YICHENG ZHUANG

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ORCID | Google Scholar

EDUCATION

Peking University, Beijing, China Sep. 2022 – Present
B.S. in Physics (expected July 2027) GPA: 3.9 / 4.0 | Rank: top 5%

RESEARCH APPOINTMENTS

Harvard University, Cambridge, MA, USA Aug. 2025 – Apr. 2026
Full-time Research Intern, Professor Eric J. Heller's Group *on site*

Stanford University, Stanford, CA, USA Apr. 2026 – Sep. 2026
Full-time Research Intern, Professor Alfred Zong's Group *on site*

RESEARCH INTERESTS

- Collective excitations and nonequilibrium phenomena in quantum materials
- Ultrafast scattering, spectroscopy, and imaging of electronic and lattice dynamics
- Physics-informed inverse modeling and machine-learning analysis of complex experimental data

PUBLICATIONS

[1] J. Lin*, **Y. Zhuang***, A. M. Graf, E. J. Heller, and J. Keski-Rahkonen. "Shaping Chaos in Bilayer Graphene Cavities." *Proc. Natl. Acad. Sci. U.S.A.* **123**(24), e2538081123 (2026). [DOI] *equal contribution

[2] B. Dong*, M. Zhang*, **Y. Zhuang**, S. Zhang, D. Liu, M. Xu, S. Li, A. Ischenko, H. Xu, R. J. Miller, Z. Li. "Identifiability Limits and Deep-Learning-Assisted Reconstruction of Rotational Density Matrices for Symmetric-Top Molecules." *J. Chem. Phys.* **165**(3), 034102 (2026). [DOI]

[3] M. Zhang, B. Dong, X. Mi, X. Dong, Z. Xing, **Y. Zhuang**, B. Qin, H. Xu, and Z. Li. "Jahn–Teller Effect on CF_3I Photodissociation Dynamics." *J. Chem. Theory Comput.*, 20(24), 10875–10885 (2024). [DOI]

[4] H. G. Bell*, C. Xu*, A. McCray, M. Han, **Y. Zhuang**, H. Y. Hwang, C. Ophus, and A. Zong. "Bend Contour Electron Tomography (BCET): Quantitative Strain and Topography Mapping." *Phys. Rev. Materials* **10**(11), L110801 (2026). [DOI]

RESEARCH EXPERIENCE

Ultrafast Electron Microscopy and Diffraction of Phonon Dynamics Mar. 2026 – Present
Advisor: Prof. Alfred Zong, Stanford University, Physics & Applied Physics (alfredz@stanford.edu)

✧ **Ultrafast electron microscopy (UEM) study of photoinduced Lamb waves in thin silicon films**
Co-advised by Prof. Colin Ophus, Stanford University, Materials Science and Engineering (cophus@stanford.edu)

- Led the experimental data analysis and methodology development.
- Extracted Lamb wave signals from UEM measurements at Argonne National Laboratory, and built a forward model of how a vibrating film changes the image, identifying that diffraction contrast biases the wavefield.
- Designed a physics-informed machine-learning method to resolve the vibrational wavefield from TEM and UEM data, and extracted the source profile and the relative phases of the phonon modes.
- Developed a theoretical framework for evanescent-wave topology in hyperbolic media, predicting quantized phase-winding transitions and exploring optical pump–probe detection methods.

- Proposed several follow-up research ideas. Designed and simulated excitation sources to explore frequency-selective focusing, wavefield topology, and disorder effects.

  Manuscript in preparation: H. G. Bell*, **Y. Zhuang***, C. Xu*, E. Park, C. Grossman, K. Reidy, T. E. Gage, C. Ophus, and A. Zong. "Nanoscale Metrology and Spectral Demultiplexing of Ultrafast Phonon Pulses."

✧ **Tabletop ultrafast electron diffraction (UED) instrument** Apr. 2026 – Sep. 2026

- Developed and commissioned a 95 keV DC-gun UED instrument with two doctoral students, including assembling the mechanics and vacuum system, conditioning the electron gun at high voltage, installing the RF cavity, aligning the optical and electron-beam paths, preparing samples, and setting up the detector.
- Contributed to the first measurements, from obtaining diffraction patterns to locating time zero on bismuth, and developed the $SrTiO_3$-based reciprocal-space calibration built into the measurement workflow.
- Characterized electron-beam stability through weeks of overnight monitoring. Traced the drift and jitter that limited long time-resolved scans to a charging insulator and the deflector power supplies, respectively.

Confinement of Relativistic Electrons in Graphene Quantum Dots

Nov. 2025 – Present

Advisors: Prof. Eric J. Heller, Harvard University, Physics & Chemistry (eheller@fas.harvard.edu)
Prof. Jairo Velasco Jr., UC Santa Cruz, Physics (jvelasc5@ucsc.edu)

✧ **STM imaging of integrability breaking in elliptical quantum dots**

- Led the data analysis, theoretical modeling, and computation for the STM experiment, and drafted the paper.
- Reproduced the measured local density of states by fitting tight-binding and continuum Dirac-model calculations to the STM data, extracting the confining potential of the dot.
- Developed the physical interpretation of the integrability breaking, combining semiclassical dynamics and Dirac–Schrödinger model comparisons to distinguish band-dispersion from pseudospin effects.

  Manuscript in preparation: T. Zhu*, **Y. Zhuang***, Q. Yao*, A. M. Graf, A. Asryan, Y. Lin, Z. Ge, C. Gonzalez, X. Liu, K. Watanabe, T. Taniguchi, A. Yan, J. Keski-Rahkonen, E. J. Heller, and J. Velasco Jr. "Visualizing the Breakdown of Integrability in Elliptical Graphene Quantum Dots."

✧ **Wave-packet study of anisotropic Klein tunneling in quantum dots**

- Co-led the project. Developed a GPU-accelerated time-domain method that resolves the local density of states and resonances from short-time wave-packet decay.
- Applied the method to study the anisotropy of Klein tunneling at the boundaries of 2D quantum dots, and compared the results with experimental data. Further examined how random noise and external driving fields modulate Klein tunneling.

  Manuscript in preparation: A. M. Graf*, **Y. Zhuang***, T. Zhu, Q. Yao, J. Velasco Jr., J. Keski-Rahkonen, and E. J. Heller. "Dirac Wavepacket Dynamics and Spectroscopy in Open Quantum Nanostructures."
  Manuscript in preparation: "Anisotropic Klein Tunneling and Magnetic-Field-Induced Rephasing in Elliptical Graphene Quantum Dot."

Warping-Induced Quantum Chaos and Scarring in Bilayer Graphene

Aug. 2025 – Jan. 2026

Advisor: Prof. Eric J. Heller, Harvard University, Physics (eheller@fas.harvard.edu)

- Co-led the project from conception to publication. Discovered that rotating the boundary relative to the bilayer-graphene lattice drives a transition from near-integrable to chaotic dynamics, evident in both level statistics and eigenstate structure from million-atom tight-binding simulations.
- Explained the transition as a loss of commensurability between the warped Fermi surface and the boundary, using a semiclassical ray-tracing framework.
- Computed how the shape of the Fermi surface controls scar morphology, and connected it to the underlying classical periodic orbits.
- Co-wrote the manuscript, led the response to referees, and presented the work in an oral talk at the APS Global Physics Summit 2026.

  Published as [1] (co-first author)

Deep-Learning-Assisted Quantum Tomography of Molecular Dynamics Mar. 2024 – Jun. 2025
Advisor: Prof. Zheng Li, Peking University, Physics (zheng.li@pku.edu.cn)

- Derived the analytical forward model from rotational wave-packet dynamics to diffraction signals, and simulated time-resolved diffraction datasets of symmetric-top molecules.
- Developed an alternating-projection algorithm that reconstructs density matrices, and built a physics-informed conditional generative adversarial network for the quantum tomography.

Published as [2] and [3]

LECTURES & TALKS

Invited lecture: **"Quantum Chaos in Graphene"** (75 min)
Invited by Prof. Eric J. Heller, graduate course *Quantum Chaos and Localization* Harvard University, Mar. 31, 2026

Outreach lecture: **"Introduction to Quantum Chaos"** (60 min)
Invited by Prof. Jairo Velasco Jr., COSMOS summer program for high school students UC Santa Cruz, Jul. 27, 2026

Oral: **"Visualizing Integrability Breaking of Dirac Electrons."**
APS Global Physics Summit 2027, *scheduled* Apr. 2027, Atlanta, USA

Poster: **"Time-Resolved Wavefield Tomography Based on Ultrafast Electron Microscopy."**
Quantum Frontiers: Light–Matter Interactions in 2D Materials Jul. 30, 2026, Stanford, USA

Oral: **"Lamb Wave Dynamics in Ultrathin Films Probed by Ultrafast Electron Microscopy."**
Mini Microscopy & Microanalysis Conference 2026 Jul. 29, 2026, Berkeley, USA

Oral: **"Warping-Induced Quantum Scars in Bilayer Graphene."** [link]
APS Global Physics Summit 2026 Mar. 20, 2026, Denver, USA

AWARDS & HONORS

National Scholarship (top 0.2% in China) 2024
Merit Student Pacesetter (top 2% in Peking University) 2024
Chenyang Wang–Ya Cheng Education Fund Scholarship (2025), Qi Shu Scholarship (2023)
Beijing Undergraduate Innovation Research Grant 2024–2025

SKILLS & TECHNICAL PROFICIENCY

Experimental Ultrafast electron diffraction, vacuum systems, high-voltage conditioning, optical alignment, mechanical exfoliation and transfer
Data Analysis STM/STS, TEM, and ultrafast pump–probe datasets; image and signal processing (registration, calibration, denoising), machine learning (Scikit-learn) and neural networks (PyTorch)
Computing Python, C/C++, Mathematica, COMSOL, Gaussian; high-performance computing (SLURM clusters, GPU)

GRADUATE COURSEWORK

Quantum Field Theory, Advanced AMO Physics, Atomic & Molecular Spectroscopy, Group Theory, Lie Groups & Lie Algebras, Quantum Chemistry, Laser Physics Lab, Stochastic Analysis

Ongoing: Scattering Spectroscopy of Solids, Physical Properties of Quantum Materials