

J. LUNA ZAGORAC

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Physics PhD Candidate ◊ Yale University ◊ New Haven, CT 06511

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EDUCATION

Yale University, New Haven, CT

Ph.D. anticipated in August 2022

August 2016 - Present

Colgate University, Hamilton, NY

B.A. with Honors in Astronomy/Physics & Anthropology

Aug 2012 - May 2016

SKILLS AND QUALIFICATIONS

Programming Languages

Python, C/C++, MATLAB, Chapel, Pascal

Python Packages

Jupyter, Matplotlib, Numba, NumPy, SciPy, PyFFTW, AstroPy

Software & Tools

LaTeX, Excel, Mathematica, ImageJ

Communication skills

Science & grant writing, outreach, public speaking, data visualization

Languages

English & Serbian (native)

French & Italian (proficient), Arabic (conversational)

Latin & Middle/Late Egyptian (intermediate)

RESEARCH EXPERIENCE

UltraLight Dark Matter Simulations and Observational Constraints

Jan 2019 - Present

Professor Nikhil Padmanabhan & Professor Richard Easther

Yale University

Developing the **CHAPELULTRA** pseudo-spectral solver, optimizing it for HPC use, using it to simulate UltraLight Dark Matter, and assessing candidate feasibility. Projects currently underway include:

- developing calculator for ULDM eigenstates and comparing them with perturbation theory.
Publication: [Zagorac et al. \(2021\)](#)
- investigations of the core-halo mass relation and imprints of merger history on ULDM halos
- modelling stellar streams around a ULDM halo using the streakline method
- probing ULDM phenomenology in the presence of baryonic disk potentials

An Astronomical View of Ancient Egyptian Star Clocks

Sep 2019 - May 2021

Professor Priya Natarajan & Professor John Coleman Darnell

Yale University

Developed the code **DECANO.PY** to track and analyze the movement of Ancient Egyptian decans in the night sky and compare the results with primary sources. Results were **presented** at the 2021 Meeting of CT Digital Humanities (CTDH) and the 72nd Annual Meeting of the American Research Center in Egypt (ARCE). This interdisciplinary project was funded by the Franke Program in the Humanities & Natural Sciences at Yale.

Gravitational Signatures of Primordial Black Holes

Sep 2017 - Mar 2019

Professor Nikhil Padmanabhan & Professor Richard Easther

Yale University

Modeled primordial black hole creation mechanisms in the early universe, constrained their 2-body interactions and dynamics, and calculated resultant gravitational wave spectra from mergers for allowed parameter space.

Publication: [Zagorac et al. \(2019\)](#)

Particle Mesh Code for Bi- and Power Spectra*Professor Nikhil Padmanabhan*

Jan 2017 - Aug 2017

Yale University

Wrote particle mesh code to calculate the power spectrum and bispectrum from GADGET-2 simulation data in C++. Tested the code by generating a Gaussian random field to run through the code and compared results with analytically calculated power spectra and bispectra for the Gaussian case.

Data Reduction for SMARTS Consortium at Yale*Professor Charles Bailyn*

Nov 2016 - May 2017

Yale University

Reduced a backlog of AGN spectra collected by the Yale SMARTS Consortium using Yale's software pipeline. Prepared data for online publication for use by collaborators.

Supermassive WIMP Production in the Early Universe*Professor Patrick Crotty*

Aug 2015 - May 2016

Colgate University

Wrote an equation solver in Python, using Numpy and Scipy for analysis and Matplotlib for visualizations. Varied coefficients describing shape of sigmoid inflaton field and calculated resulting DM abundances with assumed particle mass. Presented preliminary results at Syracuse University Undergraduate Research Day. This work constituted my senior honors thesis titled "Constraining WIMPzilla Production in the Inflationary Phase of the Early Universe."

Volunteer Archaeologist at South Asasif Conservation Project*Dr. Elena Pischikova*

Jun - Jul 2015

Luxor, Egypt

Supervised team of workers doing excavation; organized, labeled, and stored finds, and documented site progress daily. Used dumpy-level photography and measurements to produce accurate technical drawings of the site. Wrote up extensive field reports for the site director.

Observations and Analysis of 2014 Flare of Blazar 3C454.3*Professor Thomas Balonek*

Jun 2014 - Aug 2014

Colgate University

Observed AGN at Foggy Bottom Observatory at Colgate University on a 16-inch, Newtonian-Cassegrain telescope. Reduced all data using UNIX, IRAF, and Pascal-based software, with analysis focusing on 3C454.3 and its historic flare that summer. Compared our optical data with Yale SMARTS data of the same object to find excellent agreement, as well as radio data from the Submillimeter Array. No correlation between radio and optical flares was found.

HONORS & AWARDS

Future Investigator in NASA Earth and Space Science and Technology*May 2020*

NASA Grant for \$90,000 funding two years of doctoral work and independent investigations of ULDM.

Loyde and William C. G. Ortel Fellowship in Physics*Nov 2020*

Awarded to an outstanding student pursuing a Ph.D. in Physics.

Franke Science & Humanities Interdisciplinary Research Award*Sep 2019*

Yale Fellowship funding two years of interdisciplinary work on Egyptian constellations.

Colgate Physics and Astronomy Department Founders Award*Apr 2016*

Awarded periodically to a senior who has demonstrated four years of outstanding progress and development of her understanding of physics or astronomy.

Sigma Pi Sigma Physics Honors Society*Apr 2016*

Honorary membership to Sigma Pi Sigma Honors Society.

Alumni Memorial Scholar at Colgate University*Aug 2012 - May 2016*

Scholars are selected at the time of admission to Colgate for their dedication and interest in scholarship and have the opportunity to apply for grants totaling up to \$5,000 to fund independent research.

PUBLICATIONS

3. **Zagorac**, Sands, Padmanabhan, and Easter. “Schrödinger-Poisson Solitons: Perturbation Theory.” (2021). arXiv preprint: 2109.01920.
2. Padmanabhan, Ronaghan, **Zagorac**, and Easter. “Simulating Ultralight Dark Matter with Chapel: An Experience Report.” In *SC19 Proceedings* (2019).
1. **Zagorac**, Easter, and Padmanabhan. “GUT-scale primordial black holes: mergers and gravitational waves.” *Journal of Cosmology and Astroparticle Physics* 2019.06 (2019): 052.

PRESENTATIONS

† = Invited Speaker

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| 21. † Stony Brook University
<i>UltraLight Dark Matter Dynamics in the Language of Eigenstates</i> | Oct 2021
Virtual |
| 20. † Carnegie Observatories
<i>UltraLight Dark Matter Dynamics in the Language of Eigenstates</i> | Oct 2021
Virtual |
| 19. † University of Hawaii Institute of Astronomy
<i>UltraLight Dark Matter Dynamics in the Language of Eigenstates</i> | Oct 2021
Virtual |
| 18. † Northwestern University CIERA Science Happy Hour
<i>UltraLight Dark Matter Dynamics in the Language of Eigenstates</i> | Oct 2021
Virtual |
| 17. † Newcastle University Cosmology Journal Club
<i>Schrödinger-Poisson Solitons: Perturbation Theory.</i> | Sep 2021
Virtual |
| 16. Weak Interaction Discussion Group at Yale
<i>Linear Approximations to UltraLight Dark Matter Stationary States</i> | May 2021
Virtual |
| 15. American Research Center in Egypt Annual Meeting
<i>In Search of Lost Time: An Astronomical View of Ancient Egyptian Star Clocks</i> | Apr 2021
Virtual |
| 14. Aspen Winter Conference, A Rainbow of Dark Sectors
<i>UltraLight Dark Matter & Its Eigenstates</i> | Mar 2021
Virtual |
| 13. † Yale Institute of Sacred Music
<i>Cosmogonies, Cosmologies, & Time</i> | Mar 2021
Virtual |
| 12. † Connecticut Digital Humanities
<i>In Search of Lost Time: An Astronomical View of Ancient Egyptian Star Clocks</i> | Feb 2021
Virtual |
| 11. † Bay Area Science Festival Science Cafe Mini-Talks in Astronomy
<i>Cosmic Archaeology, or: How Do We Know the Things We Know?</i> | Oct 2020
Virtual |
| 10. 236th Meeting of the American Astronomical Society
<i>Parametrizing UltraLight Dark Matter Haloes Through Binary Soliton Core Mergers</i> | Jun 2020
Virtual |
| 9. † Center for Computational Astrophysics
<i>Parametrizing UltraLight Dark Matter Haloes Through Binary Soliton Core Mergers</i> | May 2020
Virtual |
| 8. Weak Interaction Discussion Group at Yale
<i>Parametrizing UltraLight Dark Matter Haloes Through Binary Soliton Core Mergers</i> | May 2020
Virtual |
| 7. 235th Meeting of the American Astronomical Society
<i>A Light in the Dark: Ultra Light Dark Matter in Theory and Simulation</i> Hawaii Convention Center | Jan 2020 |
| 6. Great Lakes Cosmology Workshop
<i>Pseudo-Spectral Solvers for Fuzzy Dark Matter</i> | Aug 2019
Rochester Institute of Technology |
| 5. Poster: Tri-Institute Summer School on Elementary Particles
<i>Gravitational Wave Spectrum of Ultralight Primordial Black Holes</i> | Jul 2018
Perimeter Institute |

4. Colgate University Honors Thesis Defense <i>Saving Tokyo: Constraining WIMPzilla Production in the Early Universe</i>	Apr 2016 Colgate University
3. Syracuse University Undergraduate Research Day <i>Constraining WIMPzilla Production in the Early Universe</i>	Dec 2015 Syracuse University
2. Keck Northeastern Astronomy Consortium <i>The Optical and Radio Variability of the Blazar 3C 454.3</i>	Nov 2014 Swarthmore College
1. Colgate Physics & Astronomy Welcome Seminar <i>The Variability of Blazar 3C 454.3</i>	Sep 2014 Colgate University

TEACHING EXPERIENCE

Curriculum Development & Lecturing <i>Yale Bootcamp on Physics Fundamentals</i>	Summer 2019 - 2021
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Co-developed a curriculum for 20 hours of Classical Mechanics instruction, met weekly with staff supervisor to polish lectures and example problems. Delivered 10 hours of lecture at the Bootcamp. Developed a Mathematica tutorial for incoming graduate students. Re-vamped the curriculum and moved it online for Summer 2020

Head Teaching Fellow Positions <i>PHYS170/171 - University Physics for the Life Sciences</i>	Aug 2017 - May 2018
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Organized other teaching fellows, staffed weekly help sessions and office hours, held review sessions on material before exams, graded weekly homework, proctored and graded exams.

Teaching Fellow Positions	Fall 2016 - Fall 2020
PHYS/ASTR600 - Cosmology	Fall 2020
PHYS442 - Introduction to Nuclear and Elementary Particle Physics	Spring 2020
PHYS410 - Classical Mechanics	Fall 2019
ASTR343 - Gravity, Astrophysics, and Cosmology	Spring 2019
PHYS165/166 - General Physics Laboratory	Fall 2016 - Spring 2017

SCIENCE COMMUNICATION

Popular Science Presentations

Bay Area Science Festival "Astro Coffee" Presenter: <i>Cosmic Archaeology</i>	Oct 2020
"Ask a Scientist" Webinar Presenter: <i>Dark Matter</i>	May 2020
"Astronomy on Tap" Presenter: <i>Cosmic Archaeology</i>	Aug 2019
"3 Minute Thesis" Yale Finalist: <i>How Small Black Holes Teach Us about the Big Bang</i>	Apr 2019

Writing

Astrobites Media Intern at AAS238	Jun 2021
Astrobites Contributing Author (>15 articles and interviews)	Dec 2019 - Present
ComSciCon at AIP Participant	Sep 2019

SERVICE & LEADERSHIP

University Positions

Yale Digital Humanities Lab Consultant	<i>Sep 2020 - Present</i>
McDougal Graduate Student Life Fellow at Yale	<i>Aug 2018 - May 2019</i>
Graduate Affiliate, Pauli Murray College at Yale	<i>Fall 2017 - Present</i>

Committee Work

Astrobites Diversity, Equity, and Inclusion Committee Member	<i>Mar 2020 - Present</i>
Physics Climate and Diversity Committee Member	<i>Jan 2018 - May 2020</i>

Conference & Seminar Organization

Co-organizer: Black in Physics Week at Yale Event Series	2020
Volunteer: Conference for Undergraduate Women in Physics	2019-2020
Co-organizer: Equity in the Job Search Symposium	2018-2019

Outreach Volunteering

Astronomy Ambassador, American Astronomical Society	<i>Jan 2020 - Present</i>
Volunteer, Yale Pathways to Science	<i>Fall 2018 - Spring 2019</i>
Activity Leader, CT Students Exploring Engineering Day	<i>Spring 2018</i>
Activity Leader, Girls Science Investigations	<i>Sep 2016 - Present</i>

MENTORSHIP

Undergraduates Researchers Supervised

Claire Recamier, junior at Yale: <i>Stellar Streams in UltraLight Dark Matter Halos</i>	<i>Jun 2021 - Present</i>
Isabel Sands, now Ph.D. student at Caltech: <i>Constructing a Binary Soliton Merger Library</i> <i>Linear Approximations to UltraLight Dark Matter Stationary States</i>	<i>Jan 2020 - Jun 2021</i>

Formalized Mentoring Activities

SU(5) Group Mentor	<i>Fall 2020</i>
Científico Latino Graduate Student Mentoring Initiative (GSMI) Mentor	<i>Fall 2019</i>
Women in Science at Yale (WISAY) Mentor	<i>2016-2019</i>