Michael **Camilo**

Astrophysics Researcher · Senior Undergraduate Student

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Aspiring to continue my education and research interests in a Ph. D. program in astrophysics.

Education

Montclair State University (MSU) — *Montclair, NJ*

Bachelor of Science, Physics, Concentration in Astronomy — *Aug. 2020 - Present*

- Overall GPA: 3.862 Major GPA: 3.800

Clifton High School (CHS) — *Clifton, NJ*

Honor Roll Student, Academic Decathlete — *Sep. 2016 - Jun. 2020*

- Cumulative GPA: 93.674 Overall GPA: 3.8

Undergraduate Experience

Gravitational-Wave Research — *Montclair, NJ*

Dept. of Physics & Astronomy, Advisor: Dr. Shaon Ghosh — *January 2021 - Present*

- Initially worked to understand the underlying processes involved in the Laser Interferometer Gravitational Wave Observatory's (LIGO) gravitational wave (GW) detection and characterization. Transitioned to the exploration of new methods of constraining the equation of state (EoS) of neutron star (NS) matter using real/simulated GW detections and/or electromagnetic (EM) observations. Learned to use Metropolis-Hastings, Markov Chain Monte Carlo (MCMC), and nested sampling algorithms.

Supplemental Instructor — *Montclair, NJ*

Dept. of Physics & Astronomy — *September 2023 - Present*

- Conducted tutoring sessions for students taking courses: "Astronomy for Everyone", "Introductory Physics 1", and "Waves & Oscillations". Served as a teaching assistant for the "Introductory Physics 1" lab class every week.

Awards and Honors

Oct 2023 **MAS23 Student Travel Award**, American Physical Society (APS) Mid-Atlantic Section (MAS)
May 2023 **Richard Hodson Physics Award**, Dept. of Physics & Astronomy
April 2023 **Audience Favorite Award**, Mario M. Casabona Future Scientists Program
May 2022 **Honors Program Graduate**, MSU Honors Program
May 2021 **Ben Minor Physics Award**, Dept. of Physics & Astronomy
2020-Now **Presidential Scholarship**, MSU Admissions
2020-Now **Dean's List**, College of Science & Mathematics (CSAM)

Publication

Rapid Hierarchical Inference of Neutron Star Equation of State from multiple Gravitational Wave Observations of Binary Neutron Star Coalescences — *Phys. Rev. D 107, 043035*

Anarya Ray, **Michael Camilo**, Jolien Creighton, Shaon Ghosh, Soichiro Morisaki — *February 2023*

—Sought to obtain constraints on the NS EoS using real/simulated GW data with an already existing approximation scheme. Collaborators and I made additions to a model selection code package that uses this scheme, *GWXtreme*. The changes expanded its capabilities from only being capable of propping up proposed EoS models that are closest to the true EoS, to now including parameter estimation logic that allows the user to produce 90% confidence intervals on the pressure - density (p-ρ) form of the NS EoS.

Presentations

Poster: Assessment of Proposed Equations of State for Neutron Stars Using Multi-Messenger Astronomy

Newark, DE

American Physical Society (APS) Mid-Atlantic Section (MAS) - Conference — *November 2023*

- *(Same material as below).* Obtained the BFs of the proposed EoSs for each of the three GW/EM events at my disposal, and their joint BFs.

Poster: Assessment of Proposed Equations of State for Neutron Stars Using Multi-Messenger Astronomy

New Brunswick, NJ

Louis Stokes Alliances for Minority Participation - Conference — *October 2023*

- Obtained the BFs of the proposed EoSs for each of the three GW/EM events at my disposal, and their joint BFs.

Talk: Inference on Neutron Star Matter Using Multi-Messenger Astronomy

Montclair, NJ

North Jersey Astronomical Group Meeting — *May 2023*

- *(Same material as below).* Developed a technique to get a joint constraint on (p-ρ) relation of NS matter using both GW source, *GW170817*, and EM sources, *J0030+0451* and *J0740+6620*.

Poster: Understanding Matter at Super-Nuclear Density Using Gravitational Waves and X-Ray Astronomy

Montclair, NJ

Student Research Symposium / New Jersey Space Grant Consortium — *April 2023*

- *(Same material as below).* Developed a technique to get a joint constraint on (p-ρ) relation of NS matter using both GW source, *GW170817*, and EM sources, *J0030+0451* and *J0740+6620*.

Poster/Talk: Understanding Matter at Super-Nuclear Density Using Gravitational Waves and X-Ray Astronomy

Montclair, NJ

Mario M. Casabona Future Scientists Competition — *April 2023*

- Developed a technique to get a joint constraint on (p-ρ) relation of NS matter using both GW source, *GW170817*, and EM sources, *J0030+0451* and *J0740+6620*.

Poster/Sparkler-Talk: GWXteme: A Scalable Method for Multi-Probe Inference of Neutron Star Equation of State

Evanston, IL

LIGO-Virgo-Kagra (LVK) Collaboration Conference — *March 2023*

- Constrained (p-ρ) relation of NS matter using LIGO's detection of a binary NS coalescence, *GW170817*.

Talk: Inference on Neutron Star Matter Using Mock NICER Data

Montclair, NJ

North Jersey Astronomical Group Meeting — *May 2022*

- *(Same material as below).* Constrained (p-ρ) relation of NS matter using an EM observation of pulsar *J0030+0451* instead of the conventional GW source data.

Poster: Inference on Neutron Star Matter Using Mock NICER Data

New Brunswick, NJ

New Jersey Space Grant Consortium — *April 2022*

- Constrained (p-ρ) relation of NS matter using an EM observation of pulsar *J0030+0451* instead of the conventional GW source data.

Poster/Talk: Studying Neutron Star Structure Using Gravitational Waves

Montclair, NJ

Mario M. Casabona Future Scientists Competition — *November 2021*

- Obtained the best-fit piecewise polytropic NS EoSs to those proposed in the literature. Presented the similarity in the Bayes factors (BF) of the proposed and best-fit counterpart EoSs to confirm their validity.

Poster: Studying Neutron Star Structure Using Gravitational Waves

Montclair, NJ

CSAM Summer Research Program Meeting — *September 2021*

- Implementated a parametric form of NS EoS previously shown in the literature, called the piecewise-polytropic method, to the EoS model selection code package, *GWXtreme*.

Talk: Embedded Signal Detection

Montclair, NJ

CSAM Summer Research Program Meeting — *July 2021*

- Developed rudimentary signal detection code utilizing a match filtering technique. Performed analysis on different statistics used for match filtering, such as a sum-product, and chi-square.

Outreach

Open House *Montclair, NJ*

MSU Admissions *October 2023*

- General Q&A. Showcased of the physics demos. Gave tour of physics labs to those who were interested.

Freshmen Major Fair *Montclair, NJ*

CSAM *February 2023*

- General Q&A. Showcased of physics demos.

MSU Club Fair *Montclair, NJ*

CSAM *September 2022*

- Showcased physics demos such as the mechanics of a Michelson Interferometer using an educational kit, the transfer of mechanical energy to electrical energy via a dynamo torch, and magnetic induction with the dropping of a magnet down a copper tube.

Student Researcher Panel Discussion *Montclair, NJ*

CSAM *September 2021*

- Discussed how to start doing research with a professor, and my experience in it, with underclassmen of varying STEM majors interested in pursuing research themselves.

New Physics Student Seminar *Montclair, NJ*

Dept. of Physics and Astronomy *August 2021*

- Shared my experience as a physics student/researcher at MSU to freshman and transfer students entering the physics major program.

Freshmen Major Fair *Montclair, NJ*

MSU Admissions *July 2021*

- Advertised the curriculum and research opportunities available to incoming freshmen, with undecided majors, who showed interest in physics. Reaffirmed the job opportunities and salaries awaiting those with physics degrees to those who showed skepticism.

Interests

General	Gravitational-Wave Physics, Computational Physics, Neutron Stars
Ongoing	Multi-Messenger Astronomy
Aspiring	Stellar Structure, The Strong Nuclear Interaction, Stellar Dynamics

Skills

Coursework	E&M (Griffiths), Astrophysics (Carroll), General Relativity (Hartle), Quantum Mechanics (Griffiths)
Programming	Python (intermediate), Bash (novice)
Languages	English (native tongue), Spanish (conversational)
Software	Google Workspace, Wolfram Mathematica, LateX

Memberships

LIGO Scientific Collaboration	2021 - Present
Louis Stokes Alliance for Minority Participation	2023 - 2024

Other Interests

DIY Arduino Controlled Drone (WIP) *Montclair, NJ*

Physics Club *August 2023 - Present*

- Having completed the rover, we began work on an Arduino-controlled drone, and have looked through various builds differing in their approach. The start of the Fall 2023 semester interrupted our progress, but we plan to complete it in the coming months.

DIY Arduino Controlled Rover *Montclair, NJ*

Physics Club *August 2023*

- This was the first physics club sponsored project in its history. The president of physics club and I wanted some hands-on experience with soldering and 3D printing, and general comfort with Arduino programming. We followed an online *guide* and finished construction while wrapping up this summer's research term.