Proposal for an interference experiment to test the applicability of quantum theory to event-based processes

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We propose a realizable single-particle Mach-Zehnder interferometer experiment in which the path length of one arm can change before each passage of a particle through the interferometer. We demonstrate that the analysis of the time-series produced by this experiment can be used to determine to which extent quantum theory provides a description of the observed detection events that goes beyond statistical averages. This is important because quantum theory postulates that it is fundamentally impossible to give an explanation that goes beyond the description in terms of frequency distributions to observe events. Although in practice, it may be impossible to give such an explanation, the present state of knowledge does not support the premise that it impossible in principle. Moreover, as there exist event-based, locally causal corpuscular models that reproduce the statistical results of quantum theory for this experiment if the path lengths are fixed during experiment (the simplest one being given in Ref.[1]), this premise is untenable. We also show that the proposed experiment may be used to refute whole classes of event-based, locally causal corpuscular models for optical phenomena.

* Based on work done in collaboration with M. Richter, Th. Lippert, B. Barbara, S. Miyashita and H. De Raedt.