Nianyi Chen

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RESEARCH INTERESTS

Keywords: numerical simulation, massive black holes, gravitational waves, galaxy formation, cosmic reionization, cosmic microwave background

EDUCATION

Carnegie Mellon University, *Pittsburgh, PA*
Ph.D. in Physics, GPA: 4.0/4.0;
Ph.D. Minor in Machine Learning *Sep. 2018 – Present.*
Advisors: Hy Trac, Tiziana Di Matteo

The University of Chicago, *Chicago, IL*
B.A. in Math & Physics *2014 - 2018*
Thesis: Comparing mass proxies for tSZ-selected galaxy clusters in SPT-SZ

RESEARCH EXPERIENCE

Graduate Research Assistant, *Carnegie Mellon University* *Sep. 2018 – Present.*

- *Cosmological and isolated hydrodynamical simulations on massive black hole evolution, dynamics, and mergers; semi-numerical simulation and emulation of cosmic reionization and its imprint on the cosmic wave background.*

Advisors: Hy Trac, Tiziana Di Matteo

Undergraduate Research Assistant, *KICP, UChicago* *May. 2016 – June. 2018*

- *Worked on compression algorithms for extracting maximum information from cosmic shear data in the Dark Energy Survey; comparing mass proxies for galaxy clusters in the South Pole Telescope Survey*

Advisors: Scott Dodelson, Bradford Benson

AWARDS & HONORS

MCS Graduate Conference Travel Award, Carnegie Mellon University, *March 2023*
John Peoples Jr. Research Fellowship, Carnegie Mellon University, *2019-2020*
Undergraduate Summer Research Fellowship, Enrico Fermi Institute, *Summer 2015*

GRANTS ALLOCATION

McWilliams Seed Grant, *Pittsburgh Supercomputing Center* *2023*
"Towards Better Modeling of the Super-Massive Black Hole Orbital Evolution in Cosmological Simulations", awarded 150,000 CPU hours on the Bridges-2 Cluter

PROFESSIONAL MEMBERSHIP & SERVICES

Referee, Monthly Notices of the Royal Astronomical Society (MNRAS)
Member, Laser Interferometer Space Antenna (LISA) Astrophysics Working Group
Contributor, Massively Parallel Cosmological SPH Simulation Software `MP-Gadget`
Contributor, Semi-numerical simulator for the cosmic dawn and reionization `AMBER`

OUTREACH & SERVICES

Organizer, McWilliams Center Career Development Series, *CMU* *Feb. 2023 – present.*
Design and organize presentations and workshops for learning "soft skills" in career development.

Organizer, McWilliams Center Weekly Journal Club, *CMU* *June. 2020 – Dec. 2021*
Organize and coordinate speakers for the weekly journal club for discussing new papers on the Arxiv.

Presentation, Astronomy on Tap Pittsburgh, *Pittsburgh* *May. 2023*

Tutorial, McWilliams Software Development Workshop, *CMU* *Nov. 2022*
Deep learning with PyTorch on astrophysical datasets

Presentation, Physics Sophomore Colloquium, *CMU* *Feb. 2021*

TEACHING & MENTORING

Student Supervision, *Carnegie Mellon University* *May. 2022 – present.*
***Undergraduate Students**: Calvin Hoffman (Primary mentor, May 2022-present, leads to a major journal publication), Clytie Qiu (May 2023-present); **Graduate Student**: Ekaterine Dadiani (May 2022-present)*

Co-Instructor, *Carnegie Mellon University* *Feb. 2023 – March. 2023*
Courses: First Year Seminar: Black Holes and Gravitational Waves (33-101)

Graduate Teaching Assistant, *Carnegie Mellon University* *Sep. 2018 – August. 2021*
Courses: Physics I for Science Students (33-121); Physics II for Biological Sciences and Chemistry Students (33-122); Physics II for Engineering and Physics Students (33-142); Stars, Galaxies, and the Universe (33-224); Quantum Physics and Structure of Matter (33-225)

Physics Core Tutor, *The University of Chicago* *Sep. 2017 – June. 2018*
Role: Tutoring physics courses for non-physics majors.

PUBLICATIONS

First-Author Publications (6 total: 5 published, 1 submitted)

N. Chen, P. LaChance, Y. Ni, T. D. Matteo, R. Croft, P. Natarajan et al., *Fly-by galaxy encounters with multiple black holes produce star-forming linear wakes*, *submitted to ApJ Letters* (2023)

N. Chen, T. Di Matteo, Y. Ni, M. Tremmel, C. DeGraf, Y. Shen et al., *Properties and evolution of dual and offset AGN in the ASTRID simulation at z 2*, MNRAS **522** (2023) 1895 [2208.04970]

N. Chen, H. Trac, S. Mukherjee and R. Cen, *Patchy Kinetic Sunyaev-Zel'dovich Effect with Controlled Reionization History and Morphology*, ApJ **943** (2023) 138 [2203.04337]

N. Chen, Y. Ni, A. M. Holgado, T. D. Matteo, M. Tremmel, C. DeGraf et al., *Massive black hole mergers with orbital information: predictions from the ASTRID simulation*, MNRAS **514** (2022) 2220 [2112.08555]

N. Chen, Y. Ni, M. Tremmel, T. Di Matteo, S. Bird, C. DeGraf et al., *Dynamical friction modelling of massive black holes in cosmological simulations and effects on merger rate predictions*, MNRAS **510** (2022) 531 [2104.00021]

N. Chen, A. Doussot, H. Trac and R. Cen, *SCORCH. III. Analytical Models of Reionization with Varying Clumping Factors*, ApJ **905** (2020) 132 [2004.07854]

Publications with Major Contributions (5 total; † denotes students mentored)

C. Hoffman†, **N. Chen**, T. Di Matteo, Y. Ni, S. Bird, R. Croft et al., *Triple and Quadruple Black Holes in the ASTRID Simulation at $z \sim 2$*, *arXiv e-prints* (2023) arXiv:2303.04825 [2303.04825]

T. Di Matteo, Y. Ni, **N. Chen**, R. Croft, S. Bird, F. Pacucci et al., *A vast population of wandering and merging IMBHs at cosmic noon*, *arXiv e-prints* (2022) arXiv:2210.14960 [2210.14960]

C. DeGraf, **N. Chen**, Y. Ni, T. Di Matteo, S. Bird, M. Tremmel et al., *High-redshift supermassive black hole mergers in simulations with dynamical friction modelling*, *arXiv e-prints* (2023) arXiv:2302.00702 [2302.00702]

H. Trac, **N. Chen**, I. Holst, M. A. Alvarez and R. Cen, *AMBER: A Semi-numerical Abundance Matching Box for the Epoch of Reionization*, ApJ **927** (2022) 186 [2109.10375]

T. Ferreira, T. Zhang, **N. Chen**, S. Dodelson and LSST Dark Energy Science Collaboration, *Data compression and covariance matrix inspection: Cosmic shear*, Phys. Rev. D **103** (2021) 103535 [2010.15986]

Other Co-authored Papers (9 total: 8 published, 1 in press)

Y. ching Chen, X. Liu, A. Foord, Y. Shen, M. Oguri, **N. Chen** et al., *A close quasar pair in a disk–disk galaxy merger at $z = 2.17$*, *Nature* **616** (2023) 45

Y. Shen, H.-C. Hwang, M. Oguri, **N. Chen**, T. Di Matteo, Y. Ni et al., *Statistics of Galactic-scale Quasar Pairs at Cosmic Noon*, ApJ **943** (2023) 38 [2208.04979]

Y. Ni, S. Genel, D. Anglés-Alcázar, F. Villaescusa-Navarro, Y. Jo, S. Bird et al., *The CAMELS project: Expanding the galaxy formation model space with new ASTRID and 28-parameter TNG and SIMBA suites*, *arXiv e-prints* (2023) arXiv:2304.02096 [2304.02096]

E. J. Weller, F. Pacucci, Y. Ni, **N. Chen**, T. Di Matteo, M. Siwek et al., *Orbital and radiative properties of wandering intermediate-mass black holes in the ASTRID simulation*, MNRAS **520** (2023) 3955 [2210.16319]

S. Bird, Y. Ni, T. Di Matteo, R. Croft, Y. Feng and **N. Chen**, *The ASTRID simulation: galaxy formation and reionization*, MNRAS **512** (2022) 3703 [2111.01160]

S. Banks, K. Lee, N. Azimi, K. Scarborough, N. Stefanov, I. Periwal et al., *On the detectability of massive black hole merger events by Laser Interferometry Space Antenna*, MNRAS **512** (2022) 6007 [2107.09084]

Y. Ni, T. Di Matteo, S. Bird, R. Croft, Y. Feng, **N. Chen** et al., *The ASTRID simulation: the evolution of supermassive black holes*, MNRAS **513** (2022) 670 [2110.14154]

T. M. C. Abbott, M. Aguena, A. Alarcon, S. Allam, S. Allen, J. Annis et al., *Dark Energy Survey Year 1 Results: Cosmological constraints from cluster abundances and weak lensing*, Phys. Rev. D **102** (2020) 023509 [2002.11124]

E. Krause, T. F. Eifler, J. Zuntz, O. Friedrich, M. A. Troxel, S. Dodelson et al., *Dark Energy Survey Year 1 Results: Multi-Probe Methodology and Simulated Likelihood Analyses*, *arXiv e-prints* (2017) arXiv:1706.09359 [1706.09359]

PRESS RELEASES

Hubble Press Release, *Hubble Unexpectedly Finds Double Quasar in Distant Universe* *2023*
https://hubblesite.org/contents/news-releases/2023/news-2023-002

TALKS

LISA Mini-Workshop on Dual AGN, *online* *April 2023*
Properties of Dual and Offset AGN in the ASTRID Simulation

Extreme Black Holes Conference, *Aspen Center for Physics* *March 2023*
AGN Tuples and Their Paths to Mergers, Wanderers, and Ultra-Massive Black Holes

SZ Workshop, *Flatiron Institute, NY* *June 2022*
Patchy kSZ Effect with AMBER: From Simulation to Emulation

BCCP Reionization Workshop, *Berkeley, CA* *March 2022*
Patchy kSZ Effect with Controlled Reionization History and Morphology

3rd LISA AstroWG Meeting, *online* *June 2021*
Orbital Eccentricity and Merger Rate of SMBH Binaries from the ASTRID Simulation

SAZERAC CMB Conference, *online* *April 2021*
Patchy kSZ Effect with AMBER: From Simulation to Emulation

Astro-Coffee @ Princeton, *online* *March 2021*
Title: More Accurate Modeling of SMBH Dynamics and Mergers in Large-Volume Cosmological Simulations

DES Collaboration Meeting, *Chicago, IL* *July. 2017*
Title: Likelihood Analysis with Compresssed DES Y1 Two-point Data

OTHER PROJECTS

Web-API for BLUETIDES Simulation, *Pittsburgh Supercomputing Center* *June. 2020 – September. 2020*
Design and implement a web-API for conveniently querying from peta-bytes of data from the BLUETIDES simulation using the Bridges super-computing cluster

Visualizing Astrophysical Simulations with Artistic Generative Models, *CMU Sept.. 2019 – Dec.. 2019*
CMU Data Science Club Semester Project

RELEVANT SKILLS

Programming: Intermediate skills in Python, C, Fortran; experience with coding using Spark, Pytorch, OpenMP/MPI; frequent user of Github.
Machine Learning: Graduate-level: Machine Learning and Large-scale Data; Intro to Machine Learning; Topics in Deep Learning; Convex Optimization; Probablistic Graphical Models; Probability and Mathematical Statistics; Monte Carlo Simulations.
