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RBW: an Acausal Conspiracy Theory

Abstract:

One can construct a *local* hidden-variable theory of QM if one is willing to claim that systems which presumably have not interacted may nevertheless be correlated. Such correlations appear to require some kind of universal conspiracy behind the observed phenomena, hence Peter Lewis calls such theories "*conspiracy theories."* As he says, "the obvious strategy is the one that gives conspiracy theories their name; it involves postulating a vast, hidden mechanism whereby systems that apparently have no common past may nevertheless have interacted." Independence is the assumption that the hidden variables assigned to the particles are independent of the settings of the measuring devices. If Independence is violated, then a local hidden-variable theory (a conspiracy theory) can in principle account for the Bell correlations. But how *could* Independence be violated? The common cause principle tells us that every systematic correlation between events is due to a cause that they share. As a trivial consequence, systems that have not interacted cannot be systematically correlated, and all appearances indicate that the particles and the measuring devices in EPR-Bell phenomena do not interact before the measurement. Lewis suggests three possibilities for violating Independence:

> Hidden-mechanism theories and backwards-causal theories are both strategies for constructing a local hidden-variable theory by violating Independence. The first of these postulates a mechanism that provides a cause in the past to explain the Bell correlations, and the second postulates a cause in the future. But there is a third strategy that is worth exploring here, namely that the common cause principle is *false*—that some correlations simply require no causal explanation.

Lewis calls the third strategy of denying the common cause principle "acausal conspiracy theories."

We will defend an interpretation of QM, the relational blockworld (RBW) interpretation, a local hidden-variable theory (such as BCQM) whereby the spatiotemporal relations or spacetime symmetries provide the "hidden variables." RBW can be reasonably characterized in this fashion with the spacetime symmetries playing the role of the hidden-variables. However such a characterization is also misleading in that we are not supplementing NRQM in any standard sense, such as modal interpretations *a la* Bohm. We are not claiming that quantum mechanics is incomplete but that the spacetime symmetries provide a deeper explanation than NRQM as standardly and *dynamically* conceived. At least at this level, there is no deeper explanation for individual outcomes of quantum experiments than that provided by the structure of spacetime and the spacetime symmetries underlying each experimental configuration. The measurement problem arises because of the assumption that the dynamics are the deepest part of the explanatory story, the very heart of quantum mechanics, an assumption RBW rejects. RBW provides

a statistical interpretation of QM free of the measurement problem. It also provides a geometric account of entanglement that violates separability but not locality.

Others have suggested that we ought to take the fact of block world (BW) seriously when interpreting quantum mechanics and modeling reality. For example, Huw Price calls it the "Archimedean view from nowhen" and it has motivated him to take seriously the idea of a time-symmetric quantum mechanics and so-called backwards causation in quantum mechanics (BCQM). As he says about his book defending BCQM, "the aim of the book is to explore the consequences of the block universe view in physics and philosophy." Price is attempting to construct a local hidden-variables interpretation of NRQM that explains quantum non-locality with purely time-like dynamics or backwards causation. According to Price, BCQM provides an explanation of the Bell correlations "which shows that they are not really non-local at all, in that they depend on purely *local* interactions between particles and measuring devices concerned. They *seem* non-local only if we overlook the present relevance of future interactions." The key explanatory move that Price makes is to have information travel backwards along the light-cones of the two EPR particles, converging at the source of the entangled state. Presumably, this is the point in spacetime where the entangled state is "prepared." The picture we must think of is this: the future measurement interaction in separate wings of an EPR apparatus is the cause of the (earlier) entangled state, so the "point at which they separate" is the "effect" of a causal chain "originating" with the measurement interaction. This is to put the point directly in terms of ***backwards*** causation. The arrow of causation does not point from one spacelike separated wing of the apparatus to the other, across ***space***, but rather it points backwards in ***time*** to the point at which the particles separated.

Other blockworld motivated accounts of quantum mechanics include those by Cramer (1986), Lewis (2007) and Barrett (2005). The connection between BCQM or time-symmetric accounts of the quantum and the BW is straightforward: in a BW the state preparations and measurement outcomes are equally real, i.e., already "there." Thus, since a dynamic interpretation of the BW picture is superfluous, one might as well claim the measurement outcomes "effect the state preparations" rather than the converse. Of course it may seem trivial to explain the outcomes of quantum experiments (or anything else) using the BW. After all, one could answer ***any*** question in this vein by saying something like "it's all just there in the BW, end of story." In order to avoid trivializing the BW explanation, BW interpretations of NRQM invoke clever devices such as time-like backwards causation, advanced action and the two-vector formalism. Do these beautiful and clever devices really avoid the charge of triviality? Such explanations are no less ***dynamical*** than standard quantum mechanics, which is puzzling given that the original blockworld motivation for such accounts lacks ***absolute*** change and becoming. As far we know, only Cramer speaks to this worry. Cramer notes that the backwards-causal elements of his theory are "only a pedagogical convention," and that in fact "the process is atemporal." Indeed, it seems to us that all such dynamical or causal devices in a BW should be viewed fundamentally as book keeping. BCQM and the like, even having acknowledged the potential explanatory importance of BW, have not gone far enough in

their atemporal, acausal and adynamical thinking. Whereas such accounts are willing to think backwardly, temporally speaking, it is still essentially *dynamical, temporal* thinking.

We rather believe the key to rendering a BW explanation nontrivial is to provide an algorithm for the relevant BW construction. Thus, the answer to "Why did X follow Y and Z?" is not merely, "Because X is already 'there' in the future of Y and Z per the BW," but as we will illustrate, "Because this must be the spatiotemporal relationship of X, Y and Z in the BW per the self-consistent definition of the entities involved in X, Y and Z." If one chooses to read dynamical stories from a BW picture, they may where feasible. However, BW descriptions are not limited to the depiction of dynamical/causal phenomena, so they are not constrained to dynamical/causal storytelling. In the following passage Dainton paints a suggestive picture of what it means to take the BW perspective seriously both ontologically and explanatorily:

> Imagine that I am a God-like being who has decided to design and then create a logically consistent universe with laws of nature similar to those that obtain in our universe…Since the universe will be of the block-variety I will have to create it ***as a whole***: the beginning, middle and end will come into being together…Well, assume that our universe is a static block, even if it never 'came into being', it nonetheless exists (timelessly) as a coherent whole, containing a globally consistent spread of events. At the weakest level, "consistency" here simply means that the laws of logic are obeyed, but in the case of universes like our own, where there are universe-wide laws of nature, the consistency constraint is stronger: everything that happens is in accord with the laws of nature. In saying that the consistency is "global" I mean that the different parts of the universe all have to fit smoothly together, rather like the pieces of a well-made mosaic or jigsaw puzzle.

Does reality contain phenomena which ***strongly suggest*** an acausal BW algorithm? According to RBW, the deepest explanation of EPR-Bell correlations is such an algorithm. NRQM ***a la*** RBW provides an acausal BW algorithm in its prediction of Bell inequality violations. We show that the non-commutativity of NRQM's position and momentum operators is a consequence of the relativity of simultaneity, and as is well known the latter implies a blockworld barring some neo-Lorentzian adornment, re-interpretation or the like. We also shows the density operator of an experimental configuration is obtained from the "past, present and future" of the entire spatiotemporal configuration ***a la*** the spacetime symmetries of the experimental set-up: from the initiation of the experiment to its outcomes (as is clear, for example, in the path-integral formalism).

The blockworld as implied by the spacetime picture does real explanatory and unifying work in RBW. Thus RBW helps to unify the quantum and spacetime formally, conceptually and metaphysically in ways that neither other relational accounts nor BW-motivated accounts have to date. For all these reasons we claim that RBW constitutes a

geometric, acausal and adynamical account of NRQM and spacetime that is fundamental to dynamical explanations. As Dainton says:

> If this strikes us as odd it is because we are unused to thinking of the universe as a vast spatiotemporal mosaic, but if the universe *is* a vast spatiotemporal mosaic, then, given the reality of the future, the future determines the past as much as the past determines the future. The constraints that later events place on earlier ones are not always causal [or dynamical or in any way time-like]. It is more typically a matter of coordination: the future events exist in the same universe as the earlier events, in a coherent, smooth-fitting, law-abiding whole.

Since a trans-temporal object (such as a detector) possesses properties (to include click distributions) according to a spatiotemporally global set of relations, all trans-temporal objects are defined non-separably and relationally in "a vast spatiotemporal mosaic."