patterns of order, bits of information—but they are more than the idea of a mathematical form, because they can become real when a system jumps into them. Generalizing Heisenberg's concept of events which exist "between the idea of an event and the actual event" ([1958] 1962, 41), we can call virtual states *Heisenberg objects*—

entities of Aristotelian potentia that exist "between the idea of a thing and a real thing." An important aspect of virtual states is that, as a part of the coherent order of a system and predetermined by its conditions, their logical order already exists before it is real.

The hydrogen molecule, H_2, can serve as a simple example (Figure 1). When the wave functions of the ground states of two hydrogen atoms (the H1s states) interfere with each other, two molecular states are formed, one of which (1σ) has an energy below, the other ($1\sigma^*$) above the H1s-energy of the isolated atoms. In the ground state of H_2 the two electrons of the molecule occupy the lower state, leaving the upper one empty, or *virtual*.

When a molecule occupies a virtual state, that state becomes real; it is actualized. At that point its virtual order becomes a real order. In this way the actualization of virtual order in quantum jumps appears as a simple mechanism by which bits of transcendent order can express itself in the material world. All molecules, indeed all systems, the universe included, are centers of potentiality, of virtual states that are not quite real but possible. And constantly something new evolves from them.

Virtual States as Parmenidian Entities. Virtual states can be considered as Parmenidian Entities. Parmenides believed that motion would be possible only if empty space existed into which an object could move. Because he also believed that there is no empty space, he claimed that there can be no motion.

Quantum systems confirm and refine the Parmenidian principle: A system needs empty (virtual) states in order to be able to change. If all the states of all the systems in the universe were occupied and completely filled, nothing could happen! Quantum virtual states exist in the state space of a system. Their order resides not in observable forms but in virtual functions. The virtual wave functions are pieces of a transcendent order.

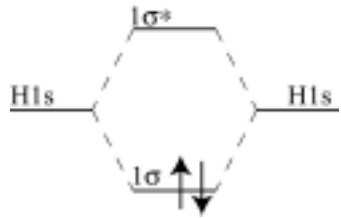

Figure 1. Energy diagram for molecular states formed in the hydgrogen molecule, H_2, from atomic H1s states. If the wave functions of the 1s-states of two hydrogen atoms (H1s) interfere with each other, two molecular states or molecular orbitals are formed, whose energies are *below* (1σ) or *above* ($1\sigma^*$) the H1s-energy of the isolated atoms. If the two electrons occupy the lower 1σ-state with antiparallel spin orientations (symbolized by the arrows), a system results that is more stable than two nonbonded atoms.

The description above focused on the formation of molecular electronic states as a simple example. In addition, many other types of states exist which constitute the total state of a system; they control the conditions of translational, vibrational, and rotational motion in space and of the movements of chemical species across surfaces of potential energy, which lead them from one conformational state to another or from one synthetic ensemble to another. In each case a given system is observed in just one *actual* total state of its state space, while many others exist that are empty. Every empty state carries with it a well-defined wave function, a pattern of order and information, but a virtual pattern, a piece of transcendence—not quite of this world but always ready to enter it. The universe bristles with empty states that have not yet provoked an actual event, and it seems safe to say, in variation of one of Wheeler's statements, that it is filled with more virtuality than actuality. In an incessant, restless dance occupied states are constantly abandoned and become virtual, while empty states become occupied and real. At the foundation of things transcendent order and real order are interlocked in an uninterrupted frantic embrace. From the transcendent to the real, from the real to the transcendent—that is how easy that is.

Virtual Cosmic States as Platonic Ideas. Virtual states can also be viewed as Platonic ideas. The entire universe is a quantum system. Its occupied states form the visible part of reality. In addition, there are infinitely many *cosmic virtual states*. Because they are not real in the material sense, the order that they define is a transcendent cosmic order that exists before it is real. *Virtual state actualization* (VSA) can be thought to be the mechanism by which the material world is secreted and separated from the wholeness of the transcendent order of the universe. In molecular quantum jumps transcendent, mindlike, virtual order can express itself spontaneously in the material world. By VSA the transcendent order of the universe emerges in the material world.

If the nature of the universe is that of a wholeness, all states are cosmic states, and even the quantum states of local molecules are a part of the one cosmic quantum structure. Thus, molecular states can be thought to exist in the virtual cosmic state space before the corresponding molecules exist as actual lumps of matter. Chances are that the quantum states that actualize in DNA already existed at a time when real DNA molecules did not yet exist as material lumps on this planet. Since, in the quantum reality, everything that can happen must happen, given sufficient time, the actualization of states that express themselves in life forms was inevitable. We have to assume that the virtual state space extends through cosmic wholeness, as though it existed beyond spacetime, so there is no reason to believe that the emergence of life was restricted to a single point in time or to a single locality, like our planet.

In the virtual state space of the universe, it is sufficient that each quantum system is represented only once, as though in a central library or in the world of Plato's Ideas. One can also think of a telephone book in which a particular number is listed just once but can be dialed repeatedly. Out of the single system of quantum states representing a hydrogen atom in the cosmic library, the countless H-atoms that exist as material particles are repeated actualizations. A single state (or coherent group of states) in the virtual library; multiplicity in the visible order of the material world. In the virtual order, Ockham's Razor ranks supreme and Cartesian clarity is the law. In this model of the universal order, it is considered that there is a nucleus of cosmic virtual states, like a central archive or processing unit, from which the material world emerges by VSA. There is wholeness in the virtual order, while the repeated actualizations create separateness in time and space. Our world has lost the sense of wholeness, because its processes are based on repeated actualizations of the same virtual quantum states.

The notion that identical material structures are repeated actualizations of the same virtual quantum state conveys a different view of things than the contention that they are copies of one another. The notion of *copies* and *errors* in mainstream biology represents the naive view of genetic processes. Like other anthropocentric views, it will eventually have to be abandoned. The reference point of a gene is not another gene but a virtual quantum state. In a pool of identical genes, we consider none as the copy of another but all as actualizations of the same cosmic quantum state. Arbitrary numbers of identical DNA molecules are produced from a single quantum state of the cosmic library, a single bit of the virtual universal order. In a way, species do not change; rather, genes change quantum states.

The Emergence of Biological Complexity through VSA. By the concept of *emergence* we mean the becoming, or coming into being, of systems for which there are no antecedents. Emergence refers to the appearance of something new. Something appears in the material world that did not exist before, like new life forms in biology.

In biology the process of becoming has often been considered as enigmatic. How can never-before-existing complex systems spontaneously emerge from simpler ones? Because the root of such processes is not found in visible forms, Darwinians often have claimed that complex biological systems are the result of nothing but chance and appear out of nothing. But invisible does not mean nothing! Because miraculous appearances out of nothing and order from chaos do not correspond to our normal experience of the nature of things, it is suggested that the creation of complex structures by VSA is immensely more satisfactory. It has a well-established empirical precedent at the molecular level, where the emergence of complex order from actualizations of a coherent virtual order is so commonplace

that it is a trivial phenomenon. The thesis that complex order evolves out of nothing is not in accordance with our general understanding of molecules. When new structures emerge from molecular interactions, they emerge not from nothing (*ex nihilo*) but from the virtual quantum structure of the systems involved. Molecules create complex order not from nothing but by transitions into virtual states.

Genes, DNA molecules, are not exempt from this rule. For each chain of nucleotides there is a high density of empty states and finite probabilities for transitions into each of them. Populating virtual states of DNA may lead to variations in phenotype, which natural selection then evaluates. The important aspect of this process is that the complex order of the biosphere is created not by chance from nothing, as Darwinians claim, but from the actualization of the virtual order of quantum states, which already exist before they are real. Jumps from one state to another are ruled by chance, but the order of the states on which the jumping will land is not.

The orthodox view is that, because mutations are random, the variations caused by mutations must be the creations of chance. As Monod wrote, "Out of a *totally* blind game, everything, by definition, can emerge; including vision itself" (1972, 128).

Monod was right: a blind game and random chance can *lead* to anything. However, whether chance is also able to create what it leads to is another question. Natural selection does not create what it selects; it just selects what first emerges from the quantum structure of the universe.

A main theme of French paleontologist and Jesuit priest Pierre Teilhard de Chardin's vision was "the primacy accorded to the psychic and to thought in the stuff of the universe" (Teilhard [1955] 1959, 30). This view is now finding some foundation in the VSA hypothesis, in that virtual states are mindlike, not matterlike. Cosmic virtual states ultimately are expressions of the mindlike background of the universe, which may be the source not only of the principles needed to construct our bodies but also of the universal principles that make up our mind.

This brings out an important difference between Darwinism and the quantum perspective of biological evolution that is proposed in this essay. The VSA hypothesis assumes the existence of an underlying nonmaterial and coherent order to all of reality that is at the same time *immanent*, because it is contained in the things, and *transcendent*, because it is not stored in visible forms and, transcending our direct experience, is part of a virtual cosmic structure. Chance plays a role in both models, but in Darwinism the evolving order is created by chance, a "noise" that natural selection will transform into "music" (Monod 1972, 113), while in the emergence by VSA the music is part of an ongoing cosmic concert that is revealed in the quantum jumps. Chance lies in the quantum jumping: whether a jump will occur or not and what state it will lead to. But the order of the states on which the jumping will land has nothing to do with chance.

Both models accept the same experimental evidence that biologists have accumulated in the course of time, but only the concept of VSA is in agreement with the general understanding of the quantum nature of molecules and all material systems. Thus, the quantum perspective of evolution is not only possible; it is necessary.

Evidence for the Need of a Quantum Perspective of Evolution. Against the quantum perspective of evolution (Schäfer 2001; 2002a, b, c; 2003; 2004a, b; 2005) it is usually argued that (1) biomolecules are too large to be considered quantum systems; (2) decoherence destroys the quantum properties of molecules in the crowded and warm environment of living cells; and (3) no experimental tests of the quantum perspective exist. Thus, according to the current practice of mainstream biology, quantum theory is completely irrelevant for biology, and it is claimed that large biological molecules can be completely understood in the mechanistic manner of dense Newtonian objects.

Many observations show that this is not so. For example, quantum computations of the structures of peptides and proteins (Van Alsenoy 1998; Jiang et al. 1995; Schäfer, Van Alsenoy, and Scarsdale 1982) have predicted details of protein structures that subsequently were confirmed experimentally by protein crystallography but are absent in computational results obtained by classical modeling procedures. These structural trends represent a clear quantum effect in an important property of proteins.

In quantum calculations of clay minerals (see, for example, Teppen et al. 2002), the size of a mineral crystal must be extrapolated to infinity in order to obtain realistic results that agree with experimental data. Such studies show that size does not exclude quantum properties. As Hans Primas has pointed out (1996), even the Kepler orbits of our solar system can be computed quantum mechanically in excellent agreement with the observations.

Cytochrome oxidase is a giant protein molecule with a molecular mass of some 400,000 atomic mass units. In living cells it has an important function in electron transfer reactions. Frank Millet and Bill Durham (2002) have studied these processes by spectroscopic means. Spectroscopic molecular phenomena always involve the absorption or emission of quanta of light (photons) accompanied by transitions of a molecule from one quantum state to another. Such phenomena demonstrate that cytochrome oxidase exists in quantum states and cannot be understood as a Newtonian corpuscle.

In referring to the quantum nature of biomolecules, I do not intend to propose that in the blood and sweat of living organisms genes perform any fancy quantum acrobatics, such as evolving in superpositions of states and making nonlocal connections. Rather, I maintain that all molecules—large and small, isolated or in crowded environments, at low temperatures or high—exist in quantum states, real or virtual; that the quantum states

are characterized by certain quantized properties and by wave functions or probability distributions that are determined by the conditions of a system; and that all that molecules can do is make transitions from one definite state to another. Given the current state of physical chemistry, these simple facts are impossible to deny. At the same time, they are all that underlies the quantum perspective of evolution, and they have nothing to do with decoherence effects that preclude certain quantum phenomena, such as superpositions of states and coherence, in crowded and noisy environments. No such sophisticated behavior is part of the quantum perspective of evolution as it is presented here.

Apart from specific experimental observations which show that biomolecules are quantum systems, one must ask in a general way what the totality or wholeness of the universe might mean for the origin of life. What does the discovery of virtual states in small molecules mean for biological order? What do the mindlike aspects of the background of reality (Schäfer 1997) mean for the nature of life that evolves in the biosphere? Such questions are not meaningless because potential answers are not now amenable to experimentation. It seems a greater risk to neglect them than to discuss them.

In statistical analyses it frequently has been pointed out that the time available since the birth of this planet was not sufficient for a process in which life evolved out of nothing by purely random variations (for a summary see Spetner 1997). In a process like VSA, the variations are not purely random; the complex order already exists in virtual states and is merely *revealed* by chance. Much less time should be needed for such a process compared to one in which the complex order has to be *created* by chance.

It is one of Darwin's famous maxims that "Nature does not make jumps" ([1872] 1956, 203). Contemporary physics tells us that nature makes nothing but jumps—namely quantum jumps. The overall progression of evolution is not exempted from this law, because the succession of evolutionary levels often is not gradual but conveys the impression that "everything seems to have burst into the world *ready made*" (Teilhard 1959, 121).

The theory of *punctuated equilibrium* is an attempt to explain geological observations that show "the geological instantaneous origination and subsequent stability (often for millions of years) of palaeontological 'morphospecies'" (Gould and Eldredge 1993, 223). Such a process—the rapid and spontaneous change of a system from an enduring equilibrium to a new state—bears all the signatures of a quantum process. Specifically, such conduct typically is found among systems with crossed quantum states: sodium iodide, NaI, is a simple example (Ewbank, Schäfer, and Ischenko 1994).

When sodium iodide is trapped in one of its molecular states, the temporal sequence of radial probability maxima corresponds to a cyclic move-

ment of the molecule from small distances to large and back to small (Ewbank, Schäfer, and Ischenko 1994). One of the states of NaI, the NaI(0+) state, is crossed by a dissociative state at an Na-I distance of ~720 picometer. Every time the system in its cyclic motion passes the crossing point, there is a spontaneous branching off of a part of the population to a different state and to different chemical species. In modeling calculations of this process (Ewbank, Schäfer, and Ischenko 1994) the branching is illustrated by a bifurcation of the population.

In this example, populations of molecules display (relatively) long periods of stasis (residence of a molecular population in the same quantum state) punctuated by short periods of spontaneous transition of a part of the population to a different state and to different chemical species. Compared to the complexity of biological systems, the potential energy surfaces of NaI are trivially simple. Nevertheless, the analogy to the branching of a vertical lineage in biological evolution by punctuated equilibrium is striking. One begins to suspect that punctuated equilibria in biological change are indicative of the crossing of quantum entities, undoubtedly immensely complex, from one definite group of states to another.

In his book *The Extended Phenotype* Richard Dawkins ([1982] 1999) points out that theories which change the way in which we view the world are meaningful even if they do "not advance testable hypotheses" (p. 2). In his own look at life Dawkins begins by looking at individual organisms. "Then suddenly the image flips. The individual bodies are still there; they have not moved, but they seem to have gone transparent. We see through them to the replicating fragments of DNA within, and we see the wider world as an arena in which these genetic fragments play out their tournaments of manipulative skill" (p. 4).

Continuing where Dawkins stopped, I think prematurely, I suggest that when looking at organisms we begin by looking at bodies and their DNA. What do we see? Gene stuff, molecules, heaps of atoms. Then suddenly the image flips: the DNA becomes transparent, and we perceive the underlying quantum structure. The specific piece of DNA that we are looking at is just the tip of an iceberg. Underlying the visible part is a quantum structure with countless virtual states, not visible because they are empty, not actual because they are not occupied; yet, in their predetermined order they have the power of becoming real in a visible way, enabling the different connections and additions of atomic components that are possible. Simply by changing the way we observe, a new understanding of living organisms and their behavior can arise.

Dawkins proposes as a likely hypothesis that replicator molecules use individual organisms as "vehicles" and manipulate the world for the selfish benefit of their replication ([1982] 1999, 4, 302). If it is acceptable to consider mindless lumps of matter as centers of purpose, it is equally plausible to reposition the center of control to the level of the quantum states

that actualize in genes, expressing the principles of quantum reality in the material world.

Quantum Selection. The formation of chemical bonds in the course of a mutation occurs at the atomic level and is a quantum process. Transitions among quantum states are involved. Because every system contains a large number of virtual states, a selection is made in a mutation, and differences in transition probabilities will favor the selection of some states over others. This is a form of selection, but it is not natural selection: it can be adequately termed *quantum selection*.

The basis for the quantum perspective of evolution is the postulate that everything in the universe that is real is the actualization of a quantum state, and everything that is possible is deposited in virtual states. Thus, every new form that emerges in the material world represents the selection of a virtual state.

We do not know now the quantum states involved in mutations. Thus, we do not know whether or not quantum selection plays an important role in the process of evolution. This is a most important concept nevertheless, because it shows that natural selection is not acting alone. Natural selection has to drive the progression of evolution in tandem with quantum selection. Even though we do not know the quantum states involved in genetic processes, it is obvious that the evolutionary progression must in some way be affected by their properties.

Quantum selection describes a true quantum effect: Classical randomness and chance can lead to anything. Quantum randomness can lead only from one well-defined state to another well-defined state and not to an arbitrary point between two states. The hydrogen atom can serve as a simple example (Fig. 2).

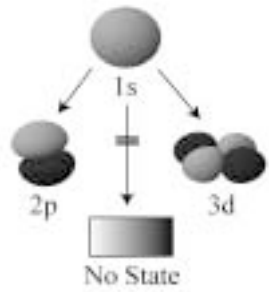

Figure 2. Probability density plots (iso-density surfaces of atomic orbitals) of possible and impossible H-atom electronic states. The probability density of the 1s state is that of a sphere; that of the 2p state is approximately that of two disconnected ellipsoids; that of the 3d state is approximately that of four disconnected ellipsoids. A state with a box-like distribution (center, bottom) does not exist.[2]

A hydrogen atom can make a transition from a state (1s) whose probability density is spherical to a state (2p) whose probability distribution is approximately bispherical or to a state (3d) whose distribution is approximately that of four disconnected ellipsoids. But a hydrogen atom cannot jump into a box (a state whose distribution is that of a box), because such a state does not exist.

Similarly, evolution may have led from fish to amphibians to mammals and human beings. But it has not been able to lead from fish to griffons, to basilisks and humans with wings, because cosmic virtual states do not exist for such mythical beasts.

In summary, when mutations are understood as transitions among quantum states,

1. the order that evolves in the biosphere is not from nothing but from the actualization of virtual states whose order exists long before it is actualized.
2. the concept of descent changes its meaning.
3. a second selection mechanism, quantum selection, must be considered, which drives evolution in tandem with natural selection.
4. the center of evolutionary activity is shifted from the material level to the level of quantum entities, whose mindlike properties may suggest that quantum reality is the source not only of the physical principles needed to construct our bodies but also of principles related to our minds.

The quantum perspective reveals the incompleteness of the Darwinian view. Like the physics of Newton, the biology of Darwin refers to the mechanistic surface of things. Like Newtonian physics, the Darwinian view is not false, but for a comprehensive view of reality it has to be supplemented by the quantum properties of matter. Orthodox Darwinism is steam-engine technology applied to the integrated circuits of life.

The Progression to Complexity. The quantum perspective of biological evolution—emergence of complex order from virtual states—enables a path to complexity that the classical perspective of evolution—emergence of complex order from nothing—does not afford.

In electronic molecular spectroscopy, the Franck-Condon principle states that transitions between two quantum states are easy when their wave functions are similar. It is possible to think that transitions between two states (or clusters of states) whose actualization gives rise to varied life forms are ruled by a similar principle.

In this way it is possible to think that for each state cluster whose actualization results in a living organism, neighboring virtual states exist that can be accessed in random quantum jumps. Among these neighboring states, some will lead to a regression in complexity, and others will lead to

more complex life forms. Even though the random quantum jumping in itself will not favor the actualization of any type of state over another—being perfectly neutral as far as the direction of evolutionary progression is concerned—this process *must* lead to increasingly complex life forms if enhanced complexity corresponds to enhanced biological fitness. This is so because the virtual states contain states for all possible life forms, including more complex ones. Thus, if all states are actualized with equal probability, virtual state actualization must lead to increased complexity in some cases, which natural selection will then preserve. Genetic mutations by classical randomness are typically destructive rather than creative. Thus, progression to complexity is not an inevitable part of a process in which new forms emerge out of nothing.

Because the complex order that evolves in the biosphere evolves not out of nothing but out of the quantum structure of molecular systems; because the emerging structures are not created by chance but result from the quantum properties and conditions of a system; and because a DNA molecule passes from one well-defined quantum state to another well-defined state but never to an arbitrary point between two states, the variations induced by mutations are quantized; that is, biological variations are intrinsically not gradual.

Because the virtual states that can be accessed by a mutating system include the states of all possible life forms, living systems must evolve toward increasing complexity.

Teilhard's Vision of Evolution and Its Similarities with the Quantum Perspective

The Power of Life. During the first half of the twentieth century, Teilhard (1881–1955) developed a theory of evolution that had no foundation in the science of his time—the mechanist materialism of the outgoing Newtonian age—but it is now seen to be in amazing accordance with basic aspects of quantum reality. One usually cannot find a description of Teilhard's views in textbooks of biology, because they are not testable science. Nevertheless, they are fascinating, and to many they have become an inspiration and a source of hope. Beyond the short description that follows, the reader will find additional details in King 1996 and Trennert-Hellwig 1993.

In Teilhard's vision, as in quantum reality, an element of consciousness is active at all levels of reality; the mental enters the material world in a natural way; and the visible order of the universe is based on the principles of a transcendent reality. The quantum phenomena make it possible to propose that the background of the universe is mindlike.

In Teilhard's view life is not "a fortuitous singularity of terrestrial matter" but "a specific effect of matter turned complex; a property that is present in the entire cosmic stuff" (Teilhard 1956, 34). "Life cannot be consid-

ered in the Universe any longer as a superficial accident but, rather, must be considered to be under pressure everywhere—ready to burst from the smallest crack no matter where in the universe—and, once actualized, it is incapable of not using every opportunity and means to arrive at the extreme of its potentiality, externally of Complexity, and internally of Consciousness" (1956, 50).

Below a certain complexity, matter seems dead. However, it is never really "dead" but should rather be called "pre-vital" (1956, 35, 44). Teilhard considered matter and consciousness not as "two substances" or "two different modes of existence . . . but as two aspects of the same cosmic stuff" (Teilhard 1978, 25).

> There is no doubt: the so-called brute matter is certainly animated in its own way. . . . Atoms, electrons, elementary particles, whatever they may be if they be anything at all outside of us, must have a rudiment of immanence; i.e., a spark of consciousness. Before on this planet the physico-chemical conditions allowed the birth of organic life, the universe was either not yet anything in itself, or it had already formed a nebula of consciousness. (Teilhard 1965, 75)

In a Newtonian universe, such statements are purely visionary. In quantum reality, elementary particles are active—they constantly explore their quantum space in quantum jumps; their actions—the quantum jumps—are spontaneous; and they are able to respond to mental principles such as information, probability waves, and the order of virtual states. Thus, elementary particles are not truly lifeless but show rudimentary signs of life in an automatic and mechanical way.

Throughout Teilhard's writings, *life* is synonymous with *consciousness*, and the process of biological evolution is basically the evolution of a spiritual sphere, the *noosphere*. In human beings, evolution has become conscious of itself and is attracted by an absolute point, *Omega Point*, where the consciousness of humanity will be united with the Consciousness that he believed is acting in the universe—the cosmic Christ (Teilhard [1955] 1959, 294).

The Importance of Consciousness. When it is the goal of life to maximize consciousness, that which bursts out of the seams of the universe ultimately is Mind. In the quantum perspective, intelligent systems can be understood as integrations over groups of states that form a subspace of the quantum structure of the universe. Each advance enlarges the subspace over which it integrates. If reality is ultimately mindlike it is not amazing that, as Teilhard proposed, the future evolution of humankind will result in beings with enhanced mental abilities. "Every time a richer and better organized structure will correspond to the more developed consciousness" (Teilhard [1955] 1959, 60).

Every mass is subject to the laws of relativity. Every system is quantized. In slow-moving objects of ordinary size relativistic and quantum effects are so subtle that they may not be discoverable. But that does not mean

that they are not there. In objects moving at high velocities, or in the elementary constituents of things, relativistic and quantum effects, respectively, clearly come to the fore. The same pertains, Teilhard proposed, to effects of consciousness. In some things there is no doubt that consciousness exists. It is clearly there. In others it also exists, but in such an attenuated state that it is not so easily discovered. Human beings clearly have a *within*. Elementary particles also have a within, even though it is so weakly expressed that it is not immediately visible. This is Teilhard's thesis of "the Within of things" ([1955] 1959, 54–57); it implies that an element of Consciousness is active at all levels of reality.

> Since the stuff of the universe has an inner aspect at one point of itself, there is necessarily a *double aspect to its structure*, that is to say in every region of space and time—in the same way, for instance, as it is granular: *coextensive with their Without, there is a Within to things*. . . . Primitive matter is something more than the particulate swarming so marvelously analyzed by modern physics. Beneath this mechanical layer we must think of a "biological" layer that is attenuated to the uttermost, but yet is absolutely necessary to explain the cosmos in succeeding ages. The *within*, *consciousness* and then *spontaneity*—three expressions for the same thing. ([1955] 1959, 56)

The thesis that elements of consciousness are active at all levels of the universe is one of Teilhard's main themes. That Consciousness may exist without a supporting material structure is a notion that science has always specifically denied but may have to get used to. If we modify Teilhard's definition of consciousness by taking *sensitivity to information* as a sign of rudimentary consciousness, we arrive indeed at the level of physical phenomena, confirming the view that all levels of reality are imbued with consciousness.

We must be clear about the fact that quantum theory cannot be taken as a license for proposing paranormal effects, new age theories, and esoteric forms of magic. Nevertheless, we also must note that the materialism and naive realism of classical science are finished, and, at the level of elementary particles, aspects of consciousness appear.

The mindlike properties of elementary particles are rudimentary. Elementary particles have no consciousness or psyche, but they can react to information in a mechanical and automatic way. Thus, they differ from intelligent systems, which use information in a systematic way. From this rudimentary base, however, a hierarchy of intelligent structures has evolved.

The important point is that in the hierarchy of intelligence—from the level of elementary particles, to the vegetative level of intelligence, as in plants and single cells, to the level of animals with limited self-consciousness, to fully self-conscious beings with the understanding of universal principles and values—universal consciousness reveals itself at all levels with increasing complexity. Beyond this hierarchy we can assume a level of Consciousness that is not confined to spacetime and not bound to localized material structures.

The interactions of virtual states and real states offer a glimpse of how the mental can express itself in the material world. The first step lies in the transformation of a virtual state into a real (occupied) state, transforming a virtual wave function to the wave function of a real state. Interestingly, both types of wave functions, virtual and real, are just invisible lists of numbers. They differ only in that the latter, *when probed*, can give rise to a real phenomenon, namely, an observable probability distribution, while the former cannot be probed. Even the probability distributions are not visible in individual events but emerge only in repeated measurements or measurements made on ensembles of members of a given population. Thus the converting of mental (virtual) order to material (real) order is possible because the first step is the subtle conversion among entities of the same kind—namely, numbers.

The power of consciousness is particularly evident in cultural evolution, "where a certain special influence (that of the psychique), which so far has been negligible for the concerns of the Systematic, all of a sudden plays a leading role in the branching of the phylum" (Teilhard 1956, 126). In the human realm, due to the force of the psychic,

> An increasingly dense and energized atmosphere is forming of creative and inventive endeavors, at first just like a light and thin fog, blown hither and thither by every whim and imagination—but becoming a formidably irresistible medium from that moment on, when, gripped and twisted by the vortex of a powerful maelstrom, it begins . . . to focus onto itself in order to attack the Real like a single arrow, in a single concerted direction, with the purpose, not only to gain a higher level of pleasure or knowledge, but a higher level of being. (Teilhard 1956, 153)

Why does humankind "brace itself onto itself in order to find? And what do they want to find, if not, ultimately, the means to super- or at least ultra-hominize?" (Teilhard 1956, 156)

A concerted research effort is now focused on "the very intelligence that is its source: the collective cerebralisation (in a convergent environment) applying the fine point of its enormous power to complete and render anatomically perfect the brain of every individual" (1956, 159). If the universe were nothing but a giant mass, the process of enhancing the mental powers of humankind would be meaningless. In a mindlike reality, expanding the spiritual human powers seems the natural thing to do and defines a sort of cosmic morality: *Act in such a way that your actions contribute to the enhancement of the mental powers of humanity*.

A reality whose nature is that of a wholeness is comparable to a point without separate parts, without extended space, and without extended time. In a reality that is a whole, each location is everywhere, each time is always. Teilhard's Omega Point is such a reality. "Strictly speaking, Omega Point is placed outside of the empirical process which it brings to its conclusion: in order to reach it, . . . we will have to leave space and time" (1956, 167).

In our current existence, it is difficult to comprehend how we can be part of a reality that is an indivisible wholeness, without parts and divisions, and how we can be separated, at the same time, from our environment and from each other. The answer can perhaps be found in the mindlike nature of reality. It is not the material cortex of reality that is an undivided whole but its mindlike basis. Only with our minds can we partake, if at all, of the nonlocal reality of the universe.

> If Omega Point is really the keystone in the vault of the noosphere, then it can be understood only as that *point of encounter* at which the universe, having reached the limits of its centralization, meets *another Center*, even more unfathomable—a Center that exists out of itself, an absolutely final Principle of irreversibility and personalization: the only true Omega. . . . And it is at this point, if I am not totally misled, that the question of God emerges for the science of evolution, . . . God as the Driving Force, Collector and Guarantor of evolution. (1956, 172)

In this way Teilhard attempted to achieve a natural union of science and theology, hoping that it might be the science of the future. "Like the meridians as they approach the poles, science, philosophy and religion are bound to converge as they draw nearer the whole" (Teilhard [1955] 1959, 30). For Teilhard the Consciousness of the world was the Consciousness of the Cosmic Christ. Thus he found, in a moving way, a synthesis of his scientific convictions and his religious faith.

Transcendent Reality. From the above quotations it appears that Teilhard envisioned that the goal of our destiny resides in a transcendent reality outside of spacetime. As already shown, the assumption of such a reality is no longer in conflict with contemporary physics, and a growing number of physicists are willing to consider phenomena that reside outside of spacetime but affect spacetime processes. For example, some have proposed that the processes underlying nonlocal phenomena have non-spacetime roots (Stapp 1977; Kafatos and Nadeau 1990; Goswami, Reed, and Goswami 1993; Nesteruk 2000).

We can only guess what the nature of the transcendent part of reality might be, but very likely it is rather mindlike than matterlike (Goswami, Reed, and Goswami 1993; Kafatos and Nadeau 1990; Schäfer 1997; Srivastava 2001a, b; 2002; 2003), and some form of consciousness, not matter, is the primary reality.

At the foundation of physical reality, the nature of material things reveals itself as nonmaterial. Entities with mindlike properties are found. At the level of elementary particles, idealike states become matterlike. The Word is becoming Flesh (John 1:14). The unobserved, wavelike states of potentia are thoughtlike; the results of quantum jumps, matterlike. Actualization is materialization. Whatever King Midas touched turned into gold. Whatever human beings touch turns into matter. The message of contemporary physics is that, at its frontiers, observable reality fades not

into nothing but into something metaphysical. In the same way in which dead atoms can form living organisms and mindless molecules can form intelligent brains, metaphysical entities can form physical reality.

If our metaphysical convictions are in any way meaningful, they must refer to a realm of metaphysics that is a part of reality. Where else should such a realm be found if not at the frontiers of physical reality and beyond? "Nature's fundamental laws," P. A. M. Dirac wrote in 1935, "do not govern the world as it appears in our mental picture in any very direct way, but instead they control a substratum of which we cannot form a mental picture without introducing irrelevancies" (quoted by Michael Polanyi [1946] 1964, 88). "One is no longer attached to the Natural," the painter Franz Marc wrote, "but one annihilates the Natural in order to reveal the powerful laws which rule behind the beautiful appearance."[1]

Dirac proposed that in quantum jumps "a choice is made" (quoted by Stapp 1993, 190). A choice can be defined as "any fixing of something that is left free by the laws of nature" (1993, 185). This puts quantum jumps outside the laws of nature as we know them.

In physics, chance is absence of causality. "A rather serious consequence of dropping causality in the external world," Eddington wrote (1929, 309), "is that it leaves us with no clear distinction between the Natural and the Supernatural." The suggestion is that in quantum jumping the supernatural comes to the fore. At the quantum level of reality, the line of demarcation is blurred between the realm of the natural and that of the supernatural. The two realms are seen to merge, like the physical with the metaphysical, the mental with the material, and the mechanistic with the teleonomic.

According to Immanuel Kant, the world is twofold: there is the world of appearances and of the things in themselves. We know the things only in the way in which they appear to us. This distinguishes the sensible world from the intelligible world. Interestingly, while Kant postulated that nothing can be known about things in themselves, he nevertheless called them *noumena*—something intelligible—implying that they are mindlike.

According to Georg Wilhelm Friedrich Hegel, the primary structure of reality, the "Absolute," is a Mind, Reason or "Spirit," and everything that exists is the actualization of this structure. Similar to Teilhard, Hegel envisioned that reality was an ascending dynamic process, leading the Cosmic Spirit toward self-realization or self-awareness (Emundts and Horstmann 2002, 35; Solomon 1993). Similarly, Johann Gottlieb Fichte and Friedrich Wilhelm Josef Schelling believed that the external world was the creation of our Reason (Fichte) or of a Reason (Schelling) that is independent of our Self.

Propagated by the religions and Idealist philosophers of all ages, categorically denied by the mechanistic sciences of the eighteenth and nineteenth centuries and by their contemporary rear guard, the assumption of

a transcendent and mindlike part of reality is now possible without being in conflict with science and can serve as a basis of the human commitment to principles that transcend individual existence and needs.

Monist materialism is not a basis for a life with values. "It must be recognized that monist materialism leads to a rejection or devaluation of all that matters in life," wrote J. C. Eccles (1979, 9). "A society refusing to be dedicated to transcendent ideals," Polanyi wrote ([1946] 1964, 79), "chooses to be subjected to servitude."

Human Beings in a Mindlike Universe

Cosmic Morality. Central to the views of Teilhard is the thesis that biological evolution has not ended with us, that we are part of an ongoing cosmic process that demands our moral commitment to it. Our quantum base cannot help but evolve by constantly exploring its quantum space in incessant quantum jumps. As a consequence, we are a doomed species—not because we have finally managed to ruin the environment but because, in the story of life, all species step into the limelight for just a short time, after which they have to yield their place.

In view of this process it is important to ask whether the species following us will share the same values. It seems safe to propose that only those of our values will survive that are in agreement with the principles of the Cosmic Consciousness. Thus, virtue is striving for a life that is in harmony with the order of the universe. A cosmic morality?

If the nature of the universe is mindlike, it must be expected to have a spiritual order as well as a physical order, and (transcribing Eddington) in human beings this order rises to the level of morality. By interacting with the mindlike background of reality our mind establishes the authority of honesty, morality, responsibility, and purpose. The human mind is not self-contained and perhaps not self-sustained but possibly online to a transcendent part of reality. To live in accordance with the essence of things, Socrates taught, is the premise of the moral life. The nature of quantum reality now seems to suggest that to live in accordance with the order of the universe is the cardinal value on which to build a system of ethics.

In this context the nonlocality of reality is an important aspect. As human beings and societies we seem separate, but in our roots we are part of an indivisible whole and share in the same cosmic process. In this way the quantum phenomena show us what is wrong with our current way of life but do not force us to accept its messages. It will take a willful effort to accept that no system can prosper by manipulating others and that only those systems will survive that are authentic in a cosmic sense.

Such views are in direct contrast to the currently accepted theories of sociobiologists and ethologists who claim that the basic patterns of animal behavior are adaptations. This implies that our values, including our moral

values, are nothing but strategies in a selfish game aimed at getting the better of someone else's genes. In "The Evolution of Ethics" Michael Ruse and E. O. Wilson write:

> Morality, or more strictly our belief in morality, is merely an adaptation put in place to further our reproductive ends. Hence the basis of ethics does not lie in God's will—or in the metaphorical roots of evolution or any other part of the framework of the Universe. In an important sense, ethics as we understand it is an illusion fobbed off on us by our genes to get us to cooperate. It is without external grounding. . . . The way our biology enforces its ends is by making us think that there is an objective higher code, to which we are all subject. (Ruse and Wilson 1993, 310)

Similarly, Ruse writes:

> Where I start, with great enthusiasm, is with Charles Darwin's theory of evolution through natural selection. This leads me to the conclusion that our morality is put in place, by our biology, to make us good social animals. . . . I do not accept objective moral properties. (2001b, 27)

> Morality is a collective illusion of humankind, put in place by our genes in order to make us good cooperators. (2001a, 20)

In the quantum world, the actions of genes are not driven by any purpose, but, following the laws of physics and chemistry, they just reveal universal order. Genes are not great deceivers of humanity, not selfish impostors; they are just messengers and relay stations by which information from deep inside reality is transmitted to us. If our behavior is an adaptation, it means that we were selected for it. If morality is an illusion set up by our genes, we were all selected for a particular type of stupidity—namely, the inability to recognize a cheap trick when we see one. One cannot avoid the impression that something else is involved.

These are two conflicting views: that the nature of reality is that of a wholeness, but that the principles of living systems are exclusively those of absolute separateness—that is, of selfishness. The possibility that, in addition to natural selection, there is quantum selection, was discussed above. When natural selection is not the only channel by which variations in behavior can evolve, it is possible that selfishness is only a part of the adaptations that constitute the human mind. Quantum selection, unlike natural selection, is committed not to selfishness but to cosmic order. If human values have a correlate in the cosmic order, it is possible to think that human conduct can bring values into actuality that are not based on selfishness, deception, and ruthlessness.

It seems reasonable to propose that the universal principles which appear in our thinking are reflections of universal order. In that case the adaptation involved in moral behavior is the capacity of the mind to comprehend the significance of universal principles. In the same way in which we evolved the capacity to understand universal principles in physics we evolved the capacity for universal principles in ethics.

Within this framework I propose that, regardless of what the mechanisms are by which moral behavior, kindness, and generosity evolved (for all we know the original motivations may have been immoral and selfish), in the practice of such behaviors inevitably the awareness of objective principles evolves. For every developing human being the initial motivation behind altruistic acts may be selfishness. But in the pursuit of such acts, internal experience will suddenly lead to the discovery that the effects are congruent with immensely fascinating, objective principles that are bits of universal order. At the level of animals, different organisms follow thoughtlessly the principles by which their programs were wired. At the level of human beings, a new element comes into play in that evolution has led to a complexity that allows us to consciously partake of a transcendent cosmic order that is independent of genes and selfish needs.

Reductionism in science is the claim that one principle exists that can provide a basis for explaining all phenomena in the universe. In contemporary biology everything is reduced to the properties of genes. This is halfway reductionism. Genes, lumps of matter, are not the terminus of reality. They are not the authors of any information, just vehicles (inverting Dawkins's term) by which the messages of a deeper order are revealed. They are agents of an underlying order, the order of quantum reality. Through genes, the (virtual) order of quantum reality can express itself in the material world.

Hope. The nature of quantum reality is the basis for considerable hope that a life with meaning and values is not incompatible with the scientific frame of mind. In the quantum phenomena the universe has opened again; the mechanistic part of reality is only the cortex of something deeper and wider that has room for the spiritual, and religious faith is not in conflict with objective science.

Monod (1972) believed that we have spiritual needs because we are the descendants of animists. But perhaps we have spiritual needs because our mind needs to be in touch with what is akin to it in nature: the mindlike background of the universe. Our music is the music of the universe. Mozart is "a touch of transcendence," as Hans Küng wrote (1991). Sickness of spirit is the sickness of those who have cut the ties with the mindlike background and are not in harmony with its principles.

We are not in conflict with any data if we want to combine the good instincts and expectations of the age of enlightenment—the desire for rational clarity, objectivity, and compatibility with experience—with the opening of our minds to a world of purpose, meaning, and truthfulness in a wider sense. If the universe is a network of instantaneous, long-distance connections, it is more likely that it will include us than not. If the universe is mindlike, it is more likely that it will communicate with our mind than not. This is the new covenant with nature.

According to Augustine, all knowledge is a gift of grace. *Nisi credideritis, non intelligitis* (If you do not believe, you will not understand). Translated out of the Christian context, this statement can be taken to mean that we are online to a transcendent part of reality.

The message of science cannot be part of an agenda. The message is not that, because nature can be explained in a natural way, one must be an atheist. The message is not that, if the universe is mindlike, one has to subscribe to a particular creed, or any creed. Science may suggest the existence of a Universal Mind, but it will not tell us what to call this Mind, how to worship, or that we must worship. Science provides a general framework into which everyone can enter his or her spiritual needs, and its message is that everyone has the right to make a choice.

The proposal that complex order emerges from the virtual quantum structure of the universe represents a position of moderation. Nothing forbids the view that the virtual order has a Creator. At the same time, the evolution of life from the virtual cosmic structure is a natural process amenable to scientific study in agreement with the existing body of data.

Science will never give up its claim that nature can be explained in a natural way. But at the ultimate level of reductionism that term will mean something entirely different than it does at the level of human consciousness. It may even be found synonymous with the Divine. The life of barbarians, nomad aliens in the realm of values, cannot be excused anymore by mechanist materialist claims on reality.

In view of the mindlike aspects of quantum reality it is possible to think that the mental element is the power of the universe. Logos. Mind. Nous. Weltgeist. By creating human minds it has found a new way to burst onto the scene—thinking in us, as Hegel believed. In sacred places, such as some of the cathedrals in Europe, at one time the transcendent order of reality burst out of the ground and cast itself into stone, using a human mind as its tool. In places like this the awareness of a Transcendent Presence can be overwhelming.

In the end, I have the courage to amend one of Kant's timeless statements: *Two things fill my mind with ever-increasing admiration and reverence the more I think about them: the miracle of my consciousness and its covenant with the mindlike background of physical reality.*

NOTES

This essay evolved from a paper originally given during a conference organized by Fordham University in New York City on 7 April 2005 to mark the fiftieth anniversary of Teilhard's death.

The author gratefully acknowledges the support of this project by David W. Dubbell, President, Pel-Freez Holdings, Inc., and by Bill Durham and Gabriele Schäfer.

1. Quotation found at the 2005 Munich Marc Retrospective.
2. Graphs of atomic orbitals were generated with the Orbital Viewer program by David Manthey, *http://www.orbitals.com*.

REFERENCES

Aspect, Alain, Philippe Grangier, and Gérard Roger. 1981. "Experimental Tests of Realistic Local Theories via Bell's Theorem." *Physical Review Letters* 47:460–63.

Aspect, Alain, Jean Dalibard, and Gérard Roger. 1982. "Experimental Test of Bell's Inequalities Using Time-Varying Analyzers." *Physical Review Letters* 49:1804–07.

Augustinus. 1989. *Bekenntnisse*. Stuttgart: Reclam.

Bell, John S. 1965. "On the Einstein Podolsky Rosen Paradox." *Physics* 1:195–200.

———. 1988. Interview. *Omni* 10 (8): 84–121.

Bubner, Rüdiger. 1978. *Geschichte der Philosophie in Text und Darstellung: Deutscher Idealismus*. Stuttgart: Reclam.

Clauser, John F., and Abner Shimony. 1978. "Bell's Theorem. Experimental Tests and Implications." *Reports on Progress in Physics* 41:1881–1927.

Darwin, Charles. [1872] 1956. *The Origin of Species*. London: Oxford Univ. Press.

Dawkins, Richard. [1982] 1999. *The Extended Phenotype*. Oxford: Oxford Univ. Press.

Eccles, John C. 1979. *The Human Mystery*. New York: Springer International.

Eddington, Arthur S. 1929. *The Nature of the Physical World*. New York: Macmillan.

———. 1939. *The Philosophy of Physical Science*. New York: Macmillan.

Emundts, Dina, and Rolf-Peter Horstmann. 2002. *G. W. F. Hegel. Eine Einführung*. Stuttgart: Reclam.

d'Espagnat, Bernard. 1983. *In Search of Reality*. New York: Springer.

Ewbank, John D., Lothar Schäfer, and Anatoli A. Ischenko. 1994. "Structural Kinetics by Stroboscopic Gas Electron Diffraction 2. Time-dependent Molecular Intensities of Predissociation Processes." *Journal of Molecular Structure* 321:265–78.

Freedman, Stuart J., and John F. Clauser. 1972. "Experimental Test of Local Hidden-Variable Theories." *Physical Review Letters* 28:938–41.

Goswami, Amit, Richard E. Reed, and Maggie Goswami. 1993. *The Self-Aware Universe*. New York: Penguin Putnam.

Gould, Stephen Jay, and Niles Eldredge. 1993. "Punctuated Equilibrium Comes of Age." *Nature* 366:223–27.

Heisenberg, Werner. [1952] 1979. "Ideas of the Natural Philosophy of Ancient Times in Modern Physics." In *Philosophical Problems of Quantum Physics*, 53–59. Woodbridge, Conn.: Ox Bow.

———. [1958] 1962. *Physics and Philosophy*. New York: Harper Torchbook.

Hirschberger, Johannes. 1976. *Geschichte der Philosophie*. Freiburg: Herder.

Jeans, James. 1931. *The Mysterious Universe*. New York: Macmillan.

Jiang, Xiaoqin, Ming Cao, Brian Teppen, Susan Q. Newton, and Lothar Schäfer. 1995. "Predictions of Protein Backbone Structural Parameters from First Principles: Systematic Comparisons of Calculated N-C(α)-C', Angles with High-Resolution Protein Crystallographic Results." *Journal of Physical Chemistry* 99:10521–25.

Kafatos, Menas, and Robert Nadeau. 1990. *The Conscious Universe*. New York: Springer.

King, Ursula. 1996. *Spirit of Fire*. Maryknoll, N.Y.: Orbis.

Küng, Hans. 1991. *Mozart-Spuren der Transzendenz*. München, Zürich: Piper.

Margenau, Henry. 1984. *The Miracle of Existence*. Woodbridge, Conn.: Ox Bow.

Millett, Frank, and Bill Durham. 2002. "Design of Photoactive Ruthenium Complexes to Study Interprotein Electron Transfer." *Biochemistry* 41:11315–24.

Monod, Jacques. 1972. *Chance and Necessity*. London: Collins.

Nesteruk, Alexei V. 2000. "Is a Wave Function Collapse (WFC) a Real Event in Physical Space and Time?" In *Recent Advances in Relativity Theory 2: Material Interpretations*, ed. M. C. Duffy and M. Wegener, 169–70. Palm Harbor, Fl.: Hadronic.

Polanyi, Michael. [1946] 1964. *Science, Faith, and Society*. Chicago: Univ. of Chicago Press.

Primas, Hans. 1996. "Zur Quantenmechanik makroskopischer Systeme." In *Wieviele Leben hat Schrödinger's Katze?* ed. Jürgen Audretsch and Klaus Mainzer, 209–43. Heidelberg.: Spektrum Akademischer Verlag.

Ruse, Michael. 2001a. "The Confessions of a Skeptic." *Research News and Opportunity in Science and Theology* 1 (6): 20.

———. 2001b. "The Bad Smell of Anti-Reductionism." *Research News and Opportunity in Science and Theology* 1 (9): 27.

Ruse, Michael, and E. O. Wilson. 1993. "The Approach of Sociobiology: The Evolution of Ethics." In *Religion and the Natural Sciences*, ed. J. E. Huchingson, 308–11. New York: Harcourt, Brace, Jovanovich.

Russell, Bertrand. [1946] 1979. *History of Western Philosophy.* London: Unwin.

Schäfer, Lothar. 1997. *In Search of Divine Reality.* Fayetteville: Univ. of Arkansas Press.

———. 2001. "On the Halfway Reductionism of Michael Ruse." *Research News and Opportunity in Science and Theology* 2 (4): 16.

———. 2002a. "Quantum View of Evolution." *Research News and Opportunity in Science and Theology* 2 (8): 26.

———. 2002b. "Biology Must Consider Quantum Effects." *Research News and Opportunity in Science and Theology* 3 (1): 16.

———. 2002c. "Reasons for Hope: Humanity in a Mind-like Universe." In *Hopefully Yours: Interdisciplinary Essays on Hope from Scientific and Religious Perspectives*, ed. K. Pandikattu. Pune, India: Jnanam.

———. 2003. *Em Busca da Realidade Divina*. Lisboa, Portugal: Esquilo.

———. 2004a. "Quantum Reality and the Importance of Consciousness in the Universe." In *Cons-Ciências, Ciência, Religião e Consciência*, ed. J. Fernandes and N. L. Santos, 81–102. Porto, Portugal: Universidade Fernando Pessoa.

———. 2004b. *Versteckte Wirklichkeit—Wie uns die Quantenphysik zur Transzendenz führt*. Stuttgart, Germany: Hirzel Verlag.

———. 2005. "Somos parte de un processo cosmico que esta em andamento." *IHU On-Line* 5 (140, 9 de maio), 7–11. Sao Leopoldo, Brazil: Unisinos.

Schäfer, Lothar, Christian Van Alsenoy. and Joe Neal Scarsdale. 1982. "Ab Initio Studies of Structural Features Not Easily Amenable to Experiment. 23. Molecular Structures and Conformational Analysis of the Dipeptide N-acetyl-N'-methyl glycyl amide and the Significance of Local Geometries for Peptide Structures." *Journal of Chemical Physics* 76:1439.

Sheldrake, Rupert. 1988. *The Presence of the Past*. Rochester, N.Y.: Park Street Press.

Solomon, Robert C. 1993. "Hegel's Phenomenology of Spirit." In *The Age of German Idealism*, ed. Robert C. Solomon and Kathleen M. Higgins, 181–215. New York: Routledge.

Spetner, Lee M. 1997. *Not by Chance!* New York: Judaica.

Srivastava, Jagdish N. 2001a. "Logic, Gödel's Theorem, Rationality and Spirituality." In *Thoughts on Synthesis of Science and Religion*, ed. T. D. Singh and S. Bandyopadhyay, 157–74. Kolkata, India: Bhaktivedanta Inst.

———. 2001b. "Science and Spirituality in the New Millennium." In *Thoughts on Synthesis of Science and Religion*, ed. T. D. Singh and S. Bandyopadhyay, 580–93. Kolkata, India: Bhaktivedanta Inst.

———. 2002. "Life Comes from Life. Part I: An Overview." In *Savijnaanam: Scientific Exploration for a Spiritual Paradigm*. *Journal of the Bhaktivedanta Institute* 1:21–30. Kolkata, India: Bhaktivedanta Inst.

———. 2003. "Life Comes from Life. Part II: Consciousness, Life, and the Validity of the Bhagavadgita Ontology." In *Savijnaanam: Scientific Exploration for a Spiritual Paradigm*. *Journal of the Bhaktivedanta Institute* 2:19–42. Kolkata, India: Bhaktivedanta Inst.

Stapp, Henry P. 1977. "Are Superluminal Connections Necessary?" *Nuovo Cimento* 40B:191–99.

———. 1993. *Mind, Matter, and Quantum Mechanics*. New York: Springer.

Teilhard de Chardin, Pierre. 1931. *L'Esprit de la Terre*. Ouevre Complet, vol. 6. Paris: Éditions du Seuil.

———. [1955] 1959. *The Phenomenon of Man*. New York: Harper and Brothers.

———. 1956. *La Place de l'Homme dans la Nature*. Paris: Éditions du Seuil.

———. 1965. *Mon Univers*. In *Science et Christ*. Paris: Éditions du Seuil.

———. 1978. *Heart of Matter*. London: Collins, and New York: Harcourt Brace Jovanovich.

Teppen Brian J., Ching-Hsing Yu, Susan Q. Newton, David M. Miller, and Lothar Schäfer. 2002. "Quantum Molecular Dynamics Simulations Regarding the Dechlorination of Trichloro Ethene in the Interlayer Space of the 2:1 Clay Mineral Nontronite." *Journal of Physical Chemistry A*. 106:5498–5503.

Trennert-Hellwig, Mathias. 1993. *Die Urkraft des Kosmos*. Freiburg, Germany: Herder.
Van Alsenoy, Christian, Ching-Hsing Yu, Anik Peeters, Jan M. L. Martin, and Lothar Schäfer. 1998. "Ab Initio Geometry Determination of Proteins. I. Crambin." *Journal of Physical Chemistry A*. 102:2246–51.
Wheeler, John A., and Kenneth Ford. 1998. *Geons, Black Holes & Quantum Foam*. New York: W. W. Norton.
Wiener, Norbert. 1961. *Cybernetics*. 2d ed. New York: MIT Press.