Hao-Yang Yen

Interdisciplinary Program of Sciences
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Personal Statement

I am passionately dedicated to the study of theoretical physics, with a particular emphasis on statistical mechanics. My research focuses on the interdisciplinary intersections between statistical mechanics and quantum dynamics, exploring the wide-ranging applications of this field across various research domains. My academic achievements and research endeavors reflect this commitment. Currently, my interests lie in applying statistical mechanics and quantum mechanics to computer science, quantum dynamics, and complex systems.

Education

BSc Interdisciplinary Program of Sciences *National Tsing Hua University*   **Hsinchu, Taiwan** *09/2021-06/2025*

The interdisciplinary program at Tsing Hua University enables students to gain comprehensive training across two scientific and related disciplines. My majors are **Physics** and **Data Science**, where I have consistently achieved top grades. (My original program was in Advanced Materials, which was abolished in 2024 and has been integrated into Physics. Due to this program's discontinuation, some of my credits have been transferred accordingly.)

Course	Grade	Course	Grade
Quantum Physics I	A+ (highest)	Numerical Methods and Applications	A+ (highest)
Statistical Mechanics I	A (highest)	Scientific Computing	A (highest)
Statistical Mechanics II	A	Algebraic Topology	A+ (highest)
Electrodynamics I	A	Advanced Linear Algebra	A
Electrodynamics II	A+ (highest)	Probability	A-
Nonlinear Dynamics and Chaos	A	Statistics	A-
Elementary Particle Physics	A+ (highest)	Statistical Learning	A-
		Algebraic Geometry I	A-

MSc Institute of Physics *National Tsing Hua University*   **Hsinchu, Taiwan** *09/2025-*

Research Experience

My main research experience lies in the interdisciplinary application of statistical mechanics, encompassing both analytic and numerical forms, in diverse theoretical physics research fields. Here are some research topics I have finished before.

Department of Physics, NTHU
Undergraduate Student, PI: Prof. Yi-Ping Huang

- **Pattern Formation and Dynamics in Quantum System**   *07/2023-present*

  I explore pattern formation in quantum systems by bridging quantum dynamics with non-linear phenomena. Using the quantum trajectories method and phase representation, I investigate pattern formation in various quantum systems. This study deepens our understanding of the interplay between non-linear dynamics, pattern formation, and statistical mechanics in quantum systems.More details

Institute of Physics, Academia Sinica
Summer Student, PI: Prof. Hong-Yan Shih

- **Leveraging Variational Matrix Product States for Stochastic Dynamics**   *07/2024-08/2024*

  The variational matrix product state (VMPS) is a powerful algorithm for investigating quantum many-body systems. Recently, there has been increasing interest in applying this approach to study stochastic dynamics. In our project, we employ the variational matrix product state to analyze the stochastic dynamics within the SIS model in epidemiology. We aim to compare the behaviors of the variational matrix product state in both quantum many-body systems and classical dynamical systems, highlighting the insights gained from each context.More details

Department of Physics, NTHU/Institute of Physics, Academia Sinica
Undergraduate Student, PI: Prof. Yi-Ping Huang, Prof. Hong-Yan Shih

- **Tensor Networks in Stochastic Dynamics**   *08/2024-present*

  Tensor networks provide a robust theoretical framework for investigating quantum many-body systems. Recently, there has been a growing focus on applying tensor networks to study classical stochastic dynamics. However, the underlying physical principles of this application remain unclear and have primarily been explored in one-dimensional systems. Our objective is to elucidate the fundamental principles governing the use of tensor networks to analyze stochastic processes in classical dynamical systems. This research aims to shed light on the connections between quantum many-body systems and classical dynamical systems, offering insights into key concepts in equilibrium quantum statistical mechanics, such as topological order and symmetry breaking. Additionally, we seek to generalize the tensor network approach to encompass two-dimensional classical dynamical systems.More details

Department of Physics, NTHU
Independent Research

- **SIR Model with Monte Carlo Method Simulation**   *2023 spring*

  We model virus spread with basic differential equations with generalized SIR models. However, considering more variables makes the differential equations more complex. To avoid solving complex differential equations systems, our project employs the Monte Carlo method to simulate generalized SIR models.More details

- **Neural Network and the Renormalization Group**   *2023 fall*

  In phase transition theory, phenomena arise when the correlation length diverges at critical points. This parallels occurrences in natural complex systems, where statistical models, like neural networks, categorize data akin to renormalization group theory, despite lacking a precise mathematical framework.More details

- **Numerical Simulation of Simplify Stellar Winds Model**   *2024 spring*

  Plasma holds a pivotal position in the cosmology and astrophysics due to its prevalence. The sun, being a star, is predominantly composed of plasma, and this composition extends to many other celestial bodies, including most planets. As a result, plasma accounts for over 99.99% of the observable matter in the universe. In this paper, I will employ MHD equations to simulate a simplified model of stellar winds.More details

Work Experience

Assistant,	*Center of General Education, NTHU*	*02/2022 - 06/2022*
Assistant,	*Executive Master of Business Administration, NTHU*	*09/2023 - 01/2024*
Assistant,	*MS in Regulatory Affairs for Drugs and Medical Devices, NTHU*	*09/2023 - present*

Teaching Experience

Teaching Assistant	*Statistical Mechanics (I), Department of Physics, NTHU*	*02/2025 - present*
Teaching Assistant	*Electrodynamics (II), Department of Physics, NTHU*	*02/2025 - present*
Teaching Assistant	*Thermal and Statistical Physics (II), Department of Physics, NTHU*	*02/2025 - present*
Teaching Assistant	*Statistical Mechanics (II), Department of Physics, NTHU*	*09/2024 - 12/2024*
Teaching Assistant	*Electrodynamics (I), Department of Physics, NTHU*	*09/2024 - 12/2024*
Teaching Assistant	*Thermal and Statistical Physics (I), Department of Physics, NTHU*	*09/2024 - 12/2024*
Teaching Assistant	*Statistical Mechanics (I), Department of Physics, NTHU*	*02/2024 - 06/2024*

Honors

Dean Feng-Chih Chang Memorial Scholarship	*College of Sciences, NCTU*	*2021*
Maxwell Scholarship	*Department of Physics, NTHU*	*2024*