

Jillian Paulin

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[LinkedIn](#)

Education

August 2023- Present

University of Pennsylvania, Philadelphia, PA – *PhD, Physics & Astronomy*

Certificate in College and University Teaching (2024)

August 2019-May 2023

Colgate University, Hamilton, NY – *BA, Astronomy-Physics*

High Honors in Astronomy-Physics; Magna Cum Laude

GPA: 3.65

Minor: Applied Mathematics

Awards & Honors

Lindau Nobel Laureate Meeting Young Scientist- *Foundation Lindau Nobel Laureate Meetings* (2024)

Selected in a competitive, multi-step, international process as one of over 600 young scientists globally to attend the prestigious Lindau Nobel Laureate Meetings. I was nominated to attend by the **National Academy of Sciences** (USA) and financially supported by the **German Research Foundation** and **AKB Stiftung**.

Cozzarelli Prize- *Proceedings of the National Academy of Sciences* (2023)

Awarded to research teams published by PNAS who have made significant contributions to their field. We were awarded this prize based on our 2023 paper, "Supermassive Dark Star Candidates seen by JWST".

LeRoy Apker Award Finalist- *American Physical Society* (2023)

One of 6 finalists nationwide for this award, which recognizes exceptional achievement in research by undergraduate physicists.

Joseph C. Amato and Anthony F. Aveni Award for Student Research- *Colgate University*

Department of Physics and Astronomy (2023)

Astronomical Society of New York Undergraduate Student Paper Prize- *Astronomical Society of New York* (2023)

Goldwater Scholarship- *Barry Goldwater Scholarship and Excellence in Education Foundation* (2022)

The most prestigious undergraduate STEM scholarship in the USA.

Sigma Pi Sigma Physics & Astronomy Honor Society member- *Colgate University Chapter* (2021)

Phi Eta Sigma Honor Society, Colgate University Eta Chapter member (2020 induction)

Secretary (2021-2022), President (2022-2023)

Edwin Foster Kingsbury Prize- *Colgate University Department of Physics and Astronomy* (2020)

Dean's Award with Distinction- *Colgate University* (Fall 2021, Spring 2021, Fall 2020, Spring 2020)

Dean's Award for Academic Excellence- *Colgate University* (Spring 2023, Fall 2022, Spring 2022, Fall 2019)

Scholarships & Grants

- Picker Interdisciplinary Science Institute Grant- *Colgate University* (2024)
- Alumni Memorial Scholars Grant- *Colgate University* (2022 & 2023)
- Braslau Family Travel Grant- *American Physical Society* (2022)
- Douglas G. '50 & Sandra Campbell Scholarship- *Colgate University* (2022, 2021, 2020)
- Valk Family Endowed Scholarship- *Colgate University* (2022, 2021, 2020)
- Halpern Scholarship Fund- *Colgate University* (2022, 2021)
- Leonard/Young Scholarship Fund- *Colgate University* (2022, 2021)

Publications

Cosmin Ilie, Katherine Freese, Andreea Petric, **Jillian Paulin**. “UHZ1 and the other three most distant quasars observed: possible evidence for Supermassive Dark Stars”. Submitted to *Nature Astronomy*, 21 Dec 2023. [arXiv:2312.13837](https://arxiv.org/abs/2312.13837)

Cosmin Ilie, **Jillian Paulin**, Katherine Freese. 11 July 2023. “Supermassive Dark Star Candidates seen by JWST” - *PNAS* **120** 30, [doi: 10.1073/pnas.2305762120](https://doi.org/10.1073/pnas.2305762120)

Cosmin Ilie, **Jillian Paulin**. 14 June 2022. “Analytic Approximations for the Velocity Suppression of Dark Matter Capture” - *ApJ* **932** 46, [doi: 10.3847/1538-4357/ac651b](https://doi.org/10.3847/1538-4357/ac651b)

Media Coverage of Research

- Quoted as an external expert in the New Scientist article, “Dark matter could be hiding inside strange failed stars,” by Alex Wilkins, 30 August 2024
- Featured on the podcast “College Matters. Alma Matters” by Venkat Raman, 23 February 2024
- 200+ news articles and YouTube videos related to our 2023 publication, “Supermassive Dark Star Candidates seen by JWST”. Reached an estimated audience of well over 1 billion people.
- “Some Astronomers Claim Dark Star Candidates in Webb Images” by Colin Stuart, *Sky & Telescope*, 18 July 2023
- “Did Massive Stars Composed of Dark Matter Fuel the Early Universe?” by Matt Hrodey, *Discover*, 19 July 2023
- “Did JWST Discover Dark Matter Stars?,” PBS Space Time, YouTube, 16 August 2023
- “Dark stars: Have we finally found a weird sun powered by dark matter?” by Jonathan O’Callaghan, *New Scientist*, 20 September 2023
- Cover of *New Scientist*, Sept. 23, 2023 issue
- “JWST Might Have Spotted the First Dark Matter Stars” by Stephanie Pappas, *Scientific American*, 20 July 2023
- “Some Astronomers Claim Dark Star Candidates in Webb Images” by Colin Stuart, 18 July 2023

Research Experience

Start date: May 2024

University of Pennsylvania, Philadelphia, PA - *Graduate Student; Principal Investigator: Masao Sako*

- Project 1: Evaluating the quality of the Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) observational strategies based on the qualities of simulated supernova light curves in the wide-fast-deep field. LSST will continuously image the entire southern sky over the course of 10 years. Part of the survey will be “wide-fast-deep”: that is, will provide near uniform coverage of the entire sky. Another part of the survey will be “deep-drilling”: that is, we will image certain regions for longer periods of time and more frequently. Ensuring we are able to get a large sample of high-quality type Ia supernovae allows us to calculate their distances, and thus probe dark energy.

August 2023-Present

University of Pennsylvania, Philadelphia, PA - *Graduate Student; Collaboration with Cosmin Ilie (Colgate University), Katherine Freese (University of Texas, Austin) and Andreea Petric (Space Telescope Science Institute)*

- Project 1: Quasar UHZ1 as possible evidence for supermassive dark stars. This project was motivated by cosmological problems presented by JWST: the mystery of the strangely high number

of very massive, very high-redshift galaxies and quasars. As presented in our paper “Supermassive Dark Star Candidates seen by JWST,” supermassive dark stars, which are one candidate for the earliest stars, and which are powered by dark matter, are an excellent possible explanation for these discoveries. In this project, we uncover additional possible evidence for the existence of supermassive dark stars. UHZ1 is the highest-redshift quasar discovered to date, and it has been hypothesized that it could have formed in a direct-collapse black hole scenario from a gaseous cloud. We demonstrated that UHZ1 is equally well explained by the death of a supermassive dark star. The results of this project have been submitted to *Nature Astronomy*.

- Project 2: Searching for additional supermassive dark star signatures. Supermassive dark stars are fascinating objects. Given the results of our two previous projects, which highlight the potential evidence for the existence of such objects, we need to figure out how we might confirm that the supermassive dark star candidates are indeed dark stars, or if we can rule out the dark star hypothesis. We are generating additional model spectra for both supermassive dark stars and galaxies, and comparing the two to find unique traits for either case. Additionally, we are evaluating the expected morphology of dark stars in the presence of nebular emission, and how this compares to the observed morphology of our existing candidates.

June 2020- July 2023

Colgate University, Hamilton, NY - *Research Assistant; Principal Investigator: Cosmin Ilie*

- Project 1: Analytic Approximations for the Velocity Suppression of Dark Matter Capture. This project focused on modifying the existing dark matter capture formalism to account for scenarios in which the capturing object (typically a star or exoplanet) has a significant velocity with respect to the ambient dark matter. In this case, one must drop the assumption that dark matter particles follow a Maxwell-Boltzmann velocity distribution. The result is a suppression in the capture rate. This can be conveniently expressed in an analytical suppression factor, and then applied to re-evaluate previously-existing bounds on the dark matter- nucleon cross section of interaction based on the velocity of the capturing object. Software used included Python, Mathematica, and LaTeX. The results of this project have been published in *The Astrophysical Journal*.
- Project 2 : Supermassive Dark Star Candidates seen by JWST. The motivation for this project was the surprisingly high number of galaxy candidates that have been observed at high redshifts, i.e., early in the universe’s history. Perhaps some of those galaxy candidates could be supermassive dark stars instead, thus helping to ease the rising tension between cosmological theory and observations. This project resulted in the identification of the first ever dark star candidates in JWST data: JADES-GS-z13-0, JADES-GS-z12-0, and JADES-GS-z11-0. I wrote the code to develop these results, which have been published in the *Proceedings of the National Academy of Sciences*, and as a result have received a significant amount of media attention.

Invited Talks

- 17th Marcel Grossman Meeting, Pescara, Italy, July 7-12, 2024. “Identifying Supermassive Dark Star Candidates in JWST Data”.
- Colgate University, September 12, 2023. “Bringing Dark Stars Into the Light”.
- Astronomical Society of New York, May 1, 2023. “Analytic Approximations for the Velocity Suppression of Dark Matter Capture”.

Conference Presentations

- Goldwater Symposium, virtual, August 9-10, 2024. Oral presentation, “Identifying Supermassive Dark Star Candidates with JWST”.
- 17th Marcel Grossman Meeting, Pescara, Italy, July 7-12, 2024. Invited talk, “Identifying Supermassive Dark Star Candidates in JWST Data”.
- 15th International Workshop on the Identification of Dark Matter 2024, L’Aquila, Italy, July 8-12, 2024. Poster presentation, “Identifying Supermassive Dark Star Candidates in JWST Data”.
- 73rd Lindau Nobel Laureate Meeting, Lindau, Germany, June 30-July 5, 2024. Attendee.
- Goldwater Symposium, virtual, August 18-19, 2023. Poster presentation, “Supermassive Dark Star

- Candidates Seen By JWST". Award-winning poster for Physics, Math & Geosciences.
- UCLA Dark Matter, Los Angeles, CA, March 29-April 1, 2023. Poster presentation, "Analyzing High-Redshift Galaxy Candidates as Supermassive Dark Star Candidates with JWST Data".
- American Astronomical Society 240th Meeting, Pasadena, CA, June 12-16, 2022. Oral presentation, "Analytic Approximations for the Velocity Suppression of Dark Matter Capture".
- XV International Conference on Interconnections between Particle Physics and Cosmology, St. Louis, MO, June 6-10, 2022. Oral presentation, "Analytic Approximations for the Velocity Suppression of Dark matter Capture".
- American Physical Society April Meeting, New York, NY, April 9-12, 2022. Oral presentation, "Analytic Approximations for the Velocity Suppression of Dark Matter Capture".
- Conference for Undergraduate Women in Physics, virtual, January 20-22, 2022. Poster presentation, "Analytic Approximations for the Velocity Suppression of Dark Matter Capture".
- Rochester Symposium for Physics Students, virtual, March 20, 2021. Oral presentation, "The Effect of Stellar Velocity on Dark Matter Capture Rates of Population III Stars".
- International Conference on Particle Physics and Cosmology, virtual, August 2-6, 2021. Poster presentation, "The Effect of Stellar Velocity on Dark Matter Capture and Detection with Pop III Stars".

Teaching & Tutoring Experience`

October 2023- June 2024

University of Pennsylvania, Philadelphia, PA – *West Philadelphia Tutoring Project: Math Tutor*

- Provided weekly, one-on-one assistance with high school Algebra II assignments
- Evaluated student understanding and adapted explanations of concepts as necessary
- Outcome: student significantly improved grades, resulting in their historically highest math grades

January 2024- June 2024

University of Pennsylvania, Philadelphia, PA – *Laboratory TA for PHYS 0150: Principles of Physics I: Mechanics and Wave Motion and PHYS 0101: General Physics: Mechanics, Heat and Sound*

- Facilitated laboratory sections for an introductory physics course intended for engineering and physics majors
- Provided guidance to student questions and encouraged students to think deeply
- Responded to student inquiries and concerns via email
- Assessed student performance on laboratory reports and provided thorough feedback

August 2023- December 2023

University of Pennsylvania, Philadelphia, PA – *TA/ Grader for ASTR 001: A Survey of the Universe*

- Equitably and fairly assessed student performance on homework and other graded tasks
- Created a supportive environment in which students may ask questions about course material through office hours
- Responded to student inquiries via email

January 2023- May 2023

Colgate University, Hamilton, NY – *Learning Assistant for ASTR 102: Stars, Galaxies, and the Universe*

- Facilitated discussions with students during help sessions, particularly in preparation for exams.
- Creatively explained fundamental concepts for a variety of levels.
- Topics covered in this course include stellar evolution, the nature of the sun, spectral features in stars, the scale of the universe, galaxies, quasars, and the big bang.

August 2022- December 2022

Colgate University, Hamilton, NY – *Learning Assistant for ASTR 210: Intermediate Astronomy & Astrophysics*

- Provided feedback on homework assignments and coding assignments to help students improve their work. Reframed topics taught in class to provide greater clarity during help sessions.
- Topics covered in this course include the nature of the sun, the interstellar medium, the hydrogen atom, emission and absorption spectra, HR diagrams, blackbody radiation, and characteristics of stars.

January 2022- May 2022

Colgate University, Hamilton, NY - *Physics Tutor for PHYS 112: Fundamental Physics II*

- Assisted students individually and in groups, particularly in preparation for exams and homework assignments.
- This course teaches the basics of electromagnetism, light, and modern physics, and is presented to a non-physics major audience.

Civic Engagement

Graduate Student Mentoring Initiative (2023-2024)

Provided substantial support and guidance to a first-generation student at the University of Pennsylvania with respect to application strategies and preparation for graduate programs.

West Philadelphia Tutoring Project (Spring 2024, Fall 2023)

Developed appropriate, attainable, and effective learning goals with a student who needed assistance with concepts in 12th grade math. Guided the student through a variety of math problems with a focus on establishing a growth mindset, building confidence, and confirming the student's understanding of the material.

Hamilton Central School (Summer 2023)

Summarized current topics in dark matter research for an interested group of high school students in Hamilton, NY. Provided advice on pursuing science as a career, selecting and applying to universities.

University of Connecticut's Junior Science and Humanities Symposium (March 2024, March 2023, March 2022)

Provided encouraging and constructive feedback to high school poster presenters regarding presentation style, content, and research methods. Communicated with students on a virtual platform. Assisted students during a workshop about elevator pitches in the research community.

Colgate Office of National Fellowships and Scholarships (Summer 2022, Summer 2023)

Provided advice to students interested in applying for the Goldwater scholarship. Discussed my personal research journey, what led me to apply for the Goldwater scholarship, and how this connected to my professional plans.

Workshops Attended

- ZTF Summer School: AI in Astronomy, virtual, July 29- August 2, 2024
- Penn Summer Computing Training, University of Pennsylvania, June 10-11, 2024
- An Introduction to JWST Data Analysis, virtual, January 12, 2022

Skills

- Programming languages including Python, Mathematica, LaTeX, and MatLab. Particular use of these languages to perform numerical analysis, including interpolation, optimization, integration and differentiation, data analysis, and data representation.
- Proficiency in simulations of telescope observations using the Pandeia software.
- Diverse presentation skills ranging from the classroom setting to large conferences. Ability to cover topics at levels ranging from introductory to advanced.
- Knowledge of current research and developments in dark matter cosmology, dark matter capture

formalisms, and JWST data pertaining to high-redshift objects.

- Knowledge of JWST-specific data analysis tools shown in the Space Telescope Science Institute's JWebbinar series.