Haoyang Ni

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Research Interest

- Understanding spin-charge-lattice coupling in strongly correlated quantum materials using (scanning) transmission electron microscopy, diffraction and spectroscopy.

- *In-situ* observations and manipulation of quantum phases in materials with external stimuli, e.g., temperature, biasing, optics, etc.

- Development of hardware and software for multi-modal, multi-dimensional microscopy, diffraction and spectroscopic data acquisition and analysis

EDUCATION

Oak Ridge National Laboratory   Oct. 2021 – Dec. 2024(Expected)

Oak Ridge, US

- Research Intern at Center for Nanophase Materials Sciences
- Advisor: Dr. Miaofang Chi

University of Illinois, Urbana-Champaign   Aug. 2019 – May. 2025(Expected)

Champaign, US

- Ph. D in Material Sciences and Engineering
- Advisor: Prof. Jian-min Zuo

ShanghaiTech University   Sep.2015 - Jul. 2019

Shanghai, China

- Bachelor of Engineering in **Materials Science and Engineering**

RESEARCH EXPERIENCE

Visualization of long-wavelength charge density wave (CDW) in EuAl$_4$ using Cryogenic 4D-STEM

- Visualizing incommensurate long wavelength (~6.5 nm) CDW in EuAl$_4$ with >200 nm field-of-view using cryogenic 4D-STEM and diffraction contrast imaging below 140 K.
- Reveal and quantify local inversion symmetry breaking and modulating polarity in EuAl$_4$ induced by CDW.
- Determination of the picometer-scale transverse atomic displacement in EuAl$_4$ accompanied by CDW transition.
- Characterize 3-dimensional atomic displacement by acquiring 4D-STEM with higher-order Laue zone (HOLZ).

Correlating magnetic, structural and chemical ordering in high temperature ferromagnet Fe$_{5-x}$GeTe$_2$

- Imaging of Skyrmionic bubble states in Fe$_{5-x}$GeTe$_2$ and their temperature and field dependence using Lorentz 4D-STEM from 90K to room temperature.
- Revealing local short-range ordering forming $\sqrt{3} \times \sqrt{3}$ superstructure from atomic resolution STEM imaging.
- Revealing symmetry breaking and local lattice constant modulation using 4D-STEM.
- Correlating local structural ordering/disordering and Fe deficiency using core-loss STEM-EELS.

Statistical analysis of atomically dispersed catalyst (ADC) using STEM imaging and deep learning

- Observation of Pt/C$_3$N$_4$ catalyst using ADF STEM imaging.
- Efficiently and robustly identifying and extracting adatom Pt positions using deep learning.
- Quantifying adatom distributions and configurations based with statistical certainty.
- Proposing an experimental procedure to quantify beam-induced adatom displacement at different imaging conditions.

PUBLICATIONS AND PRESENTATIONS

Journal Articles:

- **H. Ni**, W.R. Meier, H. Miao, et al., *Real-space Visualization of Charge Density Wave Induced Local Inversion-Symmetry Breaking in a Skyrmion Magnet*, arXiv preprint arXiv:2311.17682
- **H. Ni**, Z. Wu, X. Wu, et al., *Quantifying Atomically Dispersed Catalysts Using Deep Learning Assisted Microscopy*, Nano letters 23 (16), 7442-7448
- S. Pidaparthy, **H. Ni**, H. Hou, et al., *Fluctuation cepstral scanning transmission electron microscopy of mixed-phase amorphous materials*, Ultramicroscopy 248, 113718
- B. Werghi, L. Wu, A.M. Ebrahim, M. Chi, **H. Ni**, M Cargnello, S.R. Bare, *Selective Catalytic Behavior Induced by Crystal-Phase Transformation in Well-Defined Bimetallic Pt-Sn Nanocrystals*, Small, 2207956
- H.W. Hsiao, R. Feng, **H. Ni**, et al., *Data-driven electron-diffraction approach reveals local short-range ordering in CrCoNi with ordering effects*, Nature communications 13 (1), 6651

Presentations:
- **H. Ni**, J.-M. Zuo, M. Chi, *Imaging Modulated Structure in EuAl4 using Cryogenic 4D-STEM*, Microscopy and Microanalysis Meeting, Minneapolis, MN, U.S., 2023
- **H. Ni**, J.-M. Zuo, M. Chi, *Optimizing STEM Imaging Conditions Towards Reliable Representation of Single Atom Catalysts*, Microscopy and Microanalysis Meeting, Portland, OR, U.S., 2022
- **H. Ni**, Z. Wu, X. Wu, et al., *Robustly describing atomically dispersed catalysts using deep Learning assisted microscopy analysis*, Materials Research Society Spring Meeting, San Francisco, CA, U.S., 2022
- **H. Ni**, J.-M. Zuo, M. Chi, *Imaging Structural Modulation in Long Wavelength Charge-Density Wave via Cryogenic 4D-STEM*, Materials Research Society Spring Meeting, San Francisco, CA, U.S., 2022
- **H. Ni**, A. Yoon, J.-M. Zuo, *Compressed Sensing Inspired Line Feature Detection for In-Situ Transmission Electron Microscopy*, Microscopy and Microanalysis Virtual Meeting, U.S., 2021

Award
- Microscopy and Microanalysis 2021 Eric Samuel Memorial Scholarship Award

SKILLS

- **Sample Preparation**
  - Dual-beam SEM/FIB TEM sample lift-out and thinning
  - Ar+ ion milling using precision ion polishing system
- **(Scanning) Transmission Electron Microscopy**
  - Use of JEOL JEM-2100, JEOL JEM-ARM200F, Nion UltraSTEM 100, FEI Themis Z, Hitachi H-9500
  - Atomic-resolution, convergent beam and nanobeam 4D-STEM
  - Lorentz TEM and 4D-STEM for magnetic imaging
  - Energy filtered TEM imaging, SAED and 4D-STEM
  - Monochromated EELS with Wien filter system (FEI Themis Z)
  - Cryogenic atomic-resolution STEM imaging with Gatan double-tilt cryo holder