Journal of Cosmology

Journal of Cosmology.com

Journal of Cosmology, 2011, Vol. 14.
JournalofCosmology.com, 2011

What Consciousness Does:
A Quantum Cosmology of Mind

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Abstract

This article presents a particular theoretical development related to the conceptualisation of the role of consciousness by Hameroff and Penrose. The first three sections review, respectively: the different senses of "consciousness" and the sense to be used in this article; philosophical conceptions of how consciousness in this sense can be said to do anything; and the historical development of understanding of the role of consciousness in quantum theory. This background is then drawn upon in the last two sections, which present a cosmological perspective in which consciousness and quantum theory are complementary processes governed by different logics.
KEY WORDS: Qualia, Quantum cosmology, Quantum collapse, Epiphenomenalism, Histories interpretation, Quantum logic, Heidegger

1. Consciousness: What Are We Talking About?

"Consciousness" is notoriously difficult to define because it is so fundamental; it is the precondition for our being able to do or know anything. Surveying the voluminous controversies over the meaning of the word suggests, however, that "consciousness" tends to be used in two fairly distinct ways. Broadly considered, just as the word "spirit" has two quite different referential meanings, viz., alcoholic beverage vs religion/parapsychology, so "consciousness" has two meanings: One meaning refers essentially to subjective experience: our moment- by-moment qualitative awareness of what is happening both internally (thoughts, feelings) and externally. It is the "what it is like" of Nagel's seminal paper (Nagel, 1974). The other meaning is that used by Dennett (1991). Taking to heart Wittgenstein's dictum that "whereof one cannot speak, thereof one must be silent", he restricts the topic of consciousness to those aspects of experience that we can report on, verbally, to other people. From this he is led to restrict the concept to that part of our internal experience that is contained in our inner dialogue, the almost constant talking to ourselves whereby we make sense of the world to ourselves in verbal terms. Thus consciousness in Dennett's sense of the word is the process of our forming "drafts" of parts of our internal dialogue. I shall call these senses of "consciousness" as used by Nagel and Dennett qualis-consciousness and quid-consciousness, respectively, from the Latin words for "how" and "what". Qualis is related to quale, quality, and with the idea that qualis-consciousness is comprised of qualities (qualia) associated with perception and thinking.

This difference between these two senses is crucial when we consider what we know about the consciousness of other people or other beings. Whereas we can, and by its definition can only, explore the quid-consciousness of another person by talking to them, we can only know the non-verbal part of another's qualis-consciousness through empathy; that is, through our

evolved capacity for mirroring the sensations of others in response to a range of bodily cues and contextual information (Berger, 1987). This means that, as cogently argued by Nagel (1974), in the case of an organism like a bat with which it is difficult to have much empathy, we cannot know explicitly that they have qualis-consciousness, even though we might postulate that this is the case because they are mammals like ourselves. On the other hand when it comes to the verbally based quid-consciousness we know that bats, lacking language, cannot have it. The distinction between the two concepts is thus vital when discussing non-human consciousness. Without deeper analysis, we cannot rule out the occurrence of a "hidden" qualis-consciousness from any organism, or even from physical systems that we may not consider organisms at all - a vital point that will be revisited in section 5.

2. What Does Consciousness Do?

A major strand in the philosophy of consciousness concerns the notion of epiphenomenalism - the idea that consciousness is an add-on that appears upon ("epi") information processing without having any functional role. This is not relevant to quid-consciousness, which is actually a part of information processing rather than something added to it. In the case of qualis-consciousness, on the other hand, "epiphenomenalism" seems meaningful while at the same time seeming odd, because the whole notion of causation, in the physical sense, seems problematic in connection with qualis-consciousness. This consciousness does not do things like digesting food or moving limbs in a purely mechanical sense, but it comprises the whole of our experienced world (McGilchrist, 2009) and thereby establishes the context and preconditions as a result of which doing-events like moving limbs take place. The distinction between the two senses of "consciousness" lies not in whether they either do things or not; it lies in the distinct categories of "doing" and "being" that are involved. Quid-consciousness does things in a causal sense as part of a whole control structure of information processing. Qualis-consciousness constitutes a meaningful world within which doing is possible.

Here it becomes a matter of one's philosophical position, whether or not qualis-consciousness is anything other than a sort of emotional fog generated by processing in the brain. If one adopts a scientific-realist position on which the world is entirely reducible to mechanical processes, then qualis-consciousness is indeed such a fog. The alternative to this is to recognise that there is a whole area of discourse concerning existence, value, meaning and so on which is related to the mechanical properties of the world, but which is not equivalent to the mechanical aspect of the world.

Since it is qualis-consciousness that raises the most significant problems in consciousness studies, I shall from now on restrict attention to this sense of the word and, with this understood, I shall usually drop the "qualis" and just call it "consciousness".

3. The Changing View of the Role of Consciousness in Quantum Mechanics.

The earlier history of this topic falls into four phases:

> (a) The "quantum theory" of Planck and Einstein, based on a conventionally mechanical concept of "quanta".
> (b) The "quantum mechanics" of Bohr and Heisenberg from about 1925. This was based on complementarity and the uncertainty principle, which increasingly involved the idea of the collapse of the quantum state (also known as the wave function). It culminated in von Neumann's picture (von Neumann, 1932) of two quite distinct processes: a smooth

deterministic evolution of the state under a dynamics, and a discontinuous transition from one state to another related to observation. He did not, however, suppose that consciousness was peculiarly concerned in this, arguing that it was sufficient to consider the human being as an assemblage of rather sensitive physical detectors.

(c) The views of Wigner and London and Bauer (London & Bauer,1939, 1983) that consciousness was essential for collapse. According to this, the quantum state of the human brain was, through the process of experimental observation, coupled to the quantum state of a microscopic system; then the consciousness of the human being collapsed the joint state of human, apparatus and microsystem. This role for consciousness was strictly limited. Consciousness was not responsible for determining what particular quantity was being measured, because this was determined by the apparatus (a point that will be revisited in section 5). It could not bias the probabilities for different outcomes, because this would undermine the very laws of physics. All that consciousness could do was, somehow, to demand that some definite outcome did emerge, rather than a mixture or superposition of possibilities.

(d) A focus on the quantum-classical distinction. This began with Daneri, Loinger and Prosperi (1962) suggesting that "collapse" was the transition from a quantum state to a classical state, and that this was located not in the brain of the observer, but in the experimental apparatus. They showed that it was the large size of the apparatus, with a large number of possible quantum states all linked to the state of the microsystem being observed, which averaged out the peculiarly quantum mechanical nature of the microsystem, resulting in an essentially classical, non-quantum state for the apparatus. Subsequently Zeh (1970) included in this averaging-out of quantum states the highly effective role of interaction with the wider universe through the phenomenon of "decoherence". By this time the idea that consciousness had a role in quantum theory came to be regarded as superfluous.

In consequence of this history, it has become clear that we are here dealing with two distinct (though interrelated) physical representations. One is the superposition of states, a peculiarly quantum effect resulting in, for instance, the interference patterns produced in the experiment where particles are fired towards two parallel slits. The other is the statistical mixture of states used to represent mathematically a situation such as the result of a rolling a dice, where there is a range of possible outcomes with different probabilities for each. Considered purely mathematically, decoherence turns a superposition into a mixture. This does not, however, explain why we are actually aware, at the end of the process, of one particular outcome as opposed to a fuzzy blur of possibilities. We may recall that this, and only this, was what consciousness was supposed to achieve on London and Bauer's earlier way of looking at things. Despite much clarification between 1939 and 1970, the possible role for consciousness has remained little changed, and its operational details have until recently remained obscure.

4. The Perspective of Cosmology on the Role of Consciousness

More recent arguments from the surprising direction of cosmology now clarify things a great deal. In particular, quantum cosmology starkly underlines the need for something like consciousness. To take a particular example: the WMAP satellite observations of the universe at an age of some 380,000 years confirm a picture in which the universe has evolved as if it started in a perfectly smooth homogenous state (though strictly speaking there can be no "initial state" since the very earliest stages merge into the as yet unknown timeless conditions of

quantum gravity). By the epoch observed by WMAP we see minute fluctuations superimposed on this uniform background, of the same character as the quantum fluctuations that can be detected when a uniform beam of radiation is observed in the laboratory. On conventional theory, these cosmological fluctuations grew under the influence of gravity to produce stars, galaxies and ourselves. Note, however, that in quantum theory it is the act of observation that precipitates quantum fluctuations: without observation (in whatever generalised form we may conceive it) a homogeneous initial state evolving under homogeneous laws must remain homogeneous. So the early fluctuations that eventually give rise to the existence of planets, people and WMAP are caused by observations such as those made by people and WMAP! The problem of quantum observation lies at the heart of modern cosmology.

This cosmological perspective makes it clear that the bare mathematical formalism of quantum theory in insufficient on its own. Without some additional ingredient, the universe would remain homogeneous and sterile. Two ideas from quantum cosmology are needed in order to make sense of this. They will also provide the key to the role of consciousness.

The first was introduced by James Hartle (1991), building on the "histories" interpretation of Griffiths (1984). Instead of considering probabilities for different outcomes to a single quantum observation, Hartle examined the probabilities of sets of outcomes for any collection of observations scattered throughout the universe in space and time. The mathematics was almost the same as it would have been if one had assumed a collapse of the wave function simultaneously across the universe with each observation; but strictly speaking the latter concept cannot be used in cosmology because it is not consistent with the fact that in relativity theory "simultaneous" is an observer-dependent concept. By considering this "super-observation" extended over the whole of space-time there is no need to consider either collapse or issues of causality between future and past events.

Hartle gave no indication as to what was actually meant by an "observation" or "observer". This issue was made explicit through the second key idea, first raised by Matthew Donald. He considered quid-consciousness - i.e. information processing - but this cannot help because it is in no way essentially different from any other purely mechanical process. Then, however, the idea was explored by Don Page who focussed on "sensation", which is close to the qualis-consciousness of this paper. The aim of a cosmological theory, he argued, was to explain the universe as we see it, and this is equivalent to requiring that the quantum state of the universe is compatible with an instance of conscious sensation like ours. This in turn is equivalent to the quantum state assigning a non-zero probability to such an instance. This then gives a new way of thinking about the role of consciousness: consciousness does not alter the quantum state of the universe, but it imposes a filter on the state, selecting a component (if there is one) compatible with our capacity for sensation.

The combined work of Hartle and Page gives a picture of a universe arising from the interplay of a background homogeneous quantum cosmology with possible networks in space and time of instances of consciousness. Self-contradictory networks of awareness are ruled out because quantum mechanics assigns to them a zero probability (Everett, 1957; Clarke, 1974) . But in addition the networks of awareness are shaped by their own internal logic, manifested by qualis- consciousness and different from the Aristotelian logic of quid-consciousness (Clarke, 2007). This logic brings in elements such as agency and meaning. Consciousness, on this view, "does something", but by selection rather than modification, and in a way which is compatible with and dependent on the known laws of physics.

5. A Theoretical Understanding of Consciousness and Quantum Theory

One final building block still seems required: a non-arbitrary criterion is needed for what physical systems have the capacity for (qualis-)consciousness. Many recent authors (de Quincey, 2002; Skrbina, 2005) have, however, come to the conclusion that no such criterion exists. In other words, everything might be conscious, a position known as "panpsychism". A problem remains, however: if "everything" is conscious, what is a "thing"? The answer of Heidegger (1967) concerned only a pejorative cultural aspect of the word; the answer of Döring and Isham (2011) invokes an ad hoc external mechanism; instead we need to explore naturally occurring physical criteria for what is a thing. A consciousness-carrying "thing" must have some internal unity rather than being an arbitrary aggregate of objects, which suggests that it has an internal coherence. The simplest definition of this is that its parts are in quantum entanglement (Clarke, 2007) . In addition, it must not be merely an arbitrary subset of a larger "thing", so that it must be maximal with respect to this coherence. In other words, it must be on the boundary between the quantum and the classical, a boundary set by the onset of decoherence. The structures considered by Hameroff and Penrose (1996) are of this sort.

It now becomes clearer what consciousness does. At this quantum-classical boundary the question of what "observation" (or, more formally, what algebra of propositions) is to be expressed is not yet determined by decoherence, and so is open to determination by consciousness (Clarke, 2007). Following Hartle, this happens not in isolation, but within the whole network of "things" throughout the universe. Physical causation operates through quantum state of the universe, while consciousness independently filters this into awareness through its own sort of logic (in the sense of the structure of an algebra of propositions). The large scope this gives for future experimental and theoretical research has been outlined in (Clarke, 2007,8). Several candidates for the logic of consciousness are available, allowing us to understand how consciousness brings creativity alongside rational deduction. This model raises for the first time the possibility of a rigorous theoretical framework for parapsychology (Clarke, 2008) without which that subject remains only a semi-science. It turns out that consciousness can itself, through the "Zeno effect", enlarge the length scale for the onset of decoherence, which then offers hope for understanding how small-scale elements can be "orchestrated", in Hameroff's sense (Hammeroff & Penrose, 1996), into the ego-consciousness known to us. In addition, there will be other candidates for what a "thing" is, opening up alternative theories that can be tested against the theory just outlined.

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