

Mystical Physics: Has Science Found the Path to the Ultimate?

Victor J. Stenger

Published in *Free Inquiry*, 16(3)1996

Quantum Metaphysics

Many people have come to look to science to solve all their problems. Worried about nuclear missiles? Let science build a shield. Fretting about running out of oil? Science will find us an endless source of energy, perhaps cold nuclear fusion. Too little food? Science will grow more. Too many people on earth? Science will launch them into space. Too much pollution? Science will find a way to clean it up. Sick? Science will heal you. Feeling depressed because you are going to die someday? Science will find a way for you to live forever, if not by medical means, then perhaps by confirming your deeply-felt belief that your selfhood is intimately connected to the very fabric of reality.

How wonderful that science makes our lives so comfortable. And how wonderful that science has finally confirmed our long-held belief that human consciousness is the driving force behind the universe itself!

Quantum mechanics is arguably the greatest scientific theory every invented. It has provided us with many of the tools of modern technology, while describing matter at its most fundamental level. Some believe that quantum mechanics has done even more, demonstrating that an act of human consciousness at one point in space can instantaneously cause a material system to change its behavior, indeed its very nature, at a distant point in space - even across the universe. And not just instantaneously. Human consciousness, it is said, can cause changes at other points in space even *before* the thoughts occur.¹ After all, thoughts are part of the unbroken wholeness of all existence. The mind exists throughout all space and time. It always existed, and always will exist.

This is the profound implication that many believe to follow from

quantum phenomena. Experiments have been performed that are misinterpreted as requiring instantaneous connections across space, in apparent violation of Einstein's assertion that nothing can move faster than light. Furthermore, quantum mechanics is construed as requiring the action of human consciousness to bring physical events into existence. The popular literature abounds with this theme as New Agers of every stripe, from psychics to astrologers to physicists and cosmologists, proclaim the oneness of human mind and the fabric of the cosmos.

The notion of a holistic universe, with everything instantaneously connected to everything else, occurs in a number of interpretations of quantum mechanics. In one class of interpretations, still-undetected sub-quantum forces operate on particles to determine their microscopic motion.² Theory and experiment strongly assert that these forces, if they exist, necessarily must act instantaneously over any distance. But neither theory nor experiment *require* that such sub-quantum forces exist. Their existence is pure speculation.

In another class of interpretations, the quantum wave function does not "collapse" to its final form until someone makes a measurement. In that case, human consciousness controls the course of events throughout all of space and time. In these interpretations, the universe is one and we are one with it.³

Undoubtedly, quantum mechanics has had difficulty in gaining a consensus on how it should be interpreted - or even that it need be interpreted at all, so long as its mathematics gives answers that agree with experiment. A detailed discussion and comparison of the various interpretations is beyond the scope of this article.⁴ Suffice it to say that many interpretations have been proposed that lead to the same empirical results, and so are indistinguishable except by their ontological assumptions. Without experiment to adjudicate between rival claims, it becomes somewhat a matter of taste which interpretation one prefers. In this situation, the only rational procedure is to apply Occam's razor and

reject those interpretations that are less economical than the others, and to pragmatically adopt those remaining that are the most useful.

Not all interpretations of quantum mechanics are equally economical, or equally useful. For example, those interpretations which claim that human consciousness determines the nature of reality are not parsimonious since this bizarre notion is not required by a scrap of reliable data. Likewise, the interpretations that invoke deterministic sub-quantum forces are grossly non-economical, proposing as they do invisible holistic entities having superluminal connections for which no empirical evidence exists and furthermore violate Einstein's relativity, which has not been refuted after almost a century of precision tests.

Non-superluminal, "un-conscious" interpretations of quantum mechanics have been proposed that are fully consistent with all observations and established principles of physics, including relativity.⁵ Unfortunately, these are usually ignored in the popular literature because they fail to support the mystical delusions that people want confirmed. Still, these non-mystical interpretations exist, and by their existence they refute all claims that quantum consciousness or holistic connections are demanded by quantum phenomena.

The apparent paradoxes of quantum mechanics in fact disappear, once we recognize that elementary processes do not distinguish between past and future or cause and effect. Experiments that seem to require superluminal connections when viewed in our familiar time direction are perfectly subluminal when the arrow of time is reversed.⁶

While this violates our common intuitions, those intuitions are based on our experiences in a world of many particles where phenomena that are fundamentally statistical nevertheless behave very predictably. The arrows of time and causality are not elementary. Rather, they are heuristic principles we have invented to conveniently describe the macroscopic world of our experiences. In our lives, time flows one way, for all practical purposes. While it is technically possible for the atoms in

your body to assume a more youthful configuration, the chances are far greater that you will age with the rest of us. By consensus, we define the arrow of time to be the direction in which we all are observed to age. At the quantum scale, however, no such consensus can be formed as particles interact without regard for an arrow of time.⁷

The quantum world only appears paradoxical when we force macroscopic principles upon it that do not apply at that level. And once we rid quantum mechanics of its claimed paradoxes, we eliminate it as a basis for mystical fantasies.

Penrose Platonism

Nevertheless, mystical physics refuses to die. In a pair of recent books, Oxford mathematician Roger Penrose has argued forcefully, and controversially, that the human mind possesses *physical* capabilities that enable it to reach into a realm of reality that lies beyond time and space, to a Platonic world of timeless mathematical truth.⁸ Penrose bases this claim on the assertion that a material computer can never duplicate, or simulate, all the thinking processes of human beings. He summarizes his position as follows: “Appropriate physical action of the brain evokes awareness, but this physical action cannot even be properly simulated computationally.”⁹

Penrose is careful to distance himself from the view that awareness is not amenable to scientific study and thus must be mystical or supernatural. He says: “I reject mysticism in its negation of scientific criteria for the furtherance of knowledge.” I take this to mean that if awareness is something that can be understood scientifically, then it might still be possible for it to be simulated. It just cannot be simulated *computationally*. Some kind of non-computational machine, made of matter and still operating in the purely physical domain, would have to be devised to simulate awareness.

If awareness is a physical phenomenon that is not computable, a property that a computer (though not necessarily some other physical

system) can never simulate, then some change in our physical world-view is required to encompass a new, non-computable physics. That is, some different kind of physics is poking its head through the thoughts in our own heads, a physics unlike other physics in that its mechanisms do not follow traditional computational lines. But it is still physics.

Penrose believes that the key to the new physics lies in quantum gravity, which somehow disentangles spatially-separated, coherent quantum states. However, he does not indicate why this mechanism is necessarily non-computational, and only speculates on what it can possibly have to do with human thinking. I personally find it incomprehensible that quantum gravity, which only comes into play at distances of the order of 10^{-33} centimeters, can have a profound role on the comparatively huge scale of biological processes. I also find it rather anthropocentric to think that the next great revolution in physics will occur in the exploration of phenomena within the human body. No previous scientific revolution happened this way. In fact, science developed as a direct consequence of the Copernican discovery that humanity does not reside at the center of the universe.

Penrose insists that the evidence for the new non-computational physics is to be found in human consciousness, even if consciousness is not its source. Of course, the thesis that the brain is not simply a computer is one that the average person will grasp with open arms. Few can imagine, or want to imagine, how a computer can ever have “feelings” and “spiritual experiences.” Few believe, or want to believe, that computers ever can be capable of “understanding.”

The primary focus for Penrose’s discussion of non-computability is *Gödel’s theorem*, which says that unprovable truths can exist within any formal mathematical system at least as complicated as arithmetic.¹⁰ Gödel’s theorem, Penrose says, demonstrates that “the mental procedures whereby mathematicians arrive at their judgements of truth are not simply rooted in the procedures of some specific formal system.”¹¹ That

is, mathematicians are able to develop true propositions by means other than the strict logic of mathematical procedures.

Penrose argues: “Once it is shown that certain types of mathematical understanding must elude computational description, then it is established that we can do *something* non-computational with our minds.”¹² And, if we are to assume that the phenomenon of mind is still part of the physical world, then we are forced to relate mathematics to that world.

Penrose adds: “There is something absolute and ‘God-given’ about mathematical truth.” He admits he is very much a Platonist: “In my own mind, the absoluteness of mathematical truth and the Platonic existence of mathematical concepts are essentially the same thing.”¹³ In other words, mathematical truths are the reality beyond the appearances. This neo-Neo-Platonic view has come to be called *Penrose mysticism*, though the author firmly insists that the non-computational remains amenable to scientific study.

Mystical Matters and Minds

In his book with the catchy title *The Mind of God*, physicist-author Paul Davies has used Penrose’s ideas in discussing the possible connection between mathematics and the traditional notions of mystical truths.¹⁴ Mystics have universally claimed direct communication with deeper reality, variously called The One, The Good, God, the Cosmos, Being, and many other names. The mystical experience is supposed to open the mind to instantaneous flashes of insight about a realm beyond the senses. Distinguished physicists such as Brian Josephson and the late David Bohm have said they found mysticism useful in developing their scientific ideas, and many of the founders of modern physics have speculated about the mystical.

Ken Wilber has edited a collection of such musings. Included are essays by Heisenberg, Schrödinger, Einstein, de Broglie, Jeans, Planck,

Pauli, and Eddington. Wilber interprets the essays as showing that each author was in fact a mystic. However, he admits that, “These theorists are virtually unanimous in declaring that modern physics offers no positive support whatsoever for mysticism or transcendentalism of any variety.”¹⁵ So even if these giants of physics were mystics, which is highly debatable, their mysticism was not derived from their physics.

So where do Penrose’s ideas fit within the framework of mystical perspectives? Certainly, he attempts to be completely rational in demonstrating that we cannot determine all that is true by computational means alone. On the other hand, he asserts that the human mind nonetheless can formulate these truths, and that they have a Platonic reality to them. Is mathematics, despite Penrose’s disclaimer, really then a mystical path to truth? Is it not, consequently, more like revelation than science as it goes beyond sensory data and their numerical manipulations? Is the existence of the Ultimate “shining through,” despite the complete lack of any physical evidence or any compelling need to introduce metaphysical elements into our most fundamental theories of physics and cosmology?

Most experts remain unconvinced by Penrose’s assertion that the human mind cannot be simulated by a machine. Virtually every learned commentary on his books disagrees with most or all of his conclusions.¹⁶ I believe it is fair to say that Penrose has not achieved a consensus for his claims in any of a number of communities, from artificial intelligence to quantum computation and neurobiology.

Undoubtedly the issue will continue to be hotly debated and I will not settle it here. For my purposes, however, the following conclusion can be drawn: Even if the human brain is not a computer, this does not imply that the “mind,” which is the name we give to what the brain does, has a mystical or metaphysical component. The view that is promoted by Penrose is one in which the brain still does “thinking” by means of some physical process that remains to be determined. Whether or not he is

correct on the need for new physics, he sees no need to transcend physics - just move it to a new level. Still, no scientific observation demands such an interpretation at this time.

Is the Brain a Quantum Device?

As I have noted above, consciousness is not needed to explain quantum mechanics. We might also ask whether quantum mechanics is needed to explain consciousness.

Many authors have speculated that quantum mechanics plays a part in the functioning of the brain. Neuroscientist Sir John Eccles has presented a dualistic model in which mind exists as an entity separate from matter, initiating wave function collapse that releases neurotransmitters at neural junctions.¹⁷ Penrose and his collaborator Stuart Hameroff have more recently proposed the “orchestrated objective reduction” of quantum coherence in the microtubules of the neurons of the brain.¹⁸

Must quantum mechanics play a non-trivial role in brain processes? Physicist Henry P. Stapp thinks so: “Brain processes involve chemical processes, and hence must, in principle, be treated quantum mechanically.”¹⁹ Following the logic of this argument, we cannot use Newtonian mechanics to calculate the trajectory of a rock tossed in the air, because the rock is made of chemical elements.

Several authors have made order-of-magnitude calculations that they claim demonstrate a plausible role for quantum mechanics in synaptic signals.²⁰ All such estimates essentially come down to an application of the quantum uncertainty principle. A simple calculation shows that quantum uncertainties are unlikely to be important. Basically, neurons and their associated meatware are still “macroscopic” as far as quantum physics is concerned. (Not all objects that must be viewed with a microscope must be described by quantum mechanics.) While macroscopic quantum devices such as superconductors exist, these are characterized by temperatures much lower than those of the human brain.

The brain sits at body temperature, which results in far more random particle motion than occurs in cryogenic macroscopic quantum systems, so quantum coherent effects in the brain are very likely to be washed out.

Penrose and Hameroff have proposed a new idea: The seat of quantum effects in the brain lies in *microtubules*, hollow fibers that form part of the cytoskeletons of most of the cells of animal and human bodies (not just brain cells). They suggest these may be the cell's own "nervous system."²¹ However, microtubules are much larger than the synaptic gap and so are certainly "macroscopic" objects in the sense used above. Penrose suggests that microtubules act in a coherent way, but has no hard evidence to back up this notion. And why should the microtubules in neurons alone show quantum effects, and not those of other cells say in those of the liver?

The Force of Consciousness

Those who promote mystical physics refuse to believe that the "mind" does not play a central role in choosing between the alternative paths that can be taken as the brain moves between quasi-stable states. This belief is not based on any external objective evidence. Rather, the claim is made that our inner subjective experiences of consciousness, wholeness, and self-awareness require something more - a controlling agent capable of dealing with complex wholes. Stapp argues, very unconvincingly in my view, that such control is a logical impossibility "within a framework in which everything is asserted to be nothing but an aggregation of simple parts." He believes that quantum mechanics provides him with the holistic, non-reductionist framework that he needs.²² Of course, Stapp must ignore those quantum interpretations that are non-holistic and fully reductionist, and explain the data equally well.

Physicist Nick Herbert proposes "a kind of 'quantum animism' in which mind permeates the world at every level" with consciousness "a fundamental force that enters into necessary cooperation with matter to

bring about the fine details of our everyday world.”²³ However, Herbert does not tell us what makes humans different from rocks, which, after all, is the goal of the discussion .

The quantum mystics persist in their belief that human consciousness must act as the agent that brings about the specific choice among the alternate paths of a physical system. This is not accommodated in conventional, indeterministic quantum mechanics, which only computes the probabilities for different paths. The conscious force, in the view of Stapp, Herbert, and those of like mind, acts to “actualize” the event, changing a possibility into a happening. To physicist Euan Squires, consciousness interacts with the world in determining the choices between paths.²⁴ For Squires, the mind acts as the “selector” among alternate worlds, the way a TV viewer chooses which channel to watch.²⁵

Penrose also argues for “some kind of active role for consciousness, and indeed a powerful one, with a strong selective advantage” to avoid blind randomness.²⁶ However, he disagrees with the mind-matter dualists in an important way. In the dualistic view, consciousness is some kind of extraphysical force that acts to cause events to happen, to collapse wave functions or actualize particular paths. In the dualistic view, mind controls the universe. For Penrose, the universe still controls the mind and thinking is still material.

Penrose, as I have noted, proposes that some new physics is involved in consciousness - but it remains physics. Nevertheless, in claiming that new physics can be found in the operation of consciousness, Penrose joins Stapp, Herbert, Squires, and other authors in assigning a very special role in the universe to what may be in fact a simple accident of evolution - human consciousness.²⁷

Mystical physics sells books and makes a lot of money for their authors. People happily pay to hear what they want to hear, that they are indeed the center of existence. However, the only honest position that can be taken by a scientist who expects to retain his or her integrity and

credibility is to insist on overwhelming empirical evidence before promoting such an extraordinary claim. Four hundred years ago, Copernicus provided strong evidence that we are not the center of the universe. As we have seen, the evidence that quantum mechanics either requires the action of human consciousness, or even plays a role in mental processes is non-existent. Certainly quantum mechanics is needed to understand the atoms in the brain. But it is also needed to explain the atoms in a rock, and this implies nothing about rock consciousness.

Perhaps quantum fluctuations cause random bit errors that the brain is able to organize into new operations, but this role is neither necessary nor compelling. The environment can produce the needed fluctuations. The self-organizing capabilities of the brain's nonlinear neural network, operating at the edge of chaos, may be capable of doing all the work of selection of the best path among all possibilities, with no help from quantum mechanics.

In fact, the human brain and body probably evolved with the dimensions they have in order to *avoid* quantum effects and their inherent uncertainties. The classical physics that operates on the macroscopic scale is now well understood as the many particle limit of the quantum physics that occurs more fundamentally on all scales. The apparent deterministic quality of classical physics follows as a consequence of the large numbers of particles on the macroscopic scale, where the probabilities of the quantum world become near-certainties. Evolution may have selected classical physics as the domain of life because of its highly predictable nature.

It seems little more than primitive, wishful thinking to view consciousness as some supernatural, or at least super-material, psychic force that provides basic control over the choices the universe makes between allowed, alternative paths. Such a theory is verifiable. It should lead to phenomena such as ESP and psychokinesis that violate the laws that constrain matter. But, psychic phenomena have failed to be verified

after 150 years of attempts involving thousands of independent experiments. No other scientific hypothesis has continued to be advanced after failing to be confirmed for such a period of time. After all this time, we can safely assume that psychic phenomena do not exist.

The Me Decades

Over a decade ago, Fritjof Capra, Marilyn Ferguson, Gary Zukov, and other New Age authors had predicted that the 1980s would be a revolutionary time “because the whole structure of our society does not correspond with the world-view of emerging scientific thought.”²⁸ They blamed classical physics for all the ills of society and saw the new physics, especially quantum mechanics, as a savior.

In her 1990 book, *The Quantum Self*, Danah Zohar asserts that “Cartesian philosophy wrenched human beings from their familiar social and religious context and thrust us headlong into . . . our I-centered culture, a culture dominated by egocentricity.”²⁹ The new holistic physics was supposed to teach people to be less selfish, to recognize that they are part of a greater whole and to work cooperatively for the benefit of everyone.

As the century draws to a close, however, I can perceive no great holistic revolution actually having taken place in the decade past. The facts indicate the contrary. The 1980s have been characterized, in America anyway, as the “Me Decade.” Far from recognizing that we are each an inseparable part of the whole, and everyone pitching in to make the world a better place for its inhabitants, life in the 1980s was characterized by an unprecedented level of individual self absorption. And the 1990s so far show no sign of a change in this focus on self, as every element of our society is geared to provide maximal short-term self gratification for its members, while those who fail to be gratified view themselves as victims.

Now some will argue that the ever-increasing fixation with self only reinforces the need for a holistic philosophy like that of Capra, Ferguson,

and Zohar. They will say that the problem is simply that holistic philosophy simply has not yet taken hold.

I disagree. In fact, no small portion of the blame for the current excessive self absorption lies at the feet of the proponents of the new mysticism. Anyone listening to New Age gurus, and modern Christian preachers, cannot miss the emphasis on the individual finding easy gratification, rather than sacrificing and selflessly laboring for a better world. Holistic philosophy is the perfect self-delusion for the spoiled brat of any age, all decked out in the latest fashion, who loves to talk about solving the problems of the world but has no intention of sweating a drop in achieving this noble goal.

Reductionist classical physics did not make people egoists. People were egoists long before reductionist classical physics. In fact, classical physics has nothing to say about humans except that they are material objects like rocks and trees, made of nothing more than the same atoms - just more cleverly arranged by the impersonal forces of self-organization and evolution. This is hardly a philosophical basis for narcissism.

The new quantum holism, on the other hand, feeds our delusions of personal importance. It tells us that we are part of an immortal cosmic mind with the power to perform miracles and, as Shirley MacLaine has said, to make our own reality. Who needs God when we, ourselves, are God? Thoughts of our participation in cosmic consciousness inflate our egos to the point where we can ignore our short-comings and even forget our mortality.

The modern versions of traditional religions feed on this desire. Where once Christian preachers shouted hell-fire and brimstone from the pulpit, their successors in the very same sects now present the soothing message that we are all perfect, worthy, and destined for infinite happiness. The only sacrifice required is a regular check. Then Jesus will provide all.

Mystical physics is a grossly misapplied version of ancient Hindu

and Buddhist philosophy, which were based on the notion that only by the complete rejection of self can one find inner peace in this world of suffering and hopelessness. Capra and his colleagues say they are putting a modern face on ancient Eastern philosophy. I say they are covering a noble edifice with graffiti. Where they see similarities between the new and the old mysticisms, I see only contrasts. Where they promote the new mythology as an antidote for self absorption, I assert that they are manufacturing a drug that induces it. And while they blame rational science for the ills of the world, I hold rational science as a source of genuine hope for reducing the severity of this latest addiction, if only we and our successors have the wisdom to use it properly.

Victor J. Stenger is professor of physics and astronomy at the University of Hawaii and the author of *Not By Design: The Origin of the Universe* (Prometheus Books, 1988) and *Physics and Psychics: The Search for a World Beyond the Senses* (Prometheus Books, 1990). This article is based on his latest book: *The Unconscious Quantum: Metaphysics in Modern Physics and Cosmology* (Prometheus Books, 1995).

Notes

¹Stapp. Henry P. 1994. "Theoretical model of a purported empirical violation of the predictions of quantum theory." *Physical Review A*. 50, pp. 18-22.

²See, for example, Bohm D. and B. J. Hiley, 1993. *The Undivided Universe: An Ontological Interpretation of Quantum Mechanics*. London: Routledge.

³See, for example, Kafatos, Menas and Robert Nadeau 1990. *The Conscious Universe: Part and Whole in Modern Physical Theory*. New York, Springer-Verlag.

⁴For these details, see my book *The Unconscious Quantum: Metaphysics in*

Modern Physics and Cosmology. Prometheus Books, 1995.

⁵See, for example, Omnès, Roland J. 1994. *The Interpretation of Quantum Mechanics*. Princeton: Princeton University Press.

⁶For aficionados, the EPR experiment is perfectly local in a time-reversed frame of reference. See Stenger, 1995.

⁷There are some rare exceptions that do not bear on this discussion.

⁸Penrose, Roger 1989. *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*. Oxford: Oxford University Press.

Penrose, Roger 1994. *Shadows of the Mind: A Search for the Missing Science of Consciousness*. Oxford: Oxford University Press.

⁹Penrose 1994, p. 12.

¹⁰Gödel, Kurt 1931. *Monatshefte für Mathematik und Physik* 38, pp.173-98.

¹¹Penrose 1989, p. 110.

¹²Penrose 1994, p. 51.

¹³Penrose 1989, p. 112.

¹⁴Davies, Paul 1992. *The Mind of God: The Scientific Basis for a Rational World*. New York: Simon and Schuster, p. 226. Paul Davies was the 1995 recipient of the Templeton prize for Progress in Religion, worth a million dollars.

¹⁵Wilber, Ken (ed) 1984. *Quantum Questions: Mystical Writings of the World's Great Physicists*. Boulder, Colorado: Shambhala.

¹⁶*Behavioral and Brain Sciences* 1990, 13, pp. 643-705. At this writing, a

similar critique of *Shadows* is being assembled on the Internet by the journal *Psyche*.

¹⁷Popper, K. R. and Eccles, J. C. 1977. *The Self and Its Brain*. Berlin: Springer.

Eccles, J. 1986. "Do Mental Events Cause Neural Events Analogously to the Probability Fields of Quantum Mechanics?." *Proc. Royal Soc. London B227*, pp. 411-428.

Eccles, J. 1990. "A Unitary Hypothesis of Mind-Brain Interaction in the Cerebral Cortex." *Proc. Royal Soc. London B240*, pp. 433-451.

¹⁸Hameroff, S. R. 1994. "Quantum coherence in microtubules: A neural basis for emergent consciousness?" *Journal of Consciousness Studies* 1(1): 91-118.

Hameroff, S. R. and Penrose, R. 1996. "Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness." In *Toward a Science of Consciousness - Contributions from the 1994 Tucson Conference*, S. R. Hameroff, A. Kaszniak and A.C. Scott, eds. Cambridge, MA: MIT Press.

¹⁹Stapp, Henry P. 1993. *Mind, Matter, and Quantum Mechanics*. New York: Springer-Verlag, p. 42.

²⁰Herbert, Nick 1993. *Elemental Mind: Human Consciousness and the New Physics*. New York: Dutton, p. 254.

Squires Euan 1990, *Conscious Mind in the Physical World*. New York: Adam Hilger, p. 222.

²¹Hameroff 1994, 1996; Penrose 1994, pp. 357-377.

²²Stapp 1993, p. 25.

²³Herbert 1993, p. 5.

²⁴Squires 1990, p. 229.

²⁵Squires 1990, p. 201.

²⁶Penrose 1989, p. 446.

²⁷See *Free Inquiry* 14(4), 1994 for a discussion of the latest scientific ideas on consciousness.

²⁸As quoted in Ferguson, Marilyn 1980. *The Aquarian Conspiracy: Personal and Social Transformation in the 1980s*. Los Angeles: Tarcher, p. 145.

²⁹Zohar, Danah 1990. *The Quantum Self. Human Nature and Consciousness Defined by the New Physics*. New York: Morrow, p. 18.