Curriculum Vitae

Personal Information

Name Isaac Legred

Date of Birth *October 17, 1997*

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Research Interests

I'm an graduate student interested in computational physics, in particular astrophysics, and how people can better understand the data that humans collect from space. To be more specific, I am interested in using computers to solve important problems, and to me some of the most important problems are related to the relationships between fundamental and emergent astrophysics. For example, what can better understanding neutrinos teach us about core collapse supernovae, and vice versa? My interests lie both in producing models based on theoretical understanding, and testing these models using collected data. I am excited for the future of multimessenger astronomy, where larger datasets will be met by better analysis algorithms and faster supercomputers to examine the possibility of new physics at scales never seen before.

Education

Fall 2020 – present **California Institute of Technology** *Pasadena, CA*
Pursuing a Ph.D. in Physics

Aug 2016 – May 2020 **Cornell University** *Ithaca, NY*
B.A. in Physics, B.A. in Mathematics
Magna Cum Laude in Physics, Magna Cum Laude in Mathematics, Distinction in all Subjects

Sep 2012 – June 2016 **Mahtomedi High School** *Mahtomedi, MN*

Research Experience

Jun 2018 – August 2020 **Simulating Extreme Spacetimes Collaboration** *Cornell University* – Undergraduate Researcher

- I have worked under Professor Saul Teukolsky and Doctor Larry Kidder on developing visualizations of simulations run using the SXS Collaboration's SpECTRE code. The code is designed for large scale simulations of relativistic astrophysics, and my tasks on the project include making visualizations and writing visualization scripts, as well as working with data outputs from the code itself to improve performance in data writing and reading. In addition I have worked to interface code written in c++ with python, so as to be able to take advantage of efficient code written in c++ while using python's extensive visualization libraries.

April 2019 – June 2020 **Senior Thesis** *Cornell University – Testing the No-Hair Theorem: The Precessing Case (2020 Bethe Thesis Award)*

- This work, also advised by Saul Teukolsky, used fundamental modes of oscillation of a perturbed black hole to predict black hole parameters given gravitational wave data. To be precise, given a gravitational wave signal from a detector such as LIGO, the goal is to fit a sum of decaying waves to the signal, and in the process predict certain black hole parameters such as mass and spin by examining the sum of waves which gives the best fit. The process involved the use of techniques such as numerical minimization for the purpose of least squares fitting, data visualization and analysis, and some understanding of solving linear differential equations using clever function spaces as bases, in particular spin weighted functions.

October 2020 – **LIGO Collaboration** Caltech – Equation of State of Dense Nuclear Matter and Neutron Stars

- I'm engaged in inferring the equation of state of nuclear matter, which is the equation of state which should hold in Neutron Stars, using mulitmessenger astronomy. This research involves building models of potential equations of state, and comparing them to observed data from electromagnetic, and gravitational wave observations.

Teaching

Fall 2017 – Spring 2020 **Physics Undergraduate Teaching Assistant** *Cornell University*
I was an undergraduate teaching assistant for 6 semesters, having TA'd Introductory Quantum Mechanics, Waves and Thermal Physics, Electromagnetism (Lab), and an Engineering Waves and Quantum Physics Course.

Winter 2021 **Teaching Assistant and Section leader for Ph 1b, Caltech**
Taught an introductory Special Relativity and Electromagnetism Course.

Talks

Fall 2018 **Undergraduate Math Club Talk**
I gave a talk titled "What do Cats Have to Do with Linear Algebra", which was an axiomatic introduction to how a person could postulate quantum mechanics knowing only elementary linear algebra, and wavelike properties of particles. Poster

Fall 2019 **Undergraduate Math Club Talk**
I gave a talk titled "The Magical Mysterious Hopf Map" which is an introduction to the Hopf Fibration and an explanation of some of it's applications to solving PDE's (Such as the Linearized Einstein Equations) Poster

Spring 2020 **SCAN Seminar**
I shared a talk with Prof. Kate Meyer for the scientific computing seminar at Cornell University about a course project in optimal control with applications to ODEs.

Skills & Background Knowledge

Technical skills

Python, *Extensive use for research and projects*

C++, *Research experience, and some reading*

Java, *One course in Java and data structures*

Matlab, *Familiarity from use in projects*

Git, and Github, *Research experience, personal use*

Understanding of Unix-like systems, *Research, personal use*

Latex, *Coursework and personal use*

Languages

Spanish, *Intermediate*

English, *Native*