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Experimental condensed matter physicist studying charge order and symmetry breaking in low-dimensional quantum materials. Specializes in angle-resolved photoemission spectroscopy (ARPES) with complementary experience in crystal growth and UHV/cryogenic instrumentation. Develops ARPES instrumentation and reproducible data acquisition and analysis workflows, including the open source ARPES analysis library `erlabpy`.

Education

Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea — Mar 2023 — present
Integrated Master's and Ph.D. Program in Physics
Advisor: Prof. Yeongkwan Kim

Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea — Mar 2019 — Feb 2023
B.S. in Physics

Research Experience

Ph.D. Research — Charge density waves in $1T$-$TiSe_2$ — 2023 — present
KAIST

- Investigated symmetry breaking and charge density wave formation in $1T$-$TiSe_2$ with temperature-dependent ARPES.
- Grew single-crystal samples including Cu-intercalated compositions using chemical vapor transport, and characterized using transport measurements, X-ray diffraction, and energy-dispersive X-ray spectroscopy, enabling controlled comparisons across the phase diagram.
- Conducted photoemission matrix-element simulations based on a tight-binding model to interpret intensity distributions in ARPES spectra.

ARPES instrumentation development — 2023 — present
KAIST

- Designed a sub-2 K ARPES platform for ultra-low-temperature electronic structure studies, including a custom-built sample manipulator using piezoelectric positioners and a closed-cycle cryostat.
- Designed the optical layout integrating a 6 eV CW laser light source with tunable polarization.
- Prototyped and fabricated components with Autodesk Fusion, 3D printing, and 3-axis CNC machining.
- Supervised routine maintenance and troubleshooting of UHV/cryogenic equipment.

ARPES experiments across synchrotron and lab facilities — 2023 — present
Various facilities

- Synchrotron ARPES beamtimes at ALS and SSRL with complementary lab-based measurements at Seoul National University, Korea Research Institute of Standards and Science (KRISS), and KAIST.
- Probed spin texture and tunable band-structure changes with spin-resolved ARPES, *in situ* alkali-metal deposition, and strain application.

Research software for ARPES analysis and acquisition 2022 — present
KAIST

- Developed the open source Python package `erlabpy` for ARPES analysis and visualization.
- Maintains public `erlabpy` documentation, including API references, installation guides, tutorials, and usage examples.
- Built Python-based acquisition software for ARPES and temperature-dependent resistivity measurements, automating instrument control and improving experiment repeatability and throughput.

Publications

3. **K. Higashihira Han**[†], D. Hwang[†], Y. Ahn, J. Cha, S. Gim, G. Lee, M. Jho, C.-y. Lim, S. H. Ryu, C. Jozwiak, A. Bostwick, E. Rotenberg, J. D. Denlinger, M. Hashimoto, D. Lu, G. Y. Cho, Y. Kim
"Unexpected stabilization of a single-q charge density wave in pristine $1T$-$TiSe_2$."
Submitted to Nature Communications, Under Review (2026).
[†] These authors contributed equally.
2. Q. Qiu, S. H. Chun, J. Park, D. Jang, L. Yue, Y. Kim, Y. Ahn, M. Jho, **K. Han**, X. Jiang, Q. Xiao, T. Dong, J.-Y. Ji, N. Wang, J. v. d. Brink, J. v. Wezel, and Y. Peng
"Photoinduced dynamics and momentum distribution of chiral charge density waves in $1T$-$TiSe_2$."
Physical Review Letters **135**, 116904 (2025).
1. G. Lee, J. Koo, J. Cha, J. Hyun, **K. Han**, C.-y. Lim, J. D. Denlinger, S. Kim, S. W. Kim, and Y. Kim
"Progressive control of rashba state on topological dirac semimetal KZnBi."
Nano Letters **24**, 13727 (2024).

Contributed Talks

3. **Chiral charge density waves in $1T$-$TiSe_2$** Feb 2026
The 5th ARPES Workshop
Seoul, Korea
2. **Sequential charge density wave transition in $1T$-$TiSe_2$** Oct 2025
The Korean Physical Society Fall Meeting
Gwangju, Korea
1. **Sequential charge density wave transition in $1T$-$TiSe_2$** Aug 2025
Summer Conference of the Korean Society of Superconductivity and Cryogenics (KSSC)
Pyeongchang, Korea

Selected Posters

2. **Unexpected stabilization of a single-q charge density wave in pristine $1T$-$TiSe_2$** Dec 2025
The 14th International Conference on Advanced Materials and Devices (ICAMD)
Busan, Korea
Best Poster Award
1. **Angle-resolved photoemission spectroscopy below 2 K** Feb 2025
Winter Conference of the Korean Society of Superconductivity and Cryogenics (KSSC)
Muju, Korea
Excellent Poster Award

Awards & Honors

Excellent Award Aug 2022

KAIST Undergraduate Research Participation (URP) Program

Title: Study on chiral charge density waves in Cu-intercalated 1T-$TiSe_2$

Mentoring, Leadership & Service

Mentoring & Lab Service, KAIST 2023 — present

- Trained new lab members and undergraduate researchers in ARPES data acquisition, analysis workflows, sample preparation, and routine instrument operation.
- Created and maintained shared onboarding and troubleshooting documentation for lab instrumentation and software.

Student Representative at Department of Physics, KAIST 2020 — 2022

- Served as a liaison between undergraduate students and the department.
- Organized events and activities for undergraduate students, including online gatherings during the COVID-19 pandemic.

Vice President of the Department of Physics Undergraduate Student Council, KAIST 2021

- Participated in student government meetings as representative of the Department student body.