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Consciousness and the Born Misinterpretation

Standard quantum mechanics does not allow the simultaneous appearance of two substantially different conscious brain states because it is empirically unacceptable for a person to be aware of two conflicting things at once. More generally, standard theory forbids the simultaneous appearance of *any* dissimilar macroscopic states inasmuch as their observation would call up contradictory conscious brain states.

Imagine that a particle p at time t approaches a detector d_0 that is being observed by a brain state B_0 . If and when the particle is captured, the activated detector d_1 will be observed by another brain state B_1 . The total state of the system S at any time t before capture and after the initial time t_0 is given by

$$S(t \geq t_0) = pd_0B_0(t) + d_1B_1(t) \quad (2.1)$$

where the first component is initially equal to 1.0 and decreases in time, and the second component is initially zero and increases in time. These symbols do not represent solutions to the Schrödinger equation. Rather, they are unitless quantities that represent the *magnitudes* (i.e., square moduli) of those solutions¹.

The standard *Born interpretation* of quantum mechanics says that only one of these components represents the system, and it does so with a probability given by its magnitude. On the other hand, it is clear that the first component represents a physical system that is 100 percent real during the time $t \geq t_0$ prior to capture, and the second component represents a physical system that is 100 percent *not* real during that time, and “probability” has nothing to do with it. The first component $pd_0B_0(t)$ does not exist with “some probability” inasmuch as it exists with *absolute certainty* before capture. And the second component $d_1B_1(t)$ does not exist with

¹ The components of this equation are sufficiently different that the integrate square modulus of the associated wave function has no cross term. See appendix for this chapter.

“some other probability” because it *does not exist at all* before capture. It is my claim that Equation 2.1 is really a statement about the system, not about a possible outside observer. *Quantum mechanics is a theory about physical systems that have an objective meaning independent of observation.* Equation 2.1 says that this system has one component that is objectively real and another that is not – or at least not yet.

Classical probability is used to cover our ignorance. It is a way of saying that we don’t know the answer. We don’t know if the coin will come up heads or tails, so we assign a probability. Probability is therefore a property of the observer (i.e., the observer’s ignorance) not the system, and the Born interpretation attempts to preserve that meaning. Since we cannot avoid probability in quantum mechanics, it is generally concluded that quantum probability is about *an observer’s knowledge of the system*, and that the system itself is beyond that knowledge. I believe this is fundamentally incorrect. We certainly do have a knowledge of quantum probability, and we have every reason to believe that it is an *objective property of the system* [Margenau 1950].

Another Possibility

First and foremost, an objective interpretation of the above quantum mechanical system would declare that the first component in Equation 2.1 is real and the second component is unreal – no probability about it. The magnitudes (or square moduli) of these components should not be given *any* physical significance, and in particular, they should not be assigned a probability. Instead I say that there is an objective *probability current J* that flows from the first to the second component in Equation 2.1, and that this is the only way that probability should be introduced into quantum mechanics. Understood in this way, probability does not predict what *an observer is likely to see*, but rather, it predicts what the *system is likely to do*. In particular, Equation 2.1 predicts the probability that the *particle will be captured* by the detector during the time interval dt . That probability is equal to Jdt , independent of the possibility that the system is being observed. This is a more objective interpretation of quantum mechanics. It is only with this crystal-clear

interpretation of Equation 2.1 that *conscious states can be included in quantum mechanics in an unambiguous way.*

The net probability current in (or out) of a component is defined here to be the positive (or negative) time rate of change of its magnitude. Since the total magnitude is conserved in time, the total current J_{out} coming out of the components of an equation will equal the total current J_{in} going into its components. We require that the current flowing into an unreal component from a real component determines the probability that (1) the unreal component will *become real* in the time interval dt , and that (2) the other component will simultaneously *collapse to zero*. This change from one component to another is referred to as a *quantum jump*.

I have formalized this interpretation in Chapter 9 and more briefly in the appendix at the end of this chapter. This formalization adequately explains a great variety of quantum processes such as linear and parallel decays, atomic absorption and emission, laser action, as well as measurement localization in Chapter 10, and even shelving in quantum optics in Chapter 11. It is logically sound and gives a broad and consistent account of quantum mechanical phenomena. The formalization takes the form of three “q-rules” that describe every phase of the capture process, so if the particle in Equation 2.1 is finally captured at some time t_{sc} , the q-rules provide for the subsequent quantum jump and collapse of the wave. The result is a fully real component in which the observer’s brain B_1 experiences the detector d_1 after collapse

$$S(t \geq t_{\text{sc}} > t_0) = d_1 B_1(t) \quad (2.2)$$

The collapse of the wave is as much a part of the interpretation of quantum mechanics as the way in which probability enters the picture. A number of other collapse mechanisms have been proposed, such as the spontaneous localization theory of Ghirardi, Pearle, and Rimini [Ghirardi 1990]. These authors have included the collapse into the dynamic principle in a way that seems desirable, but their theory does not predict the same experimental results as the q-rules. There is at least one experiment in which the q-rules predict a collapse that contradicts the Ghirardi and Pearle idea of spontaneous decay [Collett 2003]. It involves molecular

collisions with the atoms in a rarified 4.2° K atmosphere, and it provides a way of deciding between these two interpretations (see Chapter 13). There are other theories of collapse, or non-collapse, such as the Copenhagen theory of Bohr, the many-world theory of Everett [1957], the gravitationally induced theory of Penrose [1994], and the theory of Broglie-Bohm. But only the Ghirardi-Pearle theory and the proposed q-rules predict a collapse in the cryostatic vacuum of this experiment.

Realized and Ready

The q-rules also address the question of the physical existence of the components in Equations 2.1 and 2.2. They formally distinguish between components of an equation that are *realized* and those that are *ready*, where only realized components are understood to have empirical significance, as opposed to ready components that have *no* empirical significance. The first component of Equation 2.1 is “realized” because it is stipulated to be the initially given reality. The second component in this equation is “ready.” It does not physically exist during the indicated time t because the detector is not yet activated. Ready components are labeled by underlining one of the states in the component, and realized components are not underlined. Equation 2.1 is therefore rewritten

$$S(t \geq t_0) = pd_0B_0(t) + \underline{d}_1B_1(t) \quad (2.3)$$

and Equation 2.2 is correct as it stands.

The initial state of a system is always a realized component. Furthermore, any component that survives a state reduction (Equation 2.2) will always stand alone as a realized component. This means that all equations that appear under these rules will contain one and only one realized component, so we can have only one empirically real brain state (per conscious spectator) at a time². If we are ever to include conscious systems in the universe, we must begin with a physics like this – one that guarantees the uncontested appearance of single conscious states.

² An exception is a resonance (like stimulated absorption and emission) between two or more realized atomic states. However, brains never directly observe resonances of this kind.

The Achilles' heel of the Born interpretation is that conscious systems cannot be treated quantum mechanically without introducing absurdities in the form of the simultaneous existence of more than one conscious state (e.g., the cat paradox). It is true that these states are introduced with different degrees of probability. But this is said to be a property of the observer (i.e., his ignorance), whereas the system itself cannot be comprehended by us mortals – or so they say. Accordingly, the two conscious states appearing in Equation 2.1 are given a very ambiguous status that raises the paradoxical possibility that they play a dual role in the system itself during this interaction.

On the other hand, the q-rules allow conscious systems to be unmistakably included in the quantum mechanical universe without paradox. In fact, they permit the unambiguous superposition of *any* macroscopic state. In addition to the macroscopic brain in Equation 2.3, the macroscopic detector is also in superposition with itself. But this is no contradiction because it too has only one empirically real component in that equation.

Some years ago I wrote a paper that I called “The Conscious Universe”. I dropped it on the desk of a colleague who glanced at the title and said, “You don’t really believe that do you?” “Of course I do” I said. “I am conscious and I am part of the universe. Therefore, the universe is conscious” “That’s ridiculous”, he roared. “Wait a minute” I said, “Aren’t you conscious?” “Of course I’m conscious”, he replied. “And aren’t you part of the universe?” I asked. “Certainly Not!” he said with great indignation.

We both laughed at the time, but I am convinced that part of him was serious. He really did think of himself as being, in some way, apart from the universe. That’s what standard quantum mechanics teaches. It teaches that we observers are implicitly on the outside. There is the observed system, and there is the observer of the system, and these two things cannot be quantum mechanically confused. With the Born interpretation we observers cannot be thought of as being fully a part of the universe that we observe. And *that*, I say, is ridiculous.

A Conscious Pulse

A single brain state like B_0 is no more likely to exist by itself (as a delta function) than a photon is likely to exist with a sharply defined frequency. A photon always exists as a pulse of some kind, and it makes sense to suppose that the same will be true of a conscious states. The apparent difficulty is that we have allowed only one conscious brain state to exist at a time, and this appears to exclude the possibility that many conscious states can exist in superposition inside of a brain pulse.

However, there is no contradiction if we understand that the states in a conscious brain pulse fall within the brain's ability to resolve a conscious experience. These states will overlap sufficiently so that they will not include quantum jumps of any kind, and therefore, will not come under the q-rules. It is the brain that decides the matter. The Hamiltonian of a normal brain *converts a chosen conscious state into a conscious pulse whose width is within the ability of the brain to resolve the experience*. Paradoxical experiences are thereby avoided for an observer who normally experiences one thing at a time. A realized brain pulse is then represented by an *endogenous superposition* of quantum mechanical brain states given by

$$\{B_k\} = \int c_k(u)B_u du$$

where u ranges over different brain states and the coefficients $c_k(u)$ are normalized over u . Presumably, this pulse is shaped (by the brain) into a more or less bell-shaped curve with a maximum value at B_k . Ready conscious brain pulses are constructed in the same way. Equation 2.3 then becomes

$$S(t \geq t_0) = p d_0\{B_0\}(t) + d_1\{\underline{B}_1\}(t)$$

If the ready pulse $\{\underline{B}_1\}$ is to peak at \underline{B}_1 , then probability current must flow into \underline{B}_1 much faster than it flows into one of the states near the edge of the pulse. For that reason, \underline{B}_1 is far more likely to be stochastically chosen during the interaction than one of the edge states. This result is the same as that predicted by the Born interpretation, which says that the peak of the pulse is more likely to be stochastically chosen because it has the greater square modulus. However useful the

Born interpretation may be for the purpose of prediction, it must be remembered that it is essentially incorrect for reasons that are given at the beginning of this chapter. The correct interpretation refers only to probability current flow.

If the ready state that is actually chosen inside a pulse $\{B_k\}$ is B_s , then the brain will collapse to a realized pulse $\{B_s\}$. The intensity of a conscious experience (e.g., light or dark, quiet or loud) does not depend on the magnitude of a conscious pulse, but on the variables that define the states within the pulse.

The source of a pulse superposition might very well be the calcium ion uncertainty described by Stapp [1993]. These ions migrate by diffusion to the release sites of vesicles containing neurotransmitters prior to their release into a synaptic junction in the brain. Calcium ion uncertainty of position leads to an uncertainty of neurotransmitter release, and that results in an uncertainty in the time of their capture at receptor sites of target dendrites. Applying this uncertainty throughout the brain gives a possible source of endogenous superpositions of pulsed brain states.

Appendix: The q-rules

Definitions:

Ready components introduced in the first q-rule are empirically unreal.

Realized components are empirically real. If a component is not ready, then it is real.

Periodic interactions are those that produce discontinuous oscillations between or among orthogonal states (e.g., Rabi oscillation between energetically different atomic states).

Q-rule (1): *If a non-periodic interaction results in a current flow to a new component that includes at least one newly created particle or annihilates at least one previously existing particle, then the new component will be a ready component and will remain so unless converted by q-rule (3).*

Note: We say there has been a quantum jump from an old to a new component when there has been a newly created or annihilated particle. In the above case, the

new particles in the component $d_1B_1(t)$ are the photons that surely appear in the ion cascade inside the detector when the particle p is captured. This “jump” requirement guarantees the orthogonality of the components in Equation 2.1 – that is, there will be no cross term appearing in that equation.

Q-rule (2): *A stochastic trigger can only strike a ready component, and it does so with a probability per unit time equal to the probability current J flowing into it from a realized component.*

Q-rule (3): *When a ready component is stochastically chosen, it will begin a transition to a normalized realized component, and all other components will go immediately to zero.*

Note: A collapse is neither spontaneous in the Ghirardi-Pearle sense, nor is it due to an interaction with an outside observer, a macroscopic instrument, or any other agent external to the system. A collapse is initiated by factors that are related only to the internal dynamics of the system.

Note: Again, whereas the Born interpretation uses probability to say what the observer is likely to observe, the q-rules use probability to say what the system is likely to do.

The application of these q-rules to atomic systems is explored in Chapters 9–11, where they are explained in detail and are shown to have great theoretical value. But when applied to the macroscopic features of the above particle capture, the rules become statements of empirical fact. Apart from a caveat to be stated in connection with the third q-rule, these rules are macrostatements, like the laws of thermodynamics, that are confirmable by laboratory observation.

Consider the first q-rule. It says that the second component in the equation

$$S(t \geq t_0) = pd_0B_0(t) + \underline{d}_1B_1(t)$$

Is not empirically real. During the time $t \geq t_0$ before capture, the initial condition $pd_0B_0(t)$ can be empirically confirmed, but the product d_1B_1 is not yet a observable physical reality, so the first rule is empirically correct.

The second q-rule says that there will be a stochastic event at a time t with a probability per unit time equal to the probability current flow into the second component. This is no theoretical stretch. To the extent that the Born interpretation can predict probability per unit time, the second q-rule can do the same. In this respect they give empirical support to one another.

The third q-rule says that when a stochastic hit occurs, the real component $pd_0B_0(t)$ is replaced by a different real component $d_1B_1(t)$. That too is empirically correct. Harkening back to the first q-rule, there are newly created cascade photons in d_1 that do not appear in the initial detector d_0 , and this is the signature of a quantum jump. These photons are observable in principle.

The only speculative part of the third q-rule has to do with the nature of the collapse. In particular, it is claimed that the collapse is instantaneous. I believe that is true, but of course I don't know that it's true. However, the speed with which a collapse occurs is of no concern for our present purpose, for the third q-rule would be completely adequate if it were stated without any reference to instantaneousness. In any case, the rule can be modified on this point if that becomes warranted, and without doing harm to the above proposed interpretation of quantum physics.