Weak Measurements: Wigner-Moyal and Bohm in a New Light?

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Abstract

I will discuss the recent experiments of Kocsis *et al.* [1] claiming to measure 'photon trajectories' using the notion of a 'weak' measurement [2]. This type of measurement enables us to obtain 'weak values' from which the trajectories are constructed. In the case of the momentum operator the weak value turns out to be the Bohm momentum, while the energy gives the Bohm energy for the Schrödinger particle. I will show how the same results are obtained using the Wigner-Moyal approach. I will also show how the recent results extending the Bohm approach to the Pauli and Dirac particles using Clifford algebras [3] can be combined with the Moyal algebra give weak values involving spin [4]. Finally I will briefly indicate how all of this finds a natural setting in a non-commutative geometry.

Further reading

[1] S. Kocsis, B. Braverman, S. Ravets, M.J. Stevens, R.P. Mirin, L.K. Shalm and A.M. Steinberg, *Observing the average trajectories of single photons in a two-slit interferometer*, Science, **332**, 1170-73 (2011).
[2] Y. Aharonov, and L. Vaidman, *Properties of a quantum system during the time interval between measurements*, Phys. Rev. A, **41**, 11-20 (1990).
[3] B.J. Hiley and R.E. Callaghan, *Clifford Algebras and the Dirac-Bohm Quantum Hamilton-Jacobi Equation*, Foundations of Physics, **42**, 192-208 (2012).
[4] B.J. Hiley, *Weak Values: Approach through the Clifford and Moyal Algebras*, `arXiv/1111.6536`.