

Personal Statement

of Dante Buhl (Applied Math PhD applicant for Fall—2024)

Growing up in the Greater Sacramento Area and coming from a low-income family, I had never thought that I would want to become an academic, or at least get a PhD one day. And yet, here I am at 22 years of age with a drive to learn more and make new insights in the field of fluid dynamics. I went to the University of California Santa Cruz as a first-gen student for my undergrad in Mathematics and graduated in 3 short years with a GPA of 3.74 and highest honors in the major. Before my departure, I found a department that was doing a really interesting fusion of mathematics and computer science. This was, of course, the Applied Mathematics Department (later referenced as A.M. Department), which happened to have an amazing 4+1 master's program. This is my current academic position as I am writing this: a graduate student in UC Santa Cruz's A.M. Department.

My undergraduate experience, although overall very strong, had a rough start. This was primarily a result of the online medium of education in my freshman year, at the height of the pandemic. Since most of my assignments and lectures could be done at my leisure, I began working upwards of 55 hours per week in order to support my family. I eventually failed a course due to this practice, and had to re-evaluate my study style. Besides this, some high notes of my undergraduate career were research projects I did in my last year of undergrad. The first project was an investigation of the Lorenz Ski-Slope system published in Lorenz's book, *The Essence of Chaos*. Our work involved reproducing poincare maps, phase portraits, and even visualizations of the four-dimensional chaotic attractor found in the book. The second was for the Mathematics Department's Directed Reading Program in the Winter Quarter of 2023. This research was focused on numerical methods for computing the lyapunov dimension of three dimensional chaotic attractors, and utilized the Gram-Schmidt Ortho-normalization Process and variational methods for dynamical systems. These experiences ultimately introduced me to the complex world of numerical methods for differential equations and linear algebra which would become the focus of my master's degree.

Towards the end of my undergraduate career, I took two graduate level fluid dynamics courses. One was an introductory course taught by Nicholas Brummell from the A.M. Department, and the other by Chris Edwards from the Ocean Sciences department and focused on Geophysical Fluid Dynamics. These courses cemented my interest in the general subject of fluid dynamics while also preparing me for work in the field of study.

Upon graduating from UC Santa Cruz in June 2023, I participated in a summer REU program at Towson University in Maryland. The principal investigator for this research was Herve Nganguia, a fluid dynamicist who specializes in math-bio related problems. Our work was focused on using Deep-Learning to find a numerical model which complemented prior analytical work published in a paper by Nganguia concerning the propulsion efficiency of ciliated spherical "squirmers" in Stokes Flow. This program was also focused on preparing participants in research-focused mathematical work and featured several presentation opportunities. The most notable presentation on this work is scheduled to be at the Joint Mathematics Meeting in San Francisco

this coming January 2024. The REU ended at the beginning of August, and I soon after started a new research project in Santa Cruz.

Currently, I am in my first quarter of graduate studies and plan to complete a master's thesis on the effect of rotation on stratified turbulence in stellar fluids under the guidance of Pascale Garaud, a well-published researcher in astrophysical and geophysical fluid dynamics. This research involves both Direct Numerical Simulations (abbreviated DNS) and analytical work that will append to Garaud's prior findings on stratified turbulence. Some details of this work includes multi-scale analysis of the governing equations and investigation of the regimes that originate from relevant non-dimensional numbers. Features of the DNS design, in this project include stochastic forcing methods with Gaussian Processes, Spectral Integration Methods, and triply-periodic domains. In addition to my thesis, I plan to take another course in fluid dynamics titled, "Waves, Instabilities, and Turbulence", in order to prepare for a PhD on the subject. I will also be working as a Teaching Assistant in order to fund my degree, gain teaching experience, and support lower division mathematics courses within the department. The expected time of completion for the degree is the spring or summer of 2024.

Moving into the future, I could see myself fitting in very well at Stanford. I very much want to remain in California, the state I grew up in and Stanford is not very far from where I live now in Santa Cruz. It is also well known that Stanford has one of the largest collections of Fluid Dynamicists in the world, and thus there are many faculty members that I would be happy to work with. Specifically within the Institute for Computational and Mathematical Engineering, there are two affiliated professors that seem to have highly attractive programs. First is Catherine Gorlé, who has focused a lot of work on multi-scale CFD methods and predictive modeling in conjunction with the Wind Engineering Lab at Stanford. Some of the group's recent publications on developing ventilation flow models with variable boundary conditions are just one example of the kind of work that might revolutionize infrastructure design and urban planning that I would want to be a part of. Another interesting faculty member is Ali Mani of the Mani Group. That particular group seems very stimulating due to the focus of solving fluids problems that involve chaos and/or turbulence.

Ultimately, I'm a proud and hard-working student who has, within the last year, developed a passion for working with Navier-Stokes and Fluid Dynamics. My recent academic experiences have culminated into a well rounded foundation for PhD research and I look forward to navigating opportunities in the future.