A RESPONSE TO ERVIN LASZLO: QUANTUM AND CONSCIOUSNESS

by Lothar Schäfer

Abstract. I respond to Ervin Laszlo's suggestions and criticism regarding my essay in this issue of *Zygon*. Virtual atomic orbitals are used as a model to illustrate the existence of a general realm of potentiality in physical reality from which the actual world emanates. Laszlo's suggestions for "paradigm repair" are supported and accepted as essentially being in agreement with my intentions and as offering highly useful clarifications. I compare virtual states to historic ideas of forms as metaphysical principles of being that inspire thoughts regarding the actions of a Cosmic Consciousness in the processes of the universe. Metaphysical and theological interpretations of the results of scientific research are defended, provided that they are not used to interfere a priori with the technical program of scientific research.

Keywords: Aristotle's *potentia*; Cosmic Consciousness; emergence of complexity; historic ideas of forms; Plotinic concept of emanation; quantum reality; reality as potentiality and actuality; rejection of materialism; transcendent order; virtual states.

THE QUESTION OF WHAT TO CALL THE VIRTUAL STATES

In this essay I respond to Ervin Laszlo's suggestions and criticism regarding my essay "Quantum Reality and the Emergence of Complex Order from Virtual States" (Schäfer 2006). I begin with the description of the virtual states of a specific example: the hydrogen atom, a particularly simple case.

In 1926 Erwin Schrödinger suggested that electrons in atoms and molecules are not tiny material particles but should be considered as standing waves. Inspired by the wave properties of matter and the inability of classical physics to explain the properties of atoms and molecules, Schrödinger

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proposed a new kind of mechanics—wave mechanics—which describes the dynamic properties of material systems by a wave equation similar to the equation used in optics to describe the propagation of a light wave in space. Schrödinger's extraordinary creative achievement was to develop a set of rules that make it possible to formulate the wave equation—now generally called Schrödinger's equation—for the specific conditions of any given system of interest.

An important property of Schrödinger's equation is that a single equation set up for a specific system, such as for a particular atom, molecule, or a crystal, will yield a whole spectrum of different solutions or different wave functions, usually denoted by the Greek letter Ψ. Each of these functions defines a different state—a quantum state—of the system for which the equation was set up. In the case of the hydrogen atom, solving Schrödinger's equation yields an infinite number of wave functions, or orbitals, that depend on three numbers, called quantum numbers and symbolized by the letters *n*, *l*, and *m*; we write $\Psi_{n,l,m}$ for the orbitals of the hydrogen atom. Each mathematically allowed combination of the three numbers defines a specific state. Different combinations correspond to different mathematical expressions for the wave functions $\Psi_{n,l,m}$, which in turn determine the properties of a state.

Using the formalism of Schrödinger, the wave functions can be calculated a priori for all atoms and molecules and in principle for all material systems. The waves in themselves are not visible, but their squared amplitudes, Ψ^2, correspond to an observable property; that is, Ψ^2 determines the probability of finding an electron in the space surrounding an atom or molecule. One can say that the Ψ^2 determine the probability of presence. A selection of atomic orbitals is shown in Figure 1.

Schrödinger's wave mechanics has been tested in many ways. On its basis we conclude that every atom, every molecule, every piece of matter is the center of a system of quantum states, of which one is occupied by the system at any given time, while the others are empty. This quantum structure of matter implies that all changes of material systems are changes of states, involving transitions between occupied states and empty states. All that a material system can do is to jump from a state that it occupies to an empty state that is accessible to it.

In this way every material system is constituted not only of the state that it occupies when it is observed but also of countless other, invisible, states that are vacant. For example, when a particular hydrogen atom is observed in its most stable (1,0,0)-state, an infinite number of other states also exist, some of them shown in Figure 1, but they are not quite *real* in the ordinary sense of that term, because they are empty.

At this point Ervin Laszlo's comment is well taken that we have to watch our language in order to avoid a paradigm that needs repair (Laszlo 2006, 534). To begin with, we can say that an occupied state is *real* because it

possesses observable, empirical, or measurable properties, specifically an observable probability of presence. Similarly, an unoccupied state is said not to be real in the same way, because its probability of presence is not observable, and nothing else is measurable there. Not to be real in a measurable way is not meant to say that such a state is not part of reality.

Quantum chemists call empty states *virtual states*. That term must be the beginning of my description, because it represents the ruling nomenclature, even though I acknowledge Laszlo's criticism of the language; I am actually quite excited about it. As my description shows, the term is not an affirmation of materialism, as Laszlo says; on the contrary. But, existing in an actual world, I must find a descriptive term that underlines how different the empty states of material systems are, unoccupied, from actual states, occupied. The empty quantum states of material systems have no equivalent in the commonsense world of classical physics or in our conscious experience of what Charles Scott Sherrington called the *space-time energy sensible* reality. Using a more recent terminology (see Audretsch 2002; Blanchard et al. 2000; Joos et al. 1996; Küblbeck and Müller 2002; Fischbeck 2005), we can say that ordinary reality consists of decoherent, thinglike objects. Thus, from the perspective of someone living in the actual world and addressing the properties of material systems, I find it useful to distinguish between *virtual* states, or quantum-ontological potentiality, and *actual* states, which are factually and decoherently real. I owe Laszlo the awareness of the need to emphasize that describing the states of material systems in this way is not meant to deny the existence of nonmaterial entities not bound to material structures.

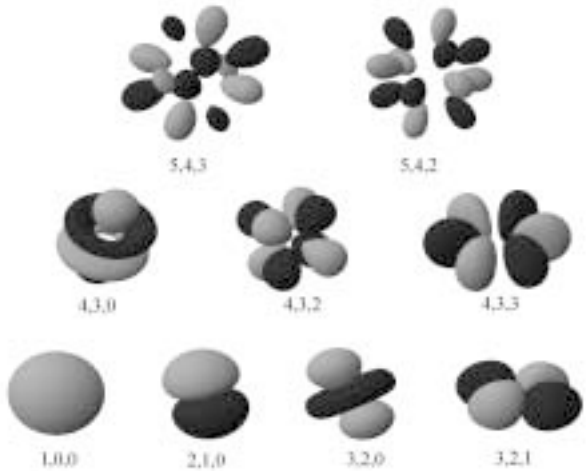

Fig. 1. Atomic orbitals (iso-density surfaces of probability distributions, $|\Psi_{n,l,m}|^2$) of some selected atomic n,l,m-states. The graphs were generated with the Orbital Viewer program by David Manthey, *http://www.orbitals.com*.

In further consideration it is seen that the concept of virtual states revives the historic idea of forms as "metaphysical principle of being," or as the "arché of all things," as Johannes Hirschberger says (1976, 1:24). Virtual states are forms, but they are more than mere formulae of mathematical forms, because they can actualize in the space-time energy sensible reality when they are occupied. Clearly, virtual states form a nonmaterial part of reality.

It seems that Aristotle developed his term of *potentia* (or *dynamis*) to solve Parmenides's logical paradox that there can be no becoming. Werner Heisenberg was the first to make the connection between Aristotelian *potentia* and quantum reality, applying Aristotle's concept to superposition states (Heisenberg [1958] 1962). In a superposition of states, a quantum entity is not in a specific state. Such a state of existence is impossible for ordinary things, which always exist in a single state. My body cannot be in a state where there is a simultaneous probability of presence in the library, in my bedroom, and in the pub on the corner. From that, Heisenberg's description of the situation is plausible: In a superposition of states a quantum entity is not quite real, he said, but it has the potential to become real when an observation (measurement) is made; in an observation, the transition from the "possible" to the "actual" takes place ([1958] 1962, 54).

Inspired by Heisenberg's comparison, I have extended the concept of *potentia* to virtual states (Schäfer 2004). This is an important extension, because it appends the property of potentiality or possibility to decoherent things that cannot perform fancy quantum acrobatics in superposition states. In the warm and noisy environment of living cells, for example, biomolecules cannot exist in superposition states, but they do have the faculty of *potentia* because they have virtual states. In this way the proposition by physicist Hans-Jürgen Fischbeck (2005, 20) that reality is "a dual structure of potentiality and actuality" is seen to generally apply under all conditions to all atomic and molecular systems.

Turning to the wave forms shown in Figure 1 and considering a hydrogen atom in the (1,0,0)-state, we realize that the wave forms of all the other states—(2,0,0), (2,1,0), (3,0,0), (3,1,0), (3,2,0), and so on—also somehow exist in this atom, but not in a factual-material sense, because they are empty forms. Nevertheless, they exist in the sense that their logical or mathematical order is part of the constitution of the system, completely determined and fixed by the conditions of the system, and can be calculated a priori; that is, the order of virtual states is preestablished and entirely predictable before it is actual. Because this order is beyond direct experience and beyond the properties of ordinary material systems—that is, it transcends both—I call it a *transcendent* order. Because this order is part of the constitution of material systems, I call it an *immanent* order. When I use these terms, which many will accuse as historically burdened, I do so with this simultaneous way of defining what is meant by them and

emphasize that they are made relative to the normal properties of decoherent material systems. I repeat these terms, even though they are severely criticized by Laszlo, because they describe the situation quite well from the perspective of a human being whose body exists in an actual world. At the same time I embrace with enthusiasm Laszlo's suggestion that this state of the matter should be scrutinized for a possible "paradigm repair," arriving at a position that describes reality from a more general perspective than the human perspective.

Figure 1 illustrates what is involved when a virtual state is actualized. For example, in the (1,0,0)-state the probability of presence of a hydrogen atom is that of a sphere. When this atom finds a way to make a transition from the (1,0,0)-state to the (4,3,0)-state, *that* state becomes real, while the former becomes virtual, and the spherical probability distribution will abruptly vanish and doughnutlike forms appear. Similarly, when the system jumps into the (4,3,3)-state, forms like a bracelet come to the fore, and increasingly complex forms can emerge, like the gothic shapes of states (5,4,3) and (5,4,2). From this we see that, *at the atomic and molecular levels, the emergence of new and complex forms is not from nothing but from the actualization of virtual states whose logical order already exists before it is actual*. Because living organisms are molecular systems, the emergence of complex order in biological evolution is not out of nothing but out of virtual states, and the order that emerges is not created by chance but is determined by the quantum properties of the systems involved.

I take this as a model of all of reality. The interactions of quantum objects that form a common quantum state are ruled by potential surfaces, on which many possible states exist, of which one is occupied while the others are empty. Applying the model to the universe, I consider that all visible reality is the actualization of cosmic virtual states. In response to Laszlo's criticism, I emphasize that the cosmic virtual states are a natural part of reality, but, in the sense described above, the order that they define is transcendent relative to the actual world. Even though reality is a wholeness, it has a structure; that is, it has a structure of virtual states, or forms. That the virtual order can be meaningfully described as mindlike is discussed in the following section.

At this point Laszlo suggests replacing the term *virtual state actualization* (VSA)—denoting the mechanism by which the material world is separated and actualized from the mindlike wholeness of the transcendent order of the universe—with the term *potential state actualization* (PSA). Even though I appreciate Laszlo's motivation, and we both want to express the same thoughts, calling a state of potentiality a *potential state* somehow changes the meaning in a subtle and undesirable way. Virtual states are definite and exactly determined states and in that sense not potential states. This consideration may show how difficult the problems of language are in describing these entities and how useful the critical input is by different

minds. The quantum phenomena force us to exactly define simple terms that are used tacitly in everyday language. For material systems, *real* means actual. What *reality* means to a superior spirit, surveying the universe from outside of space-time, is another matter (pun intended). But even for human minds the way of material systems to be real does not preclude the assumption that nonmaterial entities can also be real—like the states of a consciousness not bound to a material structure.

In this way one arrives at a quantum ontological postulate (Schäfer 2004): The visible order of the universe is the phenotypic expression of a deeper order—namely, that of quantum reality. Everything that we see, everything that is factually and decoherently thinglike *real* is the actualization of a quantum state; everything that is possible, everything visible in the future, is deposited in cosmic virtual states.

In the realm of biology, DNA molecules, which exist as lumps of matter, are actualizations of quantum states. All of the DNA molecules that are possible—mutations of actual DNA molecules—are deposited in virtual states. Because of the nonseparability of reality, these states can be thought to be not only molecular, belonging to individual molecules, but also cosmic. States that can actualize in DNA are a part of the quantum structure of the universe by which they are conditioned and out of which they are actualized.

Without the virtual order of the universe everything would come to a standstill, and we could probably not even think. Molecular states can be thought to exist in the virtual cosmic state space before the corresponding molecules exist as actual particles. Chances are that the quantum states that actualize in DNA already existed at a time when real DNA molecules did not yet exist on this planet as material lumps. Chances are that each of us is the actualization of a group of virtual states that existed in the virtual cosmic state space before we were born and will exist after we die. In this context I owe to one of my students in a current class, Lacy Fincannon, the reference to a wonderful biblical quote that expresses that same thought: "Before I formed you in the womb I knew you" (Jeremiah 1:5 NRSV).

The Question of a Cosmic Consciousness

That the universe should be endowed with the presence of consciousness and not communicate with the human mind—the one organ to which it is akin—is not likely. In fact, one of the most fascinating faculties of the human mind is its ability to be inspired by unknown sources, as though it were sensitive to signals of a mysterious origin. (A summary of historic cases is given in Schäfer 1997.) Thus, to me it is more important that Laszlo and I arrive at the same conclusion—that mind and consciousness are integral and important elements in the universe—than that our premises should be different. But are they so different?

Laszlo takes as the main argument of my essay the view that virtual states (nonactualized) are the basis for inferring the presence of mind and consciousness, and he proposes a different premise. Indeed, considering various traditions of thinking in our history, it is possible to suggest that, through virtual states or the realm of quantum-ontological potentiality, divine reality is shining into human reality. Virtual state wave functions are pure forms in which matter abandons itself and forgets its material properties. These forms are determined by the conditions of material systems, but in themselves they are devoid of matter and energy. One is reminded of Aristotle's metaphysics in which God is the only pure form. Similarly, in the quantum world the actualization of reality from virtual states is an emanation out of a wholeness that is One, as in Plotinus's metaphysics, in which God is the One and reality is not a creation of the One but an emanation, due to a necessary flowing over of the Divine. "The One is all. All is out of the One" (Hirschberger 1976, 1:304). In quantum-Plotinic terminology, visible reality is created not by VSA or PSA but by DSA—*divine state actualization*. Quantum potentiality has inspired Fischbeck's view that "God is all-encompassing potentiality," and, "since human consciousness is not thing-like, that is, not in a state of decoherence, it can be entangled with the all-encompassing potentiality that is the Cosmic Consciousness" (Fischbeck 2006). Augustine believed that eternal forms exist in the mind of God and that even human beings are actualizations of divine preconceptions. What an inspiring thought that virtual quantum states are thoughts in the mind of God and that we are actualizations of states that are part of the logical order of the Cosmic Consciousness, which has assumed matter in the form of our bodies. Whether that same logic can also be actualized in bodies that are not like ours, as the same thoughts can be expressed in different languages, is an interesting question.

There is a connotation of virtual states with something *thoughtlike* in the same way in which all thoughts have an inherent aspect of virtuality or potentiality. A thought exists in the mind of a speaker long before it is put into words. It is not quite real, but it has the potential—*potentia*—of becoming real by being expressed in words. Augustine described this aspect in the following way:

> Look, I, who is talking to you, thought before I came to you, what I would tell you. When I was thinking what to say, the word was already in my heart. Obviously, I would not talk to you without first thinking about it. I found you as a Roman, so in Latin the word has to be presented to you. If, however, you were a Greek, the word would have to be put before you in Greek. But that word is neither in Latin in me nor in Greek: it is entirely beyond any language, what is in my heart. I am seeking a language for it. I am practically looking for a vehicle, trying to find out how it can penetrate to you, without that it would ever leave me. Alright, you have heard what is in my heart, so now it is also in yours. It is in my heart and in your heart. You have started to own it, and I have not lost it.

Like my word assumed a language by which it was heard, so the word of God assumed flesh, by which it was seen. (Sermones, CCXXV.3; emphasis added)[1]

In his inspiring book *Does God Exist?* Hans Küng points out:

> There can be no going back behind Hegel to a naïve-anthropomorphic or even rationalist-deistic image of God, of a supramundane or extramundane God who exists along with and over against this world and man. Against all *biblicistic* appealing to the biblical God and all *traditionalistic* appealing to the traditional Christian God, we must abide by the post-Copernican, modern understanding of God in the *world*, transcendence in *immanence*, the hereafter in the *here and now*. ([1978] 1980, 164)

As already mentioned, from the perspective of the actual world in which my body exists, the virtual states form an order that is both immanent and transcendent. Why should it be impossible to think together the immanent-transcendent, extramundane and intramundane reality that is God with the immanent-transcendent order that we find in the virtual quantum states? Virtual reality is a liaison reality, as it were, through which Spirit or Consciousness interacts with human reality.

In this way, virtual reality inspires thoughts about divine reality. In defense of Laszlo's criticism, however, such thoughts are entirely outside of physical science. Searching for a less speculative access to cosmic consciousness from quantum reality, I cite the argument by Menas Kafatos and Robert Nadeau (1990), which is based on the nonseparability or nonlocality of reality: If reality is nonseparable, it is an indivisible wholeness. Since our Consciousness has emerged from this wholeness and is part of it, it is possible to infer that an element of consciousness is active in the universe.

The quantum ontological postulate defined above offers yet another argument (Schäfer 2004): If the visible order of reality is the phenotypic expression of an underlying primary order, every aspect of the visible reality, including our consciousness, arises from a corresponding element of the primary reality. The virtual states that actualize in human consciousness can be thought to be a subspace of states forming a cosmic consciousness. Different levels of consciousness are thus understood as integrations over different subspaces of the states of cosmic consciousness.

In a situation in which we are largely dealing with elements of tacit knowledge, in Michael Polanyi's sense (1966), Laszlo's criticism of my essay is extremely valuable in working out a comprehensive and consistent *explicit* description. Laszlo himself illustrates this difficulty: "Thus the events known as virtual states can be considered nonactualized states (or nonactualized wave functions of states) within the dynamic structure of space; more exactly, in the complex field that fills . . . space" (2006, 537–38). Here we should add that quantum potentiality may be deposited not only in the dynamic structure of space but also outside of space-time. At least, a growing number of physicists are willing to consider phenomena

that reside outside of space-time but affect space-time processes. Already in the 1930s, James Jeans suggested that

> the minutest phenomena of nature do not admit of representation in the space-time framework at all . . . other phenomena can only be represented by going outside the (space-time) continuum. We have, for instance, already tentatively pictured consciousness as something outside the continuum. . . . It is conceivable that happenings entirely outside the continuum determine what we describe as the "course of events" inside the continuum, and that the apparent indeterminacy of nature may arise merely from our trying to force happenings which occur in many dimensions into a smaller number of dimensions. (1931, 132)

Similarly, Heisenberg proposed that "the indivisible elementary particle of modern physics . . . is not a material particle in space and time" ([1952] 1979, 55).

More recently, Henry Stapp (1977), Kafatos and Nadeau (1990), Amit Goswami et al. (1993), and Alexei Nesteruk (2000) have proposed that nonlocal processes involve a reality outside of space-time. Stapp: "Everything we know about Nature is in accord with the idea that the fundamental process of Nature lies outside of space-time (surveys the space-time continuum globally), but generates events that can be located in space-time" (1977, 202). Huston Smith, the prominent writer about world religions (1958), concluded: "This makes that process metaphysical by including the physical while also being beyond and before it" (1997).

If we accept the suggestion that processes outside of space-time can affect events in space-time, we are facing not only an actual world, a potential (virtual) world, but also a noumenal part of reality, further aggravating the problems of language in dealing with what reality really is.

To put my thoughts into perspective, they are not science, but that does not mean they are illegitimate. Questions of the kind discussed here offer a choice: one can take it or leave it. I cannot express the justification better than it has been expressed in a recent manifesto published by a group of scientists in *Le Monde*:

> We are a group of scientists from the most diverse scientific and cultural backgrounds. We share the belief that religious or metaphysical ways of thinking should not, a priori, interfere in the ordinary practice of science. However, we also consider that it is legitimate, indeed necessary, to reflect, a posteriori, on the philosophical, ethical and metaphysical implications of scientific discoveries and theories. Indeed, to fall short of doing so would be to isolate many scientists and science itself from a large proportion of society. (Arsac et al. 2006)

NOTES

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1. For the translation of this passage of Augustine's sermons into German I had the assistance of E. F. Paulus (2003).

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