

# EVAN J. ARENA

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## RESEARCH INTERESTS

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**Theoretical astrophysics and cosmology**, including general relativity, gravitational lensing, modified gravity, large-scale structure, 21 cm cosmology, dark energy, inflation, dark matter, radio astronomy, and gravitational waves.

## EDUCATION

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### Drexel University

Ph.D. Student/Candidate of Physics

*Expected:* July 2024

*Thesis: “Flexion in gravitation and cosmology”*

*Advisor: David M. Goldberg, Ph.D., Co-advisor: David. J. Bacon, Ph.D.*

M.S. in Physics

June 2020

### Stony Brook University

B.S. in Physics, second major: Astronomy/Planetary Sciences

May 2017

*Cum Laude*

*Departmental Honors in Physics*

## POSITIONS HELD

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### Drexel University

2018 – Present

*Doctoral Research Fellow, Doctoral Teaching Fellow, And CoAS Dean’s Fellow*

Department of Physics

### Stony Brook University and Brookhaven National Laboratory

2015 – 2019

*Research Assistant*

SBU Department of Physics & Astronomy and BNL Department of Physics

### Brookhaven National Laboratory

2012 – 2013

*Intern*

Department of Physics

## FUNDED GRANTS

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National Science Foundation (NSF) **Grant №2306989 “Cosmic Flexion”**

2023 – 2026

*Funded Graduate Student*

NSF organization: Division of Astronomical Sciences

NSF program: Extragalactic Astronomy & Cosmology

Award amount: \$359,436.00

Contribution: Wrote significant portion of proposal.

## AWARDS AND HONORS

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*Graduate College Continuing Excellence in Teaching Assistance Award, Drexel University* 2023

*Graduate College Continuing Excellence in Teaching Assistance Award, Drexel University* 2022

*Graduate College Continuing Excellence in Teaching Assistance Award, Drexel University* 2021

*Graduate College Teaching Assistant Excellence Award, Drexel University* 2020

*Sigma Xi Scientific Research Honor Society Member, Drexel University* 2019

<i>College of Arts and Sciences (CoAS) Dean's Fellowship</i> , Drexel University	2018
<i>Sigma Pi Sigma National Physics Honor Society Member</i> , Stony Brook University	2017
<i>Presidential Scholarship</i> , Stony Brook University	2013

## RESEARCH HISTORY

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2018 – Present	<b>Weak gravitational lensing</b> Developed a novel method for measuring the second-order weak gravitational lensing effect known as flexion; Created a full theoretical formalism for “cosmic flexion” – a family of cosmological weak lensing signals originating from the large-scale structure of the universe; Discovered previously unknown cosmological weak lensing signals and posited the existence of non-commutativity in weak lensing; Exploration of flexion in the Dark Energy Survey; Discovered unique weak lensing signatures for negative mass compact objects and exotic objects such as the Ellis wormhole.
2015 – 2019	<b>Low redshift 21 cm intensity mapping</b> Cosmological parameter and modified gravity forecasts for a general 21 cm cosmology experiment, member of the DOE Cosmic Visions Dark Energy 21 cm Working Group, and design and construction of the radio telescope used for the 21 cm Baryon Mapping eXperiment at Brookhaven National Laboratory.
2013	<b>Gravitational waves</b> New method for the indirect detection of gravitational waves.
2012	<b>Modified Newtonian Dynamics</b> Investigated the plausibility of Modified Newtonian Dynamics on a local scale based on rotation curves of the Milky Way.

## REFEREED PUBLICATIONS

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3. **Arena, E. J.**, “*Weak gravitational flexion in various spacetimes: Exotic lenses and modified gravity*,” *Phys.Rev.D* **106**, 064019 (2022) [[arXiv:2207.07784](#)]
2. **Arena, E. J.**, Goldberg, D. M., and Bacon, D. J., “*Cosmic flexion*,” *Phys.Rev.D* **105**, 123521 (2022) [[arXiv:2203.12036](#)]
1. Fabritius, J. M., **Arena, E. J.**, and Goldberg, D. M. “*Shape, color, and distance in weak gravitational flexion*,” *Mon.Not.Roy.Astron.Soc.* **501**, 4103 (2021) [[arXiv:2006.03506](#)]

## CONFERENCE PROCEEDINGS, SCIENCE BOOKS, WHITE PAPERS

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3. Timbie, P. et al., including **Arena, E. J.**, “*Research and Development for HI Intensity Mapping*,” ArXiv e-prints (2019) [[arXiv:1907.13090](#)]
2. Slosar, A. et al., including **Arena, E. J.**, “*Packed Ultra-wideband Mapping Array (PUMA): A Radio Telescope for Cosmology and Transients*,” *Bull.Am.Astron.Soc.* **51**, 53 (2019) [[arXiv:1907.12559](#)]
1. Cosmic Visions 21 cm Collaboration, including **Arena, E. J.**, “*Inflation and Early Dark Energy with a Stage II Hydrogen Intensity Mapping experiment*,” ArXiv e-prints (2018) [[arXiv:1810.09572](#)]

## CONFERENCES AND TALKS

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### Invited Talks

“Constraining the dark universe with light bananas”

Colloquium at the Institute of Cosmology and Gravitation, University of Portsmouth 9 Nov. 2023

## Contributed Talks

“The DES Y3 Weak Lensing Flexion Catalogue”	
Dark Energy Survey Fall Collaboration Meeting, NCSA at UI Urbana-Champaign	10 Oct. 2023
“Constraining the small-scale matter power spectrum with cosmic flexion”	
AstroPhilly ‘23, Villanova University	27 July 2023
“Weak gravitational flexion in the Dark Energy Survey”	
Talk to DES Weak Lensing Working Group, Virtual meeting	11 May 2022
“Hybrid analytic image modeling and image moments approach to gravitational lensing”	
Research talk to incoming graduate students, Drexel University	17 Sep. 2019
“Observation of gravitational waves through precision stellar redshift measurement”	
High School Research Program conference, Brookhaven National Laboratory	16 Aug. 2013

## Poster Presentations

“Hybrid analytic image modeling and image moments approach to gravitational lensing”	
First-year graduate student presentations, Drexel University	11 Jun. 2019
“Dark matter and its alternatives”	
High School Research Program conference, Brookhaven National Laboratory	27 Nov. 2012

## SOFTWARE DEVELOPED

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### Authored

<b>F-SHARP</b>	Code for computing weak gravitational lensing correlations. <i>Publicly available code written in Python.</i> <a href="https://github.com/evanjarena/F-SHARP">https://github.com/evanjarena/F-SHARP</a>
<b>Lenser</b>	A tool for measuring weak gravitational flexion. <i>Publicly available code written in Python.</i> <a href="https://github.com/DrexelLenser/Lenser">https://github.com/DrexelLenser/Lenser</a>
<b>21cmMG</b>	A suite for probing modified gravity with 21 cm cosmology. <i>Publicly available code written in Python.</i> <a href="https://github.com/evanjarena/21cmMG">https://github.com/evanjarena/21cmMG</a>
<b>Fisher21cm</b>	Fisher forecast for a general 21 cm experiment. <i>Publicly available code written in Python.</i> <a href="https://github.com/evanjarena/Fisher21cm">https://github.com/evanjarena/Fisher21cm</a>

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### Contributed

<b>PythonOpenMPI</b>	A generalizable utility for efficient task-based parallel programming using the <code>mpi4py</code> library. <i>Publicly available code written in Python.</i> <a href="https://github.com/seanlabean/PythonOpenMPI">https://github.com/seanlabean/PythonOpenMPI</a>
<b>LensTools</b>	Useful computing tools for weak lensing analyses. <i>Publicly available code written in Python.</i> <a href="https://github.com/apetri/LensTools">https://github.com/apetri/LensTools</a>

## TEACHING

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### Drexel University

*Teaching Assistant* (Recitation and Lab Instructor)

PHYS 100, *Preparation for Engineering Studies* Winter: 2023, 2021, 2020, 2019

*This is a basic mathematics foundational course to prepare the students for the beginning sequence of Engineering Physics. Topics include (but are not limited to): linear and quadratic equations, simultaneous equations, basic geometry, use of trigonometric functions, vectors, translational kinematics, and Newton’s Laws.*

W’23: 3 recitation sections, 65 students total

W’21: 3 recitation sections, 63 students total

W’20: 4 recitation sections, 105 students total

W’19: 3 recitation sections, 86 students total

PHYS 152, *Introductory Physics I*

Spring: 2023, 2022, 2021, 2020, 2019

*This class is the first part of a three-course algebra-based sequence that provides a comprehensive introduction to physics and covers the fundamentals of mechanics. Topics include motion in one or more dimensions, Newton's laws, gravitation, energy, momentum, and rotational motion. This course includes in-person labs that are intended to enrich the concepts presented in lecture and recitation section.*

S'23: 3 recitation sections, 43 students total

S'22: 3 recitation sections, 50 students total

S'21: 4 recitation section, 87 students total

S'20: 1 recitation section, 70 students total

S'19: 4 recitation sections, 70 students total

PHYS 154, *Introductory Physics III*

Fall: 2022, 2021, 2020, 2019, 2018

*This class is the third part of a three-course algebra-based sequence providing a comprehensive introduction to physics and covers the fundamentals of electricity and magnetism. Topics include electric charges, electric fields, electric potential, DC circuits, magnetic induction, electromagnetic waves, special relativity, and optical interference. This course includes labs that are intended to enrich the concepts presented in lecture and recitation section.*

F'22: 3 recitation sections, 64 students total

F'21: 3 recitation sections, 58 students total

F'20: 2 recitation sections and 1 lab section, 84 students total

F'19: 4 recitation sections, 92 students total

F'18: 1 recitation section and 1 lab section, 42 students total

*Grader*

PHYS 131, *Survey of the Universe*

Winter 2022

*This is a three-credit elective course that provides an overview of modern astronomy including the scientific method, telescopes, stars and star clusters, stellar evolution, galaxies and the large-scale structure of the universe, and the Big Bang. The online version of this course is designed to engage students in an investigation of astronomy in a more active way; the hope is that, with this interactive video game platform, students will achieve a greater understanding and appreciation of astronomy.*

PHYS 231, *Introductory Astrophysics*

Winter 2022

*Guest Lecturer*

PHYS 231, *Introductory Astrophysics*

Winter 2022

*This is an introductory astrophysics course aimed for science majors. Topics include a treatment of orbits, Kepler's laws, celestial coordinates, light, blackbodies, optics, stellar structure and evolution, galactic formation, and large scale evolution and structure of the universe.*

W'21: 1 Lecture, 25 students total

**Stony Brook University**

*Lecturer*

Della Pietra High School Applied Math Program

Spring 2017

## PROFESSIONAL ACTIVITIES AND SERVICE

**Collaborations** External Collaborator, Dark Energy Survey (DES)  
Member, Packed Ultra-wideband Mapping Array (PUMA) [Inactive]  
Member, Baryon Mapping eXperiment (BMX) [Inactive]

**Working Groups** Member, DOE Cosmic Visions Dark Energy 21 cm Working Group [Inactive]

### Outreach Activities

Free physics tutoring at the Stony Brook University Veterans Student Organization (2023 – Present).

Assist in running the monthly Drexel Physics Department open house, where we open the the Joseph R. Lynch Observatory for public viewing (2018 – Present).

Invited to appear on the Drexel University Teaching Assistant Orientation Panel, as part of the Teaching Assistant Orientation and Preparation Course GRAD T580 (17 Sep. 2020).

Gave a physics demonstration at the Kaczmarczik Lecture Series Open House, hosted by the Drexel University Department of Physics (14 Nov. 2018).

### **Committee Work**

Treasurer of the Drexel University Physics Graduate Student Association (2020 – 2021).

## **TECHNICAL SKILLS**

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Proficient in *Python*.

Proficient in Bash and Linux environments.

Extensive experience with supercomputing clusters and performing parallel computation.