Habin Yim, Ph.D.

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RESEARCH & COLLABORATION PROFILE

KEY WORDS: Mathematical Fluid Dynamics, Vortex Dynamics, Flows on Curved Surfaces, Exact Solutions, Hamiltonian Systems

Research Snapshot. Habin Yim studies fluid flows and vortex dynamics on planar and curved surfaces through analytical methods and numerical computation. His work includes Stuart vortex solutions on surfaces of constant negative curvature, exact solutions of fluid equations on a sphere, and the dynamics of three geostrophic vortices in planar and spherical settings. These studies examine how surface geometry and vortex interactions shape equilibria, self-similar motion, collapse, and phase-space structure. He is currently developing physics-informed neural networks (PINNs) that incorporate conservation laws in vortex dynamics.

RESEARCH EXPERTISE

• **Fluid flows and vortices on curved surfaces**: Study of fluid flows and vortex structures on spheres and surfaces of constant negative curvature, with comparisons to planar flows.
• **Exact solutions of fluid equations**: Analysis of Stuart vortex solutions and exact solutions of the Euler and Navier–Stokes equations on a sphere, including the conditions that determine these solutions and their flow structures.
• **Geostrophic vortex dynamics**: Analysis of three-vortex interactions, self-similar motion, equilibria, and collapse in planar Bessel vortex models and spherical geostrophic vortex models.
• **Hamiltonian and phase-space analysis**: Use of governing equations, conserved quantities, trilinear coordinates, and numerical trajectory calculations to explain vortex motion.

RECENT RESEARCH HIGHLIGHTS

• **Geostrophic vortex dynamics on a sphere** — Physics of Fluids, 2025: Formulated the governing equations and Hamiltonian structure, analyzed equilibria and relative equilibria of three vortices, and demonstrated non-self-similar collapse. Combined phase-space analysis with numerical computation to examine a range of vortex motions.
• **Exact solutions of fluid equations on a sphere** — Bulletin of the Korean Mathematical Society, 2025: Studied exact solutions of the Navier–Stokes and Euler equations on a sphere. Under the assumption of a vanishing convection term, established that two oppositely rotating point vortices at the poles give the unique common solution.

POTENTIAL COLLABORATION RESEARCH

Best-fit collaborator areas: Mathematical fluid dynamics | Geophysical fluid dynamics | PDEs on curved surfaces | Nonlinear dynamics and numerical analysis
• **1. Fluid flows on curved surfaces**: Joint analysis of fluid-equation solutions and vortex structures on spheres and surfaces of negative curvature.
• **2. Geostrophic vortex models**: Study of vortex interactions in planar and spherical settings, with comparisons of motion across models and parameter regimes.
• **3. Equilibria and vortex collapse**: Analytical and numerical investigation of equilibria, relative equilibria, and collapse conditions in systems of interacting vortices.
• **4. Theory and numerical computation**: Validation of numerical trajectories using exact solutions, conserved quantities, and phase-space analysis, with an assessment of the accuracy and applicability of computational methods.

SELECTED RECENT PUBLICATIONS

• Sun-Chul Kim and Habin Yim, “Exact solutions of fluid equations on a sphere,” Bulletin of the Korean Mathematical Society 62(6), 1817–1822 (2025).
• Habin Yim, Sun-Chul Kim, and Sung-Ik Sohn, “Motion of three geostrophic vortices on a sphere,” Physics of Fluids 37, 086616 (2025).
• Habin Yim, Sun-Chul Kim, and Sung-Ik Sohn, “Motion of three geostrophic Bessel vortices,” Physica D: Nonlinear Phenomena 441, 133509 (2022).
• Jongbin Yoon, Habin Yim, and Sun-Chul Kim, “Stuart vortices on a hyperbolic sphere,” Journal of Mathematical Physics 61, 023103 (2020).

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REPRESENTATIVE RESEARCH FIGURES / SCHEMES

