Cheng-Yu Liu

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EDUCATION

Department of Physics, National Taiwan University *Sept. 2021—July. 2024*

Master of Science → *Relevant courses: Introduction to Quantum Optics (A^+), Applications of Quantum Computation (A^+), Introduction to Quantum Computation and Quantum Information (A^+), Quantum Mechanics (I)(tigp) (A^+)*

Department of Physics, National Central University *Sept. 2017—June. 2021*

Bachelor of Science → *Relevant courses: Applied Mathematics (97/100), Mathematical Methods in Physics I (99/100), Mathematical Methods in Physics II (91/100), Quantum and Statistical Physics (94/100), General Physics A First Semester (97/100), General Physics A Second Semester (100/100), Quantum Physics (83/100, among top in class)*

RESEARCH EXPERIENCE & PROJECTS

Project Collaborator | Advisor: Hsi-Sheng Goan | Department of Physics, National Taiwan University *Jul. 2025—Current*

1. Investigated bosonic quantum error correction using GRAPE, L-BFGS, and Nelder–Mead (with Julia and also on CUDA) to optimize pulse sequences for encoding and logical gate implementation [Project]

Independent Study and Research *(Four year mandatory military service) Feb. 2025—Current*

1. Studied quantum error correction, Qiskit Global Summer School, error analysis and QEC code on trapped ion [Project]
2. Worked on Qiskit Hackathon projects on BB84 protocol, conduct experiments on IBM cloud real hardware [Project]
3. Developed a CZ entangling gate scheme for trapped ions by combining motional and cavity modes [Early sketch]
4. Studied on algebraic topology, quantum error correction [Notes] and practiced toric code decoding in Python
5. Generated numerical results on one-step GHZ state in trapped ion and studied on trapped-ion parallel gate

Research Assistant | Advisor: Hsiang-Hua Jen | IAMS, Academia Sinica *Oct. 2024—Feb. 2025*

1. Studied on non-Hermitian physics
2. Generated numerical and analytic results on one-step GHZ states creation (Publications shown below)
3. Investigated possible improvement in quantum platforms from state-dependent spatially separated atoms

Research Assistant | Advisor: Guin-Dar Lin | Department of Physics, National Taiwan University *Sep. 2024—Oct. 2024*

1. Integrated and further improved the results from my master's thesis [Master's Thesis]

Graduate Researcher | Advisor: Guin-Dar Lin | Department of Physics, National Taiwan University *Sep. 2021—Jul. 2024*

1. Researched trapped-ion systems, Mølmer–Sørensen (MS) quantum gates, and micromotion trajectories through numerical simulations [2D micromotion trajectories]
2. Developed a novel cavity-mediated entangling gate for atomic qubits: proposed a theoretically exact controlled-Z gate using the Tavis–Cummings model [Gate scheme]
3. Provided a nonstandard derivation of the spin-dependent force Hamiltonian based on classical wave interference and tweezer-potential formulation from trigonometric identities [Thesis Ch. 1.2]
4. A simple derivation of the first-order micromotion trajectory amplitudes and notes [Trapped ion notes]

TECHNICAL SKILLS

Programming Languages: Python (Qiskit advocate), Julia (Fast numerical calculations), Mathematica (Proficient)
Theoretical Background and Training: Quantum optics, trapped-ion quantum computing, cavity QED, quantum error correction, mathematical methods in physics, application of AI in research, English oral presentation

PUBLICATIONS

1. **C.-Y. Liu**, C. G. Feyisa, M. S. Hasan, and H. H. Jen, "High-fidelity multipartite entanglement creation in non-Hermitian qubits," J. Phys. B: At. Mol. Opt. Phys. 58, 075501 (2025). https://doi.org/10.1088/1361-6455/adc2bd
2. G. Feyisa, **C.-Y. Liu**, M. S. Hasan, J. S. You, H.-Y. Ku, and H. H. Jen, "Robustness of tripartite entangled states in passive PT-symmetric qubits," Phys. Rev. Research 7, 033060 (2025). https://doi.org/10.1103/ypd8-r9gq

ACTIVITIES

- Qiskit advocate (2025) / Qiskit global summer school excellence badge (2025)
- QRACON 2025 Quantum Research Competition (Master's Division) – Second Prize, and Best Speaker Award at the Annual Meeting.
- Member of the Taiwan Physical Society (2025)
- Poster session at the Joint International Workshop on Quantum Computing (Poster title: High-Fidelity Multipartite Entanglement Creation in Non-Hermitian Qubits) (2025)
- Poster session at the Annual Meeting of the Physical Society of Taiwan (Poster title: Novel Drive-Through Entangling Gate Mediated by a Cavity for Atomic Qubits) (2024)
- Joint Symposium on Quantum Computing (2024) (Thesis work on atomic qubit entanglement was presented by the Speaker.)
- Participant in the Workshop on Quantum Science and Technology (2024)
- Participant in the *Atomic, Molecular, and Optical Summer School* (2023)
- Poster session and oral presentation at the *Physics Annual Meeting*, National Central University (2020)
- Street performance in Taipei and member of music clubs (2023)
- Vice President and host of the English Conversation Group at National Central University (2020–2021)