Double-slit experiment remastered

Siddhant Das*
Mathematisches Institut, Ludwig-Maximilians-Universität München, Theresienstr. 39, D-80333 München, Germany
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In [1], Peter Holland remarks that the de Broglie-Bohm (dBB) particle trajectories for the double-slit experiment—which feature invariably in expositions of the dBB pilot-wave theory—*"remain among the most striking illustrations so far of the insight provided by this theory into quantum phenomena."*

My presentation aims to argue that these trajectories serve not only to anchor one's intuition but also to provide theoretical resources for understanding/interpreting arrival-time or Time-of-Flight (ToF) experiments—one of the last areas where experts disagree about what quantum mechanics should predict. While a cornucopia of different ToF distributions exists in the literature, so far none of the suggestions have been benchmarked against experiment. To my knowledge, [2] is the first comparison of this sort.

This work presents numerical evidence showing that the statistics of impact positions *and* arrival times of He atoms in a double-slit experiment (reported in [3]) can be reproduced by a straightforward, pragmatic application of the dBB theory. I will outline the findings of [2] in my presentation. That the dBB theory offers a distinct conceptual advantage with regards to ToF measurements owing to the well-defined concepts of point particles and trajectories embedded in this theory, has long been recognized.

Time permitting, I would like to close by describing the spin-dependent dBBian arrival-time distributions predicted in [4, 5]. (Here, the set-up consists of spin-polarized electrons accelerating down a cylindrical waveguide and arriving at a distance L downstream.) These unexpected and very well-articulated arrival-time distributions appear as a direct consequence of a rare wave phenomenon called "quantum backflow" (loosely understood as the flow of probability current against the direction of propagation), which is an area of considerable recent activity. However, as it happens, *steady* backflow is extremely difficult to induce, therefore most examples display this effect for fleeting moments of time and preclude experimental inspection FAPP. In view of this, the *stable-in-time*, even *controllable* backflow observable in this waveguide set-up is one-of-its-kind and experimentally very promising. The observed backflow—consequently, the spin-dependent ToF statistics—manifests even in relativistic regimes, regardless of the initial wave function [6]. In the foreseeable future, the suggested experiment would be well-amenable to the single-electron-in-microwave-Paul-trap technology currently being developed by a few research groups [7, 8].

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* Siddhant.Das@physik.uni-muenchen.de