

# Zirui Chen

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## Education

UC Santa Barbara, Santa Barbara, CA, USA

September 2022–Present

- Ph.D. in Astrophysics
- Advisor: S. Peng Oh

Columbia University, New York, NY, USA

September 2018–May 2022

- B.A. in Physics and Astronomy (GPA 4.06/4.3)
- Advisors: Greg Bryan, Drummond Fielding, David Kipping

## Awards & Honors

James and Mary Jo Hartle Graduate Fellowship (UCSB)

September 2022

Summa Cum Laude (Columbia)

May 2022

Departmental Honor, Physics (Columbia)

May 2022

The Phi Beta Kappa Society (Columbia)

December 2021

John Jay Scholar (Columbia)

September 2018–May 2022

## Research Interests

Galaxy Formation; Circumgalactic Medium; Galactic Winds; Dynamics of Multiphase Gas; Astrophysical Atomic & Molecular Processes; Turbulence; Computational Astrophysics.

## Grants

Molecular Cloud in Galactic Winds, ACCESS PHYS230107

July 2023

- 200,000 node hours on 40+ NSF supported computational clusters in the US.

## Publications

The Survival and Entrainment of Molecules and Dust in Galactic Winds

November 2023

- Chen Z., Oh S. P.
- Submitted to MNRAS: [arxiv.org/abs/2311.04275](https://arxiv.org/abs/2311.04275)

The Anatomy of a Turbulent Radiative Mixing Layer: Insights from an Analytic Model with Turbulent Conduction and Viscosity

June 2023

- Chen Z., Fielding D. B., Bryan G. L.
- Published in ApJ: [iopscience.iop.org/article/10.3847/1538-4357/acc73f](https://iopscience.iop.org/article/10.3847/1538-4357/acc73f)

The Number of Transits Per Epoch for Transiting Misaligned Circumbinary Planets

May 2022

- Chen Z., Kipping D.
- Published in MNRAS: [academic.oup.com/mnras/article/513/4/5162/6581337](https://academic.oup.com/mnras/article/513/4/5162/6581337)

## Research Projects

Molecules and Dust in Galactic Winds

December 2022–Present

- Working with UCSB Professor Peng Oh on using athena++ hydrodynamical simulations to study the survival and entrainment of molecular temperature ( $\sim 10$  K) clouds in hot ( $\sim 10^6$  K) galactic winds.
- The drastic difference in temperature between molecular clouds and galactic winds imply a density contrast of  $10^5$ , which is long thought to prevent cloud survival and makes it hard to simulate the system numerically. We use our simulations to argue that during cloud entrainment, turbulent mixing wins over radiative cooling to keep the cloud at atomic temperatures ( $\sim 10^4$  K). This reduces the density contrast in the system and allows the cloud to survive and get entrained in a reasonable timescale. We also demonstrate that dust in the original cloud can survive this entrainment process.
- Our results of molecular gas and dust survival in galactic winds, as well as the generation of intermediate temperature, formally thermally unstable gas, are potent in explaining observational results of galactic winds and the circumgalactic medium

Turbulent Radiative Mixing Layers in Galaxies

June 2020–June 2023

- Worked with Columbia Professor Greg Bryan and Flatiron Research Fellow Drummond Fielding. Developing a novel 1.5D analytic model for Turbulent Radiative Mixing Layers (TRMLs), which form at the interface of cold, dense gas and hot, diffuse gas in motion with each other and are found in

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galactic winds and the circumgalactic medium.

- Numerically integrated the steady-state fluid equations to solve for the phase structure of TRMLs. Implemented a simple parameterization of the effective turbulent conductivity and viscosity.
- Our model reproduces the mass flux, total cooling, and phase structure of 3D simulations of TRMLs at a fraction of the computational cost. It also reveals essential insights into the physics of TRMLs, particularly the importance of the viscous dissipation of relative kinetic energy.

### Circumbinary Planets

January 2019-May 2022

- Worked with Columbia Professor David Kipping to use rebound package via Python to simulate circumbinary planets (planets orbiting binary star systems)
- Generated millions of artificial circumbinary systems and showed that
  - (i) transit counts of the two preceding epochs predict the next to high accuracy
  - (ii) the inclination distribution of a circumbinary planet population can be inferred through transit counts

### Talks and Poster Presentations

#### UCSB Astro Lunch

November 2023

- Invited talk on molecular clouds in galactic winds.

#### CCA Galaxy Formation Group Meeting

November 2023

- Invited talk on molecular clouds in galactic winds.

#### CCA Tele Aviv Workshop

June 2022

- Invited talk on analytic model of Turbulent Radiative Mixing Layers.

#### Columbia University AstroFest'21

September 2021

- Poster presentation on analytic model of Turbulent Radiative Mixing Layers.

### Teaching and Professional Experience

#### Teaching Assistant, UCSB

September 2022-Present

- ASTRO 1 (introductory astronomy course, Fall 2022 quarter)
- Physics 6AL (introductory experimental physics course, Winter 2023 quarter).
- Physics 6BL (introductory experimental physics course, Spring 2023 quarter).

#### Volunteer at Columbia's Astronomy Outreach Program

September 2018-May 2022

- Organize and publicize bimonthly lecture series and stargazing events for Columbia and the public

### Skills

#### Programming

- Proficient in Python, Java, and C++. Extensive experience in running hydrodynamical simulations using athena++ and with cluster computing.
- Studied scientific computing in the context of astrophysics. Have experience in processing and fitting raw light curve data, simulating N-body dynamics, and modeling planetary and stellar structures.

#### Languages

- Fluent in Mandarin (first language) and English
- Standardized Testing: TOEFL 118, GRE 337