EnlightenNext: I saw you give a fascinating presentation last October at the first Science and Nonduality Conference in northern California. You went through a brief history of the relationship between mind and matter in modern science, starting with Newton and Descartes and ending with the revolutionary insights of quantum mechanics. And I'd like to start by asking you to quickly retrace that same story today. If I recall, you began with classical Cartesian dualism, in which mind and matter were seen as being completely separate.

Stapp: That's right. In the seventeenth century, René Descartes conceived of nature as being built out two different kinds of things: material things, which are described by properties that have definite locations in space at each instant of time; and mental things, such as your thoughts, ideas, and feelings. The world of located material things is amenable to a theoretical description in relatively simple mathematical language. For example, we assign mathematical quantities to points in space and time to express things like the trajectories of physical particles, or the strengths of electric or magnetic fields. The world of mind-like things, on the other hand, is described in the language of psychology. And all of us feel that in some sense our inner self *is* this flow or stream of conscious experience.

For Descartes, each of these basic building blocks of nature was fundamentally independent of all the others. He believed that they could interact with each other, but that mental things could interact with material things only inside human brains. This is the classic Cartesian notion of duality, which is the foundation upon which all of our modern physical theories are built.

The first of these modern physical theories was devised by Isaac Newton, and published in 1687. Newton's theory, significantly extended during the eighteenth and nineteenth centuries, is called classical physics. It has two essential features. First, it effectively ignores the mental aspects of Descartes' conception of reality. It is based upon causal laws of motion for matter that involve only matter alone. The mental part of reality has no effect at all on the material/physical world: the principle of *the causal closure of the physical* holds*.* Second, this evolving physical world is *physically deterministic.* This means, specifically, that a complete description of all the physical properties that exist at any early time completely determines, via the physical laws of motion, all physical properties for all later times. Thus a complete description of the physical universe just after the "big bang" would completely determine every physical property of the present universe. Our conscious efforts could have no effect at all on our physical actions, beyond what was already fixed by the purely physical/material properties alone.

For more than 200 years, this idea of universal physical determinism relegated our minds to the role of passive observers, unable to alter in any way the flow of physical events from what was ordained already at the birth of the universe. There was no rational way to explain, strictly on the basis of the precepts of classical physics, either the *existence* of our conscious thoughts, or any causal *consequence* of our thoughts. Yet these experiential aspects of nature are all that we actually know. And we all base our lives on the idea that our conscious intentional efforts can have some sort of influence over how we act. Yet the classical worldview asserts that every physical thing was completely determined at the birth of the physical universe, which has been just mechanically grinding forward ever since.

In 1892, William James challenged, on the basis of his extensive studies of the connections between our conscious thoughts and our physical actions, this classical-physics-based claim of the impotence of our minds. He cautioned his readers at the conclusion of his book *Psychology: The Briefer Course* that "The natural science assumptions with which we started are provisional and revisable things." But it wasn't until eight years later, when Max Planck discovered a real failure in the precepts of classical physics, that the scientists of the day were forced to begin looking for a new set of precepts with which to understand the world around us and our role in it.

EnlightenNext: And that new set of precepts would eventually be known as quantum mechanics?

Stapp: Yes. At the beginning of the 20th century, many phenomena began to be discovered that were incompatible with the ideas of classical mechanics, and a new conceptual structure was needed in order to comprehend the empirical findings.

The initial big break was Planck's discovery concerning black-body radiation. He found that in order to accurately predict the distribution over the various frequencies of the radiant energy emitted from a heated black body, he needed to assume that the light coming from the surface was *quantized*. Contrary to what classical mechanics predicted, it seemed that electromagnetic waves could only be released in distinct units or "packets" known as *quanta*. And in order to correctly describe the energies of these quanta, and the shape of the observed energy spectrum, Planck needed to introduce a new constant of nature into the workings of the physical universe.

Now, scientists had for many years been looking at the frequencies of the light emitted from hot atoms of various kinds. The energy of the emitted light was concentrated in sharp frequency bands, and the frequencies of these bands turned out to be related in very puzzling ways to Planck's new constant. Once again, nothing like this came out of classical mechanics.

So a period of great confusion ensued as to how to understand these basic phenomena. The theoretical breakthrough came when Heisenberg tried to model what was going on, and found that in order to get the formulas to come out right, he had to assume that, contrary to the rules of ordinary arithmetic, the *order* of certain mathematical operations mattered. In classical physics, the location x of a particle times its velocity v is the same as v times x. And yet Heisenberg's formulas seemed to be saying no: x times *v did not equal v times* x. When you took the quantities x and v and multiplied them in one order, x times v, you got something different from what you got when you multiplied them in the other order, v times x. This was completely nonsensical from a classical point of view.

This was a great mystery at the beginning. On the other hand, mathematicians had, for a long time, been dealing with the fact that, unlike numbers, *actions* can depend upon the order in which one performs them. This led eventually to a radically new way of conceiving and describing how the world, as we experienced it, was operating. It was a new way of viewing things in which *human consciousness and the effects of conscious human actions* were important, and were, moreover, in a certain sense, central to the entire scientific enterprise. This reversed the Newtonian idea, in which the consciousness of human beings was, in effect, completely detached from the causal dynamical description. The new mathematical structure was such that human actions became an essential part of the whole structure of our understanding of nature. All of a sudden, the mind was elevated from the role of a detached observer to that of a fundamental part of the theory. For the first time, we now possessed a natural and rational way of gluing together the mental and physical aspects of nature, within the context of a practically useful, and extensively empirically validated, scientific theory.

EnlightenNext: Today, almost a hundred years later, many scientists still seem to believe that mind and consciousness are simply "epiphenomena" that emerge from the workings of the physical brain, rather than fundamental elements of nature in themselves. From this perspective, couldn't the actions or choices of the experimenters you're talking about still be considered subject to the laws of physical determinism, as well? Where exactly does this nondeterministic *mental* element come into the picture?

Stapp: Well, the structure of quantum mechanics has several parts, and one of them *is* deterministic. It's governed by the Schrödinger equation, which is the quantum analog of Newton's classical laws of motion. Just as the classical laws tell you how a classically conceived physical system evolves over time, the Schrödinger equation determines how the *quantum state* of a physical system evolves over time. But there's a twist.

In quantum mechanics, you can start with a system whose location is quite well defined—let's say you have a single particle, located in a certain region. You have just observed it. With your initial understanding of the state of this particle, you can then use the Schrödinger equation to predict how the system will evolve from there. This evolution can make sense in many ways. But once you let the system evolve for a while, and then try to find out what looks like at some later point in time, you will generally find that *it no longer corresponds to any possible observation*. According to the Schrödinger equation, it has now become a kind of smear of *lots* of different possibilities. So the quantum state that originally corresponded to our initial empirical knowledge has somehow evolved not into one unique later predicted empirical finding, but into a smear of later possible empirical findings.

For example, if you started at the big bang and just let the quantum state evolve according to the Schrödinger equation, everything would simply be smeared out. The moon would not have one particular location in the night sky. It would be smeared out all over the *entire* night sky. So would the mountains, the cities, and everything else, including everyone's brains. This was a huge mystery: the known deterministic equations alone were not enough to make sense of our experiences. Something was missing.

What the founders of quantum physics proposed was that in order to use the quantum mechanical equations to get predictions about what would be observed, *you,* as the experimenter, had to choose one particular yes-or-no type of property that you were interested in finding out about—and then physically act to set up an experiment, whose visible (experiencible) outcome will inform you whether the probed system has, or does not have, this chosen property. Under these conditions the quantum mechanical rules will give you a prediction about your chances of finding the answer "yes" if you actually perform that measurement..

This is where mind first comes into the dynamics: with the experimenter's choice of which probing action he will undertake. Since the quantum state of universe, evolving in accordance with the Schroedinger equation, will generally encompass a continuum of overlapping possible probing actions, any one of which you, the experimenter, could in principle perform---but you consciously experience yourself performing just one of these actions---the way is now rationally open to allow your mental aspect to do what it intuitively seems to be able to do, namely to choose from among the physically allowed possible actions, and then tend to cause your body to act in accordance with your conscious choice.

By going along with the notion that what *seems* to be making the choice---namely the mind of the experimenter---is actually making the choice, the founders enable the experimenter to see himself acting in a way that is rationally concordant with both his theory and his intuitions about himself. This rational coherence of theory and intuition is valuable in actual scientific practice. Adopting this tack brings physical theory back into concordance with Descartes' *interactive* dualism: with a Cartesian dualism in which mind interacts with matter in human brains.

This interaction is achieved by means of a so-called "collapse of the wave function", which is a *psychophysical event* whose physical aspect reduces the physical state to the part of itself that is compatible with the increment of knowledge contained in its mental aspect.

The logician and mathematician John von Neumann, in his description of the mathematical structure of quantum mechanics, called by the name "Process 1" the collapse of the quantum state associated with the choice of probing action. This action is not determined by the known physical laws, and results from a choice that *can be assumed without contradiction* to come from our minds. Thus we no longer need be mere passive observers: mere robotic, mechanical systems. Our psychology is now *allowed* to enter into the process of nature, because the known physical laws neither fully do the job by themselves, nor prevent our minds from actively helping.

EnlightenNext: Would it be correct to say that from your point of view, quantum physics actually *proves* that the mind cannot be reduced to the physical brain?

Stapp: "Allows" would describe the situation better than "proves". Let me elaborate. The initial formulation of quantum mechanics said that in order to apply the theory, you had to divide or "cut" the world into two parts. There was a part "below the cut" that was described in terms of quantum mechanics—in terms of vectors and Hilbert space and all the mathematical machinery that goes along with quantum mechanics. Then there was a part "above the cut" that was described in terms of classical physics, which deals with everything we see and do on the human scale. Below the cut, we're thinking of things as built out of (quantum-mechanically described) atoms. But according to quantum mechanics, atoms are not imagined to be points, or tiny objects. They're represented by smeared-out wave functions. Above the cut, on the other hand, we're dealing with what human observers can see and do, and we can describe what we see and do in terms of the idea of observable objects. These objects are conceived to occupy certain regions at each particular instant of time: there's no perceptible fuzziness there.

The Danish physicist Niels Bohr said that *where* we draw this cut or boundary between the microscopic world of quantum wave functions and the macroscopic world of classical objects is in some sense variable. Von Neumann used this variability to develop a sharper idea about the relationship between the mind and the brain. He imagined a sequence of devices, one on top of the other, each of which measures the output of the device below it, and signals what it sees to the device above it. In a "good measurement", if one device signals a "yes" response to the property it is probing, then the device above it will also give a "yes" response, and similarly for the two responses "no". As you move up the tower of these (good) measuring devices, you shift up the location of the cut. Each device is first considered to lie above the cut: then you're describing it in classical terms. But you then move this device below the cut, and describe it in quantum mechanical terms. In "good measurements" the predictions don't change: the probabilities of "yes" and of "no" remain fixed as you move the cut up.

You can move this cut up step by step, up and up and up, and the probability predictions remain the same, until ultimately your entire brain and body is below the cut, being described in quantum mechanical terms, but you *still* need this Process 1 choice, in order to bring theory into accord with our experience. The predictions of the theory reside in the minds of the observers, even when what is being probed is not a tiny atom but an object the size and scale of human bodies and brains.

Von Neumann effectively pushed the cut up so far that everything we call the physical world was finally being described quantum mechanically. It makes good sense to describe your brain quantum mechanically. Your brain is made up of atoms, and atoms are basically quantum mechanical things. But pushing all parts of the physically described world below the cut pushes the other dynamical part, the mental part, *outside of the physical world entirely*. This is the point. What von Neumann showed was that the quantum mechanical conception of the relationship between mind and matter continues to make sense even when the mental aspects are pushed completely outside the physically described world. Mind and matter enter quantum theory in two causally related but functionally different roles, and these relationships can continue to make sense even when the mind is pushed outside the physically described world. The conscious mental effort is in all cases an effort to make some particular contemplated experiential feedback actually occur. Von Neumann's analysis resuscitates a conception of reality quite like that of Cartesian dualism, with the mental aspect now playing a key and irreducible dynamical role.

EnlightenNext: If we're back to Cartesian dualism—to two separate realms, of mind and of matter—then what *is* the mental realm, exactly?

Stapp: Your mental realm is your stream of conscious experiences. It consists of all of your acts of coming to know or experience something, including your conscious intentions and efforts. Your conscious experiences are not definable in terms of other things, because they are the foundation of our knowledge. The quantum conception is really like what Descartes said: You have these two realms, and the mind should be able to influence the brain. But Descartes was unable to explain how these two self-sufficient kinds of things could influence each other. Newton "solved" that problem by leaving the mental realm completely out of the causal structure. That reduced us to mechanical robots, whose conscious efforts can have no effects upon our physical actions, in direct conflict with the incessant apparent empirical evidence that our conscious efforts often do effect our physical actions. Von Neumann's analysis of the issue, within the framework of orthodox quantum mechanics, shows that mind can break the physical determinism of classical physics and restore the causal efficacy of our conscious mental efforts. So we're back to a form of Cartesian dualism in which the two realms are causally related to each other—within the domain of phenomena described by quantum mechanics!

EnlightenNext: You mean there are domains that *aren't* described by quantum mechanics?

Stapp: There are domains of physical science that are not adequately covered by contemporary quantum mechanics. Copenhagen quantum mechanics is a wonderful pragmatic theory that allows us to grasp this mysterious relationship between mind and matter in a quite powerful way. But it's basically about the structure of human experience. It allows us to manipulate the concepts of mind and matter in a practically useful way. But it is by no means a complete description of nature itself. It's not an *ontology*.

One big problem with it is that it's anthropocentric. In order to make the theory testable, and useful to us, it is formulated as a theory about the structure of our streams of consciousness. And it says that what you will experience is physically undetermined, and dependent in part on your physically undetermined conscious choices between some physically possible physical actions. This makes your physically undetermined conscious choice between these physically allowed actions a crucial part of the dynamics. But it's hard to believe that human conscious choices are needed to make the universe run. For the universe was undoubtedly around long before us human beings.

One solution to this problem is to modify the Copenhagen interpretation by making it *biocentric;* by saying that the non-physical input is associated not only with human beings, but with all of life. This partially rectifies things, but it raises another problem. It suggests that before any life was formed, the universe was evolving in a particular way, and then as soon as the first little bit of life appeared on the scene—some microbe or something—now suddenly the universe evolved differently. That's also not very digestible. The boundary between life and non-life is probably not that sharp anyway. Where exactly would you draw it? And can you really believe that as soon as the first living thing came into existence, it suddenly introduced some huge difference in the way that nature evolved? That doesn't seem very likely.

At that point, there are two ways to go. One solution is to go all the way to *panpsychism*, and say that even things like atoms and totally inanimate systems possess some degree of consciousness: to say that mind is ubiquitous in the universe. But I don't really see why such a simple thing as an atom should be even dimly conscious. I think you get into trouble if you say that quantum collapse events *always* need to have both a psychic and a physical input, because then you're forced to try to follow this chain of psychic events all the way back to the beginning of the universe.

A simpler way to cope with this problem is to allow some events to be purely physical events with purely physical causes. The laws governing the occurrence of purely physical events could perhaps favor the creation of physical structures of ever greater complexity, and of societies of purely physical events that tend to hang together in some kind of mutual support. That might help to explain, in completely physical terms, the emergence of life. Even in conscious human beings most of what happens is not conscious, and much of what happens in the brain is devoted to *preparing* the brain for the entry of the conscious events.

That would be the second route, which is almost the opposite of panpsychism. There could then be purely physical events that hang together by virtue of purely physical laws of some yet-to-be discovered kind. Just because orthodox quantum theory provides an understanding of the structure of our streams of conscious experiences in terms of events that are *psychophysical*---as always having both mental and physical sides---there's no compelling reason to believe there could not also be other, currently unknown, physical processes that are sufficient to cause the wave-function to collapse without the involvement of anything resembling human or animal-based consciousness.

EnlightenNext: Do we have any idea what these purely physical collapse mechanisms might be?

Stapp: I have described an example in the second and third editions of my book *Mind, Matter, and Quantum Mechanics*. Remember, however, that we don't even know what the psychophysical collapse mechanisms in orthodox quantum theory are! We know that the known deterministic law, the Schrödinger equation, does not account for the collapses. But once you admit that there must be other processes, besides the one governed by the Schrödinger equation, I'm not sure why you'd want to say that every process not governed by the Schrödinger equation needs to have a mental side. Quantum mechanics has a causal gap in it, period. It's not a complete theory. Nor is it completely understood. But you don't have to go very far at all beyond orthodox quantum mechanics to suggest that there may be some currently unknown processes that are sufficient by themselves to collapse the wave function, without the aid of consciousness.

Once you make that step, then you can raise the complementary question: If we can have purely physical events, then why not purely mental events as well?

In *The Principles of Psychology*, William James wrote about what he called "fantastic laws of clinging" in our mental life; of how thoughts and ideas seem to "[weave] an endless carpet of themselves, like dominoes in ceaseless change, or the bits of glass in a kaleidoscope." He wanted to know where these fantastic laws of clinging came from, and why the movements of the mind could hang together in the way that they do.

With this question in mind, let us return to von Neumann's quantum mechanical conception of a person's stream of consciousness: it is a string of mental events, each of which is paired to a physical event in that person's brain. Each mental event is an increment of knowledge, and its physical mate is a reduction of the quantum state to the part of itself that is compatible with this increment of knowledge. The string of successive psychophysical events is held together by the combination of the physical connections that hold the successive physical events together and the mental connections that hold the successive mental events together. The physical connections are related to closeness in physical space, and the mental connections are presumably related to closeness in mental space. I imagine that mental closeness is closeness in *meaning*. Thus the combined effects of the mental and physical laws of clinging would tend to keep the stream of consciousness on track in terms of both physical possibility and meaning.

An interesting question then arises as to what happens at the time of bodily death? The psychophysical pairing can then no longer be maintained, because the decay of the bodily structure makes it unable to correspond to the complexity of the thoughts. But *if* James's fantastic laws of clinging are strong enough to hold the person's mental aspects together into a sort of persisting mental entity, then this entity could perhaps endure for a while in Descartes' world of mental things. That would be the end of it as far as living human beings are concerned, unless it was able to latch into, for example, some living person's stream of consciousness, in which case some of the knowledge of the deceased might be able to be transferred to a living recipient.

EnlightenNext: Wow. I never would have guessed that you were going to say that! Are you suggesting that phenomena like reincarnation could be fit into quantum mechanics?

Stapp: Well, respectable theorists hold a wide variety of views as to how to understand quantum mechanics. That theory accommodates a large variety of phenomena that are not allowed by classical mechanics. The key point here is this: If something like James' fantastic laws of clinging do exist, and they are sufficiently strong, then aspects of a personality might be able to survive bodily death and persist for a while as an enduring mental entity, existing somewhere in Descartes' world of mental things, but capable on rare occasions of reconnecting with the physical world. I do not see any compelling theoretical reason why this idea could not be reconciled with the precepts of quantum mechanics. Such an elaboration of quantum mechanics would both allow our conscious efforts to influence our own bodily actions, and also allow certain purported phenomena such as “possession”, “mediumship”, and “reincarnation” to be reconciled with the basic precepts of contemporary physics.

These considerations are, I think, sufficient to show that any claim that post-mortem personality survival is impossible that is based *solely* on the belief that it is incompatible with the contemporary laws of physics is not rationally supportable. Rational science-based opinion on this question must be based on the content and quality of the empirical data, not on the presumption that such a phenomenon would be strictly incompatible with our current scientific knowledge of how nature works. [Source Paper: www-physics.lbl.gov/~stapp/Compatibility.doc]

Sequel: The third way. The text appearing above is an elaborated version of an interview that will appear in the magazine EnlightenNext. But there is, in addition to the two ways discussed there of attempting to create a *quantum ontology*, a third way that needs to be mentioned. To see it, consider the second approach described above, and ask: If, when we go back to the beginning of the universe, we have nothing but the physical world evolving according to certain *given* laws, then what determines what those given laws are?

Physicists have recently been contemplating the possibility that certain conditions of mathematical consistency might single out one particular set of laws. Indeed, the huge recent focus of theorists on “string theory” was justified partly by the idea that it was somehow the unique consistent possibility. That hope has proved illusory, and there is a retreat to the question of what laws control the creation of the mathematically consistent universes. And if there are such universes then why should such a strange and alien thing as consciousness ever appear in any of them. But given the empirical fact that consciousness eventually did appear, it would seem that some seed of consciousness, or potentiality for consciousness, must have been there all along.

In this connection it is worth noting that, as Heisenberg emphasized, the ontological character of the quantum state is like that of an Aristotelian “potentia”, which Heisenberg described as an “objective tendency”. The quantum state represents *a collection of objective tendencies for various physically possible psychophysical events to actually happen*. This notion of “an objective tendency”, as best I can conceive it in this quantum context, is something like a contemplated possibility coupled to an urge to raise this possibility into an actuality. So it would appear that something like a primordial consciousness was present already at the birth of the quantum mechanically conceived universe. Recognition or acceptance of this notion leads, in a quantum world devoid of even the most rudimentary life forms, to the ancient idea of a *cosmic mind*, and to the conception of the universe as more like a conscious organism than like a robotic machine. Mentality becomes primordial, not in the individual atoms, but rather at the level of an “over-mind”. The emergence of conscious life forms would then become the creation, by this evolving psychophysical structure, of tiny substructures expressive of itself.

This view of nature is hardly new, but represents a rational basis for an ontological framework compatible with orthodox contemporary physical theory. [Cf. my book *Mindful Universe: Quantum Mechanics and the Participating Observer*]