

Thesis Proposal for the Master's Degree in Physics

Title: Emergent Quantum Dynamics from Pilot-Wave Systems

Abstract: Since its inception, quantum mechanics has given rise to multiple interpretations of its physical meaning, with several foundational issues still open. Pilot-wave formulations, originating from the pioneering works of Louis de Broglie (1923–1927) and David Bohm (1952), offer a deterministic framework in which both particle and guiding wave coexist. In the last two decades, macroscopic pilot-wave experiments — where a particle is coupled to its self-generated wave field — have demonstrated that quantum-like statistical behavior can arise from complex nonlinear dynamics ([Bush & Oza, Rep. Prog. Phys., 84: 017001, 2020](#)). These findings have renewed interest in developing modern theoretical models capable of reproducing quantum phenomena as emergent properties of underlying pilot-wave dynamics. This thesis investigates to what extent quantum mechanics can be interpreted as an emergent theory rooted in such complex dynamics. The project can be approached from different perspectives depending on the student's interests: theoretical physics, mathematical physics, computational modeling, or foundational aspects of quantum theory.

Supervisor(s): Dr. Giuseppe Pucci and one or two Unical Professors selected from the following list, depending on the specific focus of the thesis: Prof. Giuseppe Ali, Prof. Marco Rossi, Prof. Nicola Lo Gullo, Prof. Alessandro Papa and Prof. Roberto Beneduci. Possible foreign co-supervisors include Prof. Pedro J. Sáenz (University of North Carolina at Chapel Hill, USA) and Prof. Anand U. Oza (New Jersey Institute of Technology, USA).

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Laboratory where the thesis is carried out: Laboratory for Emergent Phenomena (LEPH).

Any participating external structures: National Research Council of Italy (CNR).

Type of thesis: Theoretical and fundamental research.

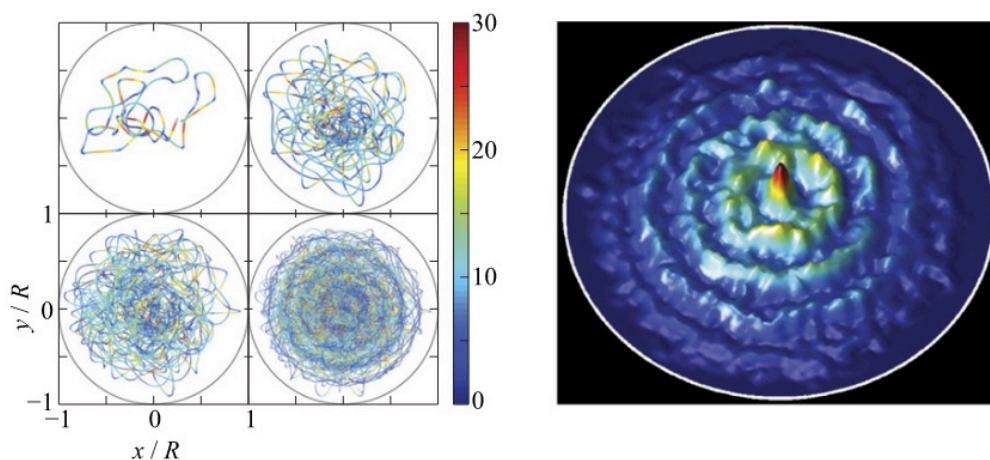


Figure. Emergent wave-like statistics arising from complex pilot-wave particle trajectories (D. M. Harris et al. Phys. Rev. E 88:011001, 2013).

<https://youtu.be/nmC0ygr08tE?si=G3lRmys8SxnPCS88>