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Quantum non-contextuality as a generalization of quantum theory

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Abstract: Quantum theory allows sets of probabilities between spacelike separated parties that cannot be recovered from a local (realistic) theory as it is shown by violations of Bell's inequalities. The violation of Bell's inequalities is equivalent with proving that there does not exist a joint probability distribution for all the different (unrealised) alternatives. The non-existence of a joint probability distribution implies that the outcomes are contextual. Inspired by path integral formulations of quantum theory, we define a generalisation of the non-contextuality condition that includes all correlations that quantum theory predicts. The condition is the existence of a joint strongly positive quantum measure. This leads to the Q^{1+AB} condition of the NPA hierarchy. Interestingly, the set of probabilities allowed by this condition are more than those allowed by quantum theory, coincide with the "almost quantum correlations" conjectured as the set of real correlations by Navascues et al (2014) and satisfies all the known information theoretic physical principles that have been proposed (such as Non-trivial communication complexity, Local Orthogonality, etc). Therefore, this extension of quantum theory appears natural both from histories perspective and from quantum information perspective.

- F. Dowker, J. Henson and P. Wallden, New J. Phys. (in press) arxiv:1311.6287.

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