Commentary

Commentary on Whitworth's "Virtual Reality Conjecture"

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This is my Comentary on Brian Whitworth's "Virtual Reality Conjecture."

The paper by Brian Whitworth [1] explores the question on how epistemology might precede ontology. If we think of classical mechanics as built up from a quantum world of wave functions, which are most often interpreted as epistemological, then the ontological aspects of the world in some manner emerge from epistemology. The relationship between the classical world or the world of objective knowledge and the subatomic world of quantum mechanics has been a point of consternation since the early days. The outcome of a measurement posed an apparent contradiction with quantum mechanics, as outlined in the famous paper by Einstein, Rosen and Podolsky [2]. Bohr introduced the idea of a dichotomy between the quantum and classical worlds, where outcomes of quantum experiments are obtained with classical instrumentation. Heisenberg wrote a letter on whether a deterministic world was possible and illustrated how Bohr's cut-off had some strange features to it; in particular an indeterminate boundary between the quantum and classical domains [3]. The boundary between the epistemological and ontological is then a mysterious problem with physics, which remains today. Brian Whitworth proposes that reality exists in a virtual setting, whereby epistemology does precede ontology. The ontological world emerges from quantum processing in a way similar to how a virtual reality emerges in a computer running an algorithm.

Brian Whitworth's thesis boils down to the idea quantum mechanics provides a processing background from which reality is derived. Of course the term reality generally refers to local reality. It is generally conceded that quantum mechanics is nonlocal and has no local reality. This conclusion is taken from the Bell theorem. As a rule non-contextual hidden variable theories are rejected by the theorems of Gleason and Kochen- Specker and Bell's theorem. It has been argued that Bell's theorem is important only to reject some additional contextual hidden variable theories. Contextuality refers to the eigenbasis of a system, where for a spin 1/2 system the two states are often refered to along the z direction. This is determined by the choice of the orientation of a Stern-Gerlach apparatus the experimenter chooses. The axes directions of the quantum states are not determined by quantum physics; quantum physics lacks this "context." Yet the idea quantum physics computes reality was proposed by John Wheeler [4]. Seth Lloyd proposed a way in which the entire universe is a quantum computer [5]. Whitworth takes this idea in a philosophical sense to include the emergence of context from quantum mechanics which is inherently noncontextual.

A review of Bell's theorem is worth considering, where this demonstrates how classical logic does not operate with quantum mechanics. The corresponding case classically involves projecting onto subspaces of an entangled state

$$\psi\rangle \;=\; \frac{1}{\sqrt{2}}(|+,\;-\rangle\;+\;|-,\;+\rangle)$$

for the singlet state configuration of a bipartite entanglement. So the Pauli matrices for the two are σ_i τ_i, the set of projector operators on the 1 and 2 states are employed

$$P(1)_z \;=\; \frac{1}{2}(1\;+\;\sigma_z),\; P(2)_z \;=\; \frac{1}{2}(1\;+\;\tau_z)$$

and for the 45 degree case

$$P(1)_{45} \;=\; \frac{1}{2}(1\;+\;(\sigma_z\;+\;\sigma_x)/\sqrt{2}),$$
$$P(2)_{45} \;=\; \frac{1}{2}(1\;+\;(\tau_z\;+\;\tau_x)/\sqrt{2})$$

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and

$$P(1)_x \ = \ \frac{1}{2}(1 \ + \ \sigma_x), \ P(2)_x \ = \ \frac{1}{2}(1 \ + \ \tau_x).$$

The projections onto the entangled state which correspond to the classical probability rules is

$$Prob(|, \_) \ = \ P(1)_z * P(2)_{45} \ = \ \frac{1}{2\sqrt{2}}$$

$$Prob(/, \ ) \ = \ P(1)_{45} * P(2)_x \ = \ \frac{3}{8\sqrt{2}}$$

$$Prob(|, \_) \ = \ P(1)_z * P(2)_x \ = \ \frac{3}{8}$$

Here the vertical line is the z axis, the horizontal the x axis and the slant is at 45 degrees. Some calculations with the matrices and the states leads to the Bell result that this violates a classical inequality.

The classical inequality may be derived from set theory from the intersection of sets $A, \ B, \ C$. The classical inequality is then

$$P(b, \ c) \ \geq \ P(a, \ b) \ + \ P(a, \ c)$$

We then let the a correspond to the z axis, the 45 degree the b and the x axis c. We then have

$$\frac{3}{8\sqrt{2}} \ \geq \ \frac{3}{8\sqrt{2}} \ + \ \frac{3}{8}$$

$$.265 \ \geq \ .640$$

from quantum mechanics, which is clearly false. This is a violation of the Bell inequality. The conclusion is that quantum mechanics does not obey classical logic with respect to state outcomes. Instead the multiplication of projectors is geometrically interpreted as a span within a vector space.

This loosely tells us there are no classical underpinnings to quantum mechanics. The dichotomy between quantum mechanics and classical or macroscopic reality remains an unknown. W. Zurek [6] has proposed einselection as a way to understand how a macroscopic world emerges from quantum mechanics. This is a conjecture on how pointer states obtain through decoherence as environment states become orthogonal. However, in an implicit manner context has been slipped into the picture. The Many Worlds Interpretation implicitly slips context in as well by proposing a sort of eigenbranching of "worlds" according to some eigenbasis. We seem to live in an age where the ghost of Bohr continues to grin at us like some Cheshire cat; we still have not dethroned his Copenhagen interpretation

Can quantum mechanics through a computational process compute contextuality? If we were to follow the main argument Whitworth advances it does so because we are observers in the universe. We are "avatars" in the quantum computer simulation and in this process we consciously perceive context, or equivalently we assign the direction of a Stern-Gerlach apparatus. A quantum system with a large mass or an action $S \ >> \ \hbar$ exhibits comparatively small quantum interferences or superpositions. Hence we as observers perceive a classical-like world as avatars. The virtualism approach posits that reality emerges from the action of consciousness. This argument has a weakness in that we do not understand what it means to be conscious. If we think of consciousness as a computation then this returns to the conjecture that quantum computation, which lacks contextuality, computes contextuality.

The conjecture of virtualism is worth laying on the table of possibilities. It strikes me if it is true to potentially be some sort of Gödel theorem result applied to physics. The formal system QM has that contextuality is not provable. Maybe then in a formal setting contextuality then exist in QM in a self-referential manner. After all, an experimenter and apparatus is a complex system of quantum states which measures quantum states. This might also work if it does not at the same time give rise to local hidden variables, or if it necessitates "large N." At this time this conjecture does not rise to the level of a formal hypothesis.

Unfortunately there are some physics problems with some of the arguments in the papers. The idea that a lepton is an "extreme photon" is clearly wrong. The grid argument is also suspect, where this leads to Lorentz violations which have been ruled out by FERMI and INTEGRAL data. There are other occasions of nonstandard argumentation with physics present as well. It is advised that if the reader is to garner the main thrust of this paper that these specifics be considered appropriately.

[1] B. Whitworth,"Virtual Reality Conjecture".*Prespacetime Journal* **2** (9): 1404-1433 (2011)

[2] A. Einstein, Podolsky, Rosen, N, "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?".*Physical Review* **47** (10): 777-780 (1935)

[3]http://philsci-archive.pitt.edu/8590/1/Heis1935_EPR_Final_translation.pdf

[4] J.A. Wheeler, "Information, physics, quantum: The search for links" in W. Zurek (ed.) *Complexity, Entropy, and the Physics of Information.* Redwood City, CA: Addison-Wesley (1990)

[5] Lloyd, S., *Programming the Universe: A Quantum Computer Scientist Takes On the Cosmos*, Knopf, p 240 (2006).

[6] W.H. Zurek, "Decoherence, einselection, and the quantum origins of the classical," *Reviews of Modern Physics* **75**, 715(2003)