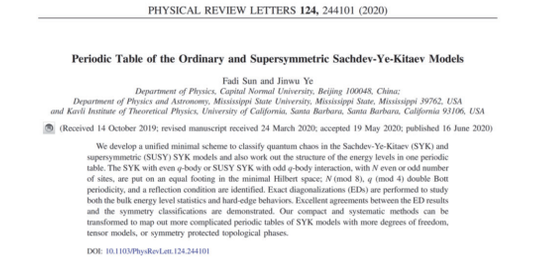
# 首都师范大学物理系标志性科技成果掠影

“十三五”（2016—2020）建设期间，物理系呈现出快速发展的良好势头．2016 年光学工程博士点转换成物理学博士点，2017 年材料物理与化学硕士点转换为光学工程专业硕士点．在学科建设过程中培育和引进了一批优秀中青年人才：张岩教授被评为美国光学学会会士，李志鹏教授入选国家万人计划青年拔尖人才，张亮亮教授获首批北京市杰出基金项目，沈京玲教授被评为北京市优秀教师；通过北京市“海聚工程”引进了冉仕举副教授，聘请欧洲科学院 Lewenstein 院士为外聘教授．

## 标志性成果一：实现 Sachdev–Ye–Kitaev（SYK）模型完全分类，创新张量网络算法；揭示超辐射转变新机制及其诱导的奇异物态

SYK 模型及其在量子黑洞、量子混沌等方面的研究具有重要意义．系统发展随机矩阵理论，构建一般情况和超对称 SYK 模型的周期表并进行完全分类，可推广到多自由度、张量模型和对称性保护的拓扑相．开创性发展张量网络算法，高效模拟多体量子系统的量子相和相变、拓扑序和量子纠缠性质．针对无序势与原子 - 光相互作用的竞争和合作这一重要问题，提出原子局域化波函数对光的共振散射机制，预言局域化驱动的超辐射失稳现象，揭示无序在超辐射及其转变中的重要作用．发现超辐射诱导的原子 - 光耦合束缚态、非平庸光子关联态和超辐射莫特绝缘体等新奇量子态，推动超辐射诱导的奇异物态研究．



PHYSICAL REVIEW LETTERS **124,** 244101 (2020)

**Periodic Table of the Ordinary and Supersymmetric Sachdev-Ye-Kitaev Models**

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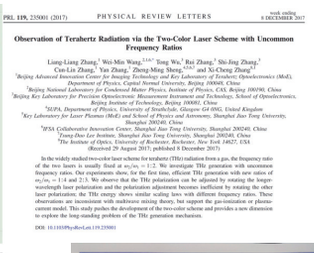
We develop a unified minimal scheme to classify quantum chaos in the Sachdev-Ye-Kitaev (SYK) and supersymmetric (SUSY) SYK models and also work out the structure of the energy levels in one periodic table. The SYK with even $q$-body or SUSY SYK with odd $q$-body interaction, with $N$ even or odd number of sites, are put on an equal footing in the minimal Hilbert space; $N$ (mod 8), $q$ (mod 4) double Bott periodicity, and a reflection condition are identified. Exact diagonalizations (EDs) are performed to study both the bulk energy level statistics and hard-edge behaviors. Excellent agreements between the ED results and the symmetry classifications are demonstrated. Our compact and systematic methods can be transformed to map out more complicated periodic tables of SYK models with more degrees of freedom, tensor models, or symmetry protected topological phases.

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## 标志性成果二：显著提升太赫兹辐射效率，实现波前动态调控

瞄准国家对太赫兹时域光谱技术的重大需求，提出非谐频激光场激发空气等离子体和液态水产生太赫兹波的新原理，显著提高了频谱宽度、电场强度和损伤阈值等；提出太赫兹动态超构表面，发展设计、制备和表征的方法，实现了太赫兹波前的多参量和逐点调控，太赫兹调制、存储器件所需的泵浦光强指标为国际最优．在国家重大仪器专项支持下，实现从太赫兹源基础理论研究到关键技术的突破，成功研制出系列太赫兹光谱仪产品，形成核心知识产权．目前已形成 4 000 万元的直接仪器销售额，各项技术指标受到国内外同行充分肯定．正应用于航空航天、生物医药和文物保护等多个领域，对太赫兹技术推广及产业化做出突出贡献．2018 年重大仪器专项结题时专家组给出的意见是：“开发出 4 款各具特色的太赫兹光谱仪，其中，超宽谱太赫兹源、等离子体探测器、太赫兹数据处理，拥有核心技术产权，形成了具有国际竞争力的产品．”



PRL 119, 235001 (2017) PHYSICAL REVIEW LETTERS week ending 8 DECEMBER 2017

**Observation of Terahertz Radiation via the Two-Color Laser Scheme with Uncommon Frequency Ratios**

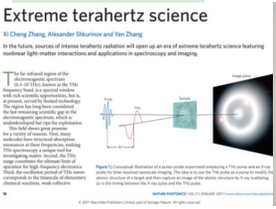
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In the widely studied two-color laser scheme for terahertz (THz) radiation from a gas, the frequency ratio of the two lasers is usually fixed at $\omega_2/\omega_1 = 1:2$. We investigate THz generation with uncommon frequency ratios. Our experiments show, for the first time, efficient THz generation with new ratios of $\omega_2/\omega_1 = 1:4$ and 2:3. We observe that the THz polarization can be adjusted by rotating the longer-wavelength laser polarization and the polarization adjustment becomes inefficient by rotating the other laser polarization; the THz energy shows similar scaling laws with different frequency ratios. These observations are inconsistent with multiwave mixing theory, but support the gas-ionization or plasma-current model. This study pushes the development of the two-color scheme and provides a new dimension to explore the long-standing problem of the THz generation mechanism.

DOI: 10.1103/PhysRevLett.119.235001



Extreme terahertz science

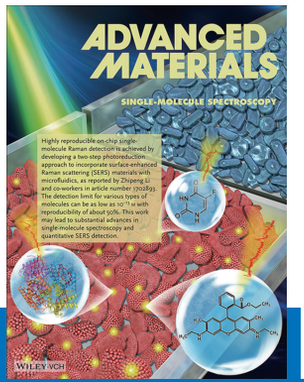
Xi Cheng Zhang, Alexander Shkurinov and Yan Zhang

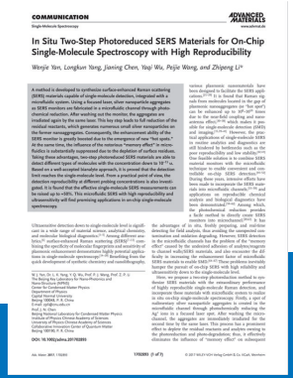
In the future, sources of intense terahertz radiation will open up an era of extreme terahertz science featuring nonlinear light–matter interactions and applications in spectroscopy and imaging.




## 标志性成果三：增强低维尺度物性，实现分子灵敏度检测芯片

面向国家对超灵敏检测、癌症治疗新手段等需求，构建各类新型低维结构，揭示表面等离激元、磁交换耦合、等离子与激子强相互作用、纳米激光、准晶电子态的演化过程与调控手段，突破传统光谱仪检测灵敏度，实现了单分子水平的表面增强光谱检测芯片，检测重复率将国际水平提高了 1 倍．



COMMUNICATION

Single-Molecule Spectroscopy

**In Situ Two-Step Photoreduced SERS Materials for On-Chip Single-Molecule Spectroscopy with High Reproducibility**

*Wenjie Yan, Longkun Yang, Jianing Chen, Yaqi Wu, Peijie Wang, and Zhipeng Li**






COMMUNICATION

Magnetic Nanoparticle Hyperthermia

**Maximizing Specific Loss Power for Magnetic Hyperthermia by Hard–Soft Mixed Ferrites**

*Shuli He, Hongwang Zhang, Yihao Liu, Fan Sun, Xiang Yu, Xueyan Li, Li Zhang, Lichen Wang, Kyoo Moo, Genghsi Wang, Yunjuan Lin, Zhenchuan Han, Renat Sabirianov, and Hao Zeng**

（供稿：物理系，尹 沛）