# **ANTONIO TANG**

Department of Physics University of California, Santa Barbara, CA Tel: +1 8058698669 | Email: zifan@ucsb.edu

#### **EDUCATION Yunnan University Kunming**, China **Bachelor of Science in Physics** Sept. 2020 - Aug. 2024 GPA: Major: 3.9/4.0 Upper Division:3.9/4.0 Cumulative: 3.7/4.0 (rank: 1/50) **Fudan University** Shanghai, China Joint-Cultivated Undergraduate Program Sept. 2021 – Apr. 2022 Admitted with the highest score among the class of 2024. Expected to finish in June 2023, but was forced to quit due to the 2022 Shanghai Spring Lockdown **University of Notre Dame** International Summer Undergraduate Research Experience (iSURE) Understanding the Origin of the Cluster Population in the M33 Galaxy University of California, Santa Barbara International visiting student Jan. - Mar., Sept. 2024 - Present GPA:3.8/4.0 Ugrad Course: Stellar Strctr.&Evol., Planet and Exoplanet Grad Courses: High Energy Astro., Classical Mechanics **RESEARCH EXPERIENCE**

## **Theory and Simulation**

# Nuclear burning in an accretion flow around a stellar-mass black hole embedded within an AGN disk

#### Supervisor: Prof. Yang Luo, Yunnan University

A new type of fast accretion black hole (accretion-modified star, AMS) could form in the disk of an AGN. The AMS could collapse to a sMBH at the end stage of stealer evolution. It accretes very fast and may bring some new features.

- Solved the structure of the accretion disks with Eddington ratio around  $10^6 10^9 \dot{M}_{edd}$  using the 4th-order Runge-Kutta Method performed in Python and got the disk structure in steady-state.
- Stability analysis shows stable of the disk when considering nucleosynthesis.
- Simulated the nuclear network reactions in the fast accretion disk using an open-source FORTRAN code (the workhorse of Modules for Experimental Stellar Astrophysics, MESA).
- The simulation result showed a significant burning of  ${}^{12}C$  and  ${}^{3}He$  and a rise in the mass ratio of O/C and N/C. This may be interpreted as an indication of super-solar metallicity in the broad line region.
- This work has led to Tang, Z., Luo, Y., & Wang, J.-M. (2024). MNRAS, 535(4), 3050-3058.

# Simulation and Visualization of Phase Transitions in the 2D Ising Model

# Supervisor: Distinguished Prof. Bo Zheng, Zhejiang University

Implemented Monte-Carlo methods to simulate the Paramagnetism-Ferromagnetism phase transition in the 2D Ising model as temperature varies.

- Simulated the phase transition of the system using the Wolff Algorithm and Metropolis Algorithm, and calculated thermodynamic parameters and order parameter (magnetization).
- The simulation results showed that the cluster-flip strategy of the Wolff Algorithm brought a much faster convergence in computing and closer to the theoretical predictions. The behavior near the critical point ( $T_c = 2.269$ ) is also closer to the power law of  $(T - T_c)^{1/8}$ . But the heat capacity diverges, suggesting a second-order phase transition.
- Created a GIF animation for the evolution process of the 2D Ising model to illustrate the system's condensing process in the same spin direction (symmetry breaking).

**Observational Study of Galaxy Evolution** 

Understanding the Origin of the Cluster Population in the M33 Galaxy

Notre Dame, IL, US

July 2023 - Aug. 2023

May 2023 - Nov. 2024

May 2023 - July 2023

Santa Barbara, CA, US

# Supervisor: Prof. Boja Anguiano, University of Notre Dame

We investigated the kinematical and chemical properties of the M33 galaxy using integrated light moderate-resolution, multiobject optical spectra for about 100 individual clusters taken with the Hectospec instrument at the MMT Observatory

- Data was processed using Python. Separated the clusters into young clusters ( $\leq 3 \times 10^8$  yr), intermediate clusters, and old clusters(> 8 × 10<sup>8</sup> yr). Calculated metallicity, velocity, and spatial distributions and identified statistical patterns of the clusters.
- Young clusters are more metal-rich ([Z/H] ~ -0.1). Older clusters exhibit higher scatter in metallicity and weaker correlation with age. The dispersion of cluster velocities concerning local disk motion increases with age, and rotational velocities decrease with age. Young clusters are concentrated in the inner disc regions (< 4 kpc), while older clusters are more evenly distributed.</li>

### • Course Projects at UC Santa Barbara

#### **A New Class of Object: Blanet**

Advisor: Prof. Ben Mazin. A literature review in the frame of planet formation near black hole. See the link.

### **Repeated Tidal Disruption Event: An Unluckiest Star**

Advisor: Prof. Omer Blase. A survey on the observational and theoretical study in repeated TDE. See the link.

## • Experimental Research for Freshmen

# Measuring Minuscule Elongation: a Project for China's Undergrad Physics Experiment Competition(CUPEC)

Used the principle of diffraction to measure the elongation of metal wires and calculate its Young's Module.

- Set up an optical path in the perpendicular direction of a metal wire; utilized a narrow slit attached to the wire to create the conditions for single-slit diffraction.
- Measured the positions of dark fringes before and after elongation by an optical power meter to calculate Young's Module of metal wires; applied method of successive differences for data processing to reduce measurement errors.
- Led the three-person team to win the National Second Prize.

## • Application Developments at Fudan

**Advanced Topics in Ouantum Mechanics** 

## Development of a 24-Point Game Based on LabVIEW

Realized a Poker game in the frame of LabVIEW that requires the user to input a solution that solves the four given numbers to 24 and automatically provides hints based on the user's input

- Utilize the visualization of LABVIEW to show the game in the front panel. A group of numbers are randomly picked. The user inputs the answer to solve the equation to 24. The program will judge the user's input and give corresponding prompts.
- To compensate for the deficiency of LabView in processing string data, the Python node was used to call the external Python program to calculate the user input in real time and give the reference answer.

# Development of simulating Light Diffraction Based on PyQt Module

- Used the PyQt5 module to simulate the diffraction of light passing through various optical objects, such as single slits and gratings, and display the penetrated light intensity distribution. The user can change the parameters, such as the width of the slit and the distance from the slit to the light source, to get a real-time change in the intensity.
- This program is practical in multimedia teaching. It can help students directly perceive the impact of changes in various parameters on light transmission.

### PUBLICATION

• Tang, Z.-F., Luo, Y., & Wang, J.-M. (2024). Nuclear burning in an accretion flow around a stellar-mass black hole embedded within an AGN disc. *MNRAS*, *535*(4), 3050–3058. <u>https://doi.org/10.1093/mnras/stae2557</u>

### WORKSHOPS AND CONFERENCES

Summer School in Peking University, advisor: Baruch Rosenstein	July 7 <sup>th</sup> –Aug. 3 <sup>rd</sup> , 2022
The 2 <sup>nd</sup> Workshop on Astrophysical Phenomena of Accretion Modified Stars in the AGN disk	Wuhan, China
Link of the workshop	May 10–13 <sup>th</sup> , 2024
The Frontier of Machine Learning and Statistical Physics: A Workshop in Fall	Kunming, China
Link of the workshop	July 7 <sup>th</sup> –Aug. 3 <sup>rd</sup> , 2023
The 7th Conference on Statistical Physics and Complex Systems	Kunming, China
Link of the conference (Concurrently held with the Workshop)	July 19 <sup>th</sup> –Aug. 1 <sup>st</sup> , 2023
The 18th Peng Huanwu Theoretical Physics Forum	Kunming, China
Link of the conference	May 10–15 <sup>th</sup> , 2023

May 2020 - Oct. 2020

Jan. 2024 - Mar. 2024

Sept. 2024 - Dec. 2024

May 2022 – July 2022

Oct. 2021 - Jan. 2022

Beijing, China

#### **AWARDS AND HONORS** First Prize Scholarship at Yunnan University (annually awarded to top 2 undergraduates in the college) Sept. 2021 National Second Prize of the China Undergraduate Physics Experimental Competition (CUPEC) Nov. 2021 SERVICE AND OUTREACH Political Protest: Led students in Yunnan Univ. to participate in the "White Paper Protests", opposing the Chinese government's • harsh lockdowns and restrictions on individual freedoms during the pandemic Sept.-Dec. 2022 On-campus Job Position: worked at the International Student Exchange Office at Yunnan University, successfully facilitated the ٠ establishment of Yunnan University's first undergraduate English transcript system. May-Nov. 2023 Red Cross Member: Served as an aidman in the Fudan University's basketball team 2021-2022

- Electronic Sports: Leader of the San-Guo Sha team (Member of Fudan University Starry Sky Board Game Alliance) 2021–2022
- Founder of the Fudan University Joint-Cultivated Student Union: We searched stories, shared the experiences at Fudan, and offered advice and support to students from other universities studying at Fudan, helping these under-representatives adapt to academic and campus life
  2021–2024
- Volunteer, FIBA 3x3 World Master Tour Competition, Chengdu Station

#### **ADDITIONAL INFORMATION**

Oct. 2020

- Programming: Python, Linux Shell, FORTRAN, C/C++
- Software: Mathematica, MATLAB, LabVIEW, Arduino
- Interests: Basketball, Road Cycling, Bike Modification, Car Racing
- Personal website: antoniotang12138.github.io