Michael **Camilo**

Astrophysics Researcher · First-Year Graduate Student

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Actively engaged in time-domain astronomy research, specifically in modeling the radio synchrotron emission spectrum of a new class of transients known as Fast Blue Optical Transients (FBOTs). Adept in the computational and analytical techniques required to advance this work.

Education

Cornell University — *Ithaca, NY*

Doctor of Philosophy, Astronomy and Space Sciences — *Aug. 2024 - Present*

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

Bachelor of Science, Physics, Concentration in Astronomy — *Aug. 2020 - May 2024*

- Overall GPA: 3.862 Major GPA: 3.800

Graduate Experience

Project: Modeling the Synchrotron Emission Spectrum of Supernovae Shocks — *Ithaca, NY*

Cornell Dept. of Astronomy, PI: Dr. Anna Ho — *September 2024 - Present*

- As some of the brightest and fastest dimming optical transients ever observed, FBOTs challenge the rigor of our models for the spectral energy distribution (SED) of synchrotron emission resulting from their shock waves. The effect of the dominant and more energetic distribution of thermal electrons, compared to non-thermal electrons, that is present in all energetic transient shocks has only recently been implemented in a new model by collaborators in *2021 ApJL 923 L14*. I am working towards comparing inferred parameters, characterizing each detected FBOT and its shock, obtained by the new "thermal+non-thermal model" and the conventional "non-thermal"-only model. These parameters include the mass loss rate of the progenitor system, the ambient density of the gas impacted by the shock, shock velocity, shock radius, and energy of the explosion.

Awards and Honors

May 2024 **Joan L. Dalton Memorial Graduate Fellowship in Astronomy**, MSU Dept. of Physics & Astronomy
May 2024 **Magna Cum Laude**, MSU Academic Affairs
April 2024 **Cornell Graduate University Fellowship**, Dept. of Astronomy
Oct 2023 **MAS23 Student Travel Award**, American Physical Society (APS) Mid-Atlantic Section (MAS)
May 2023 **Richard Hodson Physics Award**, MSU 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**, MSU Dept. of Physics & Astronomy
2020-2024 **Presidential Scholarship**, MSU Admissions
2020-2024 **MSU Dean's List**, College of Science & Mathematics (CSAM)

Presentations

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

Lakewood, NJ

New Jersey Space Grant Consortium — *April 2024*

- *(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

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.

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

Talk: My Experience in Graduate School. Advice on Prep and Good Habits
Montclair, NJ

MSU Dept. of Physics & Astronomy — *April 2025*

- Will speak to my underclassmen at a MSU Physics Club meeting and anyone else who's interested in hearing from me, about my experience in graduate school and how I dealt with the transition.

Museum in the Dark
Ithaca, NY

Cornell Dept. of Astronomy — *October 2024*

- At the Museum of the Earth, fellow Astronomy grad students and I hosted spooky stations with fun astronomy activities. I volunteered to help with the Infrared Camera station.

Panel Member: LSAMP PhD Program Admissions Panel
Montclair, NJ

Louis Stokes Alliances for Minority Participation — *October 2024*

- Participated in a zoom panel discussion where current LSAMP students asked me questions about PhD programs.

Yogi Berra Science Outreach Event
Montclair, NJ

MSU Dept. of Physics & Astronomy — *April 2024*

- Helped organizer, Dr. Rodica Martin, prep the hall full of different intro physics demonstrations. Performed an angular momentum conservation demo to multiple groups of elementary school students.

Open House
Montclair, NJ

MSU Admissions — *October 2023*

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

New Jersey Space Grant Consortium Spring Meeting
Montclair, NJ

MSU Dept. of Physics & Astronomy — *April 2023*

- Helped department chairperson, Dr. Marc Favata, prep and conduct a poster symposium, involving 40 research students, I myself was also presenting in.

Freshmen Major Fair
Montclair, NJ

CSAM — *February 2023*

- General Q&A. Showcased some basic physics demos.

MSU Club Fair
Montclair, NJ

CSAM — *September 2022*

- Showcased physics demos such as the mechanics of a Michelson Interferometer using an educational "Thorlabs" 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 to undergrads seeking to join a club.

Student Researcher Panel Discussion
Montclair, NJ

CSAM — *September 2021*

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

New Physics Student Seminar
Montclair, NJ

MSU Dept. of Physics & 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 MSU's physics program. Affirmed that job opportunities and pathways to even higher education awaited for those with physics degrees.

Publications

WIP-Title - "Inferring the Neutron Star Equation of State from Multiple Compact Binary Merger Observations: A Study of Systematics" *WIP*

Michael Camilo, Anarya Ray, Shaon Ghosh, Jolien Creighton *End of 2024 / Early 2025*

—Aimed to make our NS EoS constraints more robust as more BNS events are detected by LIGO. We improved the approximation technique in *GWXtreme* to now support inspiral-merger-ringdown (IMR) waveforms. Using this additional functionality, we obtain better (p-ρ) constraints from BNS events (real and simulated) and new (p-ρ) constraints from NSBH events (real and simulated).

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.

Interests

General Time-Domain Astronomy, Stellar Evolution, Supernovae
Ongoing Computational Modeling, Shocks

Skills

Programming Python (intermediate), Bash (novice)
Languages English (native tongue), Spanish (conversational)
Software Google Workspace, Wolfram Mathematica, LateX

Memberships

Cornell First Generation & Low Income Graduate Student Organization 2024 - Present
Cornell Graduate Student Union Member 2024 - Present
Louis Stokes Alliance for Minority Participation Member 2023 - 2024
NJ Space Grant Intern 2022 - 2024
LIGO Scientific Collaboration Member 2021 - 2024

Undergraduate Experience

Project: Modeling the Equation of State of Neutron Star Matter *Montclair, NJ*

MSU Dept. of Physics & Astronomy, Advisor: Dr. Shaon Ghosh *January 2021 - August 2024*

- Explored equation of state (EoS) models, proposed in the literature, describing the interiors of neutron stars (NSs) and modeled this relation myself using approximation schemes introduced in *Phys. Rev. D 104, 083003*. (i) Tested a parametrized EoS model by confirming it could produce the same pressure - energy density curve as those proposed in the literature. (ii) Developed new methods of constraining the EoS of NS matter using this parametrized model given real/simulated gravitational wave (GW) detections and/or electromagnetic (EM) observations.

Teaching Assistant / Supplemental Instructor *Montclair, NJ*

MSU Dept. of Physics & Astronomy *September 2023 - April 2024*

- Conducted bi-weekly tutoring sessions for students taking the courses: "Astronomy for Everyone", "Intro Physics 1", "Intro Physics 2", and "Waves & Oscillations". Served as the lab instructor for an "Intro Physics 1" lab every week during the Fall 2023 semester.