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A giant planet transiting a 3-Myr protostar with a misaligned disk

绕附近恒星运行的年轻凌星行星

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▲链接：

https://www.nature.com/articles/s41586-024-08123-3

▲摘要：

美国科学家探测到一颗迄今发现最年轻的凌星行星。凌星行星是从一颗恒星与地球这类观察者之间经过的行星。迄今，科学家已经在年龄在1000万到4000万年的恒星周围发现了超过十几颗凌星行星，但却一直未能探测到更年轻的凌星行星。这或许是因为这些行星还没有完全形成，或是因为人们对这类行星的视野被残余的原行星盘（新形成恒星周围的致密气体和尘埃环）遮挡了。

研究者事分析了NASA“凌日系外行星勘测卫星”传回的数据，观测到一个年龄在300万年的年轻恒星，这个名为IRAS 04125+2902的恒星与地球相对较近（160秒差距）。围绕该恒星的外部原行星盘没有对齐，而且几乎是正面朝上而不是侧面，同时还有一个缺损内盘；集合这些特征让科学家得以对凌星原行星IRAS 04125+2902 b进行了观测。

分析发现，这颗行星的轨道周期为8.83天，半径是地球的10.7倍，质量约是木星的30%。研究者认为，它可能是常被发现绕主序星旋转的超级地球和超级海王星的前体。鉴于这颗恒星和行星都很年轻，拥有罕见的非对齐盘，且相对地球位置较近，因此，他们认为这个系统可能是研究行星形成早期阶段的一个有用目标。

▲ Abstract：

Astronomers have found more than a dozen planets transiting stars that are 10 – 40?million?years old, but younger transiting planets have remained elusive. The lack of such discoveries may be because planets have not fully formed at this age or because our view is blocked by the protoplanetary disk. However, we now know that many outer disks are warped or broken; provided the inner disk is depleted, transiting planets may thus be visible. Here we report observations of the transiting planet IRAS?04125+2902?b orbiting a 3-million-year-old, 0.7-solar-mass, pre-main-sequence star in the Taurus Molecular Cloud. The host star harbours a nearly face-on (30?degrees inclination) transitional disk and a wide binary companion. The planet has a period of 8.83?days, a radius of 10.7?Earth radii (0.96?Jupiter radii) and a 95%-confidence upper limit on its mass of 90?Earth masses (0.3?Jupiter masses) from radial-velocity measurements, making it a possible precursor of the super-Earths and sub-Neptunes frequently found around main-sequence stars. The rotational broadening of the star and the orbit of the wide (4?arcseconds, 635?astronomical units) companion are both consistent with edge-on orientations. Thus, all components of the system are consistent with alignment except the outer disk; the origin of this misalignment is unclear.

Local probe of bulk and edge states in a fractional Chern insulator

分数阶陈绝缘子体态和边态的局部探测

▲ 作者：Zhurun Ji, Heonjoon Park, Mark E. Barber, Chaowei Hu, Kenji Watanabe, Takashi Taniguchi, Jiun-Haw Chu, Xiaodong Xu Zhi-Xun Shen

▲链接：

https://www.nature.com/articles/s41586-024-08092-7

▲摘要：

分数量子霍尔效应是拓扑量子多体现象的一个重要例子，它是由强电子相关、拓扑有序和时间反转对称性破缺相互作用而产生的。最近，在零磁场下观察到分数量子霍尔效应的晶格模拟，证实了零场分数陈氏绝缘子（FCI）的存在。尽管如此，体积边缘对应——FCI具有导电边缘的绝缘体的标志——尚未被直接观察到。事实上，由于实验的挑战，这种对应关系还没有在任何分数态系统中被可视化。

研究者报道了使用微波阻抗显微镜成像扭曲MoTe2（t-MoTe2）的FCI边缘状态。通过调整载流子密度，他们观察到系统在金属态和FCI态之间演变，后者表现出绝缘体和导电边缘，正如从体边界对应所期望的那样。进一步分析表明FCI边缘状态具有复合性质。他们还观察了作为层间电场函数的边缘态在拓扑相变中的演变，并揭示了不同分数阶邻近畴的令人兴奋的前景。

这些发现为研究零磁场下各种任意子态之间的拓扑保护一维界面铺平了道路，例如具有非零拓扑纠缠熵的一维对称保护相、Halperin-Laughlin界面和非阿贝尔任意子的创建。

▲ Abstract：

The fractional quantum Hall effect is a key example of topological quantum many-body phenomena, arising from the interplay between strong electron correlation, topological order and time-reversal symmetry breaking. Recently, a lattice analogue of the fractional quantum Hall effect at zero magnetic field has been observed, confirming the existence of a zero-field fractional Chern insulator (FCI). Despite this, the bulk – edge correspondence—a hallmark of a FCI featuring an insulating bulk with conductive edges—has not been directly observed. In fact, this correspondence has not been visualized in any system for fractional states owing to experimental challenges. Here we report the imaging of FCI edge states in twisted MoTe2 (t-MoTe2) using microwave impedance microscopy. By tuning the carrier density, we observe the system evolving between metallic and FCI states, the latter of which exhibits insulating bulk and conductive edges, as expected from the bulk – boundary correspondence. Further analysis suggests the composite nature of the FCI edge states. We also observe the evolution of edge states across the topological phase transition as a function of interlayer electric field and reveal exciting prospects of neighbouring domains with different fractional orders. These findings pave the way for research into topologically protected one-dimensional interfaces between various anyonic states at zero magnetic field, such as gapped one-dimensional symmetry-protected phases with non-zero topological entanglement entropy, Halperin – Laughlin interfaces and the creation of non-abelian anyons.

化学Chemistry

Photocatalytic low-temperature defluorination of PFASs

全氟磺酸的光催化低温除氟

▲ 作者：Hao Zhang, Jin-Xiang Chen, Jian-Ping Qu Yan-Biao Kang

▲链接：

https://www.nature.com/articles/s41586-024-08179-1

▲摘要：

多氟烷基和全氟烷基物质（PFASs）存在于许多日常消费品中，通常是因为它们具有高热稳定性和化学稳定性，以及疏水和疏油特性。然而，赋予全氟辛烷磺酸特性的惰性碳氟（C-F）键也提供了通过除氟分解的抵抗力，导致其长期存在于环境和人体中，引起了重大的安全和健康问题。尽管最近在销毁功能化全氟辛烷的非焚烧方法方面取得了进展，但回收全氟碳化合物以及聚四氟乙烯等聚合全氟辛烷的工艺仅限于使用高温或强还原试剂的方法。

研究者报道了一种高度扭曲的咔唑核超光还原剂KQGZ对全氟烷的脱氟。在40°C ~ 60°C的光催化条件下，一系列PFASs可被脱氟。聚四氟乙烯的主要产品是无定形碳和氟盐。全氟化合物、全氟辛烷磺酸、多氟辛酸等低聚全氟磺酸及其衍生物的脱氟产品为碳酸盐、甲酸盐、草酸盐和三氟乙酸盐。这样就可以将全氟磺酸中的氟作为无机氟化盐进行再循环。机理研究揭示了聚四氟乙烯和低聚全氟乙烯在反应行为和产物组分上的差异。

这项研究为“永久化学物质”全氟化合物的低温光还原除氟，特别是聚四氟乙烯，以及新的超光还原剂的发现打开了一扇窗。

▲ Abstract：

Polyfluoroalkyl and perfluoroalkyl substances (PFASs) are found in many everyday consumer products, often because of their high thermal and chemical stabilities, as well as their hydrophobic and oleophobic properties1. However, the inert carbon – fluorine (C – F) bonds that give PFASs their properties also provide resistance to decomposition through defluorination, leading to long-term persistence in the environment, as well as in the human body, raising substantial safety and health concerns. Despite recent advances in non-incineration approaches for the destruction of functionalized PFASs, processes for the recycling of perfluorocarbons (PFCs) as well as polymeric PFASs such as polytetrafluoroethylene (PTFE) are limited to methods that use either elevated temperatures or strong reducing reagents. Here we report the defluorination of PFASs with a highly twisted carbazole-cored super-photoreductant KQGZ. A series of PFASs could be defluorinated photocatalytically at 40 – 60? ° C. PTFE gave amorphous carbon and fluoride salts as the major products. Oligomeric PFASs such as PFCs, perfluorooctane sulfonic acid (PFOS), polyfluorooctanoic acid (PFOA) and derivatives give carbonate, formate, oxalate and trifluoroacetate as the defluorinated products. This allows for the recycling of fluorine in PFASs as inorganic fluoride salt. The mechanistic investigation reveals the difference in reaction behaviour and product components for PTFE and oligomeric PFASs. This work opens a window for the low-temperature photoreductive defluorination of the

‘forever chemicals’ PFASs, especially for PTFE, as well as the discovery of new super-photoreductants.

Silicon heterojunction back-contact solar cells by laser patterning

激光图案化硅异质结背接触太阳能电池

▲ 作者：Hua Wu, Feng Ye, Miao Yang, Fei Luo, Xiyan Tang, Qing Tang, Haoran Qiu, Zhipeng Huang, Genshun Wang, Zhaoqing Sun, Hao Lin, Junzhe Wei, Yunpeng Li, Xiaoqiang Tian, Jinsheng Zhang, Lei Xie, Xiaoyu Deng, Tuan Yuan, Mingzhe Yu, Yong Liu, Ping Li, Hao Chen, Shenghou Zhou, Qishu Xu, Xixiang Xu Show

▲链接：

https://www.nature.com/articles/s41586-024-08110-8

▲摘要：

背接触式硅太阳能电池因其美观而受到重视，因为它们在向阳的一面没有电网，可以应用于建筑物，车辆和飞机，并且可以在不影响外观的情况下实现自我发电。图案化技术将触点安排在硅片的阴影面，这也为光线入射提供了好处。然而，图案过程使生产复杂化并导致功率损耗。

研究者采用激光简化了后接触太阳能电池的制造，提高了功率转换效率。利用这种方法，他们生产出了效率超过27%的硅太阳能电池。在硅片上沉积氢化非晶硅层进行表面钝化，并收集光生载流子。开发了一种不同于传统工艺实践的致密钝化触点。使用不同波长的脉冲皮秒激光来创建背接触图案。

该方法是一种生产高性能背接触硅太阳能电池的流线型工艺，总有效加工时间约为新兴主流技术的三分之一。为了满足太瓦的需求，他们开发了效率为26.5%的无铟电池和26.2%效率的无银电池。随着这些技术的进步，将太阳能解决方案整合到建筑和交通中将会得到扩展。

▲ Abstract：

Back-contact silicon solar cells, valued for their aesthetic appeal because they have no grid lines on the sunny side, find applications in buildings, vehicles and aircraft and enable self-power generation without compromising appearance. Patterning techniques arrange contacts on the shaded side of the silicon wafer, which offers benefits for light incidence as well. However, the patterning process complicates production and results in power loss. We employed lasers to streamline the fabrication of back-contact solar cells and enhance the power-conversion efficiency. Using this approach, we produced a silicon solar cell that exceeded 27% efficiency. Hydrogenated amorphous silicon layers were deposited onto the wafer for surface passivation and to collect light-generated carriers. A dense passivating contact, which differs from conventional technology practice, was developed. Pulsed picosecond lasers operating at different wavelengths were used to create the back-contact patterns. The approach developed is a streamlined process for producing high-performance back-contact silicon solar cells, with a total effective processing time of about one-third that of the emerging mainstream technology. To meet the terawatt demand, we developed indium-less cells at 26.5% efficiency and precious silver-free cells at 26.2% efficiency. Thus, the integration of solar solutions into buildings and transportation is poised to expand with these technological advances.

可持续发展Sustainability

Keeping the global consumption within the planetary boundaries

保持全球消费在地球可承受范围内

▲ 作者：Peipei Tian, Honglin Zhong, Xiangjie Chen, Kuishuang Feng, Laixiang Sun, Ning Zhang, Xuan Shao, Yu Liu Klaus Hubacek

▲链接：

https://www.nature.com/articles/s41586-024-08154-w

▲摘要：

不同国家对环境影响的差异已得到广泛承认。然而，在经济和消费群体的复杂相互作用中确定具体责任仍然是一项具有挑战性的努力。研究者使用了一个包含168个国家201个消费群体的支出数据库，调查了6个环境足迹指标的分布，并评估了特定消费支出对地球边界越界的影响。他们发现，31%-67%和51%-91%的地球边界突破责任可分别归因于全球前10%和前20%的消费者，分别来自发达国家和发展中国家。

通过遵循有效的缓解途径，全球前20%的消费者可以采用在其五分位数内对环境影响最小的消费水平和模式，从而将环境压力减少25%-53%。在这种情况下，仅以粮食和服务部门为重点的行动将足以减少环境压力，使土地系统变化和生物圈完整性恢复到各自的地球边界之内。研究强调，迫切需要关注高消费消费者，以有效地解决地球边界越界问题。

▲ Abstract：

The disparity in environmental impacts across different countries has been widely acknowledged. However, ascertaining the specific responsibility within the complex interactions of economies and consumption groups remains a challenging endeavour. Here, using an expenditure database that includes up to 201 consumption groups across 168 countries, we investigate the distribution of 6 environmental footprint indicators and assess the impact of specific consumption expenditures on planetary boundary transgressions. We show that 31 – 67% and 51 – 91% of the planetary boundary breaching responsibility could be attributed to the global top 10% and top 20% of consumers, respectively, from both developed and developing countries. By following an effective mitigation pathway, the global top 20% of consumers could adopt the consumption levels and patterns that have the lowest environmental impacts within their quintile, yielding a reduction of 25 – 53% in environmental pressure. In this scenario, actions focused solely on the food and services sectors would reduce environmental pressure enough to bring land-system change and biosphere integrity back within their respective planetary boundaries. Our study highlights the critical need to focus on high-expenditure consumers for effectively addressing planetary boundary transgressions.

Global influence of soil texture on ecosystem water limitation

土壤质地对生态系统水分限制的全球影响

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▲链接：

https://www.nature.com/articles/s41586-024-08089-2

▲摘要：

低土壤水分和高蒸汽压亏缺（VPD）会引起植物水分胁迫，并导致各种干旱反应，包括蒸腾和光合作用的减少。当土壤干燥低于临界土壤湿度阈值时，生态系统从能量向水分限制过渡，气孔关闭以缓解水分胁迫。然而，在生态系统尺度上，这些阈值背后的机制仍然不明确。

研究者通过分析全球土壤临界水分阈值的观测结果以及土壤水力传导性曲线（其陡度随沙粒含量的增加而增加），发现土壤质地在调节生态系统水分限制发生中具有突出作用。这阐明了生态系统对VPD和土壤湿度的敏感性是如何由土壤质地决定的，沙质土壤中的生态系统对土壤干燥相对更敏感，而粘性土壤中的生态系统对VPD相对更敏感。

由于同样的原因，沙质土壤中的植物适应水分限制的潜力有限，这对气候变化如何影响陆地生态系统产生了影响。因此，尽管植被-
大气交换受大气条件驱动，并受植物调节的调节，但其命运最终取决于土壤。

▲ Abstract：

Low soil moisture and high vapour pressure deficit (VPD) cause plant water stress and lead to a variety of drought responses, including a reduction in transpiration and photosynthesis. When soils dry below critical soil moisture thresholds, ecosystems transition from energy to water limitation as stomata close to alleviate water stress. However, the mechanisms behind these thresholds remain poorly defined at the ecosystem scale. Here, by analysing observations of critical soil moisture thresholds globally, we show the prominent role of soil texture in modulating the onset of ecosystem water limitation through the soil hydraulic conductivity curve, whose steepness increases with sand fraction. This clarifies how ecosystem sensitivity to VPD versus soil moisture is shaped by soil texture, with ecosystems in sandy soils being relatively more sensitive to soil drying, whereas ecosystems in clayey soils are relatively more sensitive to VPD. For the same reason, plants in sandy soils have limited potential to adjust to water limitations, which has an impact on how climate change affects terrestrial ecosystems. In summary, although vegetation – atmosphere exchanges are driven by atmospheric conditions and mediated by plant adjustments, their fate is ultimately dependent on the soil.

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