Personal Statement

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

My name is Dante Buhl, and my choice in applying for a PhD is a decision I'm making due to a long line of work and personal history, none of which has been relatively easy. Some of the many factors originate from my upbringing and family culture, while others are indicental to my experiences in college and the skills I've developed in my two degrees at UC Santa Cruz. They have culminated in my decision to keep learning and develop my knowledge further.

I grew up on the edge of the Greater Sacramento Area in a town called El Dorado Hills, where its always a little hotter and drier than you would like, and there isn't all that much to do. As a result, I was always sort of bored; school never quite needed my full attention to pass, and I was without many hobbies. My parents weren't very wealthy either, and divorced soon after we lost our house in the Recession. Since then my mother has had to work 2 full-time jobs to provide for the family, and I've always followed that model been a very driven and busy person. Working throughly for hours on a specific thing is something I've never had a problem with and lead me to love math in my own way. Given a fixed period of time, I could obsess over a new set of mathematical ideas. Every time a new subject was taught, if it wasn't terribly proof-heavy, I would consume it rather rapidly. Moreover, I never found it sufficient to just learn a formula or concept, I had to also know why it worked. When I learned about the Quadratic Formula, I had to try proving it myself, my teacher guided me through the proof after class per my inquiry. And once I found calculus, it seemed a limitless world had been opened to me and I decided I wanted to study Mathematics in college at UC Santa Cruz.

By the middle of my undergrad in Mathematics at UCSC, I found myself somewhat without purpose. I had been studying math so long, just because I found it pleasant to study math, that I sort of forgot what I wanted to do with my life. I also realized that knowing how to compute some integrals wasn't what made you the coolest mathematician ever. I wanted something to specialize in, and something to be the best at. I remember looking at courses offered that would satisfy my major requirements and feeling so bored; why was this upper-division course just called "Algebra"? It was then I realized that Mathematics was a subject so tedious and convuluted that it had lost touch with the real world.

That same day, I saw the course offering "Introduction to Fluid Dynamics" from the Applied Math department, and I became wonderfully curious. Curious enough such that I realized I wanted to make a change. I took a Dynamical Systems class in Fall 2022 from the Applied Math department as it satisfied a requirement in my current major, and I fell in love with the concept. Proofs and specificity were still part of the subject, but the air of the subject was different. There was a freedom in that course which was never really present in any of the math classes I took. Moreover, the professor for that very course happened to be a part of the Fluids group. Very suddenly, my prior wonder become something tangible, it became conversations. Before that quarter ended, those conversations turned into an application, and I applied to the department's masters program and enrolled in the graduate level dynamical systems course.

Now, a year later, I'm in the first year of my accelerated masters program working on a masters thesis on Stratified Turbulence in Stellar Flows with Pascale Garaud. I have already taken 2 graduate level Fluid Dynamics courses at UCSC, and spent a summer in Towson's REU program with Herve Nganguia studying numerical models of propulsion in fluids at micro scales using machine learning. It is sort of amazing how fast your life can change when you find something that really sparks your interest like that. And yet, I feel I'm still missing something. This year will end before I know it and I've only just started my exploration into Fluid Dynamics and Applied Math. There are simply more classes I want to take, more professors that I want to meet, and potentially more subjects to find and become enamored with. For this reason, I want to continue my education with a PhD in fluid dynamics.

Personal experience with these subjects have been developed in my work with Pascale Garaud in our exploration of Stably Stratified Turbulence generated with rotation and stochastic forcing in Stellar Fluids. This work is focused on using a HPC fortran script, called PADDI, which has been utilized on several supercomputers, and by Pascale and myself, most recently on San Diego's Supercomputer Cluster named Expanse. PADDI is a code which relies on a spectral decomposition of Navier-Stokes terms and proceeds to perform discretized integration using several popular numerical methods techniques.

My work has been focused on developing a stochastic forcing process compatible with the PADDI's discretization structure, and which relies on Gaussian Random Processes.

My other research experience over the summer of 2023 with Herve Nganguia and the rest of our research group (consisting of Garrett Hauser, Kristin Lloyd, Jazmin Sharp, and Samuel Armstrong), was focused on using a deep-learning python toolbox, DeepXDE, in order to attempt to reproduce an analytical result found in one of Nganguia's papers. This project was specifically dependent on GPU accelerated deep-learning using a Physics Informed Neural Network, PINN for short. Our experimentation relied on the attunement and experimentation with the "hyperparameters" of the neural network, and methods of boundary condition defintion in order to optimize the performance of the network. The specific PDE we used was the Navier-Stokes equations in spherical and spheroidal coordinate systems with the inclusion of the Boussinesque Approximation in a low Reynolds Number environment. Due to the scaling arguments of the problem, we were able to use the continuity equation to reduce Navier-Stokes equations even further by simplifying the diffusivity term expansion.

Besides my direct research experience in the field of fluid dynamics, I've completed several courses which would supplement my investigation into the field greatly. Those being "Intro Fluid Dynamics" and "Geophysical Fluid Dynamics", and I plan to take "Waves, Instabilities, and Turbuluence in Fluids" this Winter. My masters program at UC Santa Cruz in Scientific Computing and Applied Mathematics, SciCAM for short, also has a curriculum which is focused on numerical methods for linear algebra, differential equations, and high performance computing. All of which are very focused in further developing my ability to become a scientific researcher in the world of Direct Numerical Simulations and Fluid Dynamics.

Going into the future, I want to continue this line of work in the realm of DNS in order to study fluid dynamics as it is the perfect fusion of mathematics and computing in an interesting and seemingly endless field. The prospect of a physical lab to conduct fluids experiments is also highly alluring as I've seen smaller practical demonstrations which were highly motivating. Ultimately, the pursuit of knowledge in this field is all I desire and am prepared to dedicate several years of my life to. With my current and planned future experience, I will be a strong PhD applicant with a good foundation of previous research and expertise to start a long-term project.