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Scientific abstract – Steps to a natural interpretation of quantum mechanics

Quantum mechanics has several plausible interpretations, but no single agreed interpretation. Our **main aim** is to lead the way to an interpretation of quantum mechanics so natural as to achieve consensus. Inspired by the work of Y. Aharonov, our **specific aims** towards such an interpretation are to apply and extend novel types of measurements (including "weak" and "protective" measurements) that yield a more complete account, both theoretically and experimentally, of what is measurable in quantum mechanics; we will apply a causal-retrocausal formulation of quantum mechanics to avoid preconceptions that lead to paradoxes; and we will continue the attempt to derive quantum mechanics, or part of it, from a new set of axioms with clear physical content. The **significance** of these aims is progress towards an interpretation of quantum mechanics that has eluded physicists and philosophers for more than a century – a new paradigm for understanding quantum mechanics. Our **work plan** consists of four projects. The first project applies "weak" values, "modular" variables and direct measurement of the quantum wave function as theoretical tools to exhibit the measurable content of quantum mechanics, including new quantum effects. The second project is the design of experiments allowing weak values to emerge in the laboratory and shape our intuitions of the quantum world. The third project is to integrate two convergent analyses of retrocausality in microphysics, one from physics and one from philosophy, so as to place quantum mechanics in a broader context of theories. The fourth project is to find alternative axioms, with clear physical meaning, for deriving all or part of quantum mechanics. These four projects are closely related. In all but the third project, we have **preliminary results,** including a breakthrough: we have shown that all stronger-than-quantum correlations violate relativistic causality in the classical limit. Possible **pitfalls**: we may not achieve all our aims. But the response to our initial attempt at deriving quantum correlations (according to the Web of Science, over 200 publications cite the "Popescu-Rohrlich" or "PR" box), and to experiments yielding weak values, shows how potent these ideas are and how ready the physics community is for a paradigm change.