

Quantum Materials Physics (QMP) Group

2023

Distinguished Research Fellow

Maw-Kuen Wu
吳茂昆



Yeu-Kuang Hwu
胡宇光



Sungkit Yip
葉崇傑



Chii-Dong Chen
陳啟東



Research Fellow

Chia-Seng Chang
張嘉升



Shang-Fan Lee
李尚凡



Yang-Yuan Chen
陳洋元



Ing-Shouh Hwang
黃英碩



Wei-Bin Su
蘇維彬



Associate Research Fellow

Wei-Li Lee
李偉立



Hsin Lin
林新

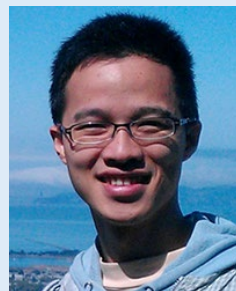


Tien-Ming Chuang
莊天明



Assistant Research Fellow

Yu-Chieh Wen
溫昱傑



Chung-Ting Ke
柯忠廷



Chen-Hsuan Hsu
徐晨軒



Research Scientist

Kung-Hsuan Lin
林宮玄



Min-Nan Ou
歐敏男



Raman Sankar



Honors & Awards (2018~2023)

***Taiwan Physics Society Special Contribution Award (2022)**

Chia-Seng Chang

***Distinguished Research Fellow**

Yeu-Kuang Hwu(2019), Sungkit Yip (2020)

Chii-Dong Chen(2023)

***Stanford/Scopus World Top 2% Scientists
Sungkit Yip, Hsin Lin (2022)**

***Highly Cited Researcher, Clarivate Analytics
(2017~2022)**

Hsin Lin

***Academia Sinica Presidential Scholars Program**

Yang-Yuan Chen (2021 – 2023)

Chii-Dong Chen (2022 – 2024)

*** 2030 Cross-Generation Young Scholars**

Chung-Ting Ke

***Future Technology (FUTEX) Award, MOST (2019)**

Yang-Yuan Chen

***Outstanding research achievement award, Asia Pacific Society
for Materials Research (APSMR), (2019)**

Yang-Yuan Chen

***NSTC Excellent Young Scholars Research Grant (2018-2020)**

NSTC Wu Ta-You Memorial Award Research Grant (2020)

The 17th Taiwan National Innovation Award (2020-2023)

Tien-Ming Chuang

***Research Award, Taiwan Association for Magnetic Technology
(2020)**

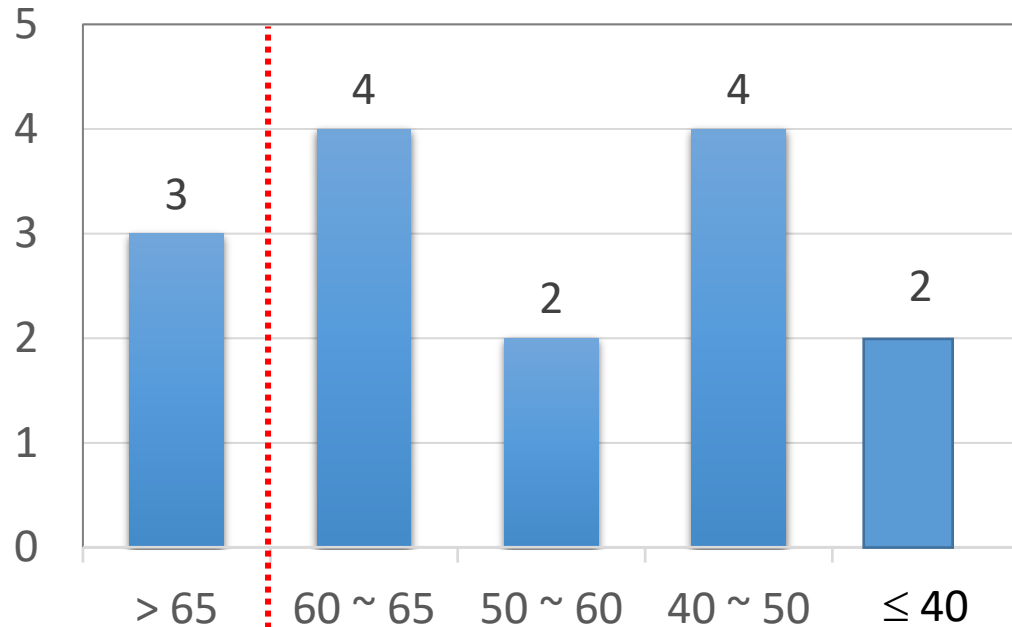
Shang-Fan Lee

*** JSPS Invitational Fellowships for Research in Japan (2022)**

Ing-Shouh Hwang

Challenges

PIs' age distribution (Total 15+3)



Mandatory retirement except for distinguished fellows or academicians

- Recruitment for new PIs, especially in the field of ARPES, MBE and quantum computing
- Decline of research manpower, i.e. PhD students and postdocs

Research Topics & Highlights (2018~2023)

Topological materials

Hsin Lin,

PRL (2018), *Science* (2019), *Nature* (2019, 2020), *PNAS* (2019), *Nature Mater.* (2018, 2020, 2022), *Nature Phys.* (2019), *Nature Nanotech.* (2022), *PRMater*(2022), *Adv. Mater.* (2022), *Nano Letters* (2022), *npj Quantum Materials* (2023)

Wei-Li Lee, Raman Sankar,

Adv. Sci. (2022)

Raman Sankar, > 124 publications, > 28 corr.

Nature Comm. (2022), *Adv. Mater.* (2023)

Adv. Funct. Mater. (2022, 2023), *PRL*(2021)

Phys. Rev. Materials (2022),

Tien-Ming Chuang & Chia-Seng Chang, Raman Sankar

Nano Lett. (2023)

Wei-Li Lee,

npj Quantum Materials (2023)

Magnetism and Spintronics

Shang-Fan Lee,

Nature Comm. (2018, 2022), *ACS Nano* (2022)

Tien-Ming Chuang and Shang-Fan Lee,

Nano Letters (2020)

FeSe, MnSe Superconductivity

Maw-Kuen Wu, *PNAS* (2019), *PNAS* (2020), *Nature Comm.* (2021),

Interfacial superconductivity

Wei-Li Lee, *npj Quantum Mater.* (2020)

Sungkit Yip and Wei-Li Lee, *PRR* (2020)

Topological superconductivity

Sungkit Yip, *PRB* (2019,2023), *PRR* (2020)

2D superconductivity

Tien-Ming Chuang and Chia-Seng Chang,

Nature Comm. (2018)

2D materials

Wei-Bin Su and Chia-Seng Chang, *Carbon* (2021),

Adv. Mater. (2019)

Shang-Fan Lee, Kung-Hsuan Lin, and Raman Sankar

Adv. Mater. (2023)

Research Topics & Highlights (2018~2023)

Quantum computing and communication

Chii-Dong Chen and Kung-Hsuan Lin

Advanced Science (2021)

Nature Physics (2018)

X-ray imaging and biomedical applications

Yeu-Kuang Hwu

Chem. Sci. (2018),

Nature Comm. (2019), *Cell* (2020)

Femtosecond laser spectroscopy

Kung-Hsuan Lin, *Nature Comm.* (2020)

Water interface

Ing-Shouh Hwang,

Small (2018), *Chem. Sci.* (2021)

Yu-Chieh Wen,

J. Phys. Chem. Lett. (2019, 2020), *Sci. Adv.* (2023).

Field emission Resonance-STM

Wei-Bin Su and Chia-Seng Chang,

Nanoscale Advances (2020), *PRB* (2022)

Spin polarized STM

Tien-Ming Chuang & Chia-Seng Chang,

Ultramicroscopy (2019)

Thermoelectrics

Min-Nan Ou, Maw-Kuen Wu, and Yang-Yuan Chen,

Materials Today Physics (2020), *Adv. Sci.* (2020,2022)

Raman Sankar, *J. Mater. Chem* (2019)

Li-ion battery

Maw-Kuen Wu

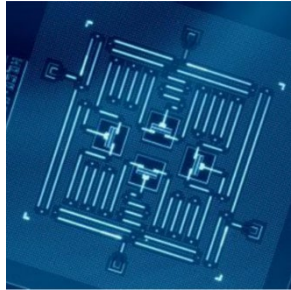
Nature Commun. Chem. (2019), *Material Today*

Physics (2021), *PNAS Nexus* (2022), *Adv. Funct.*

Mater. (2022)

Future research plans

- 2 Alpha projects, AS



**Quantum computing
& communication**

Chii-Dong Chen



CO₂ emission reduction

Yang-Yuan Chen



**Human brain
connectome**

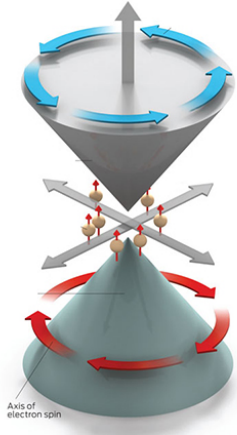
Yeu-Kuang Hwu



Li-ion battery

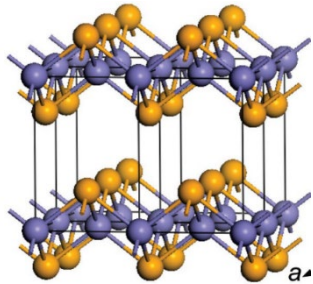
Maw-Kuen Wu

Future research plans



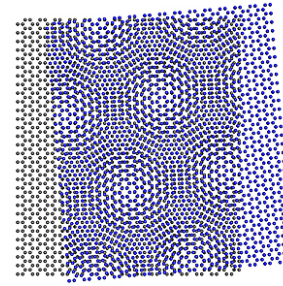
Topological materials

Hsin Lin
Sungkit Yip
Chen-Hsuan Hsu
Chung-Ting Ke
Chia-Seng Chang
Tien-Ming Chuang
Shang-Fan Lee
Wei-Li Lee
Yu-Chieh Wen
Raman Sankar



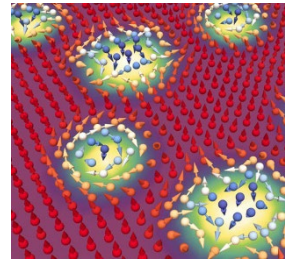
FeSe Superconductivity

Maw-Kuen Wu



2D materials

Chung-Ting Ke
Chia-Seng Chang
Chen-Hsuan Hsu
Wei-Bin Su
Kung-Hsuan Lin
Raman Sankar
Shang-Fan Lee



Magnetism & Spintronics

Shang-Fan Lee
Wei-Li Lee
Hsin Lin
Kung-Hsuan Lin
Raman Sankar



Superconductivity under high pressure

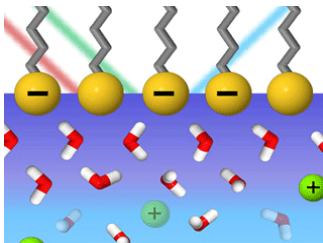
Maw-Kuen Wu
Yang-Yuan Chen
Min-Nan Ou

Future research plans



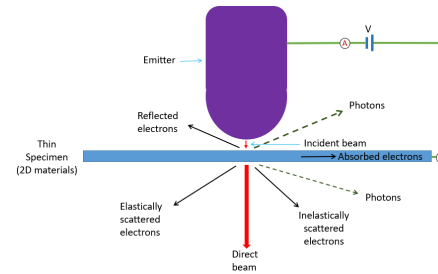
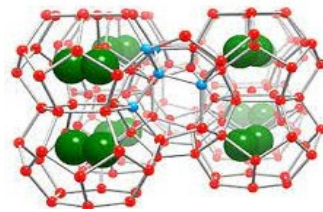
Thermoelectrics

Maw-Kuen Wu
Yang-Yuan Chen
Raman Sankar
Min-Nan Ou



Water interface

Ing-Shouh Hwang
Yu-Chieh Wen

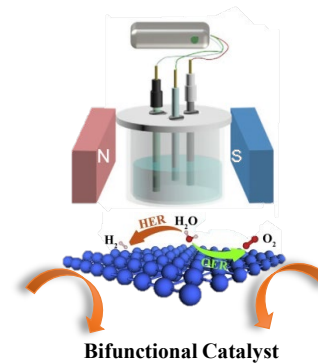


Proximity scanning transmission electron microscopy

Ing-Shouh Hwang, Wei-Bin Su

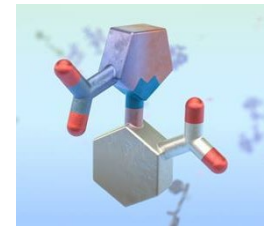
Entangled photon source by FER-STM

Wei-Bin Su



Magnetic-Spin Enhanced Electrochemical Water-Splitting

Raman Sankar



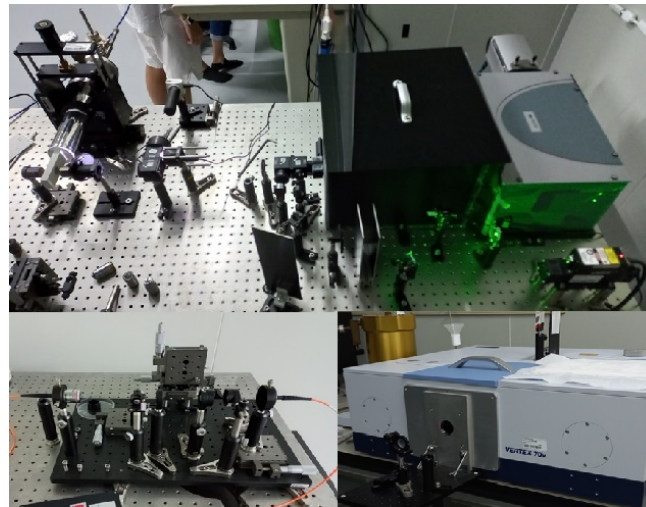
Renovated Shared facility

Nanofabrication in cleanroom



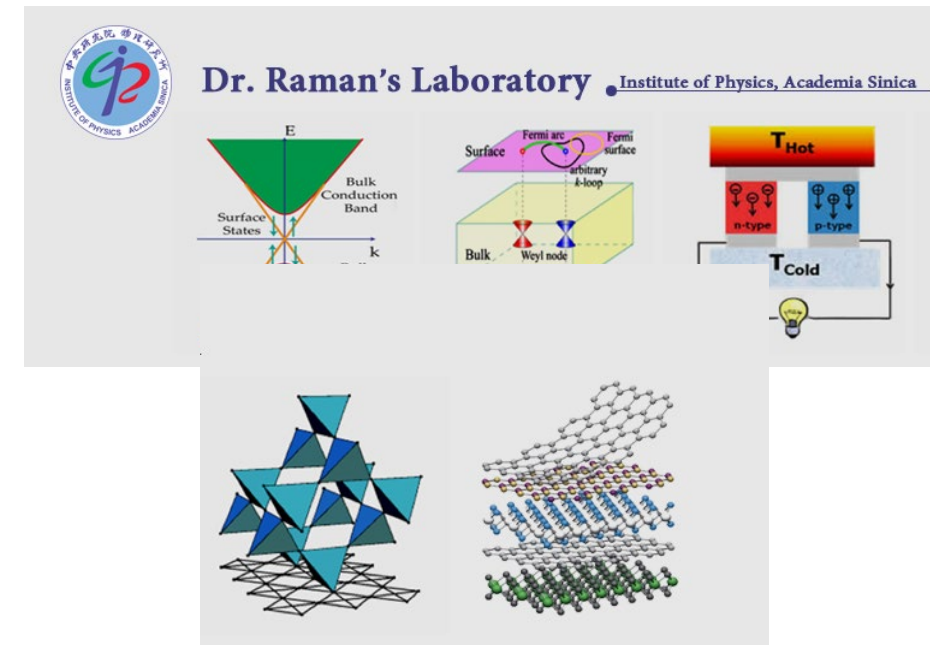
Miau, Tzong-Tsong

Optical spectroscopy facility



Lin, Kung-Hsuan
Wen, Yu-Chieh

Single Crystal Synthesis



Raman Sankar

Existing Shared facility

Precision machine shop



He liquefaction facility



Magnet & physical properties measurement



Raman Sankar

Structural characterization facility



Ou, Min-Nan, AS shared facility

Specific Issues to be Discussed and future plans

- hiring in the next three years
- Chii-Dong (and Chung-Ting) to move to Southern campus
- Cluster system (B113-115)
- Research Scientist (研究技師) vs Project Research Manager (專案研究人員)

- Free lab space B2A,

- Replacement of shared facility in three to five years
 - E-beam writer – Cleanroom (ongoing)
 - Focused ion beam – Cleanroom (??)
 - PPMS or SQUID VSM

Facilities of THz spectroscopies and current research topics in IoP

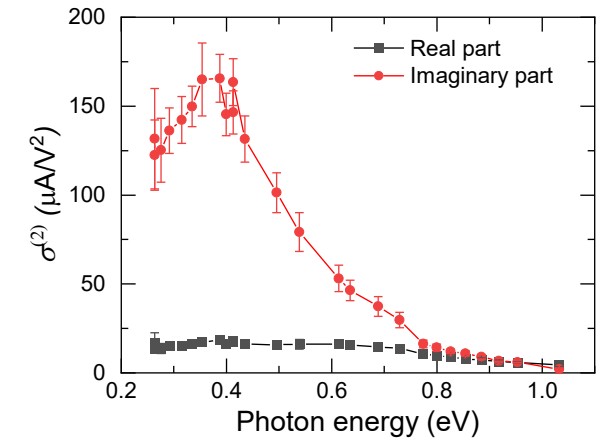
Facilities

- THz time-domain spectroscopy (1 ~ 32 meV)
- Fourier transform infrared spectroscopy (> 6 meV)
- THz emission spectroscopy
- Optical/THz pump-probe spectroscopy

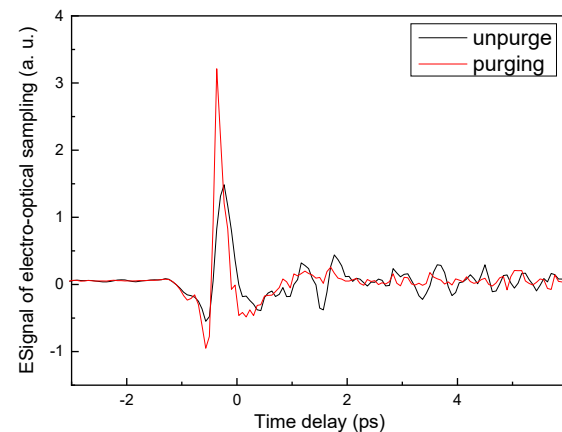
Topics

- Linear and nonlinear optical conductivity of topological semimetals
- Ultrafast electron dynamics of topological semimetals
- Strong-field phenomena in crystalline systems
-

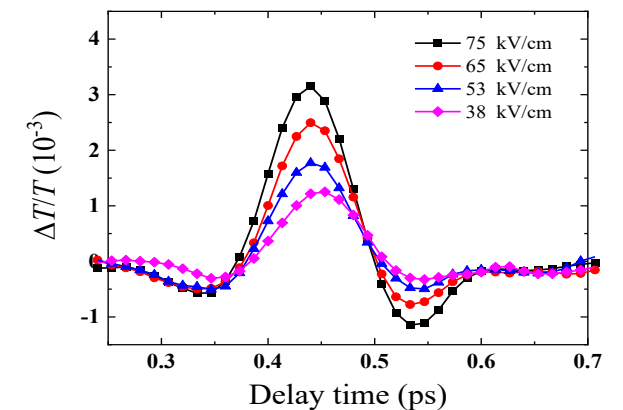
Linear/circular photogalvanic effect in chiral multifold Weyl semimetals



Broadband THz time-domain spectroscopy (>8 THz)



Dynamic Franz-Keldysh effect in centrosymmetric semiconductor

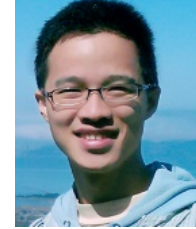


Shared Optical Facility

managed &
developed by



Kung-Hsuan Lin

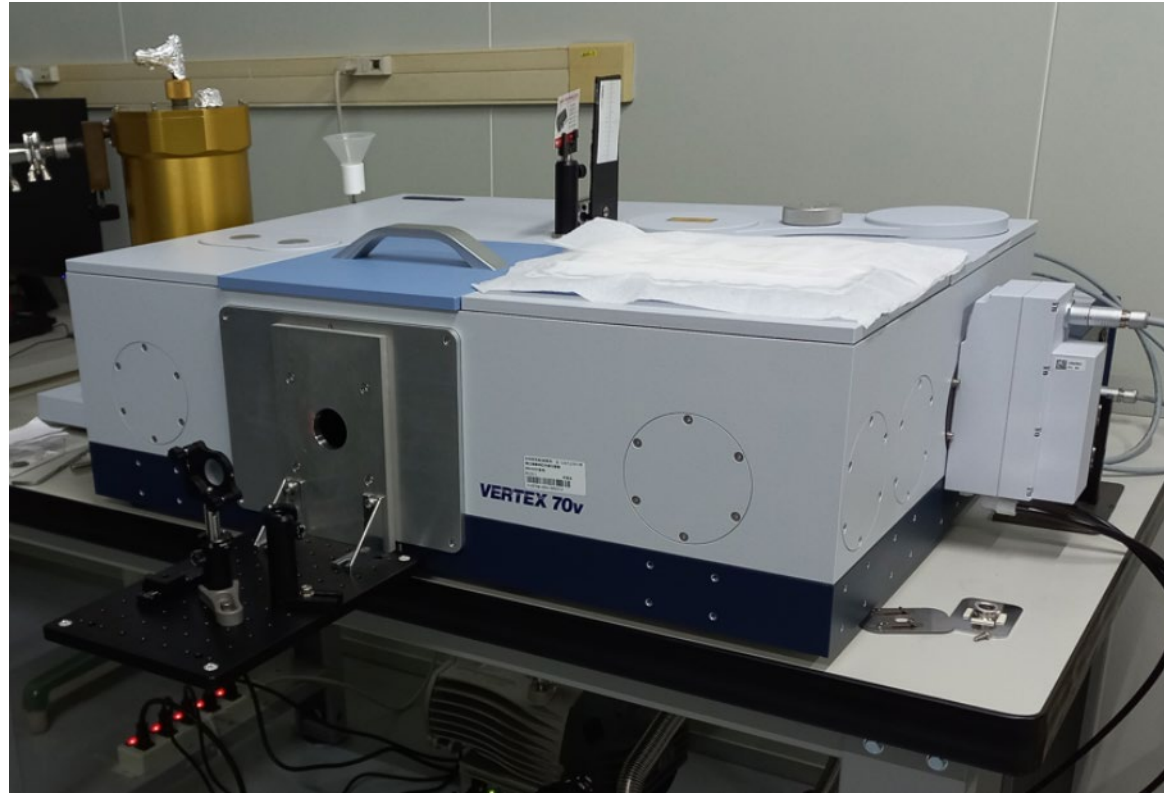


Yu-Chieh Wen

- **FTIR (Fourier Transform Infrared) spectroscopy**
 - ✓ Far IR (THz) to Visible range
 - ✓ Transmittance & Reflectivity measurements for obtaining optical constants
 - ✓ Available for low temperature measurements
- **Transmission/absorption micro-spectroscopy**
 - ✓ 450 nm – 1600 nm
 - ✓ Measurement spot size $\sim 50 \mu\text{m}$
 - ✓ Available for low temperature measurements
- **Raman & PL micro-spectroscopy**
 - ✓ Raman laser 532 nm, PL laser 405 nm
 - ✓ Measurement spot size $\sim 1 \mu\text{m}$
 - ✓ Available for low temperature measurements

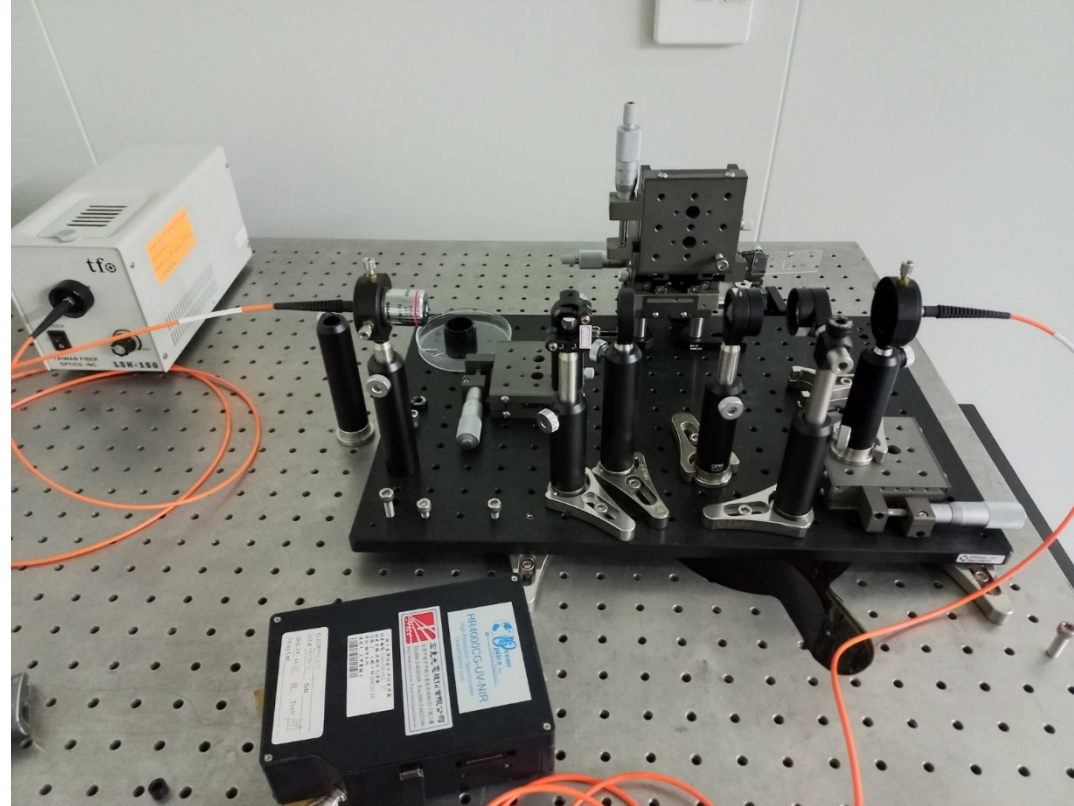
Supplement

FTIR spectrometer



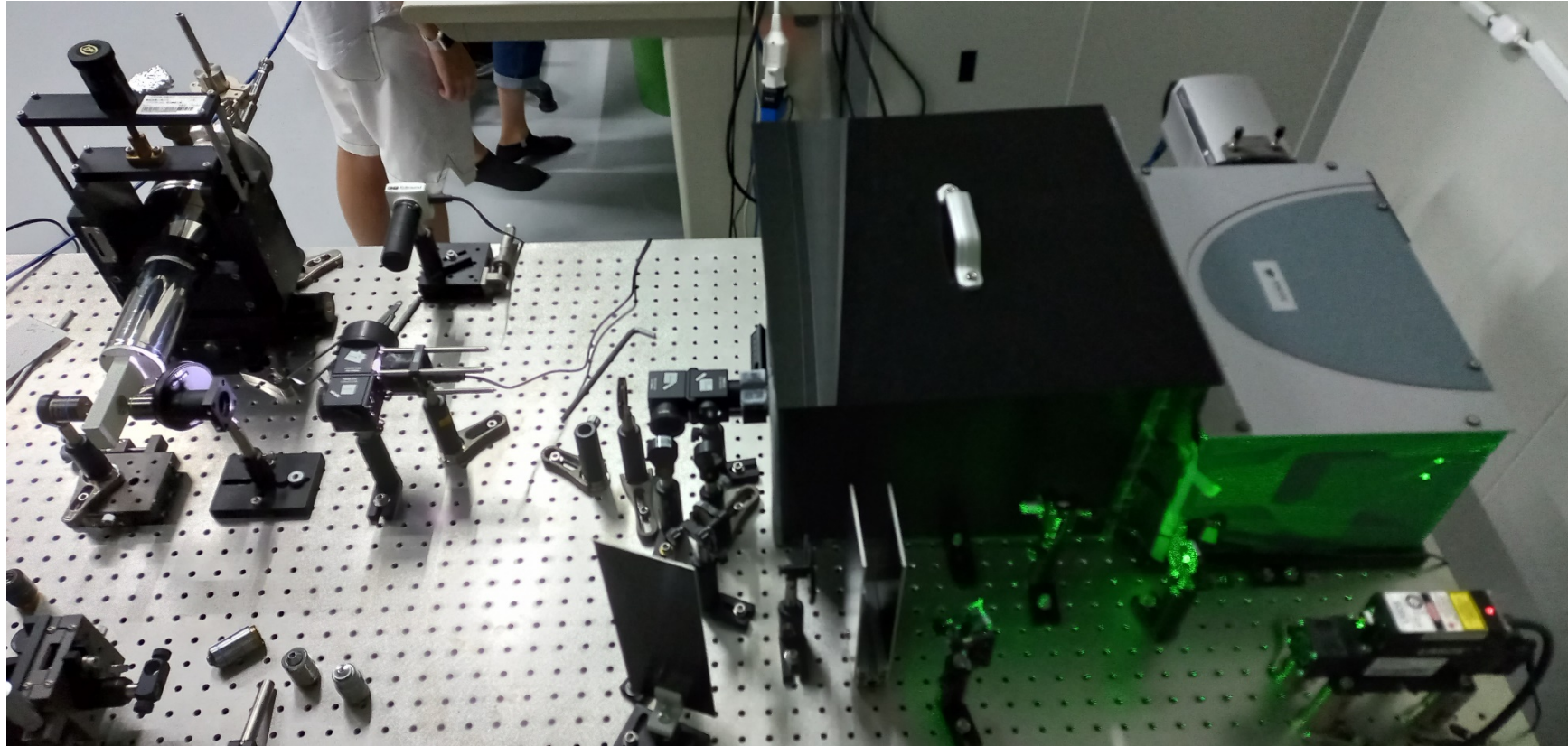
- Far IR (THz) to Visible range
- Transmittance & Reflectivity measurements for obtaining optical constants of emergent materials
- Available for measuring relatively small samples with rough surfaces
- Available for low temperature measurements

Optical Transmission/Reflection micro-spectroscopy



- VIS (450-1100 nm), NIR (950 – 1600nm)
- Optical spot size \sim 50 micron
- Available for low temperature measurements

Raman (532nm laser) & PL (405nm laser) micro-spectroscopy



- Custom designed experiments (polarization)
- Non-magnetic table for magnetic experiments
- Available for low temperature measurements

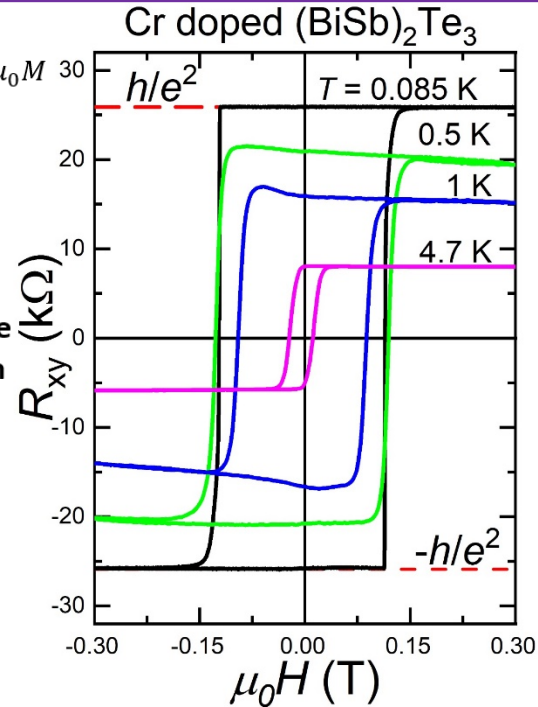
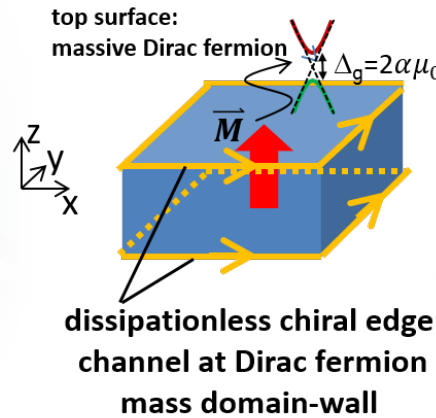
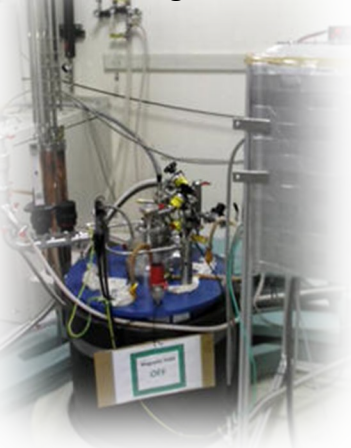
Magnetotransport study in quantum materials

Supercond. magnet with dilution fridge. 17 Tesla, 15 mK

2D microcrystal dry transfer system

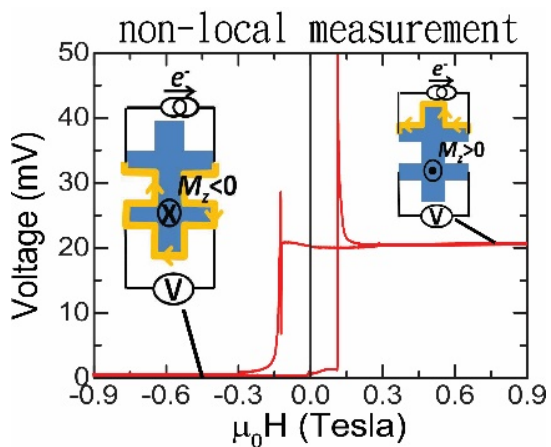
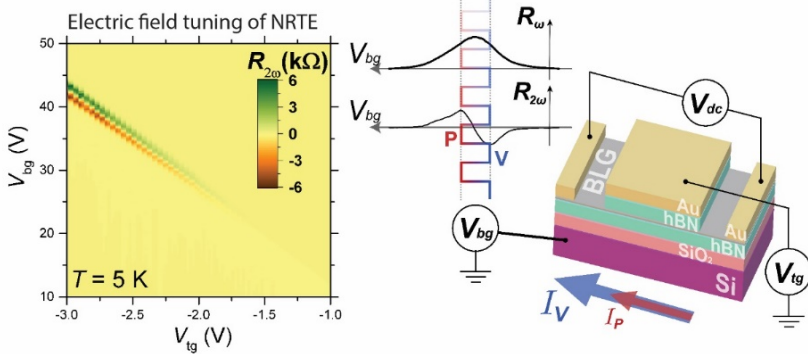
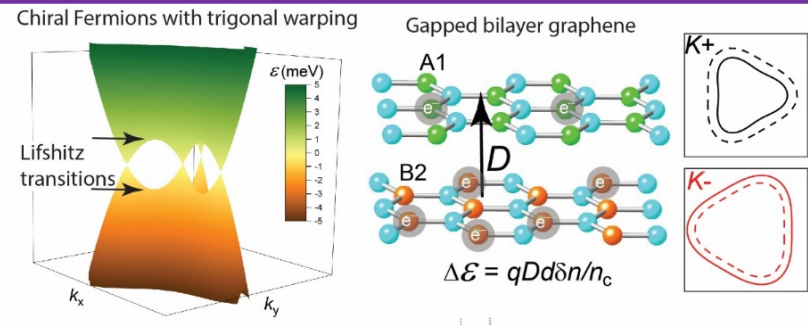
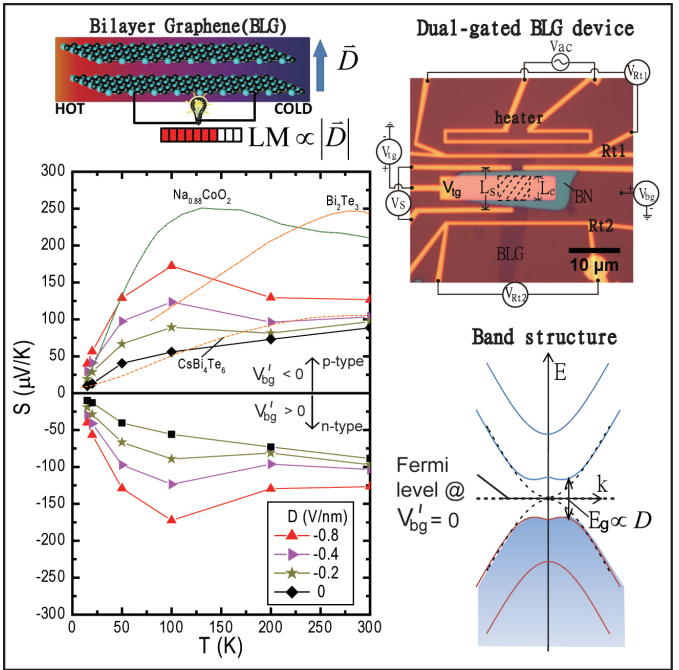
Quantum anomalous Hall effect (QAHE) in ferromagnetic topological insulator

李偉立 Wei-Li Lee



Full electric field tuning of thermoelectric power in Dual-Gated Bilayer Graphene

Nonreciprocal and nonlinear charge transport in massive chiral Fermions with trigonal warping



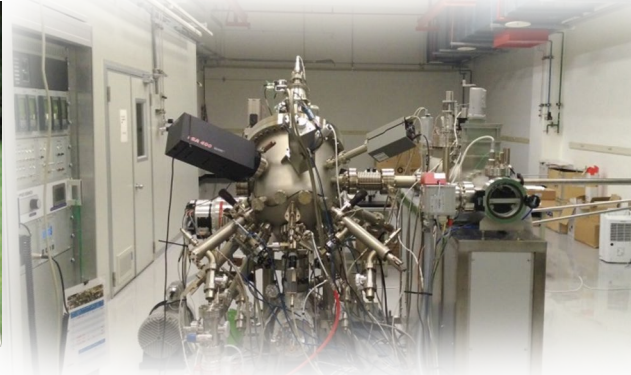
Physical Review Letters 107, 186602 (2011)

Physical Review Research 3, 033160 (2021)

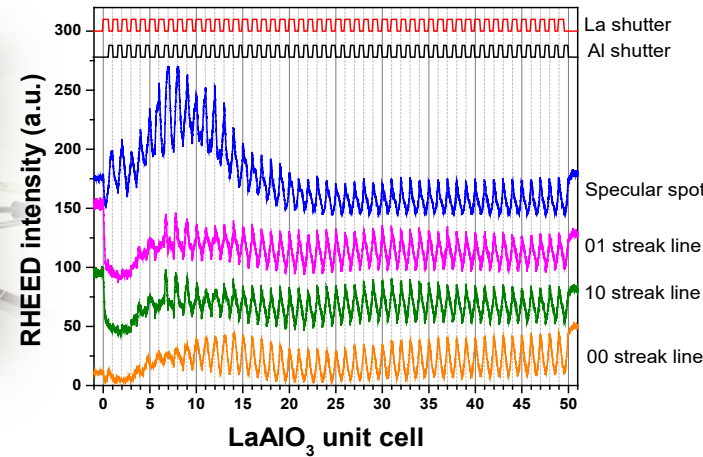
Physical Review Letters 113, 137201 (2014)

Oxide MBE system with ozone distiller

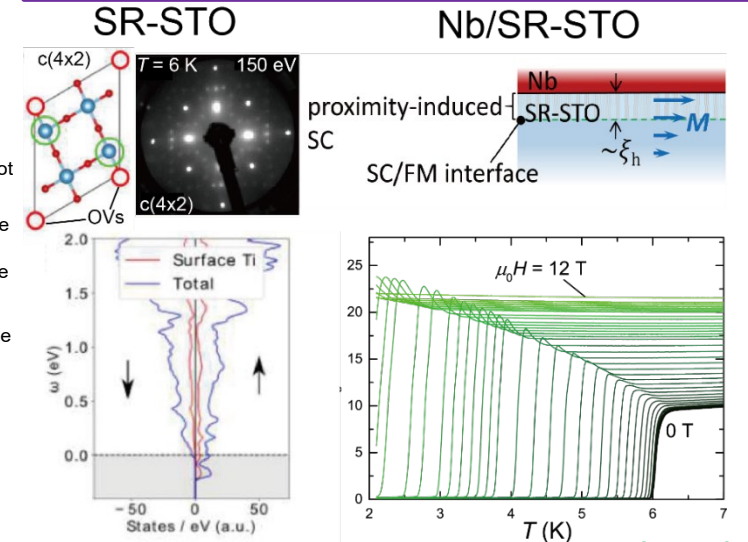
李偉立 Wei-Li Lee



In-situ RHEED monitor

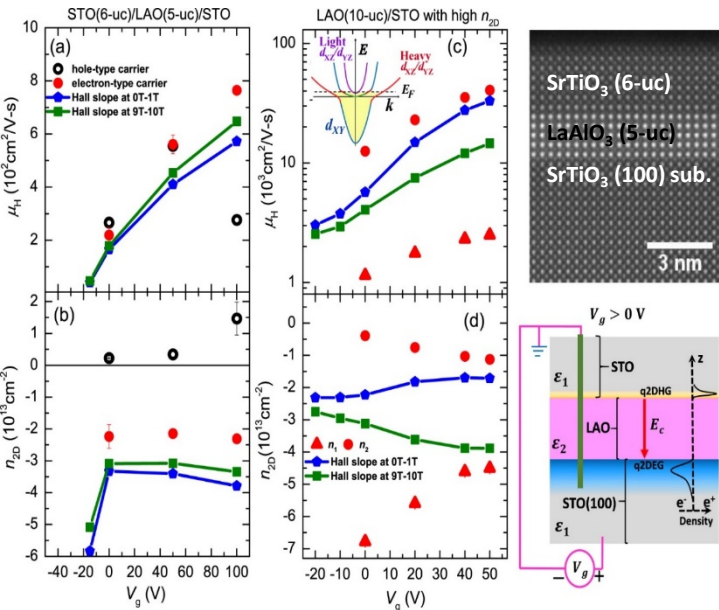


Spin-polarized in-gap states in surface-reconstructed SrTiO3



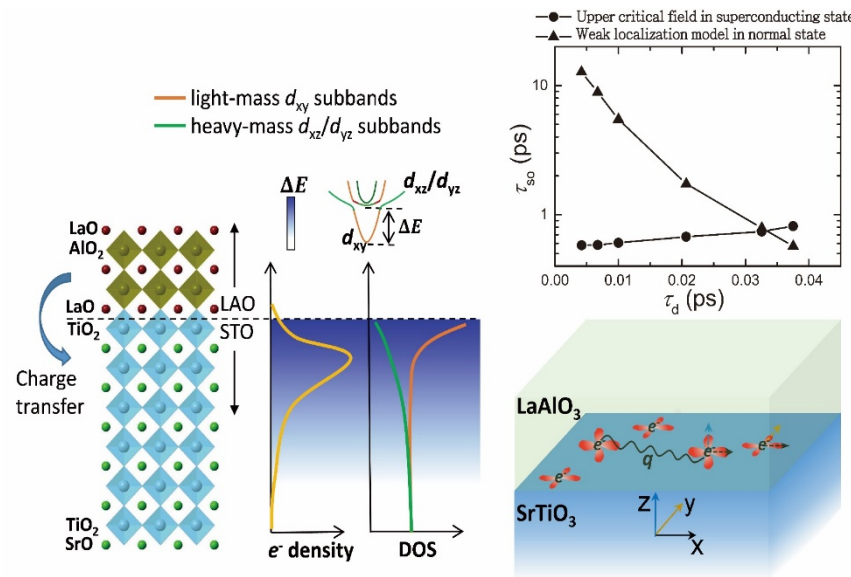
npj Quantum Mater. 5, 45 (2020)

Quasi-two-dimensional hole gas at complex oxide interface



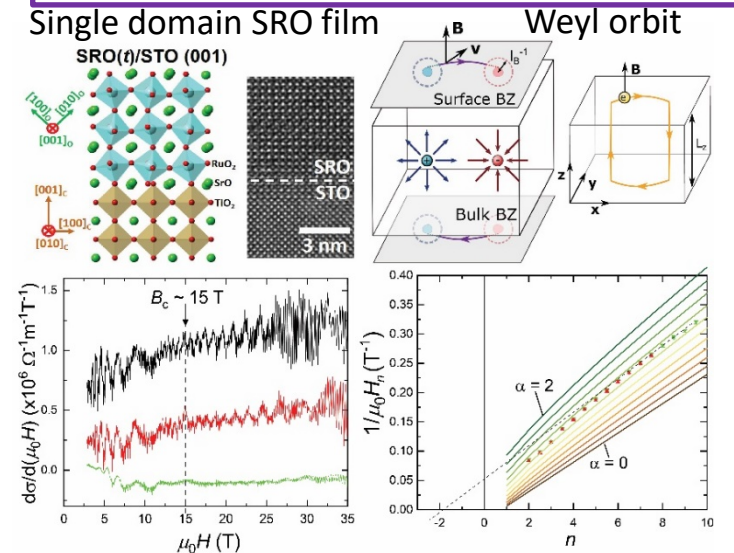
Phys. Rev. Materials 2, 114009 (2018)

Orbital selectivity for Cooper pairing at superconducting interface



Phys. Rev. Research 2, 013311 (2020)

Weyl-orbit quantum oscillation in topological Weyl semimetal SrRuO3



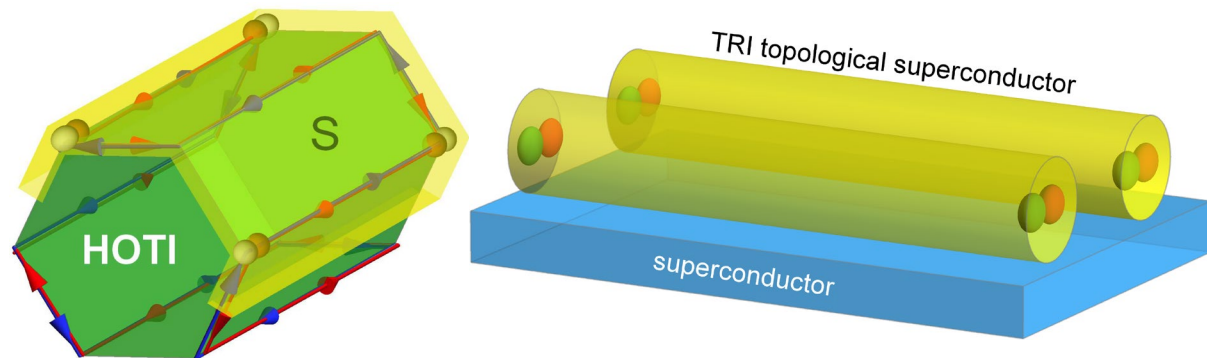
npj Quantum Mater. 8, 8 (2023)

Quantum matter in nanoscale systems

- condensed matter theory (Chen-Hsuan Hsu)

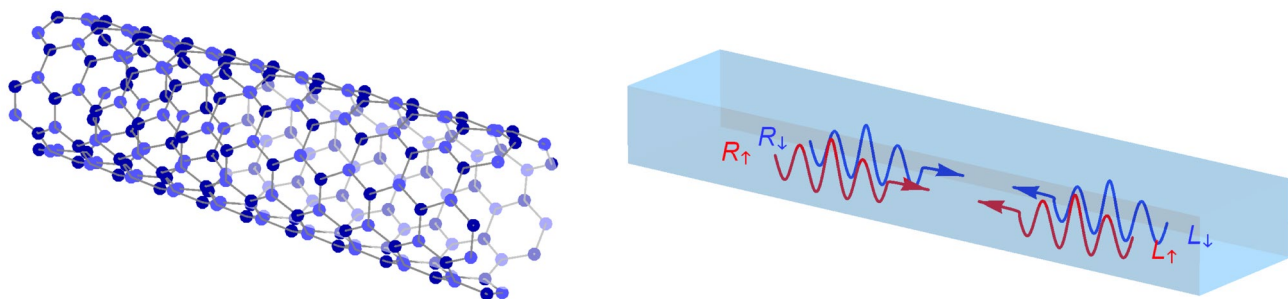
- Hybrid systems for topological zero modes

- 2D layered systems

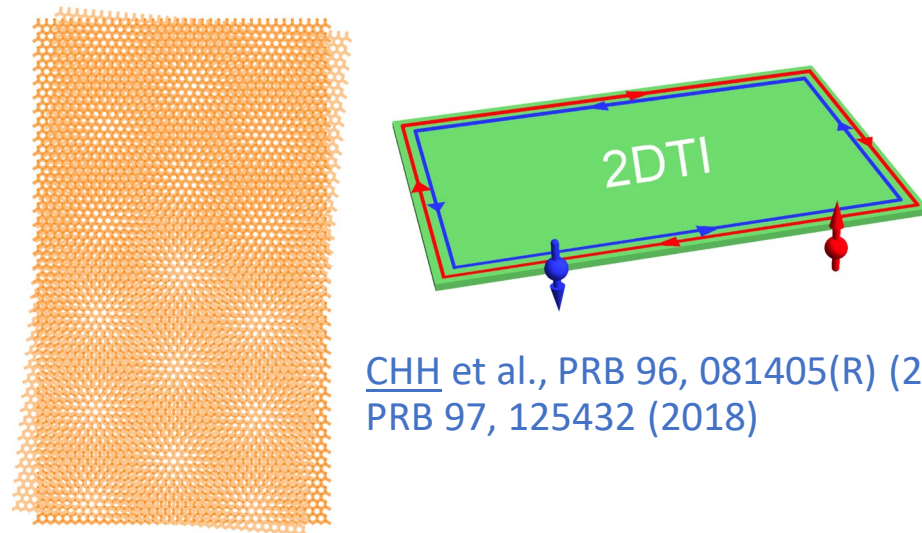


[CHH et al., PRL 121, 196801 \(2018\); SST 36, 123003 \(2021\)](#)

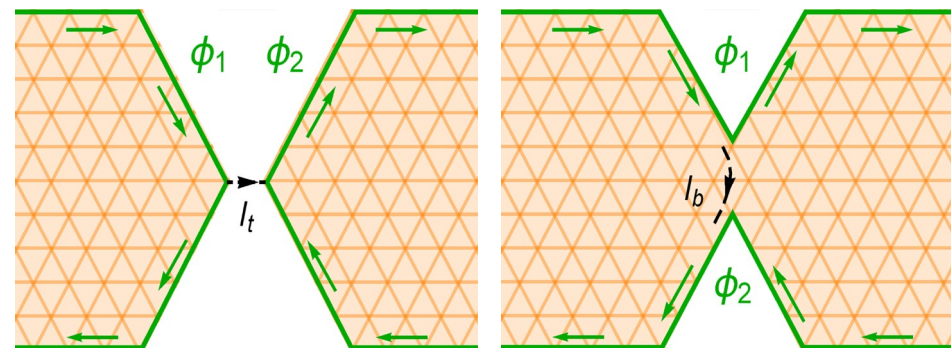
- Correlated electrons in nanowires/nanotubes



[CHH et al., PRB 92, 235435 \(2015\); PRB 100, 195423 \(2019\); PRR 2, 043208 \(2020\)](#)



[CHH et al., PRB 96, 081405\(R\) \(2017\); PRB 97, 125432 \(2018\)](#)



[CHH et al., arXiv:2303.00759](#)

Critical comments from AAC & AS Review

Collaborative research (within and outside IOP) are strongly encouraged by both committees.

Ongoing collaboration: iMATE project (Chuang, Sankar, Wen, Yip), Thematic?

PIs should identify and tackle new challenging research directions, giving the stable funding and minimum teaching load.

The Director encourages the new program by funding.

Organizing international conferences and better industrial collaborations are recommended.

Quantum computing and machine learning are also suggested to be two key directions.

Critical comments from AAC & AS Review

The core facilities are commended by both committees but the APRES+MBE remains underutilized for the lack of suitable personnel.

We are actively looking for candidates.

Aggressive recruiting new PIs in key areas with attractive offers and novel facilities. Diversity should be improved.

While the salary is rigid, we do work hard to improve our shared facilities.

Collaboration with domestic and international universities to address the issue of decreasing student/postdocs.

H-index and averaged citation are consistent with world averages but not impressive.