

## Ziyu He

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### EDUCATION

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**Sun Yat-sen University**, Guangzhou, China  
BS in Physics  
**Shenzhen Middle School**, Shenzhen, China

9.2021 — 6.2025 (Expected)  
**GPA: 4.0/4.0, Ranking: 4/95**  
9.2018 — 6.2021

### RESEARCH INTERESTS

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Superconducting Circuit, Ultracold Atom, Quantum Computation, Quantum Simulation, Quantum Optics

### PUBLICATIONS

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- Rui-Yang Gong, Zi-Yu He, Cheng-He Yu, Ge-Fei Zhang, Ze-Liang Xiang\*, “Tunable quantum router in a dual-rail quantum network via giant atom” (in preparation for submission to Communication Physics)

### RESEARCH EXPERIENCE

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**Experimental Survey of Giant Atom in Superconducting Circuits** 08.2024 — Current  
*Intern, Supervisor: Prof. Zhihui Peng, Hunan Normal University*

- Conducting experiments on a transmon qubit capacitively coupled at two distinct points to a coplanar waveguide.
- Calibrated the transmon frequency and analyzed its relationship with the Z line bias using dispersive readout techniques.

**Fitting the ToF of the 2D Er Ultracold Atom** 07.2024 — 08.2024  
*Summer Research, Supervisor: Prof. Gyu-Boong Jo, Hong Kong University of Science and Technology*

- Examined quasi-2D ultracold Er 166 gases confined in a strong z-direction harmonic potential and a square potential well in the xy-plane.
- Developed codes using the Hartree-Fock method to iteratively calculate the occupation distribution of interacting atoms in z-direction eigenlevels at finite temperature  $T$  and chemical potential  $\mu$ .
- Computed the theoretical spatial distribution of the gases after Time of Flight (ToF), accounting for the finite time effect by integrating over initial positions.
- Develop scripts to fit experimental measurements with theoretical predictions, enabling determination of the sample's temperature and chemical potential.
- Analyzed experimental data by averaging multiple optical density measurements, successfully separating contributions from the condensed phase and the thermal cloud.

**Analytical and Numerical Study of Photons in Nonlinear Waveguide** 05.2024 — 06.2024  
*Remote collaboration with Prof. Xueyue (Sherry) Zhang, Columbia University*

- Calculated the energy spectrum for the two-photon subspace in a nonlinear waveguide constructed by a cavity array.
- Analyzed how nonlinear interactions contribute to the formation of two-photon bound states.
- Explored parameter adjustments in the nonlinear waveguide and emitters to facilitate two-photon interactions, inducing phenomena like effective four-body interactions and supercorrelated radiance.
- Modeled the generation of flying cat states under driven-dissipation conditions and investigated the potential for preparing entangled cat states in two cavities side-coupled to the nonlinear waveguide.

**Numerical Study of Quantum Pulse Interaction with Localized Quantum Systems** 12.2023 — 03.2024  
*Research Assistant, Supervisor: Prof. Zeliang Xiang, Sun Yat-sen University*

- Investigated the dynamics between incident light in various quantum states and localized quantum systems within a waveguide, utilizing the numerical method from Phys. Rev. Lett. 123, 123604 (2019).
- Developed Python scripts using the QuTiP library to simulate these dynamics, effectively reducing the computational complexity of correlation functions from  $O(N^3)$  to  $O(N^2)$ .
- Reproduced key results, including pulse shaping of a cavity with phase noise and the generation of a flying Schrödinger cat state.
- Provided simulation scripts to an experimental group, facilitating their research in quantum control.

**Tunable Quantum Router in a Dual-Rail Quantum Network via Giant Atom** 11.2022 — 12.2023  
*Research Assistant, Supervisor: Prof. Zeliang Xiang, Sun Yat-sen University*

- Theoretically designed a tunable quantum router using a three-level giant atom in a dual-rail waveguide on a superconducting circuits platform.
- Applied the Bethe ansatz method to analytically calculate the scattering properties of incident photons interacting with the giant atom.
- Discovered chiral and nonreciprocal scattering behaviors, enabling high-fidelity quantum routing, quantum gates, and quantum circulators through parameter tuning.
- Investigated non-Markovian effects and their influence on the system's quantum device performance.
- Prepared a manuscript detailing our findings for submission to a peer-reviewed journal.

## PROJECTS

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### China Undergraduate Physics Tournament

11.2021 — 10.2022

*Team Captain*

- Led a team of twelve to tackle seventeen physics problems, requiring theoretical modeling, experimental work, and data analysis, resulting in a comprehensive final report.
- Coordinated weekly team meetings to facilitate problem-solving and task distribution.
- Directed the 'Droplet Explosion' project, modeling the wetting dynamics of water-ethanol solutions and instability at three-phase contact lines, awarded Best Player for outstanding research contribution.

## AWARDS

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### First Prize of SYSU Outstanding Student Scholarship

11.2023 &amp; 12.2022

Top 5% in Physics major, Sun Yat-sen University.

### First prize in the 13th China Undergraduate Physics Tournament

10.2022

Ranked 5<sup>th</sup> nationwide, worked as a team captain.

### First Prize in the National Undergraduate Mathematical Contest in Modelling

9.2022

Top 5% in Guangdong Province Division.

### First prize in the 13th China Undergraduate Physics Tournament (South Central China)

6.2022

Ranked 1<sup>st</sup> in the South Central China, worked as a team captain.

### The Best Player in the 13th China Undergraduate Physics Tournament (South Central China)

6.2022

The best performance in the South Central China.

## MEMBERSHIP

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### Society of Physics Students in Sun Yat-sen University

Guangzhou, China

*Vice President*

9.2022 — 7.2023

- Coordinated lectures by professors on current physics research, aiming to broaden the academic perspectives of students.
- Invited senior students to share research methods and experiences, contributing to the professional growth of peers.

## SKILLS

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Mathematica, MATLAB, Python, C++, COMSOL, LabVIEW.

## SELECTED COURSES

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### Theoretical Physics Courses

- Theoretical Mechanics: 96.4
- Electrodynamics: 95
- Thermodynamics and Statistical Physics: 98
- Quantum Mechanics: 97
- Solid State Physics: 95
- Methods of Mathematical Physics: 94
- Group Theory in Physics\*: 96
- Topological Physics\*: 99
- Advanced Quantum Mechanics\*: 94

### Numerical & Experimental Physics Courses

- Numerical Calculations: 98
- Analysis of Circuits: 97
- Electronic Technology: Analog Electronics: 92
- Electronic Technology: Digital Circuit: 92
- Experiments in Electronic Technology: 93
- Basic Designed Physics Experiment: 90
- Experiments of Frontier Physics: 90

\* denotes graduate courses.