

Survival of Bodily Death  
An Esalen Invitational Conference  
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## Quantum Physics and the Psycho-Physical Nature of the Universe

Henry Stapp

UC Berkeley quantum physicist **Henry Stapp** joined the conference series for the first time this year. Stapp was once an active participant in an annual conference series at Esalen in the 1970s and 80s on the subject of Bell's theorem and non-locality in quantum physics, so he was happy to be back at Esalen participating on another topic.

In his presentation Stapp described a number of the implications from quantum mechanics for the mind-body problem and thus for the survival hypothesis. He also touched on his most recent work that applies quantum theory to contemporary neuroscience research, particularly to an area called "self-directed brain plasticity." In contrast to classical physics, Stapp maintains that quantum physics is fundamentally psycho-physical and thus provides a way of understanding the causal effect of conscious effort on neural processes and actual changes in the brain.

### From von Neumann to Stapp

Stapp has recently been articulating the features of a quantum interactive dualism, which must be distinguished from the Cartesian dualisms that underlies classical physics. Stapp sees his work as part of the lineage of the highly regarded mathematician John von Neumann, who provided a mathematically rigorous formulation of quantum mechanics in his seminal work *Mathematical Foundations of Quantum Mechanics*, which was published in German in 1932 and then translated into English in 1955. Stapp emphasized that von Neumann's work addresses the duality issue by bringing the psychologically described and physically described aspects of scientific practice intelligibly together through the mathematical laws.

Stapp noted that there are three core components of von Neumann's formulation of quantum mechanics:

- Process 1:** The choice made by a human agent (the probing of nature)
- Process 2:** The mechanistic law quantum evolution (Schrödinger equation)
- Process 3:** The feedback from nature (the outcome of a probing action)

**Process 1** – Quantum theory involves two realms. The "lower" realm is described in the physical language of quantum mathematics, while the "upper" realm is described in the psychological language of ordinary experience. Process 1 involves both realms. It is a psycho-physical event whose psychologically described part is an intentional action to probe nature in a way expected to elicit desired information. The physically described part is a corresponding action in the "lower" realm. Von Neumann moved the boundary between the "lower" and the "upper" realms upward from where Heisenberg had originally placed it in the mid-1920s. Von Neumann showed that for all practical purposes, the same predictions are derived from his new placement of the Heisenberg cut. This upward shift places the physical aspect of the Process 1 psycho-physical event in the brain of the conscious agent. The most orthodox formulation of quantum theory, the Copenhagen interpretation, placed the boundary in a way that excluded the body and brain of the thinking and acting subject from the part of nature described by the quantum dynamics. Von Neumann's shifting of the boundary specifically put the brain of the agent inside the world governed by the quantum rules, and thereby made it the locus upon which the psycho-physical Process 1 acts. Von Neumann called the mental aspect of Process 1 the "abstract ego." Stapp pointed out that von Neumann's approach avoided the need to divide the dynamically unified physical world into differently described parts. It shifted the causally efficacious mind out of the brain.

**Process 2** – According to von Neumann's view, the brain of an agent is controlled by the mechanical Process 2, except for certain abrupt "interventions" associated with conscious experiences. Process 2 is the mathematically describable evolution of the quantum state in accordance with certain local deterministic rules discovered originally in the 1920s by Heisenberg, Schrödinger, Dirac, and others.

**Process 3** - Von Neumann did not use the name Process 3, but Stapp uses it to describe nature's feedback to our probing action specified by Process 1. This is often called "the collapse of the wave function" or "the reduction of the wave packet." Process 3 involves probabilities, in which a statistical weight is ascribed to each of the alternative possible outcomes (or feedbacks) from the probing action of Process 1. In his own writings Von Neumann did not elaborate upon what he meant by the "abstract ego." Nor did he elaborate on the dynamics inside the brain. But Stapp's extension and elaboration of von Neumann's approach introduces some details to describe this.

### Quantum Indeterminacy at Nerve Terminals and Ion Channels

Stapp has argued, on the basis of quantum mechanics and current neuroscience, that quantum effects are in principle important to the functioning of the brain. This view stands in contrast to many, if not most, philosophers and scientists (such as Francis Crick, Dan Dennett, and perhaps David Chalmers) who think that the brain produces the mind in a way that can (eventually) be explained exclusively with the use of classical physics.

Stapp argued that quantum uncertainties must be taken into account due to the extreme narrowness of the brain's ion channels. Their small width introduces into the dynamics significant uncertainties, which propagate in a series of steps (from calcium ions to vesicles of neurotransmitters to nerve impulses to large scale uncertainties) and convert the overall state of the brain into essentially a cloud-like infinitude of classically describable brains. Crucially, something other than the mathematically described Process 2 is needed to connect the cloud-like smear of possibilities to human experience. Something must single-out from this smear of possibilities the set of distinct possibilities from which one is chosen by Process 3. Or to put it in von Neumann's terms, Process 1 must intervene in the orderly evolution occurring via Process 2. (See pp. 25 to 27 of Stapp's book *The Mindful Universe* for greater detail. It can be accessed at the website <http://www-physics.lbl.gov/~stapp/stappfiles.html> .)

### Templates for Action

The activity in nerve terminals happens faster than the blink of an eye. So, Stapp theorizes that longer, more enduring patterns of neurological activity must be operated upon by Process 1 choices. Stapp calls these patterns "templates for action." More specifically, they are macroscopic oscillatory brain states that when held in place for an extended period will tend to produce an action. Process 1 picks out a template for action from the smear or cloud of templates generated by Process 2. These templates do not exist just for a split second. They are coordinated, enduring sequences. For example, a template for action might consist of the complex neurological activity involved in planning and sequencing the neural signals integral to raising someone's arm. A template for action is the physical aspect of the psycho-physical event. It corresponds to the "yes" response to the Process 1 probing action.

Stapp believes that such templates were important in the evolution of the brain. All brains have at least a rudimentary ability to compare current experiences to prior ones. Thus, as mammalian and primate evolution proceeded, successful templates for action were selected in a Darwinian fashion, thus eliminating the less adaptive ones. As our brains evolved, we developed the neurological templates for such common responses as fight or flight.

### The Quantum Zeno Effect: Holding Templates in Place

A physicist named George Sudharshan (who came to an Esalen conference on Evolutionary Theory in 1999) coined the phrase "Quantum Zeno Effect" to describe the way repeated Process 1 probing actions hold in place the state being repeatedly probed. These probing actions are abrupt interventions that act over extended regions. Stapp said this effect is a non-local process that normally acts on some finite part of the brain. Consistent persistent mental attention activates a sequence of rapidly recurring Process 1 events that hold in place a template for action. Thus, quantum mechanics provides a natural way for an intentional Process 1 action to override the mechanics of Process 2.

On this note, Stapp pointed out that William James's psychological philosophy focused a great deal on how effort of attention was the central factor in will. Some of Stapp's current work with Jeffrey Schwartz, a neuroscientist at UCLA, is developing greater quantum and neuro-biological precision to substantiate James's original conjectures.

Stapp added that his model is different in crucial respects from the one proposed by Roger Penrose and Stuart Hammeroff, which has been criticized for the unlikelihood that one of its central features (called quantum coherence) could operate in the warmth and wetness of the brain. There are other features of the Penrose-Hammeroff model that are on shaky foundations as well. In contrast, Stapp's model is built directly upon the basic precepts of von Neumann's quantum theory.

Stapp thinks that Process 1 acts non-locally over some finite part of the brain, but he does not push this non-locality any further than that. (Process 2, in contrast, is totally local and mechanical.) In contrast, someone like Dean Radin (a parapsychology researcher) might argue that Process 1 can extend beyond the brain and body to other bodies and things.

### Responses to Stapp

Some of the participants pressed Stapp on the question of just who or what the "observer" or "abstract ego" is. Stapp said that his view remains open on this question; he has not committed himself to a definite metaphysical position. He thinks there are many ways to answer this question. One possibility is that a "soul-spirit" is instrumental to Process 1 choices. While another view is that we may eventually find a mechanical explanation for Process 1. Stapp mentioned that von Neumann himself had moved in the direction of an ontology, but he never answered such questions definitively.

Gary Schwartz pointed out that the same regionalized non-locality could be applied for any organ in the body, not just the brain. Process 1 could select non-locally for the entire kidney, for example. Stapp said that it is true that the same principle can be applied to any system with ion channels. It's not exclusive to the neuronal activity of the brain. Thus, it is possible that the whole body could be understood as a quantum mechanical system.

Eric Weiss pointed out that in Vedic thought the Samkya school maintained an idea similar to von Neumann's Process 1 and Process 2. According to Samkya, the universe is divided into Purusha and Prakriti. Purusha is the unconditioned Source (or Consciousness with a capital "C") that enjoys and decides in all manifest experience. It makes all Process 1 choices. While Prakriti is nature; it comprises the physical-mechanical events of Process 2.

Ed Kelly pointed out a deep irony in Stapp's embrace of von Neumann, because the arch-reductionist philosophers, the Churchlands, claim von Neumann supports their own views about how consciousness is produced by the brain. In response, Stapp said that von Neumann was clear that the human brain does not work like a classical computer, as the Churchlands think the brain works.

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