An Argument for Blockworld from the Relational Blockworld Interpretation of Non-relativistic Quantum Mechanics

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Abstract

We use a new interpretation of non-relativistic quantum mechanics (QM) to argue for the blockworld ontology. This new interpretation of QM, the *Relational Blockworld* (Stuckey *et al*, 2005a), is founded on two results. Kaiser (1981 & 1990), Bohr & Ulfbeck (1995) and Anandan, (2003) showed independently that the Heisenberg commutation relations $[x_i, p_j] = i\hbar\delta_{ij}$ of QM follow from the relativity of simultaneity per the Poincaré Lie algebra. And, Bohr, Ulfbeck & Mottelson (2004a & 2004b) showed that the density matrix for a particular QM experimental outcome may be obtained from the spacetime symmetry group of the experimental configuration. The Relational Blockworld (RBW) then follows from these results by adopting the blockworld implication of the relativity of simultaneity and inferring the fundamentality of spacetime relations therein. RBW easily resolves all QM paradoxes and suggests an underlying unity between special relativity (SR) and QM. Thus, the explanatory power and unifying potential of RBW, an interpretation of *non-relativisitic* quantum mechanics, provides a new argument for the blockworld interpretation of the relativity of simultaneity.

Since a blockworld (BW) is a spacetime in which the future, past and present are equally 'real' – there is no uniquely "evolving universe" or "unfolding now" – every event that will happen or has happened just 'is' in a BW. Thus, when couched in a RBW, the wave function *qua* state-space representation of QM is understood as primarily a calculational device. The relational spacetime symmetries of an experimental arrangement (that give rise to quantum statistics) are the deeper ontological story of QM according to RBW. Therefore, per RBW, the measurement problem is merely an artifact of the state-space formalism and its solution is a principled instrumentalism based on a "principle" as opposed to "constructive" account of QM.

Quantum non-locality and non-separability are likewise demystified in a straightforward fashion since RBW assumes spatiotemporal relations are fundamental in a BW. Correlations between space-like separated events that violate Bell's inequalities are of no concern as long as spatiotemporal relations in the experimental apparatus warrant the correlations. There is no need to satisfy either past or future versions of the common cause principle, since non-local correlations are not about "particles" impinging on measuring devices. Rather, the non-local correlations derive from the spatiotemporal relations in the construct of the experiment. There are no influences, causal mechanisms, etc., because non-locality is a relational property that is precisely described by the spacetime symmetries of any given experimental arrangement. Nothing 'happens' in a relational blockworld, so there is nothing for such inherently dynamical processes and entities to do. In short, RBW is a purely geometric/spacetime interpretation of non-relativistic quantum mechanics.

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It is well known that while relativistic quantum field theory unifies QM and SR in the sense of producing a relativistically invariant and covariant QM formalism, this unity leaves open all the interpretational questions of QM and does not resolve the inherent conflict between some interpretations of QM (such as standard hidden variable theories and collapse theories) and the relativity of simultaneity. That is, the aforementioned interpretations for example require some variety of a preferred frame. The RBW interpretation of QM has no conflict with SR or the relativity of simultaneity. In addition, while acknowledging that one can advert to causal and dynamical explanations in a BW, some hold that there is a deeper metaphysical tension between a "static" BW and a truly dynamical world with its "pushy" dynamical laws, which "govern" or "rule" their relevant phenomena, and its causal laws, which involves real production, influence or the creation of totally new effects. Some argue that only a "growing BW" or a world instantiating some form of presentism can explain experience or provide the "direction of causation" that grounds the success of causal and dynamical explanations or laws (Tooley, 1997). Elitzur and Dolev (2005a) for example are so vexed by a BW in which the future is real that they "seek to integrate the four-dimensional spacetime of relativity with the somewhat opposite hints provided by QM that genuine change, not static geometry, is the most basic property of reality" (p. 344). We do not claim that such arguments for a deep metaphysical incompatibility are good ones, only that they exist and motivate various interpretational moves in both QM and SR. For example, Elitzur and Dolev go so far as to postulate a "spacetime dynamics theory" in which a growing block is embedded in some kind of super-space in which unitary Schrödinger evolution is the dynamics governing growth of the block in the future direction and (somehow) the collapse of which yields at every moment a "new segment of spacetime" (2005b, p. 603). They even claim that certain experimental set-ups such as the quantum liar experiment (QLE) "entail inconsistent histories" that "undermine the notion of a fixed spacetime within which all events maintain simple causal relations. Rather, it seems that quantum measurement can sometimes 'rewrite' a process's history" (2005b, p. 593). On the contrary, RBW provides an interpretation of QM that explains QLE quite naturally in a BW setting (Stuckey *et al*, 2005b).

RBW provides an interpretation of QM that reconciles both the BW perspective and the dynamical perspective in general but shows that the former is the deeper ontological and explanatory point of view. The history of QM is littered with comparatively radical or reactionary attempts to explain various features of QM such as EPR-Bell correlations. For example, some accounts of QM give up the (past) common cause principle and invoke some kind of backwards-causal theory to explain QM phenomena (Price, 1996). Others argue that EPR-Bell correlations require no (causal) explanation whatsoever (Fine, 1989). RBW also rejects the (past) common cause principle and it rejects the need to explain EPR-Bell correlations causally. RBW therefore, contra backwards-causal or dynamical theories, even rejects the future common cause principle. However RBW does provide a unique explanation for EPR-Bell correlations in terms of fundamental spacetime symmetries. This explanation is best viewed as a "principle" theory in the Einsteinian sense. RBW invokes acausal global determination relations as given by the spacetime symmetries in a blockworld to explain the EPR-Bell correlations.

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