Hao-Yang Yen

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Personal Statement

I am committed to advancing theoretical physics, with primary emphasis on statistical physics and dynamical systems. My research integrates statistical physics, celestial mechanics, and geometry. I investigate the statistical behavior of complex and stochastic dynamical systems—such as epidemic and ecological models—and study Poisson geometry and computational algebraic geometry within classical mechanics and its related systems, with a particular focus on the analysis of celestial systems. I am also interested in the interfaces between statistical physics, data science, and information theory.

Education

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

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.)

Research Experience

My main research experience lies in the interdisciplinary applications of statistical mechanics and dynamical systems, encompassing both analytic and numerical forms, in diverse theoretical physics research fields.

Department of Mathematics, NTHU
Research Assistant, PI: Prof. Kuo-Chang Chen

- **Existence and Uniqueness of Five-Body Central Configurations** *05/2025-present*

  Although many sophisticated mathematical techniques have yielded significant progress in establishing the existence and finiteness of central configurations, the detailed structural properties and the precise regions of existence and uniqueness remain insufficiently explored. In this study, we examine the existence and uniqueness of central configurations within specific mass and distance ordering regions of five-body systems with some symmetries.

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.

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*

  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. 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 spectral topology and gaps.

Independent Projects

Teaching Experience

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

Teaching Materials

Vector Spaces and Linear Algebra for Physics Link

Vector Analysis with Differential Forms for Physics Link

Green Functions, Generalized Functions, and Their Applications in Physics Link

Honors

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