# Chun-Wei Liu
Portfolio
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## EDUCATION

**Columbia University** — New York, NY
*Master of Science in Applied Physics* — *Sep. 2021 – Jan 2023*
Courses: Quantum Optics, Condensed Matter Physics, Laser Physics, Semiconductor Physics, Device Microfabrication, and Statistical Mechanics

**National Cheng Kung University** — Tainan, Taiwan
*Bachelor of Science in Civil Engineering* — *Sep. 2017 – Jun 2020*
Courses: Quantum Physics, Electromagnetism, Machine Learning, Material Engineering, Mechanics of Materials, Automata

## RESEARCH EXPERIENCE

**Quantum Simulator - Programmable Atomic Tweezer Arrays [DAMOP2022]** — New York, NY
*Supervisor: Prof. Sebastian Will* — *Sep. 2021 - Jan. 2023*

- Building a programmable bosonic Sr-88 atomic array for quantum simulation, including a compact atomic source, laser cooling (MOT), single-atom trapping, fiber optics, and electronics design.
- Designed the defect-free atom rearranging algorithms with high array filling rate and achieved runtime within submillisecond region, supporting assembling up to 800 atoms.
- Developed a control system for moving atoms within optical dipole traps with multi-toned rf signals and acoustic-optical devices while imaging via EMCCD/sCMOS.
- Constructed a multiplexing laser-optics system for laser monitoring and locking via user-interface frontend and PID control backend.

**Quantum Walks** — Tainan, Taiwan
*Supervisor: Prof. Pei-Cheng Kuan* — *Aug. 2019 - Aug 2021*

- Explored non-Hermitian system and the corresponding topological properties through quantum simulators based on quantum walk.
- Conducted analytical and numerical analysis for the evolution of an engineered quantum walk Hamiltonian, including multi-particle, multi-branch, general coin, and jumppin steps.
- Investigated quantum spatial search algorithms powered by quantum walk protocols.

**Machine Learning in Material Design [APCOM2019][CTAM44][MLDT2021][USNCCM16]** — Tainan, Taiwan
*Supervisor: Yung-Che Wang* — *Feb. 2019 - Jun 2020*

- Applied generative adversarial networks (GAN) to generate high-fidelity microstructure images.
- Adapted the 19-layer VGG networks (VGGNet) that can predict mechanical properties from material images with 95% accuracy.
- Simulating mechanical properties of microstructure samples via Finite Element Methods (FEM) software.
- Investigated a Bayesian-optimization model that can fine-tune GAN-generated microstructure geometry through the rapid-labeling VGGNet.
- Applied multi-processing on molecular simulation to generate microstructures 40 times more efficiently on cloud platforms.
- Implemented a stochastic protocol to produce large scale homogenous microstructure datasets by two-point correlation function.

## Publications

[1] _Chun Wei Liu_, Pei Chen Kuan, _"Coherent localization in quantum walks"_. (In preparation).

[2] Minho Kwon, Aaron Holman, Quan Gan, _Chun-Wei Liu_, Matthew Molinelli, Ian Stevenson, Sebastian Will, _"Jet-Loaded Cold Atomic Beam Source for Strontium"_, arXiv:2210.14186 (2022).

[3] Aaron Holman, Weijun Yuan, Siwei Zhang, Quan Gan, _Chun-Wei Liu_, Max Aalto, Matthew Molinelli, Xiaoyan Huang, Nanfang Yu, Minho Kwon, Sebastian Will, _"Progress Towards Programmable Strontium Atom Arrays"_, 53rd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics (DAMOP2022), 2022.

[4] Aaron Holman, Weijun Yuan, Siwei Zhang, Quan Gan, Max Aalto, _Chun-Wei Liu_, Matthew Molinelli, Minho Kwon, Sebastian Will, _"A New Platform for Programmable Arrays of Strontium Atoms"_, 53rd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics (DAMOP2022), 2022.

[5] Weijun Yuan, Aaron Holman, _Chun-Wei Liu_, Quan Gan, Xiaoyan Huang, Nanfang Yu, Minho Kwon, Sebastian Will, _"Optical Tweezer Arrays Created by Holographic Metasurfaces"_, 53rd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics (DAMOP2022), 2022.

[6] Yun-Che Wang, _Chun Wei Liu_, Tsai-Wen Ko, _"Optimization of Chiral Metamaterials via Deep Neural Networks"_, 16th U.S. National Congress on Computational Mechanics (USNCCM16), 2021.

[7] Yun-Che Wang, _Chun Wei Liu_, Tsai-Wen Ko, _"Using Deep Neural Networks to Generate Hierarchical Metamaterials for Enhanced Mechanical Properties"_, Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering and Technology (MMLDT), 2021.

[8] Yun-Che Wang, _Chun Wei Liu_, Pei-Chen Cheng, Jyun-Ping Wang, Tsai-Wen Ko _"Design of Chiral Metamaterials via Deep Neural Networks"_, 44th National Conference on Theoretical and Applied Mechanics (CTAM44), 2020.

## Presentation

- **Design of Viscoelastic Auxetic Materials Through Machine Deep Learning [APCOM2019]**:
    - Discussed the use of VGG networks as an alternative of Finite Element Methods (FEM) when labeling mechanical properties for microstructures.

## Projects

- **Predicting Handwriting Recognition With Parametrized Quantum Circuit**:
    - Implemented 4qubit-Ry gate circuits in predicting MNIST dataset with the learning curve converged after ten iterations.
    - Analized the potential in predicting molecular ground state energies with Quantum LSTM Meta-Learner and VQE.
- **Subradiance of a Collective of Atoms in the Cavity**:
    - Studied the superradiance effect of compact atomic arrays in the cavity by solving the master equation with the Quantum Monte Carlo method.

## Honors

- **Chairman Special Award (final round)**, IBMq Qiskit Hackathon Taiwan 2021

- **5th Place (out of 250 students)**, Asia Pacific Mechanics Contest for College Students 2018

- **Dean's list**, GPA in top 5% of the department 2017

## Skills

- **Languages**: Python, C++, Matlab

- **Libraries/Tools**: MATLAB, Qiskits, Mathematica, PyTorch

- **Other Technologies**: COMSOL, GNU/Linux, Raspberry Pi, Git, LAMMPS