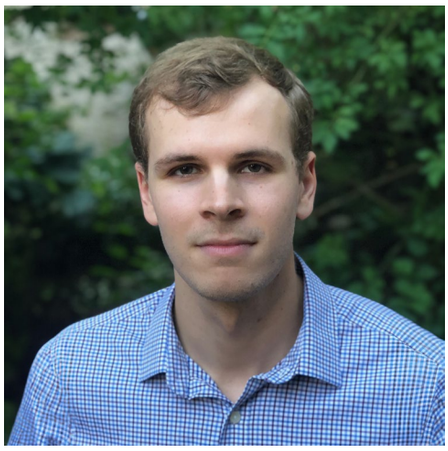
PHYSICAL MATH SEMINAR

Turbulent mixing in stratified flows



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ABSTRACT:

Understanding how turbulence enhances the irreversible mixing of scalars in density-stratified fluids is a central problem in industrial and geophysical fluid dynamics. For instance, accurately parametrizing turbulent heat transport within the ocean is a leading area of uncertainty in climate modelling. We here present a series of data-driven approaches for quantifying the spatiotemporal distribution of mixing hotspots and structures in turbulence datasets.

First, we describe an unsupervised clustering technique for analyzing oceanographic data, highlighting that traditional analyses may significantly underestimate mixing generated by rare, extreme events. We then consider mixing in complementary direct numerical simulations, revealing the importance of stable anisotropic density interfaces embedded within the flow. Finally, we introduce a dimensionality-reduction algorithm for classifying experimental videos of stratified flow instabilities, leading to a cluster-based network model quantifying turbulent transition pathways.

Collectively, our findings highlight that extreme mixing events have the potential to dominate bulk mixing statistics. Current parametrizations of turbulent heat transport may thus be skewed by undersampled measurements, resulting in a focus on the most common, but not necessarily the most significant, events.

TUESDAY, APRIL 29, 2025

2:30 PM – 3:30 PM

Building 2, Room 449

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