



# 东图学术快报

Academic express of SEU LIB

前沿经典

学科热点

学术动态

工具助手

编者按：

美国 Science(《科学》)、英国 Nature(《自然》)及美国 Cell(《细胞》)是国际公认的三大享有最高学术声誉的科技期刊，发表在这三大期刊上的论文简称 CNS 论文。

本期梳理 10 月 Nature、Science 期刊上材料科学领域的最新论文。



**CONTACT US**

联系电话：025-52090336-817

办公地址：李文正图书馆 B401 室



[1]

**Miniaturized spectrometers with a tunable van der Waals junction**

带有可调谐范德华结的微型光谱仪

出版信息: Science, 21 OCT 2022, VOL 378, ISSUE 6617

作者: HOON HAHN YOON, HENRY A. FERNANDEZ, FEDOR NIGMATULIN et al.

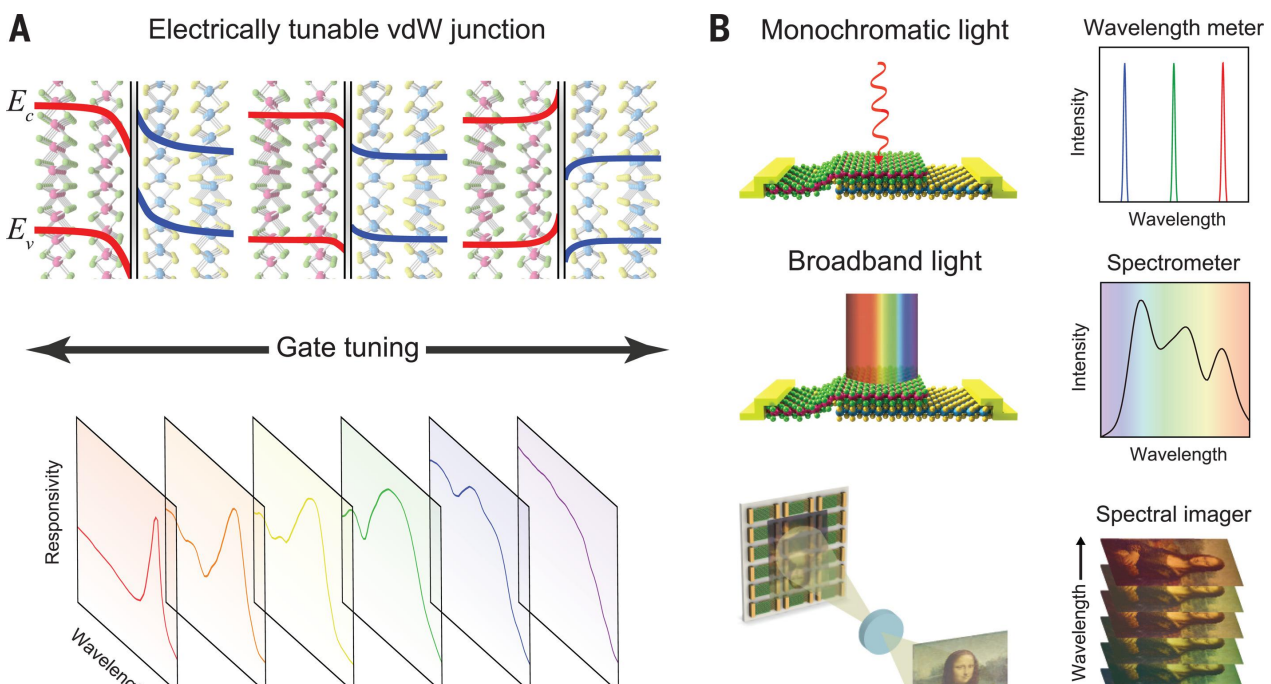
第一作者单位: Department of Electronics and Nanoengineering, Aalto University, Espoo 02150, Finland.

全文链接: <https://www.science.org/doi/10.1126/science.add8544>

**Abstract:** Miniaturized computational spectrometers, which can obtain incident spectra using a combination of device spectral responses and reconstruction algorithms, are essential for on-chip and implantable applications. Highly sensitive spectral measurement using a single detector allows the footprints of such spectrometers to be scaled down while achieving spectral resolution approaching that of benchtop systems. We report a high-performance computational spectrometer based on a single van der Waals junction with an electrically tunable transport-mediated spectral response. We achieve high peak wavelength accuracy ( $\sim 0.36$  nanometers), high spectral resolution ( $\sim 3$  nanometers), broad operation bandwidth (from  $\sim 405$  to  $845$  nanometers), and proof-of-concept spectral imaging. Our approach provides a route toward ultraminiaturization and offers unprecedented performance in accuracy, resolution, and operation bandwidth for single-detector computational spectrometers.

**摘要翻译:** 可以使用设备光谱响应和重建算法的组合获得入射光谱的小型化计算光谱仪,是芯片上和植入应用的必要条件。使用单一探测器的高灵敏度光谱测量可以使此类光谱仪的描述按比例缩小,同时实现接近台式系统的光谱分辨率。我们报道了一种基于单一范德华结的高性能计算光谱仪,该光谱仪具有电可调运输介导的光谱响应。我们实现了高峰值波长精度(约0.36纳米),高光谱分辨率(约3纳米),宽操作带宽(从约405到845纳米),以及概念验证光谱成像。我们的方法提供了一条通向超微型化的道路,并为单探测器计算光谱仪提供了前所未有的精度、分辨率和操作带宽方面的性能。

文中插图:



[2]

## Simultaneous electrical and thermal rectification in a monolayer lateral heterojunction

在单层横向异质结中同时进行电和热整流

出版信息: SCIENCE 13 Oct 2022, Vol 378, Issue 6616, pp. 169-175

作者: YUFENG ZHANG, QIAN LV, XHAIDONG WANG, SHUAIYI ZHAO, QIHUA XIONG, RUITAO LV, AND XING ZHANG

第一作者单位: Key Laboratory for Thermal Science and Power Engineering of Ministry of Education, Department of Engineering Mechanics, Tsinghua University, Beijing 100084, China.

全文链接: <https://www.science.org/doi/10.1126/science.abq0883>

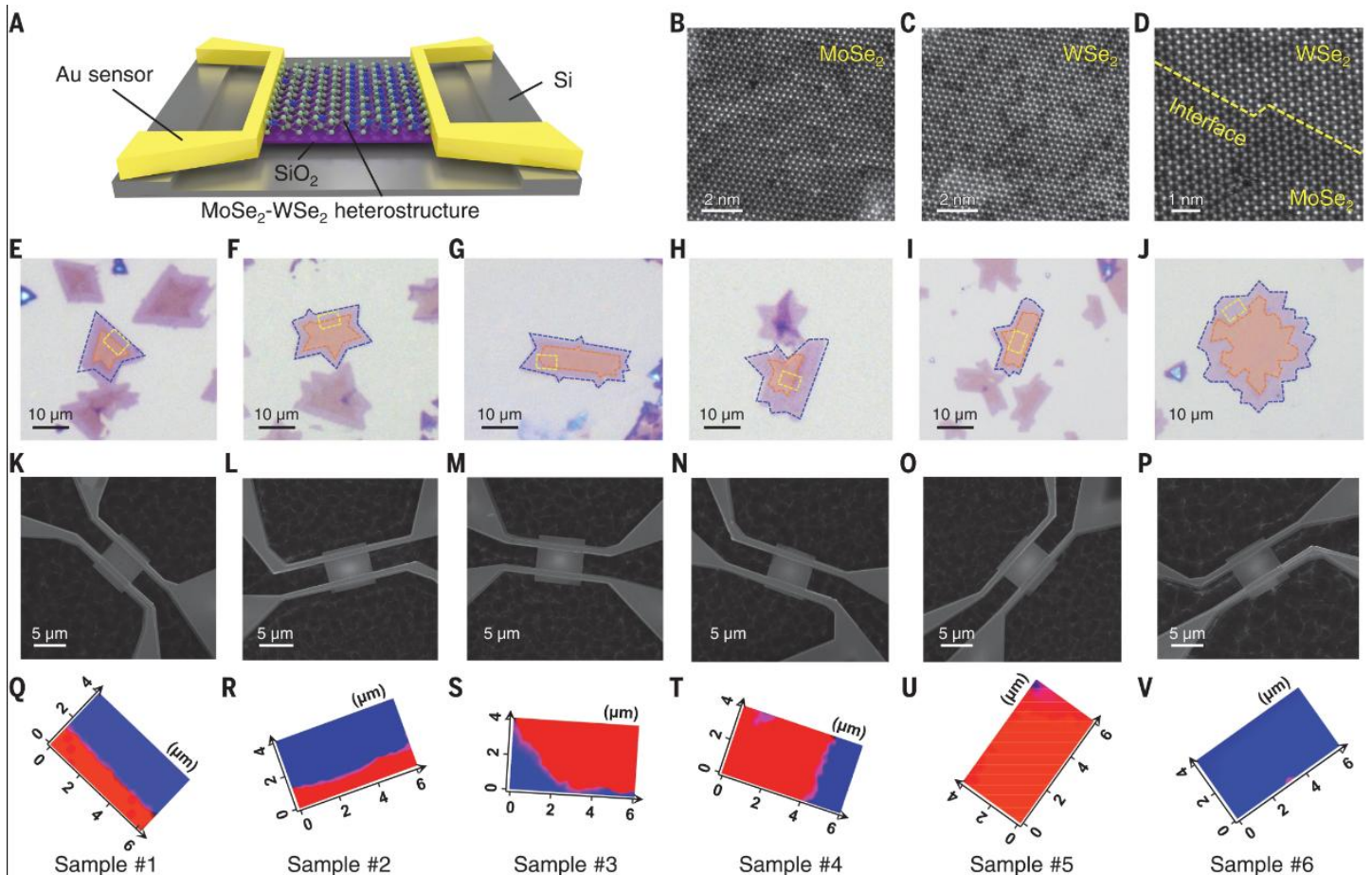
### Abstract:

For most materials, reversing the direction of the thermal gradient does not change the thermal conductivity. The difficulty in finding thermal rectifiers impedes the development of thermal diodes that would be important for managing heat flow. Y. Zhang et al. found that a heterostructure made of molybdenum diselenide and tungsten diselenide rectifies both electricity and heat. The magnitude of the effect depends on the relative geometry of the interface and the thermal gradient. The discovery provides the opportunity to develop more effective heat dissipation in highly integrated circuits.

### 摘要翻译:

对于大多数材料, 逆转热梯度的方向并不会改变热导率。寻找热整流器的困难阻碍了对管理热流很重要的热二极管的发展。作者发现, 由二硒化钼和二硒化钨组成的异质结构既能整流电又能整流热。效应的大小取决于界面的相对几何形状和热梯度。这一发现为在高度集成电路中开发更有效的散热提供了机会。

### 文中插图:



[3]

### Direct identification of the charge state in a single platinum nanoparticle on titanium oxide

在氧化钛上直接识别单个铂纳米粒子的电荷状态

出版信息: Science, 13 Oct 2022, Vol 378, Issue 6616, pp. 202-206

作者: RYOTARO ASO, HAJIME HOJO, YOSHIO TAKAHASH, TETSUYA AKASHIYOSHIHIRO MIDOH, FUMIAKI ICHIHASH, HIROSHI NAKAJIMA, TAKEHIRO TAMAOKA, KUNIO YUBUTA, YASUKAZU MURAKAMI

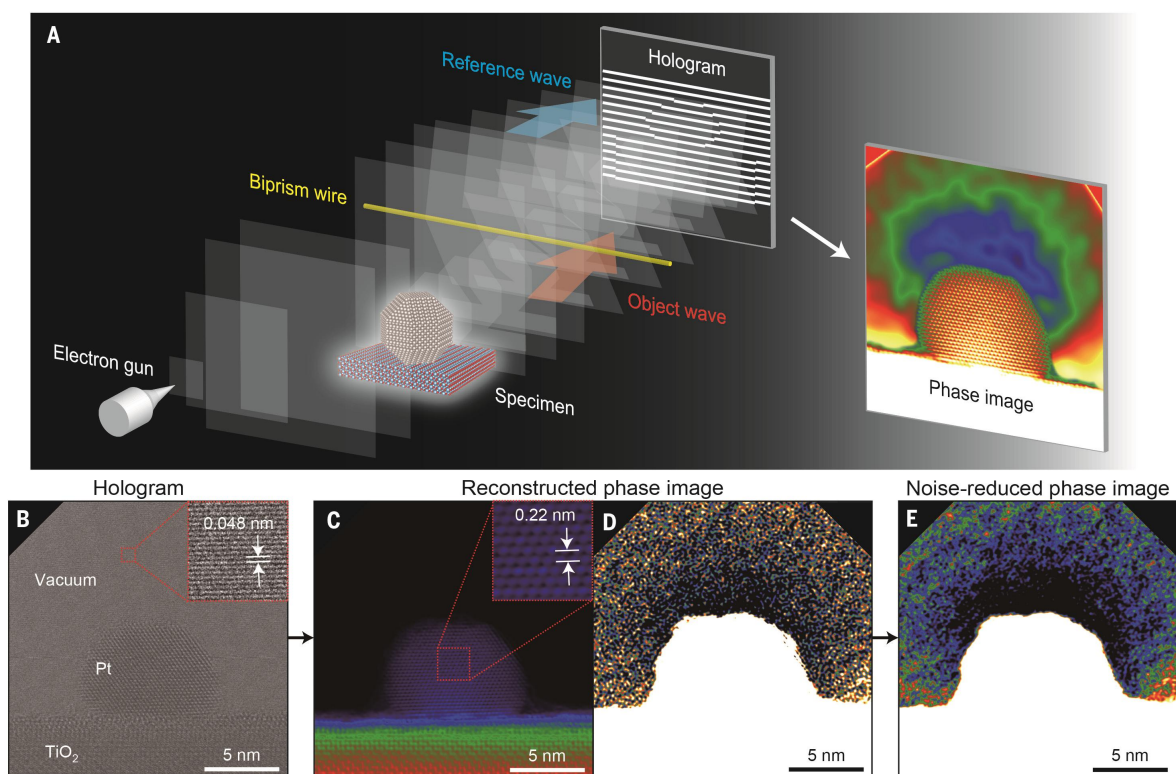
第一作者单位: Department of Applied Quantum Physics and Nuclear Engineering, Kyushu University, Nishi-ku, Fukuoka 819-0395, Japan.

全文链接: <https://www.science.org/doi/10.1126/science.abq5868>

**Abstract:** A goal in the characterization of supported metal catalysts is to achieve particle-by-particle analysis of the charge state strongly correlated with the catalytic activity. Here, we demonstrate the direct identification of the charge state of individual platinum nanoparticles (NPs) supported on titanium dioxide using ultrahigh sensitivity and precision electron holography. Sophisticated phase-shift analysis for the part of the NPs protruding into the vacuum visualized slight potential changes around individual platinum NPs. The analysis revealed the number (only one to six electrons) and sense (positive or negative) of the charge per platinum NP. The underlying mechanism of platinum charging is explained by the work function differences between platinum and titanium dioxide (depending on the orientation relationship and lattice distortion) and by first-principles calculations in terms of the charge transfer processes.

**摘要翻译:** 负载型金属催化剂的表征目标是实现对与催化活性密切相关的电荷状态的逐粒子分析。作者演示了使用超高灵敏度和精密电子全息术, 直接识别在二氧化钛上支撑的单个铂纳米颗粒 (NPs) 的电荷状态。对突出到真空中的部分 NPs 进行复杂的相移分析, 可以看到单个铂 NPs 周围的微小电位变化。分析揭示了每个铂 NP 的电荷的数量 (只有 1 到 6 个电子) 和感应 (正或负)。铂的充能机理可以通过铂和二氧化钛之间的功函数差异 (取决于取向关系和晶格畸变) 和电荷转移过程的第一性原理计算来解释。

文中插图:



[4]

Direct identification of the charge state in a single platinum nanoparticle on titanium oxide

在氧化钛上直接识别单个铂纳米粒子的电荷状态

出版信息: Science, October 2022, Volume 378 Issue 6616

作者: RYOTARO ASO, HAJIME HOJO, YOSHIO TAKAHASHI, TETSUYA AKASHIYOSHIHIRO MIDOH, FUMIAKI ICHIHASHI, HIROSHI NAKAJIMA, TAKEHIRO TAMAOKA, KUNIO YUBUTA, YASUKAZU MURAKAMI

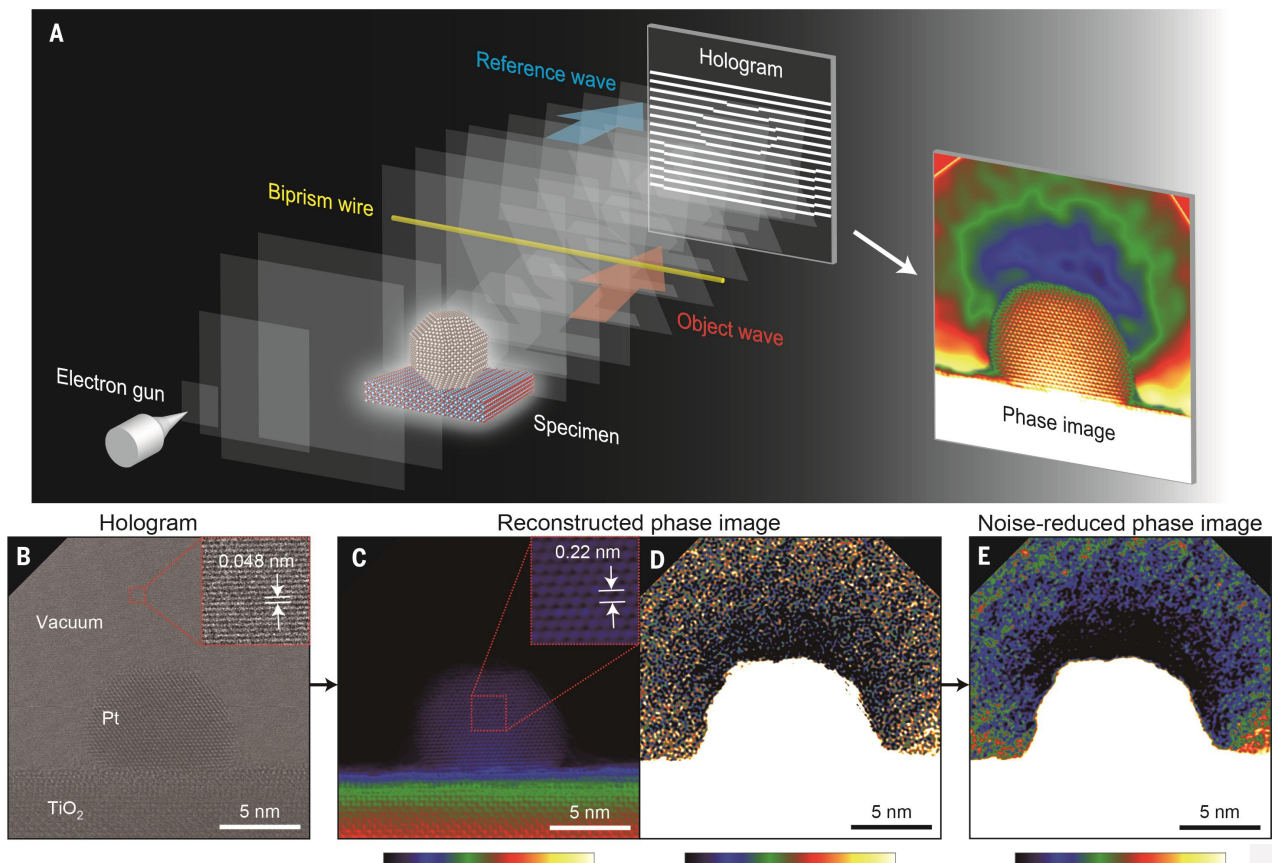
第一作者单位: Department of Applied Quantum Physics and Nuclear Engineering, Kyushu University, Nishi-ku, Fukuoka 819-0395, Japan.

全文链接: <https://www.science.org/doi/10.1126/science.abq5868>

**Abstract:** A goal in the characterization of supported metal catalysts is to achieve particle-by-particle analysis of the charge state strongly correlated with the catalytic activity. Here, we demonstrate the direct identification of the charge state of individual platinum nanoparticles (NPs) supported on titanium dioxide using ultrahigh sensitivity and precision electron holography. Sophisticated phase-shift analysis for the part of the NPs protruding into the vacuum visualized slight potential changes around individual platinum NPs. The analysis revealed the number (only one to six electrons) and sense (positive or negative) of the charge per platinum NP. The underlying mechanism of platinum charging is explained by the work function differences between platinum and titanium dioxide (depending on the orientation relationship and lattice distortion) and by first-principles calculations in terms of the charge transfer processes.

**摘要翻译:** 负载型金属催化剂的表征目标是实现对与催化活性密切相关的电荷状态的逐粒子分析。作者演示了使用超高灵敏度和精密电子全息术, 直接识别在二氧化钛上支撑的单个铂纳米颗粒 (NPs) 的电荷状态。对突出到真空中的部分 NPs 进行复杂的相移分析, 可以看到单个铂 NPs 周围的微小电位变化。分析揭示了每个铂 NP 的电荷的数量 (只有 1 到 6 个电子) 和感应 (正或负)。铂的充能机理可以通过铂和二氧化钛之间的功函数差异 (取决于取向关系和晶格畸变) 和电荷转移过程的第一性原理计算来解释。

文中插图:



## [1]Enhanced interactions of interlayer excitons in free-standing heterobilayers

## 独立异质双层中层间激子的增强相互作用

出版信息: Nature, 20 October 2022, VOL 610, ISSUE 7932

作者: Xueqian Sun, Yi Zhu, Hao Qin, Boqing Liu, Yilin Tang, Tiejun Lü, et al.

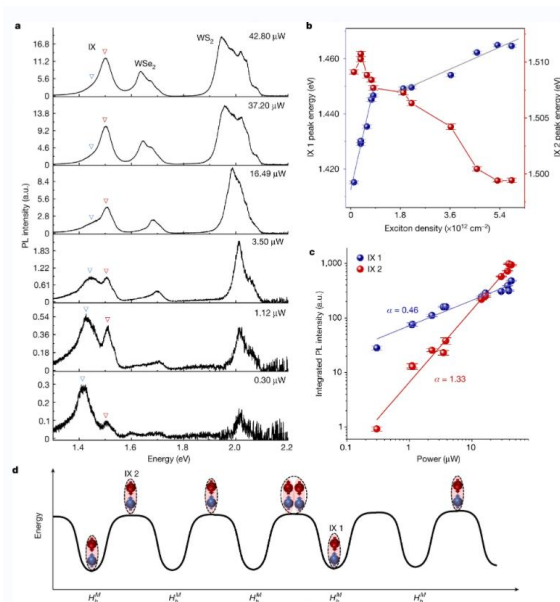
第一作者单位: School of Engineering, College of Engineering and Computer Science, the Australian National University, Canberra, Australian Capital Territory, Australia

全文链接: <https://www.nature.com/articles/s41586-022-05193-z>

**Abstract:** Strong, long-range dipole – dipole interactions between interlayer excitons (IXs) can lead to new multiparticle correlation regimes, which drive the system into distinct quantum and classical phases, including dipolar liquids, crystals and superfluids. Both repulsive and attractive dipole – dipole interactions have been theoretically predicted between IXs in a semiconductor bilayer, but only repulsive interactions have been reported experimentally so far. This study investigated free-standing, twisted ( $51^\circ$ ,  $53^\circ$ ,  $45^\circ$ ) tungsten diselenide/tungsten disulfide (WSe<sub>2</sub>/WS<sub>2</sub>) heterobilayers, in which we observed a transition in the nature of dipolar interactions among IXs, from repulsive to attractive. This was caused by quantum-exchange-correlation effects, leading to the appearance of a robust interlayer biexciton phase (formed by two IXs), which has been theoretically predicted but never observed before in experiments. The reduced dielectric screening in a free-standing heterobilayer not only resulted in a much higher formation efficiency of IXs, but also led to strongly enhanced dipole – dipole interactions, which enabled us to observe the many-body correlations of pristine IXs at the two-dimensional quantum limit. In addition, we firstly observed several emission peaks from moiré-trapped IXs at room temperature in a well-aligned, free-standing WSe<sub>2</sub>/WS<sub>2</sub> heterobilayer. Our findings open avenues for exploring new quantum phases with potential for applications in non-linear optics.

**摘要翻译:** 层间激子 (IXs) 之间强长程偶极-偶极相互作用可产生新型多粒子关联机制, 驱动系统进入不同的量子 and 经典相, 包括偶极液体、晶体和超流体。人们在理论上已预测了半导体双层中 IXs 间的排斥和吸引偶极-偶极相互作用, 但迄今为止只有排斥相互作用的实验报道。课题组研究了独立、扭曲的 ( $51^\circ$ 、 $53^\circ$ 、 $45^\circ$ ) 二硒化钨/二硫化钨 (WSe<sub>2</sub>/WS<sub>2</sub>) 异质双层, 在其中观察到 IXs 间的偶极相互作用性质从排斥转变为吸引。这是由量子交换相关效应引起的, 导致出现了一个稳健的层间双激子相 (由两个 IXs 形成), 这在理论上已预测过, 但此前从未在实验中观察到。独立异质双层中介电屏蔽的降低不仅大大提高了 IXs 的形成效率, 还极大增强了偶极-偶极相互作用, 从而能够在二维量子极限下实验观察到原始 IXs 的多体关联。此外, 研究组首次在室温下排列良好、独立的 WSe<sub>2</sub>/WS<sub>2</sub> 异质双层中观察到莫尔阱 IXs 的几个发射峰。该发现为探索具有非线性光学应用潜力的新量子相开辟了道路。

文中插图:



## [2] Magnetic fields of 30 to 100 kG in the cores of red giant stars

红巨星的核心有 30 到 100 千高斯的磁场

出版信息: Nature, 6 OCTOBER 2022, VOL 610, ISSUE 7930

作者: Gang Li, Sébastien Deheuvels, Jérôme Ballot & François Lignières

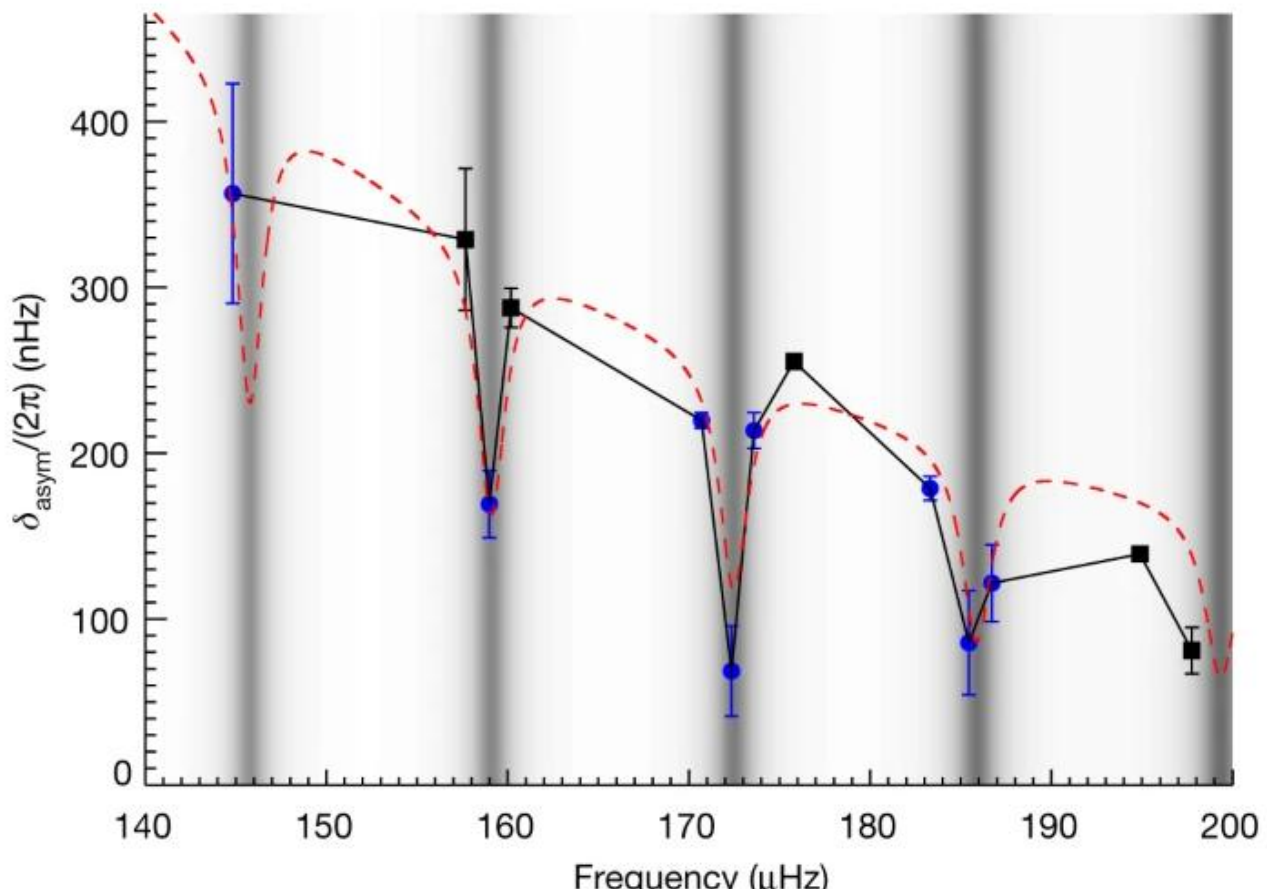
第一作者单位: IRAP, Université de Toulouse, CNRS, CNES, UPS, Toulouse, France

全文链接: <https://www.nature.com/articles/s41586-022-05176-0>

**Abstract:** A red giant star is an evolved low- or intermediate-mass star that has exhausted its central hydrogen content, leaving a helium core and a hydrogen-burning shell. Here we report the measurement of magnetic fields in the cores of three red giant stars observed with the Kepler13 satellite. The fields induce shifts that break the symmetry of dipole mode multiplets. We thus measure field strengths ranging from about 30 kilogauss to about 100 kilogauss in the vicinity of the hydrogen-burning shell and place constraints on the field topology.

**摘要翻译:** 红巨星是一颗逐渐演化的低质量或中质量恒星，它耗尽了中心的氢含量，只剩下氦核和燃氢外壳。作者报道了用开普勒 13 号卫星观测到的三颗红巨星核心磁场的测量结果。这些场引起的位移破坏了偶极模多胞胎的对称性。因此，他们测量的场强度范围从约 30 千高斯到约 100 千高斯的氢燃烧壳附近，并对场拓扑结构进行约束。

文中插图:



### [3] Extending the spectrum of fully integrated photonics to submicrometre wavelengths

将完全集成光子学的光谱扩展到亚微米波长

出版信息: Nature, 6 OCTOBER 2022, VOL 610, ISSUE 7930

作者: Minh A. Tran, Chong Zhang, Theodore J. Morin, Lin Chang, Sabyasachi Barik, Zhiquan Yuan, Woonghee Lee, Glenn Kim, Aditya Malik, Zeyu Zhang, Joel Guo, Heming Wang, Boqiang Shen, Lue Wu, Kerry Vahala, John E. Bowers, Hyundai Park & Tin Komljenovic

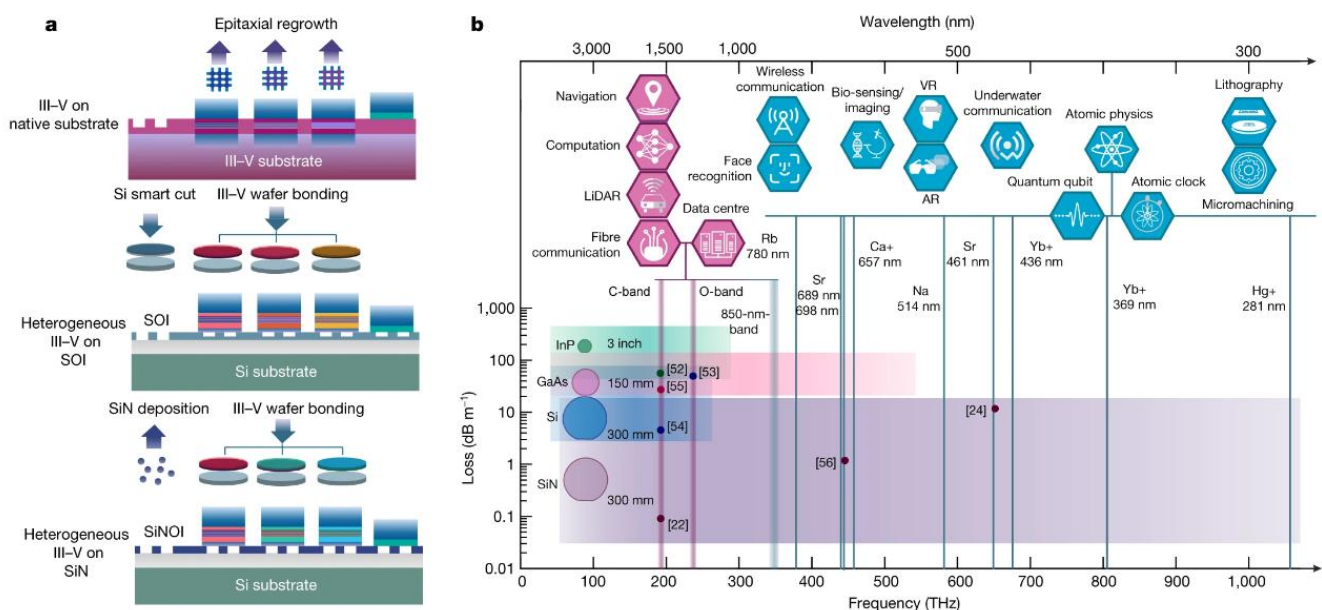
第一作者单位: Nexus Photonics, Goleta, CA, USA

全文链接: <https://www.nature.com/articles/s41586-022-05119-9>

**Abstract:** Integrated photonics has profoundly affected a wide range of technologies underpinning modern society. The ability to fabricate a complete optical system on a chip offers unrivalled scalability, weight, cost and power efficiency. Here, we present a new generation of integrated photonics by directly uniting III - V materials with silicon nitride waveguides on Si wafers. Using this technology, we present a fully integrated PIC at photon energies greater than the bandgap of silicon, demonstrating essential photonic building blocks, including lasers, amplifiers, photodetectors, modulators and passives, all operating at submicrometre wavelengths. Using this platform, we achieve unprecedented coherence and tunability in an integrated laser at short wavelength. Furthermore, by making use of this higher photon energy, we demonstrate superb high-temperature performance and kHz-level fundamental linewidths at elevated temperatures. Given the many potential applications at short wavelengths, the success of this integration strategy unlocks a broad range of new integrated photonics applications.

**摘要翻译:** 集成光子学深刻影响了支撑现代社会的众多技术。在一个芯片上制造一个完整的光学系统的能力提供了无与伦比的可扩展性、重量、成本和功率效率。作者通过将 III-V 材料与硅晶圆上的氮化硅波导直接结合,提出了新一代集成光子学。使用该技术,他们提出了一个光子能量大于硅带隙的完全集成 PIC,演示了基本的光子构建模块,包括激光器、放大器、光电探测器、调制器和被动,都可在亚微米波长下操作。利用该平台,他们实现了集成激光器在短波内前所未有的相干性和可调性。此外,通过利用这种更高的光子能量,作者展示了高超的高温性能和高温下 khz 级的基本线宽。鉴于在短波长的许多潜在应用,这种集成策略的成功解锁了广泛的新型集成光子学应用。

文中插图:





#### [4]General-relativistic precession in a black-hole binary

#### 黑洞双星中的广义相对论旋进

出版信息: Nature, 27 October 2022, Volume 610 Issue 7933

作者: Mark Hannam, Charlie Hoy, Jonathan E. Thompson, Aaron Zimmerman, etc.

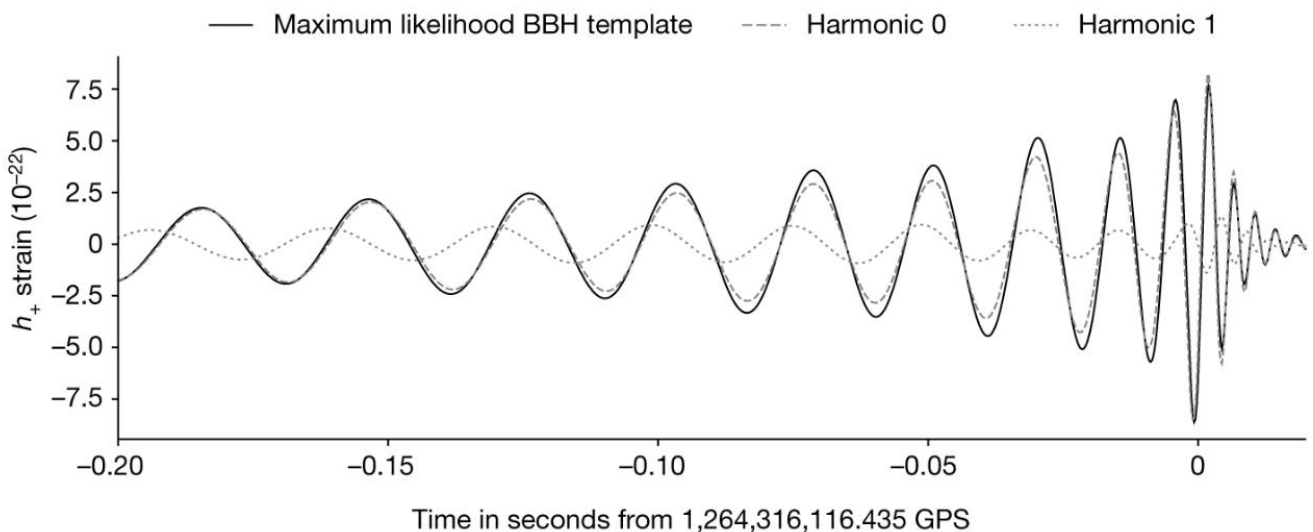
第一作者单位: Gravity Exploration Institute, Cardiff University, Cardiff, UK

全文链接: <https://www.nature.com/articles/s41586-022-05212-z>

**Abstract:** The general-relativistic phenomenon of spin-induced orbital precession has not yet been observed in strong-field gravity. Gravitational-wave observations of binary black holes (BBHs) are prime candidates, as we expect the astrophysical binary population to contain precessing binaries. Imprints of precession have been investigated in several signals, but no definitive identification of orbital precession has been reported in any of the 84 BBH observations so far by the Advanced LIGO and Virgo detectors. Here we report the measurement of strong-field precession in the LIGO - Virgo - Kagra gravitational-wave signal GW200129. The binary's orbit precesses at a rate ten orders of magnitude faster than previous weak-field measurements from binary pulsars. We also find that the primary black hole is probably highly spinning. According to current binary population estimates, a GW200129-like signal is extremely unlikely, and therefore presents a direct challenge to many current binary-formation models.

**摘要翻译:** 自旋诱导轨道进动的一般相对论现象尚未在强场引力中被观测到。双星黑洞 (BBH) 的引力波观测是主要的候选者, 科学家猜测天体物理双星种群包含进动双星。在一些信号中已经研究了旋进的印记, 但在迄今为止由美国和欧洲探测器 LIGO 和 Virgo 观测到的 84 个 BBH 中, 没有任何一个明确识别出轨道旋进。作者报道了 LIGO-Virgo-Kagra 引力波信号 GW200129 的强场进动测量。这颗双星的轨道进动速度比以前对双星脉冲星的弱场测量要快 10 个数量级。研究者还发现, 主黑洞很可能是高度旋转的。根据目前的二元总体估计, 类似 gw200129 的信号极不可能出现, 因此对目前许多二元形成模型提出了直接挑战。

文中插图:



[5]

## The time-programmable frequency comb and its use in quantum-limited ranging

时间可编程频率梳及其在量子有限测距中的应用

出版信息: Nature, 27 October 2022, Volume 610 Issue 7933

作者: Emily D. Caldwell, Laura C. Sinclair, Nathan R. Newbury & Jean-Daniel Deschenes

第一作者单位: National Institute of Standards and Technology (NIST), Boulder, CO, USA

Department of Electrical, Computer and Energy Engineering, University of Colorado, Boulder, CO, USA

全文链接: <https://www.nature.com/articles/s41586-022-05225-8>

**Abstract:** Two decades after its invention, the classic self-referenced frequency comb laser is an unrivalled ruler for frequency, time and distance metrology owing to the rigid spacing of its optical output. As a consequence, it is now used in numerous sensing applications that require a combination of high bandwidth and high precision. Many of these applications, however, are limited by the trade-offs inherent in the rigidity of the comb output and operate far from quantum-limited sensitivity. Here we demonstrate an agile programmable frequency comb where the pulse time and phase are digitally controlled with  $\pm 2$ -attosecond accuracy. This agility enables quantum-limited sensitivity in sensing applications as the programmable comb can be configured to coherently track weak returning pulse trains at the shot-noise limit. To highlight its capabilities, we use this programmable comb in a ranging system, reducing the required power to reach a given precision by about 5,000-fold compared with a conventional dual-comb system. This enables ranging at a mean photon per pulse number of 1/77 while retaining the full accuracy and precision of a rigid frequency comb. Beyond ranging and imaging, applications in time and frequency metrology, comb-based spectroscopy, pump - probe experiments and compressive sensing should benefit from coherent control of the comb-pulse time and phase.

**摘要翻译:**经典的自参照频率梳激光器发明二十年后,由于其光输出的刚性间距,在频率、时间和距离计量方面成为无与伦比的标尺。因此,它现在被用于许多需要高带宽和高精度结合的传感应用。然而,其中许多应用都受到了梳状输出固有刚度的权衡的限制,而且操作的灵敏度远远没有受到量子限制。作者演示了一个灵活的可编程频率梳,其中脉冲时间和相位以阿秒精度进行数字控制。这种敏捷性使其在传感应用中具有量子限制的灵敏度,因为可编程梳可以配置为在脉冲噪声极限下连贯地跟踪微弱返回脉冲序列。为了突出其功能,他们在测距系统中使用了这种可编程梳子,与传统的双梳子系统相比,达到给定精度所需的功率降低了约 5000 倍。这使得平均光子每脉冲数的测距为 1/77,同时保留了刚性频率梳的全部精度和精度。除了测距和成像,在时间和频率计量、梳基光谱、泵探针实验和压缩传感方面的应用都应该得益于梳脉冲时间和相位的相干控制。

文中插图:

