Critical Question Seminar 7
Quantum World
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Why can't the "empty" reflected wave from a single slit serve as a better empirical test for Pilot Wave Theory?

According to Antony Valentini, Standard QM can be falsified with respect to the Pilot-wave formulation if we find cases of quantum non-equilibrium in the early universe (Matarese, 2023).

In a single-slit experiment, standard quantum mechanics and the de Broglie–Bohm pilot wave theory utilize the exact same time-dependent Schrödinger equation, which dictates that an incoming wave function splits into a transmitted component passing through the slit and a reflected component bouncing off the barrier (Figure 1). Once a particle is confirmed to have passed through the slit, standard quantum mechanics posits "collapse", discarding the reflected component as an unrealized probability amplitude.

By contrast, Bohmian mechanics treats the wave function as an ontologically real physical field whose phase determines the velocity of the particle. The wave only "effectively" collapses as the particle's position is determined to within the width of the slit. The reflected wave packet continues to propagate backward through space as a physical, "empty wave packet".

If this empty reflected packet is a real physical entity, it should be possible to use a system of mirrors to redirect it, looping it back around the apparatus to intersect with the transmitted particle downstream. This re-interference would alter the particle's trajectory.

Why is this route to falsifiability not pursued as vigorously as the search for quantum non-equilibrium? More specifically, if empty waves are physically real, why does manipulating and recombining them fail to generate empirical predictions that differ from those of standard quantum mechanics?

241 words

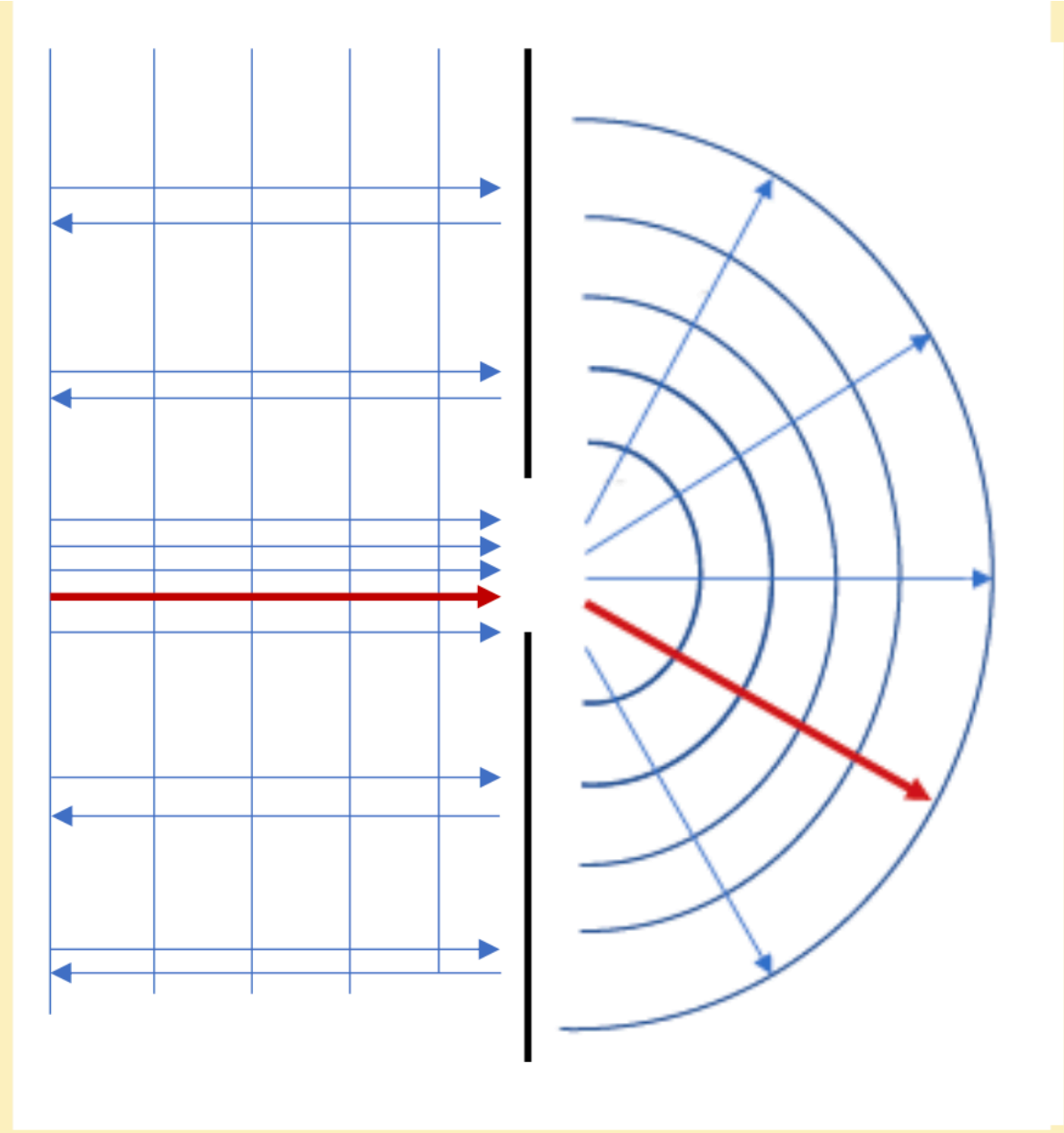

Figure 1: Lifted from Bacciagaluppi's slides. Surely using the empty, reflected wave to produce some more interference is an easy way to test the pilot wave theory?

Bibliography

Matarese, V. (2023). De Broglie-Bohm Theory, Quo Vadis?. *Foundations of Physics*, *53*(1), 18. https://doi.org/10.1007/s10701-022-00647-w