Yun Wang

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Research Interests

My current works focus on investigating various properties of the large-scale structure of the Universe from cosmological simulations, with the goal of bridging theoretical models with sky surveys and offering insights into fundamental cosmic phenomena. For this, I proposed a series of novel summary statistics, including the environment-dependent Wavelet Power Spectrum (env-WPS), environment-dependent Wavelet Cross-Correlation (env-WCC), scale-dependent PeaK Height Function (scale-PKHF), and scale-dependent VaLleY Depth Function (scale-VLYDF). By employing the env-WPS and env-WCC, I analyzed the spatial deviation between baryonic gas and dark matter, the turbulent behavior of baryonic gas, and baryonic feedback effects on matter distribution. I also investigated the potential of the scale-PKHF and scale-VLYDF in constraining primordial non-Gaussianity and cosmological parameters from late-time matter distribution, highlighting their superiority over the ordinary power spectrum and bispectrum.

Education

Ph. D. degree — 09/2018 – 06/2023
College of Physics, Jilin University — Changchun, P. R. China

- **Major:** Cosmology
- **Thesis:** Applications of the continuous wavelet analysis to the large-scale structure of the Universe
- **Supervisor:** Prof. Ping He

Gap Year for Personal Development — 06/2017 – 09/2018
Changchun, P. R. China

- Dedicated time to self-improvement, including studying advanced mathematics and physics to prepare for graduate-level studies

Bachelor degree — 06/2013 – 06/2017
School of Physics, Northeast Normal University — Changchun, P. R. China

- **Major:** Physics
- **Thesis:** Primordial Gravitational Waves: theory and progress of detection
- **Supervisor:** Mr. Shiju Cui

Work Experience

Postdoctoral Research Fellow — 07/2023 – Present
College of Physics, Jilin University — Changchun, P. R. China

- **Field:** The Large-Scale Structure of the Universe
- **Postdoctoral Advisor:** Prof. Weimin Song and Prof. Ping He

Funded Projects

Theoretical Physics Research Project of the National Natural Science Foundation of China 01/2024 – 12/2024

- **Role:** Principal Investigator
- **Grant No.:** 12347163
- **Grant Amount:** 180,000 RMB
- **Project Title:** Accurately constraining cosmological parameters with the continuous wavelet transform
- **Description:** Based on the continuous wavelet transform, this project intends to build two statistics, i.e. the environment-dependent wavelet power spectrum and the scale-dependent wavelet probability distribution function, and utilize them to constrain cosmological parameters and explore the uncertainties of the baryonic effects, thereby providing a theoretical basis for the optimal extraction of cosmological information from the next-generation survey data.

General Program of the China Postdoctoral Science Foundation 11/2024 – 07/2025

- **Role:** Principal Investigator
- **Grant No.:** 2024M761110
- **Grant Amount:** 80,000 RMB
- **Project Title:** Multi-scale modeling of baryonic effects on the cosmic web
- **Description:** The project aims to analyze baryonic effects on the cosmic web using the environment-dependent wavelet power spectrum while incorporating machine learning techniques for theoretical modeling. This innovative approach is expected to provide reliable information for the upcoming large-scale sky surveys.

Fellowships and Awards

- **Dingxin Postdoctoral Fellowship** Jilin University, 2023 – 2025
  Selected through a highly competitive process to lead innovative research on cosmology and astrophysics, with an annual salary of 300,000 RMB.
- **Outstanding Graduating Ph.D. Award** Jilin University, 2023
  Recognized for exceptional academic performance and research contributions during doctoral studies.
- **Outstanding Doctoral Dissertation Award** Jilin University, 2023
  Recognized for contribution to the cosmological data analysis methodology
- **National Scholarship for Doctoral Students** Ministry of Education, China, 2022
  Awarded for outstanding academic performance and research excellence, with a monetary prize of 30,000 RMB.
- **First-Class Scholarship for Academic Excellence** College of Physics, Jilin University, 2022
  Awarded for research achievements during the period 2021 – 2022, with a monetary prize of 20,000 RMB.
- **First-Class Outstanding Graduate Scholarship** College of Physics, Jilin University, 2022
  Recognized for academic excellence during the period 2021 – 2022, and awarded a monetary prize of 1,500 RMB.

Codes and Softwares

- **FortranCWT** https://github.com/WangYun1995/FortranCWT
  The Fortran 95 codes for fast implementation of the Continuous Wavelet Transform (CWT) of the one-dimensional signals.
- **pyFortranCWT** https://github.com/WangYun1995/pyFortranCWT
  Python wrappers of the FortranCWT codes created with f2py.
- **WPSmesh** https://github.com/WangYun1995/WPSmesh
  The Python module that used to measure the environment-dependent Wavelet Power Spectrum (env-WPS) of the cosmic density field.
- **CWTextrema-Fisher** https://github.com/WangYun1995/CWTextrema-Fisher
  The codes for computing the scale-dependent peak height function (scale-PKHF) and the scale-dependent valley depth function (scale-VLYDF) of the cosmic-log density field, and forecasting their constraining power on cosmological parameters.
- **TNG50BaryonicFluidAnalyzer** https://github.com/WangYun1995/TNG50BaryonicFluidAnalyzer
  The codes used to explore the dynamical and thermodynamic origins of the missing baryon problem with the IllustrisTNG50-1 simulation.

Skills

- **Programming Languages:** Python, Cython, Fortran, C, C++, LaTeX
- **Data Analysis Tools:** FFTW, MPI, OpenMP, nbodykit, Pylians, pynbody, numpy, scipy, Mathematica
- **Others:** Bash, git, HTML, basics of machine learning

Conferences

1. (Oral presentation in Chinese) **Yun Wang**, "Constraining the primordial non-Gaussianity from the late Universe based on the multi-scale extrema of cosmic log-density field". 2024 Annual Meeting of the Chinese Astronomical Society, Hangzhou, China, Oct 2024
2. (Oral presentation in English) **Yun Wang**, "A pair of novel statistics to improve constraints on primordial non-Gaussianity and cosmological parameters". 2024 International Conference on the Cooperation and Integration of Industry, Education, Research and Application: 3rd China-Ukraine Frontiers Forum, online, Sep 2024
3. (Oral presentation in Chinese) **Yun Wang**, "Investigating the effects of galaxy formation physics on the cosmic matter distribution in both configuration space and the scale domain simultaneously". 2024 Annual Meeting of the Gravitational and Relativistic Astrophysics Branch of the Chinese Physical Society & The Sixth GALILEO-XU GUANGQI Meeting, Hengyang, China, Apr 2021

Publications

Publications in refereed journals

1. **Yun Wang**, P. He., "Capturing primordial non-Gaussian signatures in the late Universe by multi-scale extrema of the cosmic log-density field", PRD (Letter), vol. 111, pp. L041302, 2025
2. **Yun Wang**, P. He., "Turbulence, Thermal Pressure, and Their Dynamical Effects on Cosmic Baryonic Fluid", MNRAS: Letters, vol. 534, pp. L14 – L20, 2024
3. M.-X. Li, **Yun Wang**, P. He, "Identifying Halos in Cosmological Simulations with Continuous Wavelet Analysis: The 2D Case", ApJ, vol. 973, pp. 39, 2024

4. **Yun Wang**, P. He., "Turbulence Revealed by Wavelet Transform: Power Spectrum and Intermittency for the Velocity Field of the Cosmic Baryonic Fluid", ApJ, vol. 974, pp. 107, 2024
5. **Yun Wang**, P. He., "How do baryonic effects on the cosmic matter distribution vary with scale and local density environment?", MNRAS, vol. 528, pp. 3797 – 3808, 2024
6. **Yun Wang**, P. He., "Comparisons between fast algorithms for the continuous wavelet transform and applications in cosmology: the 1D case", RASTI, vol. 2, pp. 307 – 323, 2023
7. **Yun Wang**, P. He., "Simultaneous Dependence of Matter Clustering on Scale and Environment", ApJ, vol. 934, pp. 112, 2022
8. **Yun Wang**, H.-Y. Yang, and P. He., "Continuous Wavelet Analysis of Matter Clustering Using the Gaussian-derived Wavelet", ApJ, vol. 934, pp. 77, 2022
9. H.-Y. Yang, **Yun Wang**, P. He, and et al., "The spatial distribution deviation and the power suppression of baryons from dark matter", MNRAS, vol. 509, pp. 1036-1047, 2021
10. **Yun Wang**, P. He, "The continuous wavelet derived by smoothing function and its application in cosmology", Commun. Theor. Phys., vol. 73, pp. 095402, 2021

Preprints and Submitted Papers

1. M.-X. Li, **Yun Wang**, P. He, "CWTHF: Identifying Dark Matter Halos with Continuous Wavelet Transform", arXiv Preprint, arXiv:2501.10622