

Honglie Ning

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PROFESSIONAL EXPERIENCE AND EDUCATION

Massachusetts Institute of Technology Postdoctoral researcher Advisor: Nuh Gedik	Cambridge, MA	Sep. 2022-Now
California Institute of Technology Ph.D. in Physics Advisor: David Hsieh	Pasadena, CA	Sep. 2016-Aug. 2022
Peking University B.S. in Physics (with Honors) Advisor: Jian Wang, Yan Zhang	Beijing, China	Sep. 2012- Aug. 2016

RESEARCH INTERESTS AND HIGHLIGHTS

Topics:

- Ultrafast manipulation of order parameters in quantum materials
- Dynamical decoding of the relationship between proximate phases of matter
- Emergent phases and symmetry control through collective mode excitation
- Floquet-Keldysh engineering through nonlinear carrier generation

Techniques:

- Time-resolved optical spectroscopy and nonlinear polarimetry
- Terahertz linear and nonlinear spectroscopy and polarimetry
- Time-resolved X-ray diffraction and spectroscopy
- Ultrafast electron diffraction
- Time- and angle-resolved photoemission spectroscopy

RESEARCH EXPERIENCE

Department of Physics, Massachusetts Institute of Technology Advisor - Nuh Gedik Sep. 2022 - Now

Dynamical disentanglement of charge density wave competition:

- Unveiled the coexistence and competition between two charge-ordered ground states in the kagome superconductor CsV_3Sb_5 employing time-resolved X-ray diffraction.
- Revealed the distinct dynamics and competition of two jointly commensurate charge density waves and the emergence of shear topological defects in van der Waals EuTe_4 using complementary time-resolved X-ray and electron diffraction.

Symmetry control and chiral magno-phononics in van der Waals antiferromagnets:

- Demonstrated the spontaneous emergence of nondegenerate chiral phonons by coupling to chiral magnons and experimentally determined their ellipticity in FePSe_3 using linearly polarized intense terahertz pulses.
- Activated both linear and quadratic excitation of magnon-phonon hybrid quasiparticles using intense terahertz pulses and controlled their dynamical symmetry by tuning the driving field strength and polarization in FePSe_3 and FePS_3 .
- Uncovered the significance of infrared active phonons for both nonlinear excitation of magnon-phonon hybrids and coherent modulation of a metastable ferromagnetism in FePS_3 leveraging two-dimensional terahertz spectroscopy.

Light up-conversion and sub-bandgap photon detection upon nonlinear carrier excitation:

- Induced both incoherent and coherent photoluminescence upon sub-bandgap illumination in the solar cell candidate CsPbBr_3 and theoretically modeled the photoluminescence with Keldysh formalism.

Department of Physics, California Institute of Technology Advisor - David Hsieh Sep. 2016 - Aug. 2022

Ultrafast optical control of order parameters in quantum materials:

- Resolved the reversal of excitonic order in the excitonic insulator Ta_2NiSe_5 harnessing time-resolved optical spectroscopy.
- Detected the restoration of higher structural symmetry in the Weyl semiconductor Te with time-resolved nonlinear polarimetry.
- Established the switch into a hidden quadrupolar order in the Mott insulator Ca_2RuO_4 using broadband optical spectroscopy.

Nonlinear carrier excitation and band modulation in a Mott insulator:

- Achieved multiphoton-to-quantum tunneling Keldysh crossover using an intense midinfrared pulse and observed coherent Floquet bandwidth renormalization and nonlinear doublon-holon pair production in the Mott insulator Ca_2RuO_4 .

Emergent phases and demagnetization of a Mott insulator upon photodoping:

- Discovered a light-induced magnetic-correlation-mediated Hubbard exciton fluid phase in the relativistic Mott insulator Sr_2IrO_4 leveraging time-resolved terahertz spectroscopy;
- Distinguished the less efficient nonthermal antiferromagnetic quenching induced by Hubbard excitons from that induced by free unbound carriers in the relativistic Mott insulator Sr_2IrO_4 employing time-resolved nonlinear polarimetry.

Department of Physics, University of Michigan

Advisor - Lu Li

Jul. 2015 - Sep. 2015

Thermal transport measurements of GaSb/InAs quantum well

School of Physics, Peking University

Advisor - Jian Wang

Jun. 2014 - Mar. 2016

Synthesis and magnetotransport measurements of WS_2

School of Physics, Peking University

Advisor - Yan Zhang

Jun. 2015 - May. 2016

Angle-resolved photoemission spectroscopy measurements of single-crystal FeSe**HONORS AND AWARDS**

DMP Postdoctoral travel award

APS

2024

Miller Postdoctoral Fellowship (declined)

Johns Hopkins University

2022

Tombrello Scholar

California Institute of Technology

2021

France A Cordova Graduate Student Fund

National Scholarship

Peking University

2013-2015

WeiMingXueZi Fellowship

Samsung Scholarship

Tung OOCL Scholarship

Merit Student Award (x3)

PUBLICATIONS**Articles** (* denotes equal contribution, † denotes corresponding author):

H. Ning*, K. H. Oh*, Y. Su*, A. von Hoegen, Z. Porter, A. Capa Salinas, Q. L. Nguyen, M. Chollet, T. Sato, V. Esposito, M. C. Hoffmann, A. White, C. Melendrez, D. Zhu, S. D. Wilson, and N. Gedik†, Dynamical decoding of the competition between charge density waves in a kagome superconductor, *Nat. Commun.* **15**, 7286 (2024).

H. Ning† and N. Gedik†, Visualizing the moiré of moiré, *Nat. Mater.* 1-2 (2024).

X. Li, I. Esin, Y. Han, Y. Liu, H. Zhao, **H. Ning**, C. Barrett, J. Shan, K. Seyler, G. Cao, G. Refael, D. Hsieh†, Time-hidden magnetic order in a multi-orbital Mott insulator, *Nat. Phys.* in press (2024).

H. Ning*, O. Mehio*, X. Li*, M. Buchhold, M. Driesse, H. Zhao, G. Cao, D. Hsieh†, A coherent phonon induced hidden quadrupolar ordered state in Ca_2RuO_4 , *Nat. Commun.* **14**, 8258 (2023).

O. Mehio*, X. Li*, **H. Ning***, Z. Lenarčič, Y. Han, M. Buchhold, Z. Porter, N. J. Laurita, S. D. Wilson, D. Hsieh†, A Hubbard exciton fluid in a photo-doped antiferromagnetic Mott insulator, *Nat. Phys.* **19**, 1876 (2023).

H. Ning*, O. Mehio*, C. Lian*, X. Li, E. Zoghlin, P. Zhou, B. Cheng, S. D. Wilson, B. M. Wong, D. Hsieh†, Light-induced Weyl semiconductor-to-metal transition mediated by Peierls instability, *Phys. Rev. B.* **106**, 205118 (2022).

X. Li*, **H. Ning***, O. Mehio*, H. Zhao, M.-C. Lee, K. W. Kim, F. Nakamura, Y. Maeno, G. Cao, D. Hsieh†, Keldysh space control of charge dynamics in a strongly driven Mott insulator, *Phys. Rev. Lett.* **128**, 187402 (2022).

H. Ning, O. Mehio, M. Buchhold, T. Kurumaji, G. Refael, J. G. Checkelsky, D. Hsieh†, Signatures of ultrafast reversal of excitonic order in Ta_2NiSe_5 , *Phys. Rev. Lett.* **125**, 267602 (2020).

A. Ron, S. Chaudhary, G. Zhang, **H. Ning**, E. Zoghlin, S. D. Wilson, R. D. Averitt, G. Refael, D. Hsieh†, Ultrafast enhancement of ferromagnetic spin exchange induced by ligand-to-metal charge transfer, *Phys. Rev. Lett.* **125**, 197203 (2020).

Y. Zhang*, **H. Ning***, Y. Li, Y. Liu, and J. Wang†, Negative to positive crossover of the magnetoresistance in layered WS_2 , *Appl. Phys. Lett.* **108**, 153114 (2016).

Manuscripts under review and preprints (* denotes equal contribution, † denotes corresponding author):

H. Ning*, T. Luo*, B. Ilyas*, E. Viñas Boström, J. Park, J. Kim, J.-G. Park, D. M. Juraschek, A. Rubio, N. Gedik†, Spontaneous emergence of phonon angular momentum through hybridization with magnons, submitted, arXiv: 2410.10693 (2024).

T. Luo*, **H. Ning***, B. Ilyas*, A. von Hoegen*, E. Viñas Boström, J. Park, J. Kim, J.-G. Park, D. M. Juraschek, A. Rubio, N. Gedik†, Terahertz control of linear and nonlinear magno-phononics, under review at *Nat. Commun.*, arxiv: 2409.14669 (2024).

Z. Zhang*, **H. Ning***, Z.-J. Liu*, J. Hou, A. D. Mohite, E. Baldini, N. Gedik, K. A. Nelson†, Keldysh tuning of photoluminescence in a lead halide perovskite crystal, submitted, arxiv: 2407.15253 (2024).

O. Mehio*, Y. Han*, X. Li, **H. Ning**, Z. Porter, S. D. Wilson, D. Hsieh†, Observation of excitons bound by antiferromagnetic correlations, under review at *Phys. Rev. Lett.* (2024).

Z. Ye*, C. Zhang*, **H. Ning**, W. Li, L. Chen, T. Jia, M. Hashimoto, D. Lu, Z.-X. Shen, Y. Zhang†, Simultaneous emergence of superconductivity, inter-pocket scattering and nematic fluctuation in potassium-coated FeSe superconductor, arXiv: 1512.02526 (2015).

Manuscripts in preparation (* denotes equal contribution, † denotes corresponding author):

H. Ning*, O. Mehio*, Y. Han, X. Li, K. L. Seyler, Z. Porter, S. D. Wilson, D. Hsieh†, Differential impact of photo-excited free and bound carriers on ultrafast demagnetization, in prep (2024).

H. Ning*, K. H. Oh*, Y. Su*, D. Z. Shi, A. Zong, D. Wu, B. Q. Lv., Z. Shen, G. Kang, H. Choi, H.-W. Kim, S. Ha, J. Kim, S. Sarker, J. P. C. Ruff, B. J. Kim, N.-L. Wang, H. Jang, N. Gedik†, Optically controllable enhancement and reduction of charge density waves mediated by phase competition, in prep (2024).

K. H. Oh*, Y. Su*, **H. Ning***, A. Zong, D. Wu, B. Q. Lv., D. Z. Shi, Z. Shen, G. Kang, H. Choi, H.-W. Kim, S. Ha, J. Kim, X. Shen, D. Luo, S. Weathersby, P. Kramer, X. Cheng, S. Sarker, J. P. C. Ruff, B. J. Kim, N.-L. Wang, H. Jang, N. Gedik†, Shear-type topological defects in jointly commensurate charge density wave, in prep (2024).

PRESENTATIONS AND POSTERS**Invited:**

Ultrafast characterization and control of emergent topological materials, APS March Meeting, 2025 (scheduled)

Terahertz control of magno-phononics in van der Waals antiferromagnets, MRS Spring Meeting & Exhibit, 2025 (scheduled)

Terahertz control of magno-phononics in 2D antiferromagnets, XII Ultrafast Dynamics and Ultrafast Bandgap Photonics, 2024

Ultrafast optical control of order parameters in quantum materials, Institute of Physics, Chinese Academy of Science, 2023

Evidence for light-induced order decoupling and phase competition in a kagome metal, Moore Postdoctoral Symposium, 2023

Ultrafast manipulation of order parameters in strongly correlated materials, Massachusetts Institute of Technology, 2021

Ultrafast manipulation of order parameters in condensed matter, Stanford University, 2021

Ultrafast manipulation of order parameters in condensed matter, University of California, Berkeley, 2021

Probing the ultrafast switch of electronic orders via coherent phonons, California Institute of Technology, 2020

Contributed:

Crossover between linear and nonlinear magno-phononics, Gordon Research Conference, 2024

Dynamical decoding of competing charge density waves in a kagome superconductor, APS March Meeting, 2024

Dynamics of antiferromagnetic order in a Mott insulator upon photodoping, APS March Meeting, 2023

Signatures of light-induced switch of spin-orbit-coupled quadrupolar order in Ca_2RuO_4 , Gordon Research Conference, 2022

Wavelength-dependent coherent phonon spectroscopy of Ca_2RuO_4 , APS March Meeting, 2022

Signatures of ultrafast reversal of excitonic order in Ta_2NiSe_5 , APS March Meeting, 2021

Dynamics of an order parameter coupled phonon in an excitonic insulator, APS March Meeting, 2020

Time-resolved second harmonic generation polarimetry study of elemental tellurium, APS March Meeting, 2019

ACADEMIC SERVICEReview editor:*Frontiers in Electronic Materials.*Reviewer:*Nat. Rev. Mater., Nat. Mater., Nat. Commun., Phys. Rev. Lett., Phys. Rev. Mater., npj Quantum Mater., Nano Lett.*Conference session chair:

Light-induced phases of matter: Floquet manipulation and coherent control, APS March Meeting, 2024

Probing magnon dynamics and non-linearity in antiferromagnets, Moore Postdoctoral Symposium, 2023

TEACHING ASSISTENTSHIP AND MENTORSHIP

Teaching assistant for Physics of Measurement (Ph 118, graduate level, instructor: Prof. Michael Roukes), gave a lecture on Fourier transform, led office hours, graded homework, and drafted homework answer on a biweekly basis for 20 students	California Institute of Technology	2021
Thesis mentor for Tianchuang Luo (graduate) on developing advanced terahertz polarimetry and nonlinear spectroscopy techniques to measure excitations in quantum magnets	Massachusetts Institute of Technology	2022-Now
Thesis mentor for Kyoung Hun Oh and Zongqi Shen (graduate) on employing advanced ultrafast electron and X-ray scattering techniques to study the dynamics of charge density waves	Massachusetts Institute of Technology	2022-Now
Thesis mentor for Preston Zhou (undergraduate) on building a transient reflectivity setup and measuring coherent phonon spectroscopy on elemental Te	California Institute of Technology	2019
Thesis mentor for Xirui Wang (undergraduate) on simulating the thermal gradient and temperature distribution in a ultrahigh vacuum cryogenic chamber using COMSOL	California Institute of Technology	2018
Summer research mentor for Mathias Driesse (undergraduate) on first-principles simulations of coherent phonons in Ca_2RuO_4	California Institute of Technology	2022
Summer research mentor for Gianluca R. Delgado (undergraduate) on simulating the amplification of Higgs mode	California Institute of Technology	2021
Summer research mentor for Carmen D. Strassle (undergraduate) on simulating the dynamics of excitonic insulator	California Institute of Technology	2020

SCIENTIFIC OUTREACH

Judge at the Annual Science and Engineering Fair for high school students	Pioneer Charter School of Science	2023, 2024
DEI journal club committee member, organized eight DEI-orientated journal clubs in two years	Massachusetts Institute of Technology	2022-Now
Mentor for high school students Ian Choi and Christopher Cheung on performing coherent phonon spectroscopy measurements on the van der Waals material CrSiTe_3	California Institute of Technology	2019
Mentor for high school student Bryan Cheng on conducting Raman scattering measurements on elemental Te	California Institute of Technology	2018
Mentor for high school student Oswin So on simulating coherent phonon excitation mechanism in Te	California Institute of Technology	2018