

Abstract Submitted  
for the MAR16 Meeting of  
The American Physical Society

**Axioms for quantum mechanics: relativistic causality, retro-causality, and the existence of a classical limit**<sup>1</sup> DANIEL ROHRLICH<sup>2</sup>, Physics Department, Ben-Gurion University of the Negev, Beersheba 8410501 — Y. Aharonov and A. Shimony both conjectured that two axioms – relativistic causality (“no superluminal signalling”) and nonlocality – so nearly contradict each other that only quantum mechanics reconciles them. Can we indeed derive quantum mechanics, at least in part, from these two axioms? No: “PR-box” correlations show that quantum correlations are not the most nonlocal correlations consistent with relativistic causality. Here we replace “nonlocality” with “retrocausality” and supplement the axioms of relativistic causality and retrocausality with a natural and minimal third axiom: the existence of a classical limit, in which macroscopic observables commute. That is, just as quantum mechanics has a classical limit, so must any generalization of quantum mechanics. In this limit, PR-box correlations *violate* relativistic causality. Generalized to all stronger-than-quantum bipartite correlations, this result is a derivation of Tsirelson’s bound (a theorem of quantum mechanics) from the three axioms of relativistic causality, retrocausality and the existence of a classical limit. Although the derivation does not assume quantum mechanics, it points to the Hilbert space structure that underlies quantum correlations.

<sup>1</sup>I thank the John Templeton Foundation (Project ID 43297) and the Israel Science Foundation (grant no. 1190/13) for support.

<sup>2</sup>Keywords: nonlocal correlations, quantum nonlocality, retrocausality, PR boxes, axioms for quantum mechanics, classical limit

Daniel Rohrlich  
Physics Department, Ben-Gurion University of the Negev, Beersheba 8410501

Date submitted: 29 Sep 2015

Electronic form version 1.4