



量子磁性与自旋物理课题组

课题组负责人：于涛

2024年7月1日

一、课题组人员组成情况 <http://www.yutaolab.com/>

课题组成立第三年。

目前有教授1名，博士研究生4名，硕士研究生3名，本科生1名。



于涛 教授

课题组负责人

国家海外高层次人才项目 / 湖北省百人计划

服务器计算平台 · 磁性与超导异质结构实验室

2018年获中国科技大学博士学位。

在荷兰代尔夫特理工大学、日本东北大学和德国马普所（物质结构和动力学研究所）进行博士后研究工作。

2021年加入华中科技大学。

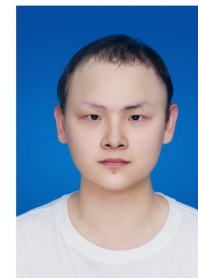
在Physics Reports(第一及通讯作者2篇)、Physical Review Letters(第一及/或通讯作者8篇)、Nature Physics、Science Advances、Physical Review B等期刊发表论文60余篇。

PhD Students



Wenxin Wu (吴文欣)

PhD Students (2024.6-now)



Chengyuan Cai (蔡成渊)

PhD Students (2021.9-now)



Xiyin Ye (叶茜茵)

PhD Students (2023.6-now)



Zhiping Xue (薛治平)

PhD Students (2024.6-now)

Master Students



Ping Li (李萍)

Master Students (2024.6-now)



Xi-Han Zhou (周熙涵)

Master Students (2022.4-now)

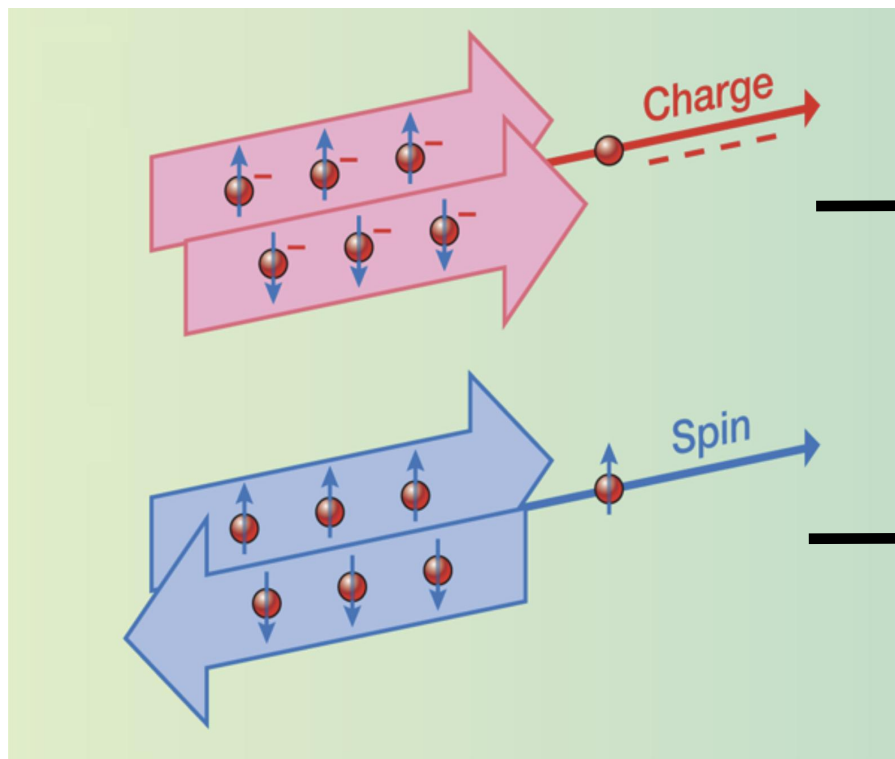


Qian-Nan Huang (黄倩南)

Master Students (2024.8-now)

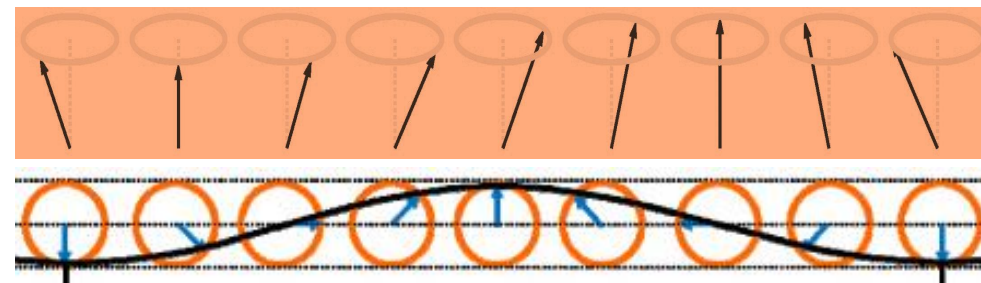
二、课题组研究方向及代表性成果

自旋电子学/磁子学：用电子或磁子自旋自由度传输信息

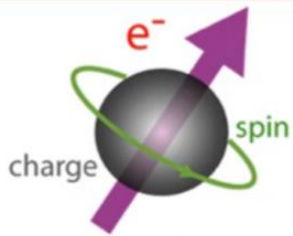


半导体
工业

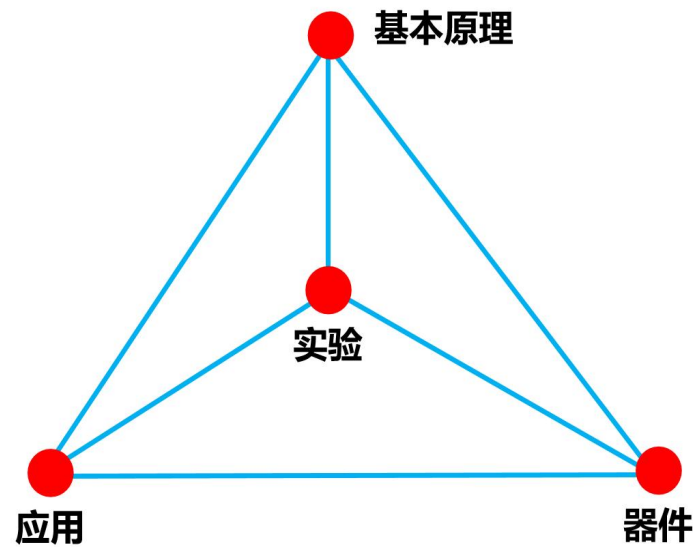
自旋电子
学/磁子学



二、课题组研究方向及代表性成果



自旋电子学研究有望
解决器件功耗问题



2021年度磁硬盘市场
~300亿美元

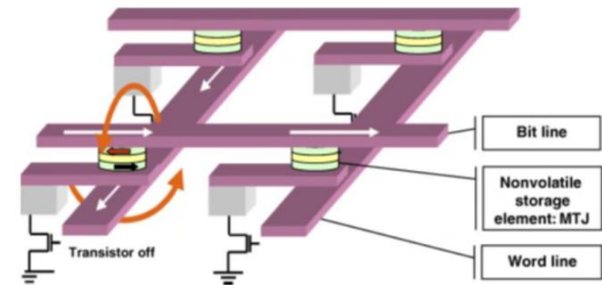


介质: CoPtCr等

2021年度磁传感器
~52亿美元



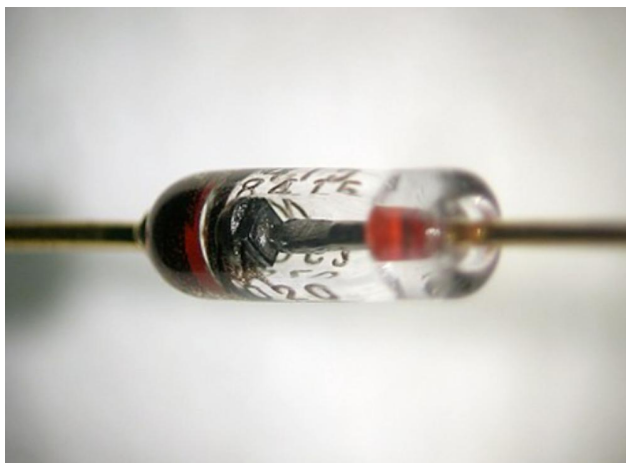
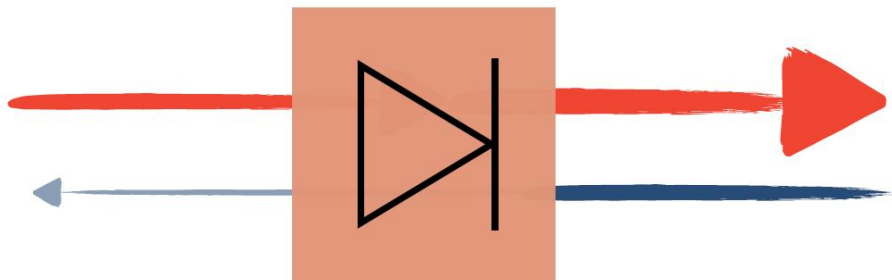
2021年度磁随机存储器
~4亿美元



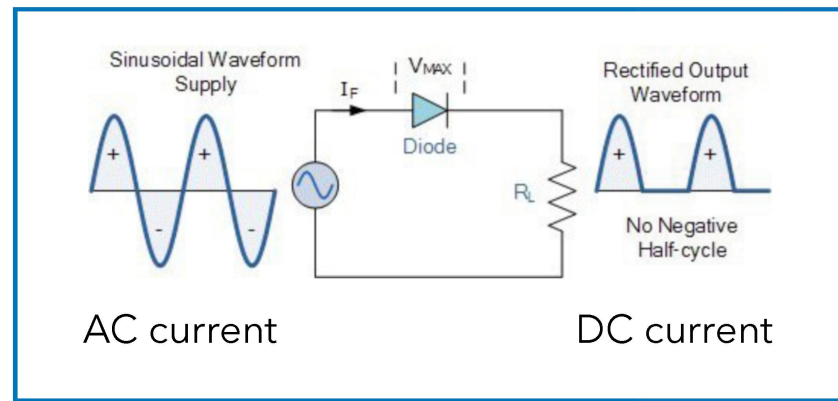
介质: CoFeB/MgO等

二、课题组研究方向及代表性成果

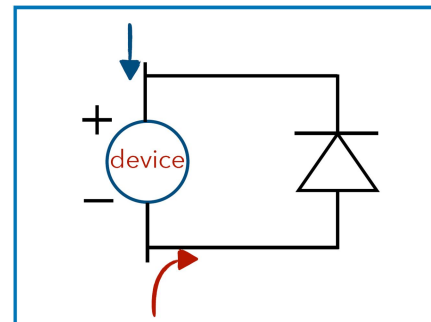
自旋输运的理论研究



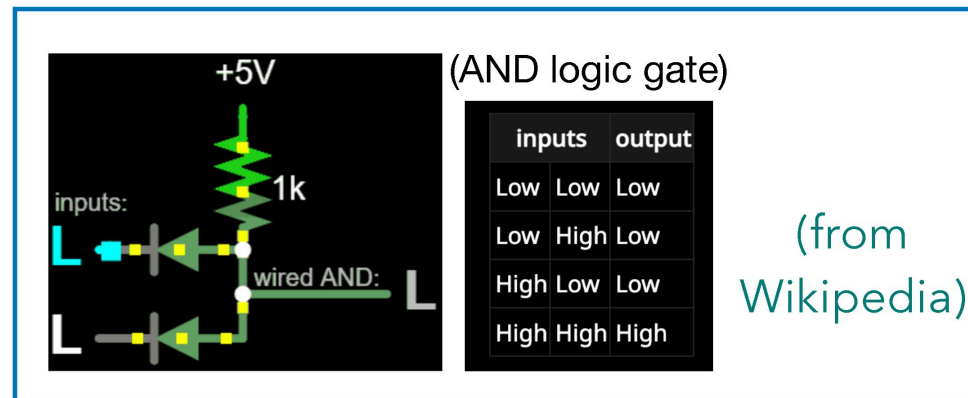
整流



电路保护



逻辑运算



(a) 手性磁子学

(b) 非厄米拓扑磁子学

(c) 超导磁子学

既有理论研究，
也有实验研究

与准粒子耦合
(光子、声子、
电子、磁子等)

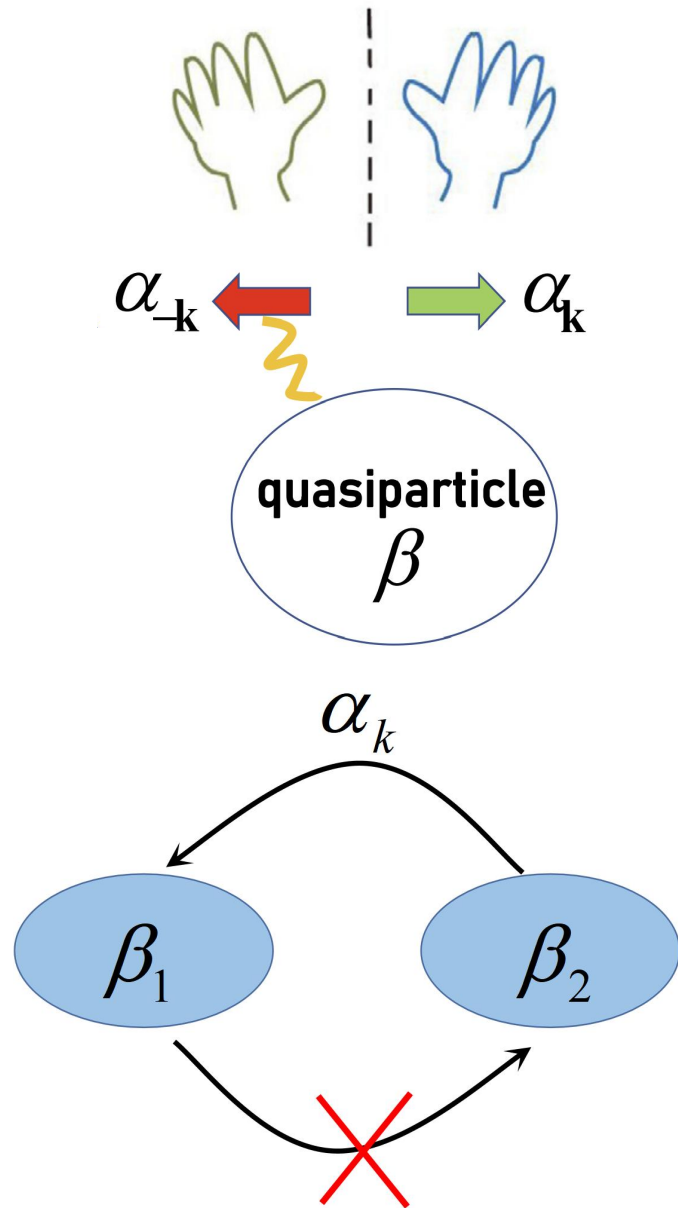
磁子或电子
(自旋、轨
道)

与超导耦合

与环境耦合

多数理论预言获实验验证。

(a) 手性磁子学：手性相互作用 [Yu, Luo, and Bauer, Phys. Rep. 1009, 1-115 (2023)]



Physics Reports 1009 (2023) 1–115



Contents lists available at ScienceDirect

Physics Reports

journal homepage: www.elsevier.com/locate/physrep



Chirality as generalized spin-orbit interaction in spintronics

Tao Yu ^{a,*}, Zhaochu Luo ^{b,c}, Gerrit E.W. Bauer ^{d,e}

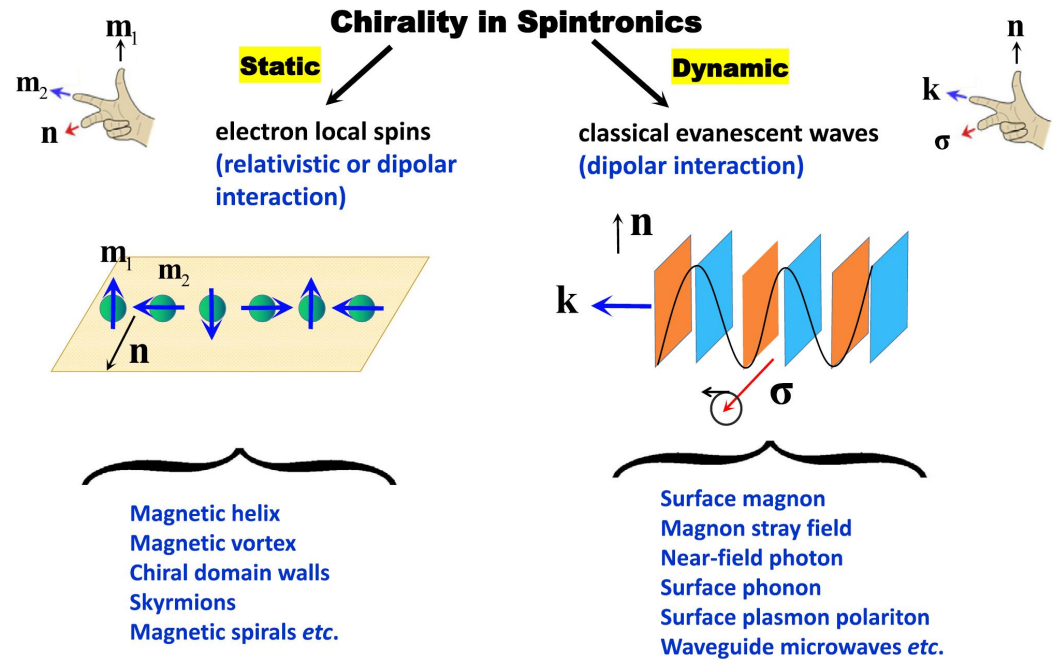
^a School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China

^b State Key Laboratory of Artificial Microstructure and Mesoscopic Physics, School of Physics, Peking University, 100871 Beijing, China

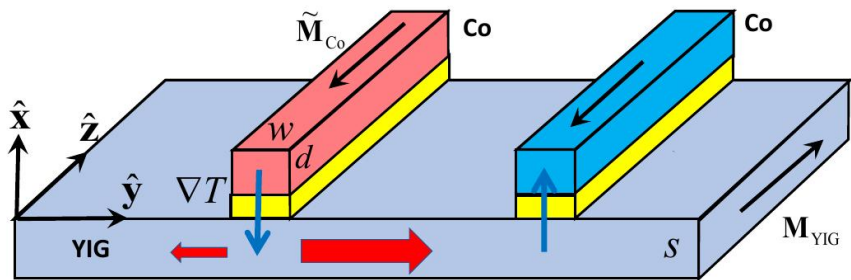
^c Beijing Key Laboratory for Magnetoelectric Materials and Devices, Beijing, 100871, China

^d WPI-AMR and Institute for Materials Research and CSRN, Tohoku University, Sendai 980-8577, Japan

^e Kavli Institute for Theoretical Sciences, University of the Chinese Academy of Sciences, Beijing 100190, China



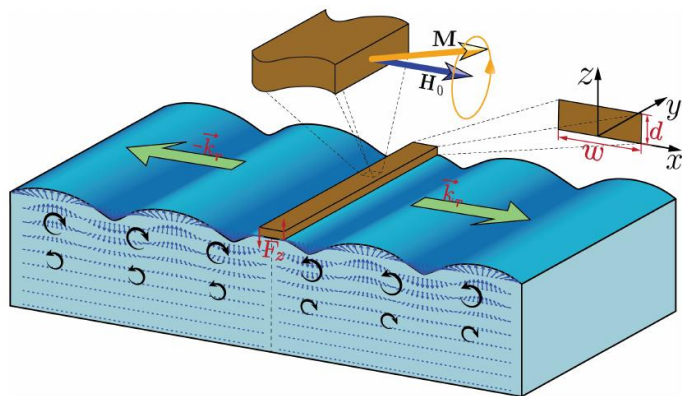
课题组贡献的主要物理效应



手性磁子泵浦、手性磁子塞贝克效应

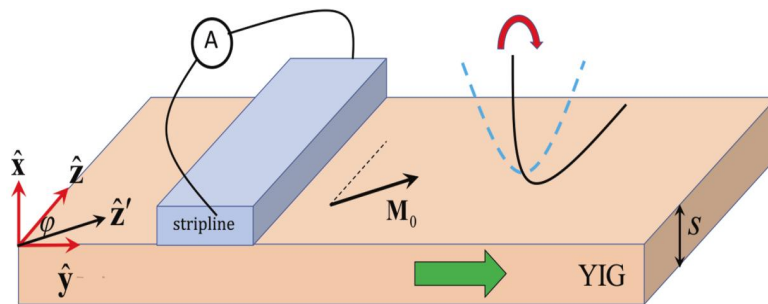
[Au *et al.*, APL **100**, 182404 (2012)]

Yu, Blanter, and Bauer, PRL **123**, 247202 (2019)]



单方向声子泵浦

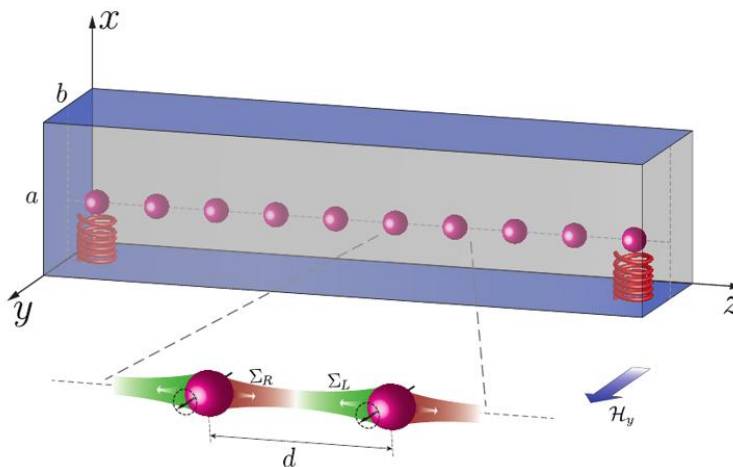
[Zhang, Bauer, and Yu, PRL **125**, 077203 (2020)]



非线性磁子多普勒效应

[Yu and Bauer, PRL **126**, 137202 (2021)]

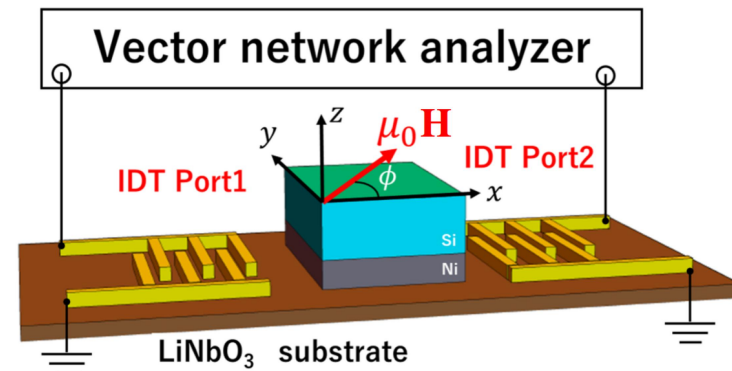
Bertelli *et al.*, Sci. Adv. **6**, eabd3556 (2020)]



微波二极管

[Yu *et al.*, PRL **124**, 107202 (2020)]

Hu, Fu, and Liu, PRL **128**, 217201 (2022)]



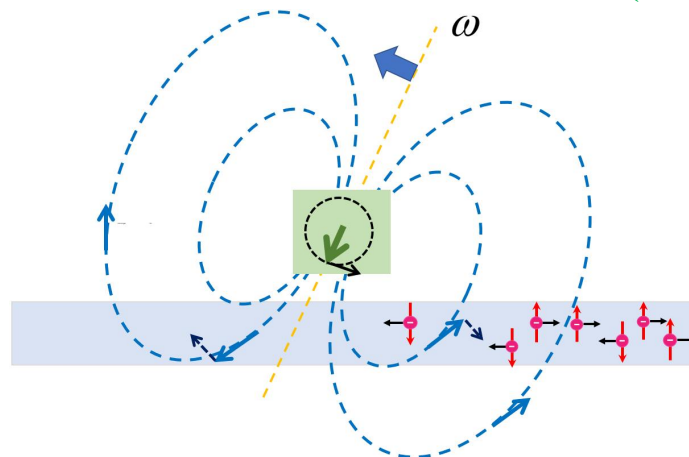
声子二极管

[Sasaki *et al.*, PRB **95**, 020407(R) (2017)]

Xu *et al.*, Sci. Adv. **6**, eabb1724 (2020)]

Küb *et al.*, PRL **125**, 217203 (2020)]

Shah *et al.*, Sci. Adv. **6**, eabc5648 (2020)]



电子非接触自旋泵浦

[Yu and Bauer, PRL **124**, 236801 (2020)]

(b) 非厄米拓扑磁子学及课题组主要贡献

[Yu, Zou, Zeng, Rao, and Xia, Phys. Rep. 1062, 1 (2024)]

Physics Reports 1062 (2024) 1–86



Non-Hermitian topological magnonics

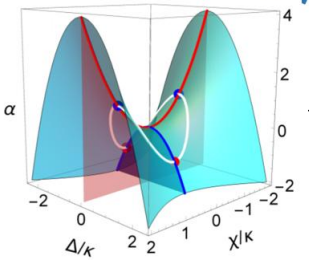
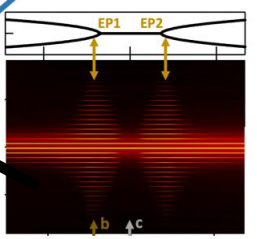
Tao Yu ^{a,*}, Ji Zou ^b, Bowen Zeng ^{a,c}, J.W. Rao ^d, Ke Xia ^e

- ^a School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China
- ^b Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel, Switzerland
- ^c School of Physics and Electronic Science, Changsha University of Science and Technology, Changsha 410114, China
- ^d School of Physical Science and Technology, ShanghaiTech University, Shanghai 201210, China
- ^e School of Physics, Southeast University, Jiangsu 211189, China

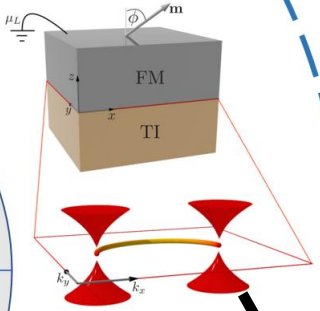


奇异点增强的磁子频率梳

[Rao, TY* *et al.*, PRL 130, 046705 (2023); Nat. Phys. (published online)]

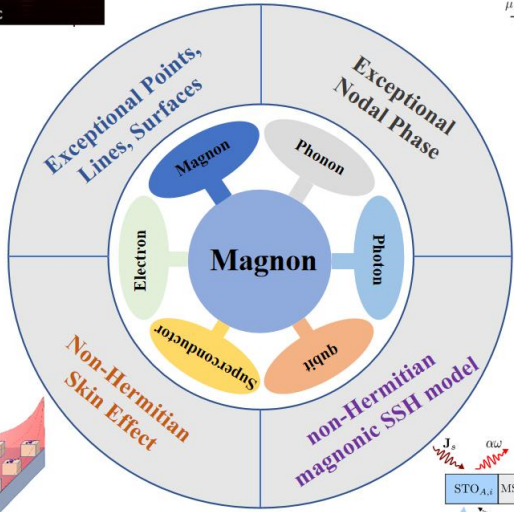
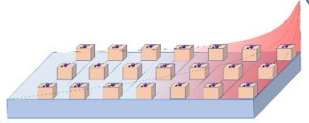
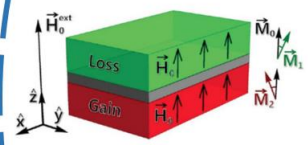


磁子奇异面

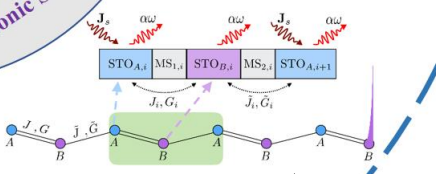


磁子非厄米趋肤效应

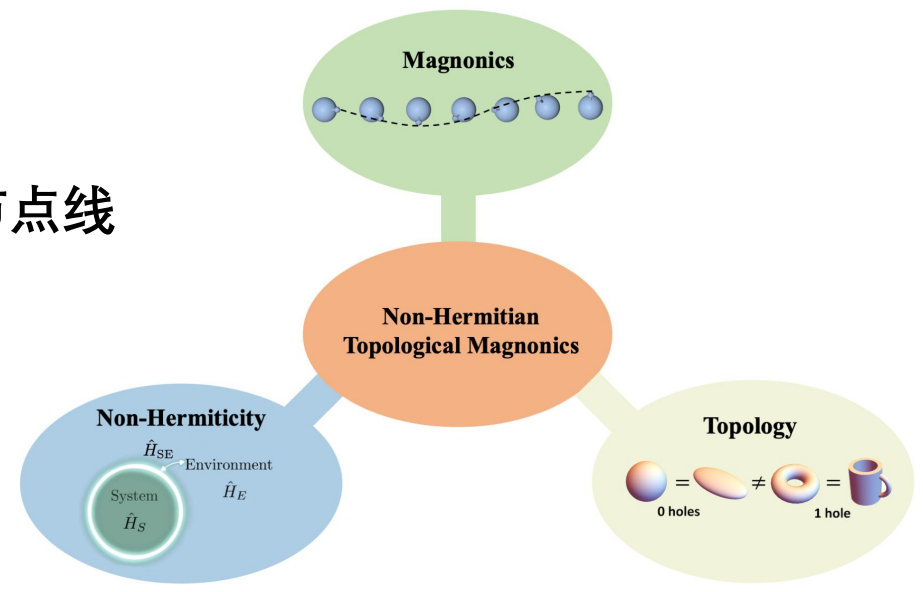
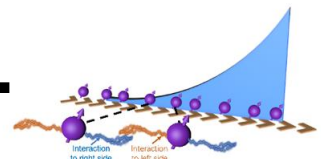
[TY* and Zeng, PRB 105, L180401 (2022); Zeng and TY*, PRR 5, 013003 (2023) Cai, Kennes, Sentef, and TY*, PRB 108, 174421 (2023)]

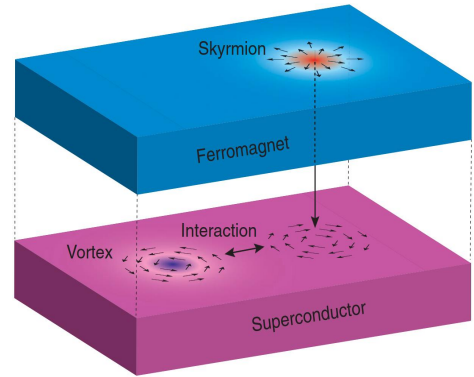


磁子节点线



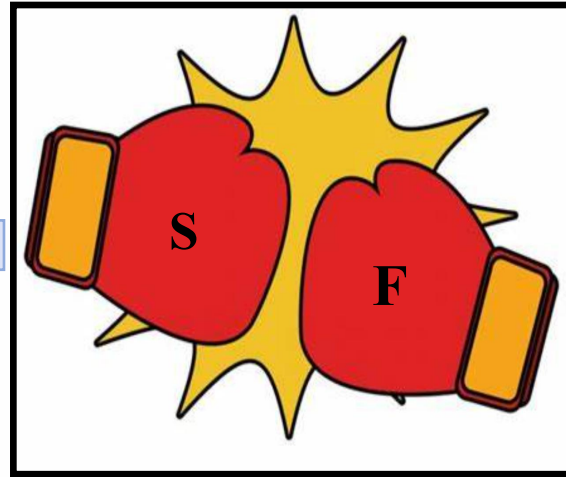
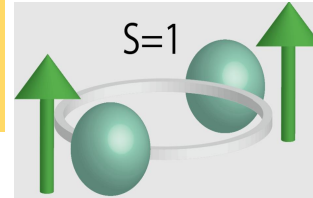
非厄米驱动磁子边界态



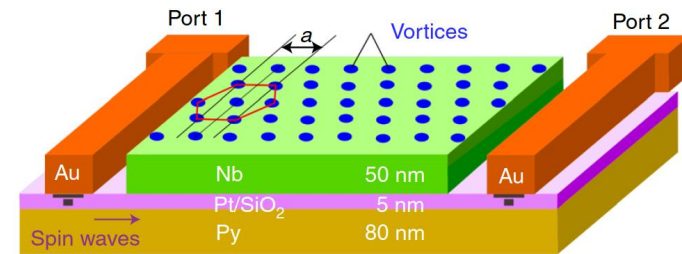


unconventional superconductivity

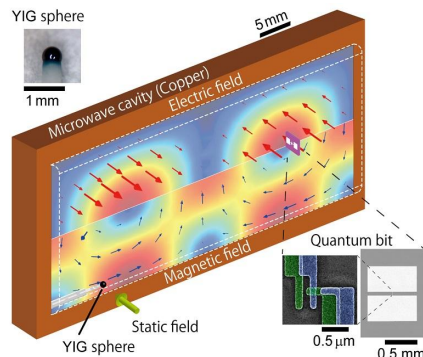
superconducting spintronics



superconducting magnonics



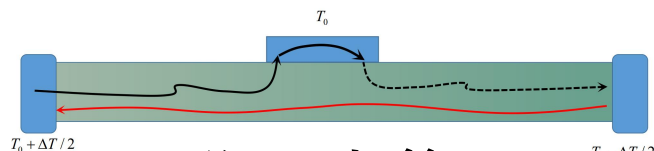
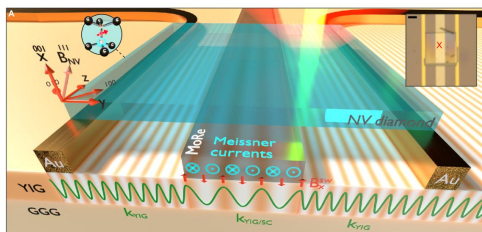
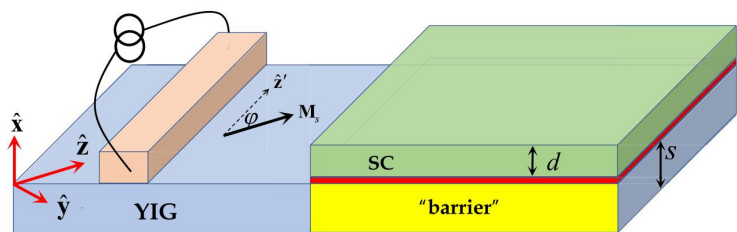
quantum magnonics



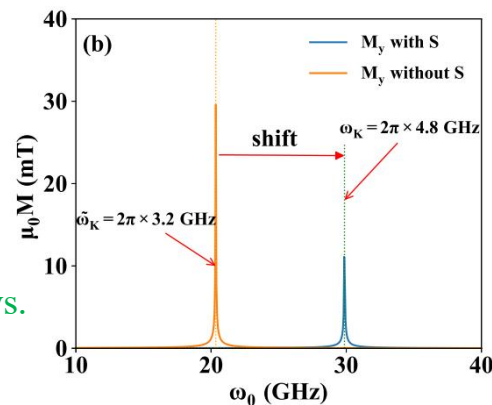
课题组贡献的主要物理效应

超导抗磁性“电控”磁子输运

片上量子磁子学（超强耦合）

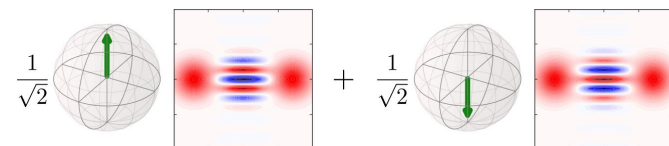


磁子二极管



片上磁子-光子超强耦合

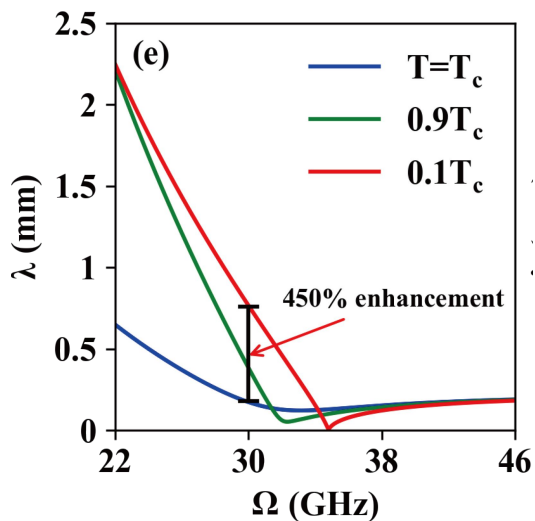
[Zhou and TY*, PRB 108, 144405 (2023)]



磁子-光子真空压缩态

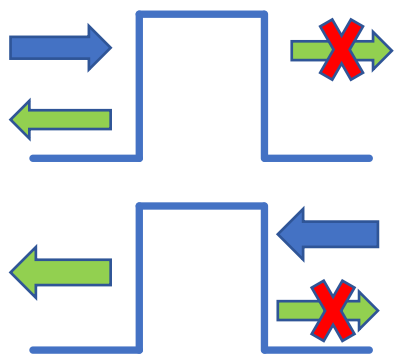
超导“电控”磁子频率

[TY* and Bauer*, PRL 129, 117201 (2022);
van der Sar c.s., Science 382, 430 (2023)]



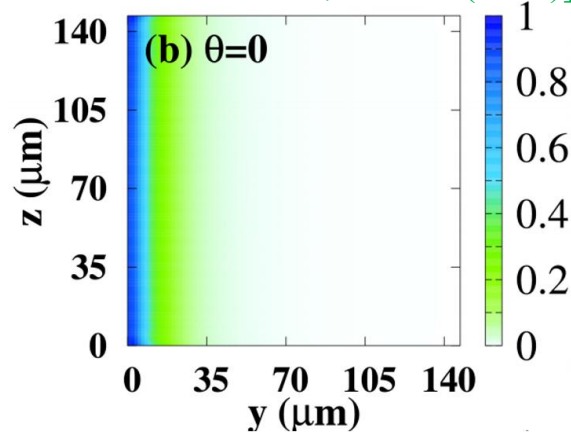
超导增强磁子输运

[Zhou, Ye, Bai, and TY*, arXiv:2404.02598]



“电控”增强磁子单向透射

[Ye, Xia, Bauer, and TY*, arXiv:2401.12022]



磁子非厄米趋肤效应

三、课题组人才培养特色及培养情况

- 1) 强化基础；
- 2) 上课和科研结合；
- 3) 与北大、科大、山大、东南、武大等进行联合组会；
- 4) 理论学生参与实验解释；实验学生参与理论学习；
- 5) 学生和国外学者频繁交流合作

经费充足

独立服务器计算平台

磁性动力学实验测试

薪水优厚

日常讨论充分，手把手传授



每个学生每年都有重要科研成果发表。

四、课题组2024年研究生招生情况及联系方式



博士研究生
名额1-2名

硕士研究生
名额1-2名

邮箱: taoyuphy@hust.edu.cn

微信: 18062429682

欢迎互动提问

课题组负责人：于涛

2024年7月1日