EVAN J. ARENA

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RESEARCH INTERESTS

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

Drexel University
Ph.D. Student/Candidate of Physics — 2018 – Present
M.S. in Physics — 2020

Stony Brook University
B.S. in Physics, second major: Astronomy/Planetary Sciences — 2017
Cum Laude
Departmental Honors in Physics

POSITIONS HELD

Drexel University — 2018 – Present
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

AWARDS AND HONORS

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

RESEARCH HISTORY

2018 – Present **Weak gravitational lensing**
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 **Low redshift 21 cm intensity mapping**
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 **Gravitational waves**
New method for the indirect detection of gravitational waves.

2012 **Modified Newtonian Dynamics**
Investigated the plausibility of Modified Newtonian Dynamics on a local scale based on rotation curves of the Milky Way.

REFEREED PUBLICATIONS

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

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

Contributed Talks

"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

Authored

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

Contributed

`PythonOpenMPI`	A generalizable utility for efficient task-based parallel programming using the `mpi4py` library. *Publicly available code written in Python.* https://github.com/seanlabean/PythonOpenMPI
`LensTools`	Useful computing tools for weak lensing analyses. *Publicly available code written in Python.* https://github.com/apetri/LensTools

TEACHING

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

Proficient in *Python*.
Proficient in Bash and Linux environments.
Extensive experience with supercomputing clusters and performing parallel computation.