《自然》（20260813出版）一周论文导读

作者：writer 来源：科学网

本文原地址：https://www.iikx.com/news/progress/41575.html

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《自然》（20260813出版）一周论文导读。编译冯维维

Nature, 13 August 2026,Volume 656 Issue 8127

《自然》，2026年8月13日，第656卷，8127期



天文物理学AstroPhysics

A gas-enshrouded and gas-reddened black hole at cosmic dawn

位于宇宙黎明时期、被气体包裹且受气体红化的黑洞

▲作者：Rohan P. Naidu, Jorryt Matthee, Harley Katz, Anna de Graaff, Pascal A. Oesch, Aaron Smith, Jenny E. Greene, Gabriel Brammer, Andrea Weibel, Raphael Hviding, John Chisholm, Ivo Labb é , Robert A. Simcoe, Callum Witten, Wendy Q. Sun, Hakim Atek, Josephine F. W. Baggen, Sirio Belli, Rachel Bezanson, Leindert A. Boogaard, Sownak Bose, Rychard J. Bouwens, Alba Covelo-Paz, Pratika Dayal,

…Katherine Whitaker Show s

▲链接：

https://www.nature.com/articles/s41586-026-10846-4

▲摘要：

在宇宙时间的前7亿年内，即“宇宙黎明”时期，形成数十亿倍太阳质量黑洞的物理过程至今仍是一个谜题。已有若干理论模型试图解释这些黑洞的种子形成与快速生长机制，但直接观测证据始终匮乏。

研究者报道了一个在大爆炸后6.6亿年出现的天体，它展现出独特的性质：在所有红移已知天体中具有最大的氢巴耳末断之一、宽且多峰的Hβ发射线，以及多个巴耳末线系的吸收特征。

他们将此源模型化为一个被包裹的黑洞，其巴耳末断和吸收特征源于极高密度、湍流的气体，形成一层无尘包层包裹在超大质量黑洞周围。

该源可能为早期黑洞嵌入致密气体中、通过超爱丁顿吸积快速生长的理论构型提供了观测证据。黑洞辐射似乎主导了几乎所有观测到的光，留给其宿主星系的贡献空间非常有限。

若此源与其更亮的邻近天体合并，它将类似于近期发现的“小红点”——这些天体的光谱能量分布令人困惑。该黑洞呈现红色并非源于尘埃，而是气体作用，且其复杂的谱线形状与光度由散射而非动力学主导——因此，这类源的黑洞质量可能被高估了数个数量级。

▲ Abstract：

The physical processes that led to the formation of billion-solar-mass black holes within the first 700 million years of cosmic time, a period known as cosmic dawn, remain a puzzle1. Several theoretical scenarios have been proposed to seed and rapidly grow black holes, but direct observations of these mechanisms remain elusive. Here we present a source 660 million years after the Big Bang that exhibits singular properties: among the largest hydrogen Balmer breaks reported at any redshift, broad multi-peaked Hβ emission, and Balmer line absorption in several transitions. We model this source as an enshrouded black hole in which the Balmer break and absorption features are a result of extremely dense, turbulent gas forming a dust-free envelope around a supermassive black hole. This source may provide evidence of an early black hole embedded in dense gas—a theoretical configuration proposed to rapidly grow black holes by super-Eddington accretion. Radiation from the black hole seems to dominate almost all observed light, leaving limited room for contribution from its host galaxy. If the source merged with its brighter neighbour, it would resemble the recently discovered ‘little red dots’ with perplexing spectral energy distributions. The redness of the black hole is due to gas, not dust, and scattering, not kinematics, gives rise to the complex line shapes and luminosities—black hole masses of these sources may therefore be overestimated by orders of magnitude.

Numerous bow shocks in the outer Helix Nebula

螺旋星云外缘的大量弓形激波

▲作者：Pieter van Dokkum, Roberto Abraham, William P. Bowman, Seery Chen, Steven R. Janssens, Deborah M. Lokhorst, Imad Pasha Carter Rhea

▲链接：

https://www.nature.com/articles/s41586-026-10724-z

▲摘要：

低质量与中等质量恒星在生命末期，会通过星风和外流抛出富含金属元素的物质，最终形成行星状星云。这些被抛出的物质预期会碎裂并混入星际介质，但这一最终同化步骤一直难以直接观测。

研究者报告了在螺旋星云东部外围探测到的22个弓形激波，它们由尚在建设中的MOTHRA望远镜在Hα发射线下观测到。与演化恒星周围常见的大尺度星风–星际介质弓形激波不同，这些激波结构紧凑，且与单个气体团块相关联。

从中心恒星向外，曲率半径在径向范围0.4–1.4秒差距内大约下降了两个数量级。与此同时，形态也从清晰的薄弓形结构过渡到模糊、斑驳的结构。

研究者将这些变化解释为渐近巨星分支壳层残骸在与星际介质相互作用过程中逐步被剥离和碎裂。所观测到的–关系斜率表明，碎块的相干性在大约104年时间尺度上丧失，这为碎裂恒星抛射物被破坏并卷入星际介质的时间尺度提供了罕见的直接约束。

▲Abstract：

Near the end of their lives, low-mass and intermediate-mass stars expel metal-enriched material in winds and outflows, ultimately producing planetary nebulae1,2. The ejected material is expected to fragment and mix into the interstellar medium (ISM), but this final assimilation step has been difficult to observe directly3,4. Here we report evidence for this process in the form of 22 bow shocks in the eastern outskirts of the Helix Nebula, detected in Hα emission with the partially completed MOTHRA telescope. Unlike the large-scale wind–ISM bow shocks commonly observed around evolved stars, the shocks are compact and associated with individual clumps of gas. Going outward from the central star, the radius of curvature Rc decreases by a factor of roughly 102 over the radial range r?=?0.4–1.4?pc. This is accompanied by a morphological transition from thin, well-defined bows to fuzzy, patchy structures. We interpret these changes as progressive stripping and fragmentation of asymptotic giant branch-shell remnants as they interact with the ISM. The slope of the observed Rc–r relation implies a loss of fragment coherence on a timescale of roughly 104?years, providing a rare direct constraint on the timescale for disruption and entrainment of fragmented stellar ejecta into the ISM.

物理学Physics

The piezochiral effect

压电手性效应

▲ 作者：Z. Zeng, M. F?rst, M. Fechner, X. Deng, A. Cavalleri P. G. Radaelli

▲链接：

https://www.nature.com/articles/s41586-026-10845-5

▲摘要：

手性是物质的一种普遍性质，支撑着物理、化学和生物学中的许多重要现象。鉴于其广泛的重要性，开发在固态系统中合理调控手性的实验方案极具吸引力，尤其是如果这种效应能够被连续且双向地调节。

然而，由于缺乏与该结构序参量线性耦合的普适共轭场，这一目标至今未能实现。

研究者提出“压电手性效应”，它使得通过机械应变来控制手性成为可能。他们通过对称性分析表明，在每一晶胞内含有相反手性碎片的宽泛一类非手性晶体中，单轴应变可诱导出手性——这一效应此前未被认识。

应变诱导的旋向性既可通过改变应变方向来调节，也可通过压缩应变与拉伸应变之间的切换来调控。

研究者在AgGaS2中通过测量应变下的光学活性，实验验证了该效应。他们的发现建立了一种控制手性的新方案，潜在应用涵盖自旋电子学、不对称催化以及生物系统中的对映选择性相互作用等多个领域。

▲ Abstract：

Chirality is a pervasive property of matter that underpins many important phenomena across physics1, chemistry and biology. Given its broad importance, the development of protocols for rational control of chirality in solid-state systems is highly desirable, especially if this effect can be tuned continuously and in two directions. Yet, this goal has remained elusive owing to the absence of a universal conjugate field that couples linearly to this structural order4,5,6. Here we introduce the piezochiral effect, which enables control of chirality through mechanical strain. We show by symmetry analysis that uniaxial strain induces chirality in a broad class of achiral crystals that host fragments of opposite chirality within each unit cell, an effect that has so far remained unrecognized. The strain-induced handedness can be tuned either by changing the strain direction or by switching between compressive and tensile strain. We experimentally verify this effect in AgGaS2, using measurements of the optical activity under strain. Our discovery establishes a new scheme for chirality control, with potential applications that range from spintronics to asymmetric catalysis, and enantioselective interactions in biosystems.

Plasmonic metamaterial time crystal

等离激元超材料时间晶体

▲作者：Tingwen Guo, Jules Sueiro, Gian Marcello Andolina, Artem Levchuk, Stefano Ponzoni, Romain Grasset, Donald Monthe, Ian Aupiais, Dmitri Daineka, Javier Briatico, Thales VAG de Oliveira, Alexey Ponomaryov, Atiqa Arshad, Arjun Karimbana-Kandy, Gulloo Lal Prajapati, Igor Ilyakov, Jan-Christoph Deinert, Sebastian F. Maehrlein, Luca Perfetti, Marco Schir ò Yannis Laplace

▲链接：

https://www.nature.com/articles/s41586-026-10825-9

▲摘要：

空间光子晶体（SPCs）因其在波长尺度上实现大且空间周期性介电对比度，成为光-物质相互作用的独特结构。其时间类比——光子时间晶体（PTCs）——通过周期性调制光学特性有望带来类似进展，但这需要强烈且超快的调制，这在实验上很难实现。

驱动超材料曾被视作实现PTCs的一条路径，但全光学实现此前一直未能达成，原因在于在如此短时间尺度上实现调制极具挑战性。

研究者展示了光子时间晶体的全光学实现，采用工作在太赫兹频率的表面等离激元腔超材料。

他们演示了通过场致动态调制载流子动能和有效质量（其有效质量可达静止质量的80%）而实现的强（接近统一调制深度）且相干（亚光学周期）的周期性驱动。

其光谱测量显示，系统经由一个例外点进入PTC区间。在PTC区间内，涌现的增益可使等离激元损耗降低超过50%，他们预测等离激元激射在现有实验条件下是可实现的。这些结果为等离激元系统中的时域光子学建立了一个稳健的平台。

▲ Abstract：

Spatial photonic crystals (SPCs) are unique structures for light – matter interactions because they achieve a large and spatially periodic dielectric contrast on wavelength scales. Their temporal analogues, photonic time crystals (PTCs), promise similar advances by periodically modulating optical properties in time, but require strong, ultrafast modulation, which is challenging to obtain experimentally. Driven metamaterials have been considered as a route to realize PTCs, yet all-optical implementations have remained unknown because of the challenge of achieving modulation on such short timescales. Here we demonstrate the all-optical realization of a photonic time crystal, achieved with a surface plasmon cavity metamaterial operating at terahertz frequencies. We demonstrate strong (near-unity) and coherent (sub-optical cycle) periodic driving of the plasmonic metamaterial enabled by field-induced dynamical modulation of the kinetic energy of the carriers and effective mass reaching up to 80% of their rest mass. Our spectroscopic measurements show a transition into the PTC regime mediated by an exceptional point, at which two Floquet-driven optical eigenmodes coalesce. In the PTC regime, emergent gain is shown to reduce plasmonic losses by more than 50% , and we predict plasmonic lasing to be within experimental reach. These results establish a robust platform for time-domain photonics in plasmonic systems.

生命科学Life Science

Ketogenic diet mediates intestinal tumorigenesis through lipids not ketones

生酮饮食通过脂质而非酮体介导肠道肿瘤发生

▲ 作者：Jessica E. S. Shay, Fangtao Chi, Constantine N. Tzouanas, Shixun Han, Xiao Zhang, Johanna Ten Hoeve, Kevin J. Williams, Seda Neptun, Tolga Sever, Isabela Fuentes, Sangeeta N. Bhatia, Gizem Calibasi-Kocal, Matthew G. Vander Heiden, Alex K. Shalek ?mer H. Yilmaz

▲链接：

https://www.nature.com/articles/s41586-026-10779-y

▲摘要：

饮食组成通过调节营养物质可利用性、代谢状态和细胞动态来塑造组织功能和疾病风险。在胃肠道中，致肥胖的高脂饮食可增强小肠干细胞活性和肿瘤发生。然而，生酮饮食（KD）——虽然脂质含量更高，但能降低循环胰岛素并诱导生酮作用——的影响尚不清楚。这对于家族性腺瘤性息肉病患者尤其相关，因为他们面临较高的小肠肿瘤风险。

研究结合饮食、遗传和代谢操控，在自发性肠道腺瘤形成的小鼠模型中，剖析了全身性和上皮生酮作用在肠道癌症中的角色。研究者发现，生酮饮食会加速肿瘤负荷并缩短生存期，且这一效应不依赖于酮体代谢物。通过对生酮通路的遗传操控，他们调节了局部和全身性酮体代谢物的产生；然而，无论是抑制还是增强生酮酶——3-羟基-3-甲基戊二酰辅酶A合酶2（HMGCS2），还是破坏酮解作用，均未改变肿瘤发生。

肠道中PPAR α / δ / γ 的联合缺失可减弱生酮饮食驱动的肠道干细胞扩增、增殖和克隆形成能力；而通过CPT1A缺失抑制下游脂肪酸氧化，则仅在生酮饮食条件下限制腺瘤形成，这表明肿瘤起始与膳食脂质的脂肪酸氧化相关，而非脂质积累。这些发现揭示了膳食脂质含量——通过脂肪酸氧化而非酮体代谢——影响肠道肿瘤发生，并强调了对遗传易感人群制定癌症预防饮食策略时需要细致审慎的考量。

▲ Abstract：

Diet composition shapes tissue function and disease risk by modulating nutrient availability, metabolic state and cellular dynamics1. In the gastrointestinal tract, obesogenic high-fat diets enhance small-intestinal stem cell activity and tumorigenesis. However, the impact of ketogenic diets (KDs), which contain even higher lipid content but reduce circulating insulin and induce ketogenesis, remains poorly understood. This is particularly relevant for patients with familial adenomatous polyposis who face a high risk of small-intestinal tumours4. Here we combine dietary, genetic and metabolic manipulations in mouse models of spontaneous intestinal adenoma formation to dissect the role of systemic and epithelial ketogenesis in intestinal cancer. We show that KD accelerates tumour burden and shortens survival, independent of ketone metabolites. Through genetic manipulation of the ketogenic pathway, we modulate the production of local and systemic ketone metabolites; however, neither inhibition nor augmentation of the ketogenic enzyme 3-hydroxy-3-methylglutaryl-coenzyme A synthase 2 nor disruption of ketolysis altered tumorigenesis.

Combined intestinal loss of PPAR α / δ / γ attenuates KD-driven intestinal stem cell expansion, proliferation and clonogenicity, whereas inhibition of downstream fatty acid oxidation through CPT1A loss limits adenoma formation specifically under KD, linking tumour initiation to fatty acid oxidation of dietary lipids rather than lipid accumulation. These findings reveal that dietary lipid content, through fatty acid oxidation rather than ketone metabolism, influences intestinal tumorigenesis and highlight the need for nuanced consideration of dietary strategies for cancer prevention in genetically susceptible populations.

Mapping the neuronal building blocks of human language with language models

利用语言模型绘制人类语言的神经元构建模块

▲ 作者：Jing Cai, Yoav Kfir, Mohsen Jamali, Hesen Huang, Young Joon Kim, Sydney S. Cash Ziv M. Williams

▲链接：

https://www.nature.com/articles/s41586-026-10691-5

▲摘要：

人类能够通过语言传达新颖且高度多样化的信息。这种将词语组合成复杂短语和句子的能力，使我们能够表达无穷无尽的意义，是人类认知的基础。然而，理解精确支撑人类语言的微观细胞构建模块及其皮层景观一直是一个挑战。

研究采用大规模单神经元记录结合自然语言处理模型，在语言产生过程中识别了人类额颞叶皮层上精细的语言表征。研究者发现，某些神经元表征词语之间详细的语法关系或词性，而其他神经元则追踪句子更高阶的句法结构、短语转换和序列。

总体而言，这些神经元可靠地捕获了词语的句法和语义属性，同时动态整合其特定的句子语境，从而能够以高度粒度的细节组合性地编码信息。

研究展示了这些细胞群体的局部组织方式，以及它们的微观表征如何不同于其更宽场电位模式，还展示了这些神经元广泛分布于额颞叶皮层，但其编码语言信息的能力呈左侧偏侧化，且在不同皮层区域之间存在差异。

综合起来，这些发现识别了人类编码语言信息的一些最基本细胞构建模块，并开始在微观（细胞）、介观（局部群体）和宏观（区域）尺度上描绘语言的皮层景观。

▲ Abstract：

Humans can convey new and highly diverse information through language. This ability to form and combine words into elaborate phrases and sentences enables us to express inexhaustible meanings and is fundamental to human cognition. However, understanding the microscopic cellular building blocks and cortical landscape that precisely underlie human language has remained a challenge. Here we used wide-scale single-neuronal recordings combined with natural language processing models to identify fine-grained linguistic representations across the human frontotemporal cortex during language production. We find that, whereas

certain neurons represented the detailed grammatical relationships between words or their parts of speech, others tracked the sentences ’ higher-order syntactic structure, their phrase transitions and sequence. Collectively, these neurons reliably captured the words ’ syntactic and semantic properties but also dynamically incorporated their specific sentence contexts, therefore enabling them to encode information combinatorially and at highly granular levels of detail. We show how these cell populations were locally organized and how their microscale representations differed from that of their wider field potential patterns. We also show how these neurons were distributed broadly across the frontotemporal cortex, but how their ability to encode linguistic information was left-lateralized and varied between cortical regions. Together, these findings identify some of the most basic cellular building blocks by which linguistic information is encoded in humans and begin to define the cortical landscape of language at a combined micro (cellular), meso (local population) and macro (regional) scale.

作者：冯维维 来源：科学网微信公众号

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