Zhenghao Xu

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ACADEMIC & CAREER

UC Santa Barbara Department of Physics	**Graduate Researcher** *Astrophysics Emphasis*	Winter 2021 - Present
Tsinghua University Institute for Advanced Study	**Research Assistant** *Computational Astronomy and Astrophysics Group*	Fall 2019 - Fall 2020
Peking University School of Mathematical Science Department of Chinese L & L	**B.S. with Honors** Major: *Information & Computing Science* Minor: *Chinese Language & Literature*	Fall 2015 - Spring 2019
MIT Department of Physics	**Visiting Scholar** *Computational Structure and Galaxy Formation Group*	Summer 2018 - Fall 2018
Minibug Games	Unity Engineer	Fall 2020 - Winter 2021

RESEARCH INTEREST

Stellar Populations, Stellar Evolution, Stellar Structure, Planetary Disks, Accretion Disks, Binary Disks, Compact Objects, Magneto-hydrodynamics Simulations, Statistical Learning, Bayesian Analysis, Machine Learning, Data-Observation Integration

RESEARCH EXPERIENCE

Bayesian Ages of Star Clusters From Rotation and Mixing Models 2022 - 2023
Advisor: Prof. Timothy D. Brandt, UCSB ⇒ STScI

- Highlighted advantages of rotation-convection star models with MESA over other codes.
- Crafted H-R diagram isochrones with grids of masses and MESA knobs comprehensively.
- Synthesized color-mag/$v\sin(i)$ diagrams with PARS specialized for rotating darkening.
- Applied GAIA/Hubble observational color-mag and $v\sin(i)$ data for Bayesian calculations.
- Rotational-Induced Boundary Mixing Models May Extend Turnoffs thus Age of Clusters.

Revealing Dark Matter Distribution Pixelwisely by Deep Learning Summer 2018
https://github.com/zhxu-astro/DeepIllustris
Advisor: Prof. Mark Vogelsberger, MIT

- Transformed IllustrisTNG data converting fluid dynamics into matrix representations.
- Deployed U-Net and GAN algorithms predicting 3D DM distribution from baryonic profiles.
- Achieved predictions consistent with true distributions in morphology and NFW profiles.

Rossby Wave Instability of Dust-Trapping Rings in Disks 2019 - 2021
Advisor: Prof. Xuening Bai, Tsinghua University

- Delineated complex physics and geometry to establish governing equations in planetary disks
- Using the perturbation method to derive the quasi-linear equations in a local Shearing-box
- Identified the dynamos corresponding to the Rossby Wave Instability from all eigenmodes
- Rossby Wave Instability provies a means to collecting dust particles for Planetesimal formation

Machine Learns to Interpret Phenomena in Disk–Planet Systems 2020 - 2021
Advisor: Prof. Ruobing Dong, University of Victoria

- Executed gas-dust coupled simulations of proto-planetary disks on GPUs via FARGO
- Altered simulation initial parameters such as viscosity, dust Stokes number, and planet mass
- Testing interpretative ML technique on the simulation data without prior knowledge

Hierarchical Distribution of Young Stellar Objects(YSO) in M17 Fall 2017
Advisor: Prof. Richard de Grijs, Peking University ⇒ Macquarie University

- Identified the YSOs according to spectrum criteria, data from UKIDSS Survey.
- Investigated the distribution of YSOs using KDE and 2-points correlation function.

OBSERVING EXPERIENCE

Keck Telescope (NIRC2), 4 half-nights. **Subaru** Telescope (FOCAS, MOIRCS) 2 half-nights.

TEACHING EXPERIENCE

Astro 1 (Basic Astronomy): Winter 2021, Fall 2022, Winter 2023, Fall 2023; **Astro 2 (History of the Universe)**: Winter 2021; **Phys 3L (Basic Physics)**: Fall 2022; **Phys 6BL (Introductory Experimental Physics)**: Fall 2022; **Phys 127BL (Digital Electronics)**: Spring 2023.

THESES & PUBLICATIONS

(in prep.) Rotational-Induced Core-Envelope Mixing Penetration Effects on the Extended Main Sequence Turnoffs in Intermediate-Age Clusters Z. Xu, T. Brandt

(B.S. dissertation) On the Large-Scale Cosmological Simulation Method for the Coupling of Dark Matter and Baryonic Matter, Z. Xu. Peking University

SKILLS

Programming Languages: Python, MATLAB, C++, Linux, Mathematica, Fortune, R
Scientific Codes: Athena++, MESA, Dedalus, Fargo3D, Tensorflow, PyTorch
Mathematical Expertise: Statistical Analysis, Computational Fluid Dynamics

SELECTED COURSE PROJECTS

Numerical PDE Solver, Numerical Partial Differential Equations(G), 2018
optimized by **Multi-Grid Preconditioner Conjugate Gradient**, using both Finite Different Scheme and Finite Element Scheme, in the best case, will reduce the time complexity from $O(n^3/2)$ to $O(n)$. for the Heat equation and anisotropic Poisson equation.

Eigensystem Solver, Numerical Algebra, 2018
by Inverse-free preconditioned **Krylov Subspace Method**, for Generalized Eigenvalue Problems $Ax = \lambda Bx$, excellent even when singular values are extremely close to zero.

Navier-Stokes Fluid Simulator, Computational Fluid Dynamics(G), 2018
one with **Quasi-Spectral** Method, the other with **Godunov Scheme Finite Volume Method**, high-accuracy and high-performance.

2D & 3D Ising Model Simulator, Numerical Analysis, 2019
using the **Monte-Carlo Markov Chain Methods(MCMC)** based Metropolis–Hastings algorithm, numerically determining the critical temperature of the phase transition $T_c \sim 2.3K$.

HONORS

Physics Graduate Fellowship, UCSB	2020-2021
Outstanding Graduate Student, School of Mathematical Sciences	Jun 2019
Meritorious Award in the Mathematical Contest in Modeling	Apr 2018
Weicheng Wang Scholarship	Feb 2016