GABRIEL CASABONA

Ph.D. Student, Engineering & Applied Sciences
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RESEARCH INTERESTS

High-energy-density physics in extreme astrophysical systems, including Type Ia supernovae

Relativistic MHD, turbulence-driven detonation, and HPC for multiscale, extreme-condition simulations

EDUCATION

University of Massachusetts Dartmouth Sep 2025 - Present
Ph.D. in Engineering & Applied Sciences
Computational Science and Engineering Track
Teaching Fellow Sep 2025 - May 2026

Northwestern University Jun 2024
M.S. (earned en route to Ph.D. in Physics)
DOE CSGF Fellow Sep 2019 - Aug 2023
Research Assistant Sep 2023 - Jun 2024

University of Massachusetts Dartmouth May 2019
M.S. in Physics
Research Assistant Jul 2018 - May 2019
Teaching Assistant Sep 2017 - May 2019

Florida International University May 2017
B.S. in Physics
Resident Assistant Jun 2015 - May 2017
Tutor Sep 2016 - May 2017

RESEARCH EXPERIENCE

University of Massachusetts Dartmouth Sep 2025 - Present

- Investigating oxygen–neon white dwarf mergers and their role in failed Type Ia supernova detonations with **Robert Fisher**, while enhancing the subgrid turbulent deflagration-to-detonation transition (tDDT) model in electron-degenerate matter to include magnetic effects, using **FLASHX** simulations to improve predictions of ignition conditions.
- Performing high-resolution magnetohydrodynamic (MHD) simulations with **AthenaK**, improving magnetic field modeling and adaptive mesh refinement (AMR) to accurately capture magnetorotational instability (MRI) in shearing-box and torus setups across a broad plasma-β parameter space.

Los Alamos National Laboratory Jul 2022 - Oct 2022

- Conducted research with **Oleg Korobkin** on developing a model to describe the general relativistic solid dynamics of the crust of neutron stars during binary mergers. The computational model will be used to make improvements on the lab-based code **SPaRTA**.

- Collaborated and published with **Roseanne Marie Cheng** and **Nicole Lloyd-Ronning** on the analysis of binary systems consisting of stellar mass black holes and main sequence stars as GRB progenitors, using the population synthesis code **COSMIC** and stellar evolution codebase **MESA**.

Northwestern University Nov 2019 - Jun 2024

- Pioneered research with **Shane Larson** to develop a new mathematical model to describe a fully general relativistic fluid model for a neutron-degenerate Fermi gas, based on Israel-Stewart hydrodynamics, for neutron stars.
- Overhauled an updated parallel processing algorithm of a general relativistic magnetohydrodynamic (GRMHD) code to solve black hole accretion with **Alexander Tchekhovskoy**. Modifications became permanent contributions to the published codebase.

University of Massachusetts Dartmouth Oct 2017 - May 2019

- Spearheaded research on turbulence-driven detonation of carbon and helium in electron-degenerate matter with **Robert Fisher**, employing **FLASH4** for hydrodynamics and nuclear burning; findings were published and motivated by the double-degenerate channel of Type Ia supernovae.

PUBLICATIONS

G. Casabona and **R. Fisher**, "*Turbulently-Driven Detonation Initiation in Electron-Degenerate Matter with Helium*," The Astrophysical Journal Letters, 962, $L31$, 2024.

L. Kenoly, *et al.*, "*Understanding Binary Systems — a Comparison between COSMIC and MESA*," Research Notes of the AAS, 7, 167, 2023.

R. Fisher, **P. Mozumdar**, **G. Casabona**, "*Carbon Detonation Initiation in Turbulent Electron-Degenerate Matter*," The Astrophysical Journal, 876, 64, 2019.

PROGRAMMING

Computer Languages	Python, Fortran, C, MATLAB, LaTeX
Parallel Processing	OpenMP, MPI, CUDA, Kokkos
HPC Techniques	Scientific Computing, AMR, Data Analysis, Visualization, Parallel I/O
Tools	UNIX Commands, vi, Bash

PRESENTATIONS

Casabona, G (Jan 2021). *Detonation Initiation in Type Ia Supernovae.*
237^{th} Meeting of the AAS. Virtual

Casabona, G (Mar 2019). *Detonation Initiation in Type Ia Supernovae.*
APS March 2019. Boston, Massachusetts

Casabona, G (Jan 2019). *Detonation Initiation in Type Ia Supernovae.*
233^{rd} Meeting of the AAS. Seattle, Washington

Casabona, G (Nov 2018). *Carbon Detonation Initiation in Turbulent Electron-Degenerate Matter.*
APS Bridge/NMC Conference 2018. Stanford University

Casabona, G (Nov 2018). *Carbon Detonation Initiation in Turbulent Electron-Degenerate Matter.*
APS New England 2018. University of Massachusetts Dartmouth

Casabona, G (Jul 2018). *Carbon Detonation Initiation in Turbulent Electron-Degenerate Matter.*
IHPCSS. Technical University of Ostrava, Czech Republic

Casabona, G (Apr 2018). *Carbon Detonation Initiation in Turbulent Electron-Degenerate Matter.*
APS April 2018. Columbus, Ohio

CONFERENCES & WORKSHOPS

IHPCSS23: International HPC Summer School 2023.
(Jul 2023). Georgia Institute of Technology

- Delivered instructional sessions on high-performance computing and professional development, covering MPI, Python, Git/GitHub, and scientific communication
- Mentored a cohort of participants—including graduate students and postdoctoral researchers—with emphasis on collaboration, leadership, and transferable professional skills in academic research environments

SC22: The International Conference for High Performance Computing, Networking, Storage, and Analysis.
(Nov 2022). Dallas, Texas

- Attended workshops:
  - Deep Learning at Scale
  - Lossy Compression for Scientific Data
  - Colossal-AI: Scaling Large AI Models on Distributed Systems and Supercomputers

SC19: The International Conference for High Performance Computing, Networking, Storage, and Analysis.
(Nov 2019). Denver, Colorado

- Attended workshops:
  - High Performance Distributed Deep Learning: A Beginner's Guide
  - Tools and Best Practices for Distributed Deep Learning on Supercomputers
  - Programming your GPU with OpenMP: A Hands-On Introduction

NuGrid/JINA/ChETEC School: Software Tools for Simulations in Nuclear Astrophysics.
(Sep 2018). University of Hull, United Kingdom

IHPCSS18: International HPC Summer School 2018.
(Jul 2018). IT4Innovations National Supercomputing Center. Ostrava, Czech Republic

Neutron Star Mergers for Non-Experts: GW 170817 in the Multi-Messenger Astronomy and FRIB Eras.
(May 2018). Michigan State University

OUTREACH

CAMBA Learning to Work Internship Program

- Casabona, G & Nephew, A. (Dec 2021). *Professional Development Basics.* Brooklyn Bridge Academy. Brooklyn, New York

Physics Honors Society (ΣΠΣ)

- Casabona, G & Tumeo, B., *et al.* (Aug 2016). *Minority and Women in S.T.E.M. Outreach.* Women in S.T.E.M. Living Learning Community, Florida International University

It's On Us/ Sexual Assault Awareness

- Casabona, G., & Nephew, A. (Jul 2016). *Let's Talk About Sex.* Office of Residential Life, Florida International University

TEACHING EXPERIENCE

Department of Mathematics Sep 2025 - Present
Instructor of Record *UMass Dartmouth*

- Direct a College Algebra course, including lectures, assignments, and exams.
- Support students through office hours, tutoring, and individualized feedback.
- Develop and implement teaching strategies and curriculum improvements to enhance student success.

Florida Scholars Academy Nov 2024 - Jun 2025
Instructor *Florida Virtual School*

- Instructed students, grades 6-12 and GED, in the following subjects:
  science, mathematics, language arts, social studies, and computer science
- Advised on recommendations to student Individual Education Programs (IEP)
- Advised on recommendations to student Exceptional Student Education (ESE) programming

Department of Physics Sep 2017 - May 2019
Teaching Assistant *UMass Dartmouth*

- Instructed students on conducting experiments related to introductory Newtonian Mechanics
- Advised on the improvements to the experiments, including installation of updated equipment and curriculum
- Facilitated the understanding and development of problem-solving techniques related to physics

STEM Learning Lab Sep 2017 - Dec 2017
Tutor *UMass Dartmouth*

- Facilitated the understanding in the following subjects:
  Introductory Physics, General Chemistry I-II, Quantum Mechanics,
  Thermodynamics, Classical Mechanics, Electrodynamics,
  Algebra, Pre-Calculus, Trigonometry, Calculus, Differential Equations

ARC Learning Center Sep 2016 - May 2017
Tutor *FIU*

- Facilitated the understanding in the following subjects:
  Introductory Physics, General Chemistry, Quantum Mechanics,
  Thermodynamics, Classical Mechanics, Electrodynamics,
  Algebra, Pre-Calculus, Trigonometry, Calculus, Differential Equations

ORGANIZATION MEMBERSHIPS

Society of Physics Students — Physics Honors Society (ΣΠΣ)

American Astronomical Society — APS Bridge Program