1. SCIENCE AND HUMAN VALUES.

This book is about what you are, and how you are connected to that which you are not. It is about the impact of the revolutionary developments in physics during the twentieth century upon science's idea of you as a thinking and acting entity, and your linkage to 'the other'.

These questions might appear to belong more to philosophy, metaphysics, or religion, rather than to physics, which is usually assumed to deal only with such tangible items as machines, rockets, transistors, and atomic bombs. But the radical change in our understanding of the physical world that occurred during the twentieth century has transformed connections that formerly had been matters of philosophical speculation into issues covered by basic physical theory. The aim of this book is to explain the new idea of the nature of human beings, and their causal role of in the unfolding of reality, to readers with no prior understanding of the quantum character of the world.

Science has improved our lives in many ways. It has lightened the load of tedious tasks and expanded our physical powers, and thereby contributed to a great flowering of human creative energy. On the other hand, it has also given us the capacity to ravage the environment on an unprecedented scale and obliterate our species altogether. Yet along with this fatal power it has provided a further offering which, though subtle in character and still hardly felt in the minds of men, may ultimately be its most valuable contribution to human civilization, and the key to human survival.

Science is not only the enterprise of harnessing nature to serve the practical needs of humankind. It is also part of man's unending search for knowledge about the universe and his place within it. This quest is motivated not solely by idle curiosity. Each of us, when trying to establish values upon which to base conduct, is inevitably led to the question of one's role in nature. The linkage of this philosophical inquiry to the practical question of personal values is no mere intellectual abstraction. Martyrs in every age are vivid reminders of the fact that no influence upon human conduct, even the instinct for self preservation, is stronger than beliefs about one's relationship to the power that shapes the universe. Such beliefs form the foundation of a person's self image, and hence, ultimately, of that person's values.

It is often claimed that science stands mute on questions of values: that science can help us to achieve what we value once our priorities are fixed, but can play no role in fixing these weightings. That claim is certainly incorrect: science plays a key role in these matters. For what we value depends on what we believe, and what we believe is increasingly determined by science.

A striking example of this influence is the impact of science upon the system of values promulgated by the church during the Middle Ages. That structure rested on a credo about the nature of the universe, its creator, and man's connection to that creator. Science, by casting doubt upon that belief, undermined the system of values erected upon it. Moreover, it put forth a credo of its own. In that "scientific" vision we human beings were converted from sparks of divine creative power, endowed with free will, to automatons---to cogs in a giant machine that grinds inexorably along a preordained path in the grip of a blind mechanical process.

Gone from this "scientific" picture of our species is any rational basis for the notion of a person's responsibility for his own actions. Each of us is asserted to be a mechanical extension of what existed prior to his birth. Over that earlier situation one has no control. Hence for what emerges, preordained, from that prior state one can bear no responsibility.

Given this conception of man the collapse of moral philosophy is inevitable. For this notion of the human being provides no rational basis for any value but self interest: behavior promoting the welfare of others, including future generations, becomes rational only to the extent that such behavior serves one's own interests. Hence science becomes doubly culpable: it not only undermines the foundations of earlier value systems, but also strips man of any vision of himself and his place in the universe that could be the rational basis for any elevated set of values.

This mechanical view of nature and man's place within it dominated science at the end of the nineteenth century. According to that notion, the physical universe is composed of tiny bits of matter, and the unfolding of the observed world over the course of time is completely fixed by direct contact interactions between these localized microscopic elements. Human beings, insofar as they are parts of this physical describable reality, are simply conglomerations of these tiny components.

During the twentieth-century this simple picture of nature was found to be profoundly wrong. It failed not just in its fine details, but at its fundamental core. A vastly different conceptual framework was erected by the atomic physicists Werner Heisenberg, Niels Bohr, Wolfgang Pauli and their colleagues. Those scientists were forced to a wholesale revision of the entire subject matter of physical theory by the strange character of the new mathematical rules, which were invariably validated by reliable empirical data.

The new theory, quantum theory, accounts in a uniform manner for all the successes of the earlier physical theories, plus the immense accumulation of new data where the earlier methods fail abysmally. However, it describes a world built not out of bits of matter, as matter was understood in the nineteenth century, but rather out of a fundamentally different kind of stuff. According to the revised notion, basic reality behaves more like *mathematically encoded information* that governs *tendencies for experiential events to occur*, than like anything resembling material substance. The new mathematics converts what the previous theory took to be *numbers* describing material properties into *actions and knowledge*: it converts *being* into *doing* and *knowing.* Moreover, according to this new understanding, the natural world is governed not by one single locally deterministic process, but by *two* very different processes, only one of which is analogous to the laws of classical physics. This quantum analog of the older classical process is the aspect of the new theory of main interest to physicists, engineers, and other workers not concerned with the psychological side of reality. But anyone interested in the role in nature of our conscious thoughts, ideas, and feelings will want to understand the other process. It is an essential feature of the structure created by the founders of quantum theory, and is called “Process I” in the rigorous formulation of the theory constructed by the eminent mathematician John von Neumann in his seminal book *The Mathematical Foundations of Quantum Theory*. Process I describes a *causal influence of conscious human agents upon the physical world*.

The existence of this dynamical effect of conscious experience upon the course of physical events is inimical to the precepts that had ruled science during the eighteenth and nineteenth centuries, and that had become nearly synonymous with the idea of what science is. Accordingly, many quantum physicists have worked assiduously to eradicate this contamination of the physics by psychology, on the grounds that it injects subjective elements in a fundamental way into a discipline that they believe should be basically objective. However, in spite of massive efforts, no rationally coherent way has been found to obtain the predictions of quantum theory without using von Neumann’s Process I, or something that stands in its place and does its job.

This revised conception of the causal connection between your thoughts and your actions amounts to a new understanding of your intrinsic nature. Widespread awareness of this revised conception of the human person has been effectively excluded from the minds of non-physicists by the focus of popular accounts of quantum theory on another novel feature: the occurrence of a statistical or random element. But Process I is something else. It pertains to choices that are *not controlled by any known law or rule of nature*, statistical or otherwise. It involves, in this very specific sense, *efficacious free choices*: choices that can significantly influence the course of physical events, but are not controlled either deterministically or statistically by any known law. In orthodox quantum theory these free choices are made by human beings. Thus, according to orthodox contemporary physics, as formulated either by the founders or by von Neumann, your physical actions are in principle determined in part by conscious choices that *are not governed by any yet-known law of nature*. This means that your thoughts, ideas, and feelings can, *by virtue of the basic laws of physics*, influence your actions, without being themselves controlled by any yet-discovered law.

Von Neumann's formulation not only *accommodates* this causal linkage: it also explains *how* it works---or at least how it *can* work. It also explains *why* this influence vanishes when one goes over to the classical approximation to the quantum laws.

You might now say: So what's new? I always knew my thoughts influenced my actions!

You may indeed have always known this. Your knowledge that your mental efforts can affect your bodily behavior is something you learned in the first few months after birth, and is fundamental to your dealings with the world. However, that seemingly obvious truth is incompatible with verdict of science that prevailed from the time of Isaac Newton until 1900. That enduring conflict produced three hundred years of philosophical turmoil, which has spilt over into the political, social, legal, educational, and moral arenas, and deeply affected the intellectual climate in which you are imbedded, and thereby inevitably influenced also your conception of yourself as part of the culturally defined universe.

Philosophers tried relentlessly for three centuries to understand the role of mind in the workings of a brain conceived to function according to principles of classical physics. We now know no such brain actually exists: no brain, body, or anything else in the real world is composed of those tiny bits of matter that Newton imagined the universe to be made of. Hence it is hardly surprising that those philosophical endeavors have been beset by enormous difficulties, which have led to such positions as that of the \`eliminative materialists', who hold that our conscious thoughts do not exist; or of the \`epiphenomenalists', who admit that human experiences do exist but claim that they play absolutely no role in how we behave; or of the \`identity theorists', who claim that each conscious feeling is exactly the same thing as a motion of the particles that nineteenth century science thought brains and everything else in the universe to be made of, but that we now know do not exist, at least as they were formerly conceived. The tremendous difficulty in reconciling causally efficacious thought with the older physics is dramatized by the fact that for many years the mere mention of "consciousness" was considered evidence of backwardness and bad taste in most of academia, including, incredibly, even the philosophy of mind.

What exactly is this conflict between classical physics and the conviction of most of us that our thoughts and mental efforts make a difference in how we behave? The problem was apparent already at the time of Newton. But during the second half of the twentieth century it has been buried under an avalanche of philosophical argumentation and counter-argumentation, erected, in desperation, upon the perceived need to rationally reconcile our understanding of ourselves with the findings of science. It is not surprising that no consensus emerged from this massive intellectual effort, for the aim was to reconcile what now appears to be valid intuition about ourselves with a false belief in the causal completeness of the physical world.

The conflict of intuition with classical physics can be illustrated by comparing a body/brain to a locomotive. The locomotive, with its pistons and rods etc., are "emergent phenomena": locomotives have not always been around, and their coming into being is not a rational consequence of the laws of classical physics. But if a locomotive does come into being, then, according to classical physics, its physical properties (together with those of its physical environment) are, in principle, sufficient to determine its future physical behavior. And the same goes for the body/brain of a person. These purportedly dynamically complete features are specified by the *geometric properties* of the *locations and velocities* of all of the tiny component parts of these systems. These properties entail all sorts of geometric properties of conglomerations of these elements, and, by virtue of the dynamical laws, all sorts of behavioral and functional properties. But these geometric properties do not entail the existence of any psychological quality, such as a painful feeling or a colorful percept. That is because the concepts and laws of classical physics, although dynamically complete, do not contain any link to the defining characteristics of experiential feelings, namely the way they feel, But, as every mathematician and logician knows, no proof or deduction can ever get out more than what is put in. Because the existence of experiential qualities is not *entailed* by the dynamically complete concepts and laws of classical physics (and the geometric structure of the body/brain) they cannot be parts of the dynamically complete causal description provided by classical physics. Hence they are at best redundant. Yet they are not even redundant, in the sense of giving an alternative rationally entailed cause of physical effects. That is because their defining characteristics---*namely the ways that they feel*---are not expressible in terms of the geometric concepts, and hence there can be no rational way to tie them into the geometrical structure of classical physics: there is a complete rational disconnect between our consciously experienced feelings and the concepts of classical physics, and hence no rational way within classical physics to account for either the power of our thoughts to influence our actions, or for the illusion of the existence of this power.

In quantum theory, on the other hand, the dynamical laws involve conscious thoughts already from the outset. Hence we are not faced with the problem of inserting known experiential realities into a conceptual structure that has no rational place for them. Indeed, the problem with quantum theory is not an *over* determination that leaves no rational place for mind. It is rather an *under* determination that leaves many possibilities open. I shall not attempt to describe all the possibilities, but will be content to present what appears to me to be the most reasonable way of filling in some of the unspecified details of von Neumann's Process I. Other options may be available. But, in any case, the participatory quantum view of the conscious human agent opens up possibilities wholly unlike the classical image of the human person as a conglomeration of atoms being mindlessly buffeted about by the chance collisions of atoms.

The way I shall fill in certain details of von Neumann's Process I allows it to function naturally in systems existing long before creatures such as ourselves roamed the planet. It also allows this process to be utilized by simple and complex systems alike to enhance their chances of survival.

What impact, if any, can this altered idea of what you are have upon your life? Does not a completely rational approach still lead you to value only your own well being? Perhaps so! But this leads to the further question: What is the self whose well being one values?

Values arise from self-image. Generally one is led by training, teaching, propaganda, or other forms of indoctrination, to expand one's conception of the self: one is encouraged to perceive oneself as an integral part of some social unit such as family, ethnic or religious group, or nation, and to enlarge one's self-interest to include the interests of this unit. If this training is successful your enlarged conception of yourself as good parent, or good son or daughter, or good Christian, Muslim, or Jew, causes you to give weight to the welfare of the unit as you would yourself. In fact, if well conditioned you may give more weight to the interests of the group than to the well-being of your bodily self.

In the present context it is not relevant whether this human tendency to enlarge one's self image is a consequence of natural malleability, instinctual tendency, spiritual insight, or something else. What is important is that we human beings do in fact have the capacity to expand our image of "self", and that this enlarged concept can become the basis of a drive so powerful that it becomes the dominant determinant of human conduct, overwhelming every other factor, including even the instinct for bodily survival.

But where reason is honored, belief must be reconciled with empirical evidence. If you seek evidence for your beliefs about what you are, and how you fit into nature, then science claims jurisdiction, or at least relevance. Physics presents itself as the basic science, and it is to physics that you are told to turn. Thus a radical shift in the physics-based conception of man from that of an isolated mechanical automaton to that of an integral participant in a nonlocal process that gives form to the evolving universe is a seismic event of potentially momentous proportions.

The quantum concept, being based on objective science equally available to all, rather than arising from special personal circumstances, has the potential of providing a universal system of values suitable to all people, without regard to the accidents of their origins. With the diffusion of this Quantum Conception of Human Beings, science may fulfill itself by adding to the material benefits it has already provided a philosophical insight of perhaps greater ultimate value.

This issue of the connection of science to values can be put into perspective by seeing it in the context of a very brief historical account. For this purpose let human intellectual history be divided into five periods: traditional, modern, transitional, post modern, and contemporary.

During the “traditional” era our understanding of ourselves and our relationship to nature was based on “ancient traditions” handed down from generation to generation: “Traditions” were the chief source of wisdom about our connection to nature. The “modern” era began in the seventeenth century with the rise of what is still called “modern science”. That approach was based on the ideas of Bacon, Descartes, Galileo and Newton, and it provided a new source of knowledge that came to be regarded by many thinkers as more reliable than tradition.

The basic idea of modern science was “materialism”: the idea that the physical world is composed basically of tiny bits of matter whose contact interactions with adjacent bits completely control everything that is now happening, and that ever will happen. According to these laws, as they existed in the late nineteenth century, a person’s conscious thoughts and efforts can make no difference at all to what his body/brain does: whatever you do was deemed to be completely fixed by local interactions between tiny mechanical elements, with your thoughts, ideas, feelings, and efforts, to the extent that they entered at all, being simply locally determined high-level consequences of the low-level mechanical process, and hence basically just elements of a reorganized way of describing the effects of the microscopic causes.

This materialist conception of reality began to crumble at the beginning of the twentieth century with Max Planck's discovery of the quantum of action. Planck announced to his son that he had, on that day, made a discovery as important as Newton's.

That assessment was certainly correct: the ramifications of Planck's discovery were eventually to cause Newton's materialist conception of physical reality to come crashing down. Planck's discovery marks the beginning of the "transitional" period.

A second important transitional development soon followed:

In 1905 Einstein announced his Special Theory of Relativity. It denied the validity of our intuitive idea of the instant of time "now", and promulgated the thesis that even the most basic quantities of physics, such as the length of a steel rod, and the temporal order of two events, had no objective "true values", but were well defined only "relative" to some observer's point of view.

Planck's discovery led by the mid twenties to a complete breakdown, at the fundamental level, of the material conception of nature. A new basic physical theory was developed, principally by Werner Heisenberg, Niels Bohr, Wolfgang Pauli, and Max Born, and it brought "the observer" explicitly into physics. The earlier idea that the physical world is composed in part of tiny particles was abandoned in favor of a theory of natural phenomena in which the consciousness of the human observer is ascribed an essential role. This successor to classical physical theory is called "Copenhagen quantum theory".

This turning away by science itself from the tenets of the objective materialist philosophy lent support to Post-Modernism. That view, which emerged during the second half of the twentieth century, promulgated, in essence, the idea that all "truths" were relative to one's point of view, and were mere artifacts of some particular social group's struggle for power over competing groups. Thus each social movement was entitled to its own "truth", which was viewed simply as a socially created pawn in the power game.

The connection of Post-Modern thought to science is that both Copenhagen Quantum Theory and Relativity Theory had retreated from the idea of observer-independent objective truth: science in the first quarter of the twentieth century had not only eliminated materialism as a possible foundation for objective truth, but had discredited the very idea of objective truth in science. Yet if the community of scientists have renounced the idea of objective truth in favor of the pragmatic idea that "what is true for us is what works for us," then every group becomes licensed to do the same, and the hope evaporates that science might provide objective criteria for resolving contentious social issues.

This philosophical shift has had profound social ramifications. But the physicists who initiated this mischief were generally too interested in practical developments in their own field to get involved in these philosophical issues. Thus they failed to broadcast an important fact: already by mid-century, a development in physics had occurred that provides an effective antidote to both the 'materialism' of the modern era, and the 'relativism' and 'social constructionism' of the post-modern period. In particular, John von Neumann developed, during the early thirties, a form of quantum theory that brought the physical and mental aspects of nature together as two aspects of a rationally coherent whole. This theory was elevated, during the forties---by the work of Tomonaga and Schwinger---to a form compatible with the physical requirements of the Theory of Relativity.

Von Neumann's theory, unlike the transitional ones, succeeded in integrating into one coherent idea of reality the empirical data of subjective experience with the basic mathematical structure of theoretical physics. Von Neumann's formulation of quantum theory is the starting point of all efforts by physicists to go beyond the pragmatically magnificent but ontologically incomplete Copenhagen form of quantum theory.

Von Neumann capitalized upon the key Copenhagen move of bringing human knowings into the theory of physical reality. But, whereas the Copenhagen approach excluded the bodies and brains of the human observers from the physical world that they sought to describe, and renounced the aim of describing reality itself, von Neumann demanded logical cohesion and mathematical precision, and was willing to follow where this rational approach led. Being a mathematician, fortified by the rigor and precision of his thought, he seemed less intimidated than his physicist brethren by the sharp contrast between the nature of the world called for by the new mathematics and nature of the world that the genius of Isaac Newton had concocted.

The common core feature of Copenhagen and von Neumann quantum theory is the incorporation of human knowings and actions into the structure of basic physical theory. How this is done, and what the consequences are, is the subject of this book. The first step is to leave no doubt about the primary fact that orthodox quantum theory does in fact bring the knowledge of human beings into the essential core of the physical theory.

2. KNOWINGS.

What are you made of? What is reality made of? What does intuition say about this? What does science say?

The deliverance of intuition on these matters is not unambiguous. Western science and philosophy begins with Thales of Miletus, who proclaimed "All is Water!". Other Greeks believed the primordial stuff to be "Air", or "Earth", or "Fire", and Empedocles settled on all four. On the other hand, Leucippus and Democritus thought everything was composed of tiny invisible, immutable atoms. Two millennia later, it looked like the two atomists had gotten it right: Isaac Newton built his seventeenth-century theory of the universe on the idea of enduring miniscule particles, and John Dalton's atomic hypothesis explained many facts of chemistry.

This notion that everything is composed of small bits of matter encountered, however, a serious difficulty. The earlier idea that "air" was a primary ingredient allowed soul or spirit to be construed as constructed out of one of the primitive substances. But it was hard to see how such a thing as a sensation of the color "red" or "green", or a feeling of "pain" or "joy" could be fully described in terms of a collection of tiny immutable bits of matter careening through space. Given even supreme knowledge and comprehension, how could the motions of billions of particles in a person's brain/body be understood to be the very same thing as a conscious sensation, or the *feeling* associated with the grasping of an idea? One can understand all manner of motions of objects, and of their changing shapes, in terms of the motions of their constituent parts, but there is a rationally unbridgeable gap between the purely geometrical concepts of motions of particles in space and the psychological realities of conscious sensations, feelings, and ideas.

Isaac Newton built his theory upon the ideas of the French philosopher Rene Descartes, who resolved this dilemma concerning the psychological realities by conceiving nature to be built out of two sorts of substances: "matter", which was located in and occupied space, and the "mental stuff" that our thoughts, sensations, and feelings are made of.

This sundering of nature worked well in science for more than two hundred years, but was abandoned by physicists during twentieth century. The old idea that the material part of nature is made out of tiny bits of reality whose changes are completely fixed by the prior state of the nearby physical stuff---independently of mind---was replaced by a very different picture. Once it became clear that the old notions could not account for the growing mountain of data concerning the properties of the atoms and their parts the focus shifted to what the experiments were actually telling us. This opened the door to a new approach that dealt directly with *what we could find out* about the systems being examined, rather than with the system itself. An incredibly beautiful and rationally coherent new kind mathematical structure eventually revealed itself, but this new mathematics was understood to describe not a self-sufficient physical reality that can exist independently of all minds, but rather our human knowledge of a reality in which our mental activities reside, and which our conscious actions influence.

This original way of conceiving and applying the quantum mathematics was created by a group of physicists working closely with the Danish physicist Niels Bohr, and is called the "Copenhagen interpretation". This approach was closely tied to actual experimental procedures, which involve in the end the human experimenters who design the experiments with some purpose in mind, and later record and interpret the results of their investigations. This practical formulation of the theory defines the way the mathematical structure is used operationally, and is the touchstone of all later efforts to retain the original predictive power of the quantum rules, while expanding their scope into the domains of cosmology and neuro-dynamics.

The foundation of all attempts to increase the scope of the theory is the work of the great Hungarian mathematician and logician John von Neumann. But before going on to describe von Neumann's contribution it will be helpful, and also fascinating, to appreciate the tremendous change in outlook instituted already by Werner Heisenberg, Niels Bohr, Wolfgang Pauli, and the other founders. For their insights are preserved and expanded in the work of von Neumann.

In the introduction to his book "Quantum theory and reality" the philosopher of science Mario Bunge (1967) said:
"The physicist of the latest generation is operationalist all right, but usually he does not know, and refuses to believe, that the original Copenhagen interpretation---which he thinks he supports---was squarely subjectivist, i.e., nonphysical."

Let there be no doubt about this point. The original form of quantum theory, which is still alive today, is subjective, in the sense that it is forthrightly about relationships among conscious human experiences, and it expressly recommends to scientists that they resist the temptation to try to understand the underlying processes of nature that are responsible for the connections between our experiences that the theory correctly describes. The following brief collection of quotations by the founders gives a conspectus of the Copenhagen philosophy:

Heisenberg (1958a): "The conception of objective reality of the elementary particles has thus evaporated not into the cloud of some obscure new reality concept but into the transparent clarity of a mathematics that represents no longer the behavior of particles but rather our knowledge of this behavior."

Heisenberg (1958b): "...the act of registration of the result in the mind of the observer. The discontinuous change in the probability function…takes place with the act of registration, because it is the discontinuous change in our knowledge in the instant of registration that has its image in the discontinuous change of the probability function."

Heisenberg (1958b :) "When the old adage `Natura non facit saltus' is used as a basis of a criticism of quantum theory, we can reply that certainly our knowledge can change suddenly, and that this fact justifies the use of the term `quantum jump'. "

Wigner (1961): "the laws of quantum mechanics cannot be formulated...without recourse to the concept of consciousness."

Bohr (1934): "In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our experience."

Bohr (1963): "Strictly speaking, the mathematical formalism of quantum mechanics merely offers rules of calculation for the deduction of expectations about observations obtained under well-defined classical concepts."

Bohr (1958): "...the appropriate physical interpretation of the symbolic quantum mechanical formalism amounts only to prediction of determinate or statistical character, pertaining to individual phenomena appearing under conditions defined by classical physics concepts."

The references to `"classical physics concepts" is explained in Bohr (1958): "...it is imperative to realize that in every account of physical experience one must describe both experimental conditions and observations by the same means of communication as the one used in classical physics."

Bohr (1958) "...we must recognize above all that, even when phenomena transcend the scope of classical physical theories, the account of the experimental arrangement and the recording of observations must be given in plain language supplemented by technical physical terminology."

Bohr is saying that scientists do in fact use, and must use, the concepts of classical physics in communicating to colleagues the specifications on how the experiment is to be set up, and what will constitute a certain type of outcome. He in no way claims or admits that there is an actual reality out there that conforms to the precepts of classical physics.

In his book "The creation of quantum mechanics and the Bohr-Pauli dialogue" (Hendry, 1984) the historian John Hendry gives a detailed account of the fierce struggles by such eminent thinkers as Hilbert, Jordan, Weyl, von Neumann, Born, Einstein, Sommerfeld, Pauli, Heisenberg, Schroedinger, Dirac, Bohr and others, to come up with a rational way of comprehending the data from atomic experiments. Each man had his own bias and intuitions, but in spite of intense effort no rational comprehension was forthcoming. Finally, at the 1927 Solvay conference a group including Bohr, Heisenberg, Pauli, Dirac, and Born come into concordance on a solution that came to be called "The Copenhagen Interpretation", due to the central role of Bohr and those working with him at his institute in Denmark.

Hendry says: "Dirac, in discussion, insisted on the restriction of the theory's application to our knowledge of a system, and on its lack of ontological content." Hendry summarized the concordance by saying: "On this interpretation it was agreed that, as Dirac explained, the wave function represented our knowledge of the system, and the reduced wave packets our more precise knowledge after measurement."

Certainly this profound shift in physicists' conception of the basic nature of their endeavor, and the meanings of their formulas, was not a frivolous move: it was a last resort. The very idea that in order to comprehend atomic phenomena one must abandon physical ontology, and construe the mathematical formulas to be directly about the knowledge of human observers, rather than about the external real events themselves, is so seemingly preposterous that no group of eminent and renowned scientists would ever embrace it except as an extreme last measure. Consequently, it would be frivolous of us simply to ignore a conclusion so hard won and profound, and of such apparent direct bearing on our effort to understand the connection of our knowings to our bodies.

Einstein never accepted the Copenhagen interpretation. He said: "What does not satisfy me, from the standpoint of principle, is its attitude toward what seems to me to be the programmatic aim of all physics: the complete description of any (individual) real situation (as it supposedly exists irrespective of any act of observation or substantiation)." (Einstein, 1951, p.667: the parenthetical word and phrase are part of Einstein's statement.);

and "What I dislike in this kind of argumentation is the basic positivistic attitude, which from my view is untenable, and which seems to me to come to the same thing as Berkeley's principle, {\it esse est percipi}. (Einstein, 1951, p. 669). [Transl: To be is to be perceived]

Einstein struggled until the end of his life to get the observer's knowledge back out of physics. But he did not succeed! Rather he admitted that: "It is my opinion that the contemporary quantum theory constitutes an optimum formulation of the [statistical] connections." (ibid. p. 87).

He also referred to: "the most successful physical theory of our period, viz., the statistical quantum theory which, about twenty-five years ago took on a logically consistent form. This is the only theory at present which permits a unitary grasp of experiences concerning the quantum character of micro-mechanical events." (ibid p. 81).

One can adopt the cavalier attitude that these profound difficulties with the classical conception of nature are just some temporary retrograde aberration in the forward march of science: one may imagine, as some do, that a strange confusion has confounded our best minds for seven decades, and that the weird conclusions of physicists can be ignored because they do not fit our classical-physics-based intuitions. Or one can try to claim that these problems concern only atoms and molecules, but not the big things built out of them. In this connection Einstein said: "But the `macroscopic' and `microscopic' are so inter-related that it appears impracticable to give up this program [of basing physics on the `real'] in the `microscopic' domain alone.'' (ibid, p.674).

The foregoing quotations document the assertion that the original Copenhagen formulation of quantum theory brought the consciousness of the human observer into physical theory in an essential way. The question before us is this: How does this radical change in basic physics effect science’s conception of the human person?