UNIVERSITY OF MARYLAND

THE BURGERS PROGRAM FOR FLUID DYNAMICS
THE FLUID DYNAMICS REVIEWS SEMINAR SERIES

HYDRODYNAMIC QUANTUM ANALOGS

Friday, October 22, 2021 | 11am

DeWalt Seminar Room
2164 Glenn L. Martin Hall

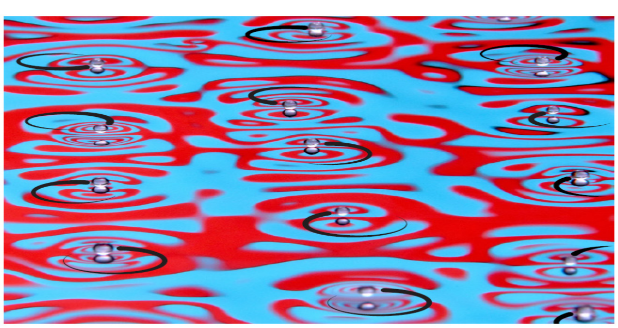
Speaker

DR. PEDRO J. SÁENZ

Assistant Professor
Department of Mathematics
University of North Carolina at Chapel Hill

ABSTRACT

Millimetric liquid droplets can walk across the surface of a vibrating fluid bath, self-propelled through a resonant interaction with their own guiding wave fields. By virtue of the coupling with their wave fields, these walking droplets, or `walkers', extend the range of classical mechanics to include certain features previously thought to be exclusive to the microscopic, quantum realm. In this talk, we will introduce a series of new Hydrodynamic Quantum Analogs involving walkers interacting with submerged topographical features at the bottom of the fluid bath. Special attention will be given to discussing Hydrodynamic Spin Lattices (HSLs), a new analog system that allow us to investigate wave-mediated interactions of effective spin degrees of freedom in inertial and rotating frames. A walker may be trapped by a submerged circular well, leading to clockwise or counterclockwise angular motion centered on the well. When a collection of such wells is arranged in a 1D or 2D lattice geometry, a thin fluid layer between wells enables wave-mediated interactions between neighboring droplets. Through experiments and mathematical modeling, we demonstrate the spontaneous emergence of coherent walker rotation dynamics for different types of lattices. For sufficiently strong pair-coupling, wave interactions between neighboring droplets may induce local spin flips leading to ferromagnetic or antiferromagnetic order. Transitions between these two forms of magnetic order can be induced through variations in non-equilibrium driving, lattice geometry and Coriolis forces mimicking an external magnetic field. Theoretical predictions based on a generalized Kuramoto model derived from first principles rationalize our experimental observations, thus establishing HSLs as a generic paradigm for active phase oscillator dynamics.



BIO

Pedro is an Assistant Professor and the director of the Physical Mathematics Laboratory (www.pml.unc.edu) in the Department of Mathematics at UNC. From 2015 to 2019, he was an Instructor in Applied Mathematics at MIT. Pedro received his Ph.D. from the University of Edinburgh in 2014, and was a post-doctoral fellow at UMD and Imperial College London in 2015. His research blends experiments, numerical simulations and theory to address fundamental problems that find motivation in physics and engineering.

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