Statement of Purpose

MIT Department of Physics · PhD Program · Fall 2024

Introduction

I am an aerospace engineer and scientific software developer who is passionate about computational dynamics. I have been fortunate to have had the opportunity to exercise this background to expand human space exploration at NASA. Now, I aspire to grow as a computational physicist, and expand astrophysical discovery through research.

As I continue to learn about open topics in astrophysics research, I am particularly drawn to research areas relating to galactic dynamics, large scale structure formation, and gravitational wave dynamics. I hope to be considered for graduate advisement by **Dr. Vogelsberger**, **Dr. Necib**, and **Dr. Hughes**. I am grateful for the opportunity to apply to the MIT Department of Physics' PhD program; thank you for your consideration.

Research Experience

My graduate research assistant experience under Dr. Dave Akin brought me into the weeds of constrained, performant software development. My final aerospace engineering course, Interplanetary Navigation & Guidance with Mr. Brent Barbee, introduced me to computational discovery and interdisciplinary research.

The University of Maryland's Space Systems Lab (**SSL**) develops and maintains an 8DOF serial manipulator (**Ranger**) for satellite servicing and dexterous manipulation research. I independently developed the final components of the lab's core robot software following a total rewrite: interfaces (`C++` templates) and implementations for all kinematic solvers and Cartesian controllers. One kinematic **solver's** implementation introduced performance problems: the computation required several intermediate-Jacobian solutions, which I initially solved-for iteratively. After contributing the required **fixes**, I used Julia's `Symbolics.jl` to print analytical intermediate-Jacobian solutions to performant non-allocating `C++` functions; as a result, each intermediate-Jacobian solve's performance improved by a factor of two. This experience at SSL, and others, taught me how to write performant software for high-speed computations. Graduate course projects, under Mr. Barbee's guidance, showed me how computation extends to physical discovery.

For my final M.S. course's term project, I replicated halo orbit and invariant manifold computations as summarized by Megan Rund's **thesis** on low-cost interplanetary transfer techniques. Intersections of manifolds can provide low-cost transfers across the solar system; NASA has labeled them ***Interplanetary Superhighways***. I **released** initial conditions for over 130k periodic orbits near planets within our solar system, and published orbit and manifold solver codes to open source **Julia packages**.

Scientific Computing

All of the scientific software I write is published on GitHub under the username `@cadojo`, and is linked-to and summarized at my personal website: `loopy.codes`.

Research Aspirations

Future Plans