Hao-Yang Yen

Interdisciplinary Program of Sciences, National Tsing Hua University

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Personal Statement

I am deeply committed to the study of theoretical physics, particularly within the domain of statistical mechanics, where I find challenges to be invigorating. With considerable experience serving as a teaching assistant for statistical physics at both undergraduate and graduate levels, I have cultivated adeptness in guiding others through the intricacies of this discipline. My fascination extends to the interdisciplinary junctions between statistical mechanics and quantum dynamics. I am captivated by the breadth of application that statistical mechanics offers, permeating diverse fields such as plasma physics, biological physics, and nonlinear systems. While classical dynamics has attained a robust foundation, the domain of quantum dynamics remains a frontier of ongoing exploration and inquiry. My scholarly interest lies in extrapolating the intriguing phenomena observed within classical systems into the nascent realm of quantum mechanics, where the landscape is rich with opportunities for further investigation and advancement.

Education

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

I am not a student in the department of physics, but I have taken many advanced mathematics and physics-relevant courses and got good grades.

Relevant Courses: Quantum Physics (I) (A+), Statistical Mechanics (I) (A), Statistical Mechanics (II) (A), Electrodynamics (I) (A), Electrodynamics (II) (A+), Nonlinear Dynamics and Chaos (A), Numerical Methods and Applications (A+), Scientific Computing (A+), Algebraic Topology (A+), Advanced Linear Algebra (A), Probability (A-), Statistics (A-), Statistical Learning (A-).

Research Experiences

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 finisher 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

- **Tensor Network in Stochastic Dynamics** *07/2024-08/2024*

  Tensor networks represent a powerful theoretical framework for investigating quantum dynamical systems. Recently, there has been a growing focus on applying tensor networks to study stochastic dynamics. In our project, we utilize tensor networks to analyze the stochastic dynamics within biological systems. The use of tensor networks provides a robust method to explore and understand the complex behaviors of stochastic dynamics in complex systems. More details

Department of Physics, NTHU

Courses Projects

Nonlinear Dynamics and Chaos

- **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

Statistical Mechanics

- **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

Electrodynamics

- **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

Condensed Matter Physics

- **Algebraic Topology Aspect of Path Integral Approach** *2024 spring*

  The Feynman path integral offers an elegant method for studying the dynamic behavior of quantum systems. Homotopy theory provides an advanced perspective on the path integral, particularly in multiply-connected configuration spaces. Our focus lies in investigating quantum dynamical systems within abstract configuration spaces. Utilizing homotopy theory, we compute the anomalous fundamental group of these spaces. We apply homotopy theorems to the Feynman path integral to analyze the quantum system's dynamic behavior. More details

Working Experience

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

Teaching Experience

Teaching Assistant *Statistical Mechanics (I) (offered in English), Department of Physics, NTHU* *02/2024 - 06/2024*

Teaching Assistant *Statistical Mechanics (II) (offered in English), Department of Physics, NTHU* *09/2024 - present*

Teaching Assistant *Electrodynamics (I) (offered in English), Department of Physics, NTHU* *09/2024 - present*
Teaching Assistant *Thermal and Statistical Physics (I), Department of Physics, NTHU* *09/2024 - present*

References

- **Asst Prof. Yi-Ping Huang:** NTHU, department of physics
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- **Asso Prof. Jen-Hao Chen:** NTHU, Institute of computational and modeling science
  Email: jh.chen@mx.nthu.edu.tw