

Caleb Levy

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EDUCATION

Colgate University, Hamilton, NY

Bachelor of Arts, Physics; GPA: 4.15/4.00

Expected May 2023

Relevant Coursework: *Electromagnetism, Thermodynamics and Statistical Mechanics, Quantum Mechanics, Math Methods for Physics, Classical Mechanics (In Progress), Computational Mechanics (In Progress), Calculus III, Linear Algebra, Ordinary Differential Equations, Functions of a Complex Variable, Abstract Algebra I, Real Analysis I*

HONORS AND AWARDS

Dec 2021, Sigma Pi Sigma Physics Honor Society – *Elected for attaining high standards of general scholarship and outstanding achievement in physics.*

Nov 2021, Beth Brown Memorial Award – *Awarded for the best undergraduate oral presentation at the annual meeting of the National Society of Black Physicists.*

April 2021, Charles A. Dana Scholar – *Selected in recognition of superior academic achievement and demonstrated leadership in the college community.*

Nov 2020, Phi Eta Sigma National Honor Society – *Elected for attaining a minimum GPA of 3.5 at the end of freshman year.*

May 2020, Edwin Foster Kingsbury Prize in Physics – *Awarded to those students whose performance and promise is judged by the department to be the most outstanding during the year of the award.*

Fall 2019 - Present, Dean's Award with Distinction for Academic Excellence - *Awarded to students who receive a term grade point average of 3.6 or higher while completing at least three course credits.*

June 2017, Caribbean Advanced Proficiency Examination (CAPE), Physics – *Attained the highest score out of 3000+ students sitting the exam across the Caribbean.*

June 2017, Caribbean Advanced Proficiency Examination (CAPE), Computer Science – *Attained the highest score out of 1000+ students sitting the exam across the Caribbean.*

RESEARCH EXPERIENCE

MSRP Research Intern, Massachusetts Institute of Technology, Cambridge, MA

June 2022 - Aug 2022

Advisor: Daniel Harlow (PhD), Associate Professor of Physics

Reproduced Hawking's result of black hole evaporation. To do so, I studied free scalar field theory in the vacuum, computing results such as the vacuum energy and the Feynman Propagator. I then applied the free scalar field theory to the Schwarzschild metric to study quantum field theory in a black hole background. The result was a 38-page write up of [notes](#) containing:

- an introduction to quantum field theory via canonical quantization,
- a derivation of the path integral formalism of non-relativistic quantum mechanics,
- an introduction to free field theory via the path integral,
- an introduction to general relativity,
- a discussion on entanglement and the Rindler decomposition of spacetime,
- a derivation of the equation of motion for a free scalar field in an arbitrary spacetime metric,
- a calculation of black hole evaporation,
- and a discussion on the black hole information problem.

SIST Research Intern (Remote), Fermilab, Batavia, IL

May 2021 - Aug 2021

Advisor: Alex Drlica-Wagner (PhD), Research Scientist/Asst. Professor at UChicago

Developed a pipeline for detecting low surface-brightness galaxies (LSBGs) in the Dark Energy Survey (DES) data release two (DR2) using the instance segmentation and object detection algorithm Mask R-CNN. Successfully identified over 20 very large LSBGs (>20 arcsecs) that went undetected by the traditional algorithms employed in the DES pipeline.

- Designed a pre-processing pipeline to remove compact sources and exaggerate low-surface-brightness features in DES coadd image tiles by manipulating NumPy image arrays using slicing and convolution.
- Developed a deep learning model for detecting LSBGs by pre-processing 1% of the DES DR2 coadd tiles with injected LSBG simulations and training the Mask R-CNN algorithm on these images.
- Devised and executed a discovery pipeline on 11,000 DES coadd image tiles which led to the identification of over 20 very large LSBGs.

Research Assistant, Physics and Astronomy Dept., Colgate University, Hamilton, NY

July 2020 - Present

Advisor: Cosmin Ilie (PhD), Asst. Professor of Physics and Astronomy

Dark Matter capture is the process through which Dark Matter (DM) particles become gravitationally bound by astrophysical objects after colliding with their constituents. The first generation of stars provide an ideal environment to study this effect and, through limits on their luminosity, can be used to place upper bounds on the DM-proton scattering cross-section.

- Developed a novel formalism for calculating the capture of DM particles by objects composed of an arbitrary number of components.
- Utilized computational techniques in Python, such as multiprocessing, to implement the novel formalism and calculate DM capture rates in the first generation of stars, composed of hydrogen and helium.
- Formulated analytic equations for calculating capture rates in a multi-component context to alleviate computational load.
- Placed competitive bounds on the DM-proton scattering cross-section through the potential observation of the first generation of stars.

PUBLICATIONS

C. Ilie and C. Levy. *Multicomponent multiscatter capture of dark matter*. 2021. [*Phys. Rev. D* **104**, 083033](#).

C. Ilie, C. Levy, J. Pilawa, and S. Zhang. *Constraining Dark Matter properties with the first generation of stars*. 2021. [*Phys. Rev. D* **104**, 123031](#).

PRESENTATIONS

APS April Meeting (Dark Matter Tests with Compact Objects), New York City, April 2022. Levy, C. "Multicomponent multiscatter capture of dark matter" (Parallel talk).

National Society of Black Physicists: Innovate Seminar Series, Remote (Hosted by The Kavli Institute for Theoretical Physics), Dec 2021. Levy, C. "Multicomponent multiscatter capture of dark matter" (Invited talk).

Machine Learning and the Physical Sciences Workshop at the 35th Conference on Neural Information Processing Systems (NeurIPS), Remote, Dec 2021. Levy, C., Drlica-Wagner, A., et al. "Detecting Low Surface Brightness Galaxies with Mask R-CNN" ([Poster](#) and [Conference Paper](#)).

National Society of Black Physicists 2021 Conference, Remote, Nov 2021. Levy, C. "Multicomponent multiscatter capture of dark matter" (Parallel talk).

The XXVIII International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2021), Remote, Aug 2021. Levy, C. "Multicomponent multiscatter capture of dark matter" (Parallel talk).

The 24th International Conference on Particle Physics and Cosmology (COSMO'21), University of Illinois (Remote), Aug 2021. Levy, C. "Multicomponent multiscatter capture of dark matter" (Parallel talk).

Rochester Symposium of Physics Students, Rochester, NY, March 2021. Levy, C. "Constraining dark matter properties with population III stars" (Parallel talk).

Colgate University Physics and Astronomy Seminar, Hamilton, NY, Sep 2020. Levy, C. "Role of helium in capture of dark matter by pop III stars" (Parallel talk).

COMPUTATIONAL SKILLS

Python (NumPy, SciPy, Matplotlib, multiprocessing), Mathematica, MATLAB, Latex, Bash/zsh.

TEACHING EXPERIENCE

Teaching Assistant – PHYS131/112/334, Colgate University, Physics and Astronomy Dept. Aug 2020 – Present

- Observed and analyzed students' tendencies during rigorous problem-solving sessions to provide individual feedback on potential areas of improvement.

Physics, Math, and SAT Tutor, GetThere Tutoring, Kingston, Jamaica Sep 2018 – July 2019

- Strategized with students to create comprehensive tutoring plans designed to maximize students' academic and personal potential.

Part-time Physics Teacher, Campion College, Kingston, Jamaica Sep 2018 – Dec 2018

- Prepared 90+ 9th grade physics students for further studies in physics by introducing them to fundamental topics in the field.
- Coordinated with the department head and fellow physics teachers to provide an excellent standard of instruction across the grade.

LEADERSHIP/SERVICE

Student Mentor, Colgate University, Physics and Astronomy Dept. Aug 2020 – Present

- Facilitated the transition to university of 50+ incoming freshman physics students by providing relevant academic resources and holding student office hours.
- Strategized with department faculty and fellow student mentors to develop a plan for improving retention among minorities in physics.

MEMBERSHIP

National Society of Black Physicists

May 2021 – Present

American Physical Society - Inclusion, Diversity, and Equity Alliance (APS-IDEA)

June 2020 – Present