Bin Xia

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Education

2021 - present Ph.D. Candidate, Physics, Georgia Institute of Technology
M.S., Computational Science & Engineering, Georgia Institute of Technology
Advisor: John Wise

2015 - 2019 B.S., Physics with Highest Honor, Jilin University, China
Advisor: Coleman Miller, the University of Maryland, College Park
Rank: 1/289, GPA: 3.95/4

Selected Honors & Awards

Top 10 Distinguished Students Award, Jilin University (0.02%) 2019
President Scholarship, Jilin University (0.02%) 2019
Dean Scholarship, College of Physics (0.5%) 2019
First-class Scholarship, Jilin University 2019
China National Scholarship (0.2%) (Twice) 2017 & 2018

Selected Research Experience

Cosmological 21cm Lightcones Generation Using High-Fidelity Conditional Diffusion 2024

- Developed a cutting-edge conditional diffusion model to generate high-fidelity 3D 21cm brightness temperature lightcones, bridging machine learning with large-scale cosmological data analysis
- Overcame computational challenges by employing multi-GPU parallelism, gradient accumulation, mixed precision training, and checkpointing to handle large-scale 3D data, ensuring stable model convergence
- Demonstrated exceptional agreement with semi-numerical simulations generated by 21cmFAST in terms of global temperature, power spectrum, and scattering transform coefficients, validating the accuracy and robustness of the model
- Tools & Techniques: PyTorch, high-performance computing, advanced hyperparameter tuning

Space-Based Radio Astronomy with Spacecraft Formations May 2022 - Dec. 2023

- Calculated the temperature evolution of baryons and dark matter (DM) during the early universe
- Explored the heating effect of the relative velocity between baryons and milli-charged DM
- Extended the *Accelerated Reionization Era Simulations (ARES)* python package to include the baryon-DM interactions when generating a global 21cm signal model
- Developed an inference program to estimate the mass of DM and the streaming velocity between DM and gas, given a 21cm signal intensity and redshift
- Developed an interpolation scheme to produce an all-sky map of the foreground emission from the Milky Way, including absorption and scattering from intervening gas. This product informs the instrument design for the minimum resolution required for a space-based radio telescope

Retention of Intermediate-mass Black Holes with Dynamical Friction Jan. 2019 - July 2019

- Explored the formation mechanisms of intermediate-mass black holes (IMBHs) within globular clusters
- Designed numerical programs to estimate the gravitational recoil velocity of binary black hole mergers
- Calculated the final recoil of IMBH after black hole merges in a globular cluster with particular distributions of mass ratios, spins, relative spin orientations, and orbital eccentricity
- Simulated the retention probability of IMBHs as a function of initial mass by *Monte Carlo methods*

Teaching & Mentoring Experience

Research Mentor

Vanessa Montgomery 2022 - 2024

Teaching Assistant

Introductory Mechanics Labs (4 sections) Aug. 2021 - May 2022

Kentucky-Rutgers-Jilin University International Courses May - June 2018

Atomic Physics, where I edited a *Question & Answer Manual* for about 200 students 2017

Publications

Bin Xia, J. H. Wise, "Cosmological 21cm Lightcones Generation Using High-Fidelity Conditional Diffusion". The Astrophysical Journal. *In Prep.*

S. Henry, M. Mancini, **Bin Xia**, J. H. Wise, S. Storm, K. Burkhardt, D. Richardson, G. Badura, V. Montgomery, J. A. Christian, "Space-Based Radio Astronomy with Spacecraft Formations". Acta Astronautica. *In Prep.*

C. Brummel-Smith, D. R. Skinner, S. Sethuram, J. H. Wise, **Bin Xia**, K. Taori, 2023, "Inferred galaxy properties during Cosmic Dawn from early JWST Photometry Results". Monthly Notices of the Royal Astronomical Society, 525, 4405.

Academic Activities

Peking University & Tsinghua University visiting student Aug. 2023

Delivered a presentation on How to Be an Outstanding Student at *TED×JLU* Oct. 2019

Gave Astrophysics lectures for outstanding elementary school students in Jilin Province 2018 - 2019

Harbin Institute of Technology-Jilin University Everest Project Exchange June 2019

Sun Yat-sen University Fu Lan Physics Festival (Twice) Dec. 2017, 2018

Gave a lecture on black holes for Harbin Institute of Technology visiting students Nov. 2018

Cambridge-JLU Summer Academic Programme in Computational Physics Aug. 2018

Delivered a presentation on How to Achieve Academic Success for about 1000 students Apr. 2018

Nagoya University-Jilin University TAQ Class Summer Program July - Aug. 2017

Skills

Programming	Python, Linux/Unix, Bash scripting, Slurm, Git, MATLAB, C, LaTeX
Machine learning	Diffusion model, Transformer, Consistency model, Generative adversarial network, Convolutional neural network, Long short-term memory, Random forest
Scientific skills	data analysis, data visualization, data reduction, feature engineering, unstructured data, qualitative data, volumetric data, technical writing, statistics

Extracurricular Activities

Served as a coach of regular trampolines and skiing activities in Changchun Sept. 2018 - June 2021

Served as the leader of a game development team; released the video game *JLU Defence* 2019

Volunteered at an orphanage in Atlanta, USA Apr. 2018

Leading role of the film *Reverse*, calling the public to care for people with depression or autism 2017

Learning breakdancing since 2010; serving as a coach of the University Street Dance club since 2015