Review of: "Quantum Entities and the Nature of Time"

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The author points out that at the time of the 1927 Solvay conference, where “quantum theory reached its conceptual framework considered definitive” despite the fact the Einstein took issue, and given that this conceptual framework was heavily concerned with the relationship of quantum entities to space, it’s worth noting that very little was known about particle physics, notably, the neutron was yet to be discovered. So it may be worth starting instead from the physics of elementary particles, given the conceptual difficulties the “definitive framework” (the Copenhagen interpretation) ran into. The author proposes to start with the de Broglie phase factor of an elementary particle. It is fascinating to begin to think through the implications of this.

The conceptual difficulties the Copenhagen interpretation ran into primarily concern measurement, a mysterious undefined operation which suspends the laws of physics (the Schrödinger evolution) but gets the right answers. One aspect of this is that the unitary evolution of the wave function is interrupted by a non-unitary collapse of the wave function. The author addresses this by taking time as a complex variable and shows that in that space the state evolution through collapse is unitary.

The problem solved is only a problem for realists. There’s no problem of the collapse of the wave function for an instrumentalist- the author mentions Heisenberg - because the effects of the operation called measurement don’t need to be given physical meaning. Likewise for modern instrumentalism such as qubism where collapse is an updating of belief states.

But if like Einstein we are seeking a realist account then the question arises how to understand complex time, just as it did for Hartle-Hawking’s no-boundary cosmology. In his best-selling book at least Hawking backed out by reverting to instrumentalism. This not to say realists can’t use complex numbers - in fluid dynamics for example we can use complex numbers to represent sinks without doubting the reality of sinks. But what is the physical reality corresponding to complex time? OK, Wick rotation recovers real time. How are we to interpret this? The author says “since all the quantum jumps that the particle undergoes are connections between the time domain tpr, represented by the circumference, and the center O of the circumference itself, then O "sees" this domain as a whole, a sort of eternal present. One can express the same concept in another way by saying that from the perspective of tpr, O is "timeless”.”, and elsewhere uses the term ‘emergence’. This scenario is well known in classical quantum gravity where quantising gravity leads to a timeless description (Wheeler-De Witt equation) and there has been work on how to understand the emergence of time, eg Rovelli utilising an analogy with thermodynamics. The scheme has an even longer history. St Augustine distinguished time from eternity- eternity involves no change, just an eternal present, a present which does not pass. Time, created along with the physical universe, does involve change where each present moment immediately passes. It would seem that what we can't do in each of these cases is to treat the timeless realm as instrumental and the temporal realm as real, if we think the latter should be explained by the former. I believe this question deserves further exploration in the context of the present proposal.

On a lesser note, the author also “specifically examines the question of Einstein's locality, specifying that this important principle of physics remains valid also in the proposed picture; an aspect, this, that greatly concerned Einstein.” I believe this is a fudge, albeit a very common one. Einstein, starting at 1927 Solvay and culminating in the EPR paper, worried that if the wave function was treated as an objective element of reality then for entangled systems we would have a kind of action at a distance where any measurement on a distant part of the system would result in the collapse of the complete state and thereby have an effect locally, ie the collapse occurs here as much as over there. Something objective has changed right here. So, sure, we can define “Einstein locality” as many do as no-signaling - ie in experiments on space separated entangled systems there's no correlation between the settings on one wing and the outcome on the other. But this was not Einstein's worry about locality. Unfortunately for Einstein and for the claim in this paper, it turned out that the experimental proofs of Bell inequality violations demonstrate quantum mechanics is non-local in the sense of Einstein's worry.