Ana-Roxana Pop

(609) 647-2661 • ana-roxana.pop@cfa.harvard.edu • anaroxanapop.com

Education

Harvard University — Cambridge, MA
Ph.D., Astronomy and Astrophysics — expected May 2021
Adviser: Professor Lars Hernquist
Secondary Field: Computational Science and Engineering
Awards: NASA Earth and Space Science Fellowship (top 5%)

Princeton University — Princeton, NJ
A.B., Physics, *summa cum laude* — 2015

Selected Grants and Awards

- **NASA Earth and Space Science Fellowship** (top 5% in 2018)
- Philip Putnam Chase Fellowship, Harvard University (2015)
- **Peirce Fellowship** (top admitted student at Harvard Astronomy, 2015)
- Elected to Membership in the Phi Beta Kappa Society (2015)
- Elected to Membership in the Sigma Xi Research Society (2015)
- Kusaka Memorial Prize in Physics, Princeton University (2015)
- Allen G. Shenstone Prize in Physics, Princeton University (2014)
- Bershadsky Research Fellowship in Physics, Princeton University (2014)
- Shapiro Prize for Academic Excellence, Princeton University (2013)
- Bell Burnell Award in Physics (2013)
- Treiman Fellowship in Physics (2012)
- Prize *Leprince Ringuet* offered by École Polytechnique, France (2011)
- Silver Medal at International Astronomy and Astrophysics Olympiad (2010)
- **Gold Medal** – International Physics Olympiad (2011)

Journal Publications

1. **Pop, A.-R.**, Pillepich, A., Amorisco, N. C., Hernquist, L. (2018), MNRAS 480, no. 2 1715-1739 [arXiv:1706.06102]
   "Formation and Incidence of Shell Galaxies in the Illustris Simulation"

2. **Pop, A.-R.**, Pillepich, A., Amorisco, N. C., Hernquist, L. (2017), Galaxies 5(3), 34 [arXiv:1708.01615]
   "Shell Galaxies in Illustris: Metallicity Signatures"

3. Marsh, D.J.E. & **Pop, A.-R.** (2015), MNRAS 451, no. 3 2479-2492 [arXiv:1502.03456]
   "Axion dark matter, solitons, and the cusp-core problem"

4. Caprioli, D., **Pop, A. R.**, and Spitkovsky, A. (2015), ApJ 798, 28 (2015) [arXiv:1409.8291]
   "Simulations and Theory of Ion Injection at Non-relativistic Collisionless Shocks"

5. Cen, R., **Pop, A. R.**, and Bahcall, N. A., PNAS 111.22 (2014) 7914-7919 [arXiv:1405.0537]
   "Gas Loss in Simulated Galaxies as They Fall into Clusters"

Submitted Publications

Barnes, D.J., Vogelsberger, M., Pearce, F.A., **Pop, A. R.**, et al (2020), [arXiv:2001.11508]
"Characterizing hydrostatic mass bias with Mock-X"

Technical Skills

Relevant Coursework: Machine Learning; Large Scale Data and Parallel Computing; Advanced Scientific Computing
Computational Physics: Finite Element Method, Quantum Computing, Lattice Boltzmann Codes

Programming and Computation: Python, Java, C, MATLAB, MPI, SQL, Amazon Web Services, LaTeX, HTML/CSS, Linux, Git, SLURM cluster manager

Machine Learning and Statistics: reinforcement learning, regression, classification, clustering, Bayesian inference, deep learning, Markov chain Monte Carlo (MCMC)

Research Experience

Harvard University Cambridge, MA

NASA Graduate Research Fellow, Ph.D. Thesis supervised by Prof. Lars Hernquist 2018 – Present

- Developed post-processing pipeline for large scale dataset (over 500TB) from cosmological simulation of galaxies
- Produced high-fidelity mock X-ray observations of over 100k galaxies, accounting for observational bias and scatter
- Proposed new statistical method using geometric means to improve the recovery of correct slopes in logarithmic space
- Formulated a new mathematical model for a smoothly broken power law and robust bootstrap regression model
- Achieved reliable predictions for galaxies spanning 3 orders of magnitude with major impact for future space missions

Graduate Research Fellow, Master Thesis supervised by Prof. Lars Hernquist 2015 – 2018

- Performed the 1st cosmological simulation study of the origin of stellar features called shells
- Studied the formation and incidence of shell galaxies in the large-volume hydrodynamical Illustris simulation
- Developed stellar history catalogs & merger trees that incorporated hash tables for efficiently tracking and storing the trajectories of more than 1 million stars
- Built code that used logistic regression & SVM to classify galaxy satellites based on whether they formed shells or not
- Our model led to a simple recipe for understanding the formation of shell galaxies in massive ellipticals, emphasizing the role of major head-on mergers between galaxies (arXiv:1706.06102)
- Devised observational test for new formation model based on the unique metallicity signature of shells (arXiv:1708.01615)
- Predictions were confirmed through observations less than 6 months later

Princeton University Princeton, NJ

Research Fellow, Senior Thesis supervised by Prof. Lyman Page 2014 – 2015

- Analyzed the levels of foreground emission in the region of sky investigated by the BICEP2 Collaboration

Perimeter Institute Waterloo, Canada

Research Intern supervised by Dr. David J. E. Marsh Summer 2014

- Developed theoretical model for axion dark matter explaining the presence of flat cores in galaxies
- Built MCMC pipeline to solve the Schrödinger-Poisson system and fit observational data from nearby dwarf galaxies
- Published new limits on axion dark matter mass in a journal article that received more than 150 citations to date

Princeton University Princeton, NJ

Research Fellow, Junior Research Project supervised by Prof. Paul J. Steinhardt Spring 2014

- Analyzed how metric effects due to the presence of black holes can catalyze the decay of the electroweak vacuum

Princeton University Princeton, NJ

Summer Intern and Junior Research Project supervised by Prof. Anatoly Spitkovsky June 2013 – Jan 2014

- Studied particle acceleration at astrophysical collisionless shocks
- Investigated the shock structure using a hybrid simulation
- Developed theoretical model for ion injection into diffusive shock acceleration
- Uncovered new results on the interplay between diffusive shock acceleration and shock drift acceleration
- Paper published in ApJ Letter (arXiv:1409.8291)

Princeton University Princeton, NJ

Research Assistant for Prof. Neta Bahcall and Dr. Renyue Cen Summer 2012

- Studied how galaxies lose their cold gas at low redshifts using high-resolution cosmological hydrodynamic simulations
- Discovered that galaxies start to feel the impact of the cluster environment on their gas content well beyond the cluster virial radius
- Uncovered that almost all galaxies that fall into clusters lose their cold gas within a single radial round-trip around the cluster center
- Paper published in PNAS (arXiv:1405.0537)

Additional Computational Experience

Harvard University Cambridge, MA

Graduate course project (Machine Learning) Spring 2020

- Designed reinforcement learning algorithm (Q-learning with ϵ-greedy policy) to play side-scrolling video game
- Model surpassed human performance after 40 epochs of training

Team Member, Graduate course final project (Extreme Scale Data and Computational Science) Spring 2018

- Developed BEHALF - a parallel Barnes-Hut algorithm for solving N-body gravitation problems
- BEHALF is a GPU-accelerated, MPI-parallel code implemented & executed on 576 cores/12 nodes with 25x speed-up

Outreach and Leadership Experience

International Astronomy and Astrophysics Olympiad Phuket, Thailand

Team Leader of the United States Team 2017

- Promoted Astrophysics among high school students as part of the USA Astronomy and Astrophysics Organization
- Devised novel problems for 2 national selection rounds and selected a team of 5 students out of 222 participants
- Co-organized one-week training camp for 15 students at MIT; coached the US team through weekly training video calls
- Fundraised more than $3,000 to cover travel expenses for the US team
- Led the US team at the International olympiad, mediated the selection of problems with team leaders from 44 countries
- Achieved best result in history of US participations at IOAA: team placed 2nd in the world and won 2 Gold Medals

Banneker & Aztlán Institute Cambridge, MA

Mentor and Scientific Adviser 2017

- Devised and directly supervised a student research project as part of 10-week summer astronomy program for undergraduate students of color; provided training in programming, research methods and science communication
- Project culminated with student giving her 1st conference talk at the annual American Astronomical Society Meeting

ComSciCon National Workshop Cambridge, MA

Member of Local Organizing Committee 2017

- Collaborated with a 12-person team to organize national STEM communication and outreach workshop
- Facilitated competitive review process of over 1000 applications and selection of 90 participants for national workshop
- Supervised conference ePoster session, coordinated with vendors, designed and acquired promotional materials

Harvard University Cambridge, MA

Graduate Teaching Fellow 2016-2019

- Led lectures on Numerical Methods and Astrophysics; guided weekly review sessions for groups of 15+ students
- Twice awarded the Derek Bok Award for Teaching Excellence

Lab Meeting Chair 2018-2020

- Led weekly lab meetings for the Hernquist Group encompassing 25-30 researchers; mediated scientific conversations; invited 50+ speakers from US and international institutions

Teaching

- Twice-awarded the Derek Bok Award for Teaching Excellence
- Teaching Assistant for AST 201: Astrophysical Fluids & Plasmas, Harvard University — Spring 2019
- Teaching Assistant for AST 202B: Extragalactic Astronomy and Cosmology II, Harvard University — Spring 2018
- Teaching Assistant for AST 202A: Extragalactic Astronomy and Cosmology I, Harvard University — Fall 2017
- Teaching Assistant for AST 200: Radiative Astrophysics, Harvard University — Fall 2016
- Teaching Assistant for PHY 104: General Physics II, Princeton University — Spring 2014
- Tutor in Physics and Mathematics, Princeton University — 2011 - 2014

Invited Talks and Conferences

- Simulating Multiscale Astrophysics to Understand Galaxies (SMAUG) — NYC, NY
  Center for Computational Astrophysics, Simons Foundation — Dec 2019
- Institute of Theory and Computation Luncheon Talk Seminar — Cambridge, MA
  Harvard University — Nov 2019
- X-Ray Astronomy Current Challenges and New Frontiers Conference — Bologna, Italy
  CNR/INAF — Sep 2019
- Kavli Institute for Cosmology, Cambridge 10th Anniversary Conference — Cambridge, UK
  KICC — Sep 2019
- Cluster Group Meeting Talk, Center for Astrophysics — Cambridge, MA
  Harvard University — Aug 2019
- Simulating Multiscale Astrophysics to Understand Galaxies (SMAUG) — NYC, NY
  Center for Computational Astrophysics, Simons Foundation NYC — Dec 2018
- Gas Fuelling of Galaxy Structures Conference Talk — Barossa Valley, Australia
  ASTRO3D — Nov 2018
- Galaxy Clusters Conference Talk — Santander, Spain
  Jul 2018
- Stellar Halos Across the Cosmos Conference Talk — Heidelberg, Germany
  MPIA — Jul 2018
- UC Santa Cruz, Astronomy and Astrophysics Seminar Talk — Santa Cruz, CA
  University of California Santa Cruz — June 2018
- Space Telescope Science Institute Seminar Talk — Baltimore
  STScI — May 2018
- Institute of Theory and Computation Luncheon Talk — Cambridge, MA
  Harvard University — Apr 2018
- Columbia U. Astronomy Department Seminar Talk — NYC,NY
  Columbia University — Apr 2018
- SnowCluster - The Physics of Galaxy Clusters Conference — Utah
  Mar 2018
- Heidelberg Institute for Theoretical Studies Talk — Heidelberg, Germany
  HITS — Jan 2018
- On the Origin of Baryonic Galaxy Halos Conference Talk — Galapagos Islands, Ecuador
  Mar 2017
- Australian National University Talk — Canberra, Australia
  ANU — Feb 2017