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天文学Astronomy

Verification of the Outer Space Treaty with cosmic protons

《外层空间条约》的宇宙质子验证

▲ 作者：Areg Danagoulian

▲ 链接：

<https://www.nature.com/articles/s41586-025-09959-z>

▲ 摘要：

研究者提出并验证了一种概念设想：通过观测内范艾伦辐射带中约GeV能量的质子与卫星材料发生散裂反应产生的中子，来核查卫星是否遵守《外层空间条约》。

计算表明，一个9U立方星大小的探测平台可以在约一周的观测时间内，从4公里距离识别出热核武器。这项概念性研究将为《外层空间条约》核查平台的未来研发提供启发和参考。

▲ Abstract：

Here a concept and feasibility study is presented for verifying a satellite 's compliance to the OST by observing the neutrons induced by spallation from the approximately GeV protons in the inner Van Allen radiation belts. The calculations show that a 9U-CubeSat-sized detection platform can identify a thermonuclear weapon from a distance of 4 km in approximately one week of observation. This conceptual study will stimulate and inform future research and development of verification platforms for the OST.

物理学Physics

Universal gates from braiding and fusing anyons on quantum hardware

量子硬件上通过编织与融合任意子实现通用量子门

▲ 作者：Chiu Fan Bowen Lo, Anasuya Lyons et al.

▲ 链接：

<https://www.nature.com/articles/s41586-026-10709-y>

▲ 摘要：

研究者表明，将任意子融合作为计算基本操作，可使这些最小非阿贝尔拓扑有序态具备通用计算能力。研究者在Quantinuum的H2处理器上制备了S3（最小非阿贝尔拓扑序）量子双体的54量子

比特基态。

将逻辑信息编码在非阿贝尔任意子的全局融合空间中，研究者通过编织与融合相结合的方式，实现了通用的拓扑门集与读出，并通过拓扑方式制备了魔法态来加以验证。

这表明S3拓扑有序态既可规模化制备，又足够丰富以支持通用门集。这项作为利用量子物质的固有性质来操控量子信息开辟了新途径。

▲ Abstract :

Here we demonstrate that anyon fusion, used as a computational primitive, renders these minimally non-Abelian topologically ordered states universal. We prepare a 54-qubit ground state of the quantum double of S_3 , the smallest non-Abelian group, on the H2 processor of Quantinuum. We encode logical information in the global fusion space of non-Abelian anyons, and by combining braiding with fusion, we realize a universal topological gate set and read-out, which we demonstrate by topologically preparing a magic state. This demonstrates that the S_3 topologically ordered state is scalably preparable, yet rich enough to support a universal gate set. More broadly, this work opens up new pathways for harnessing the intrinsic properties of quantum matter to manipulate quantum information.

人工智能Artificial Intelligence

People use fast and flat simulation to reason about new games

人类使用快速且扁平化的模拟来推理新游戏

▲ 作者：Katherine M. Collins, Cedegao E. Zhang et al.

▲ 链接：

<https://www.nature.com/articles/s41586-026-10722-1>

▲ 摘要：

研究者通过新手游戏体验来探究人们如何推理新的问题情境。研究者开展了一系列大规模行为实验，涉及超过1000名参与者和121款双人策略棋盘游戏（几乎所有游戏对参与者而言都是全新的）。

结果表明，人们在首次玩一款游戏或从未玩过的情况下评估一款游戏（例如判断其公平性或趣味性）时，表现出系统性且具有适应性理性的特征。研究者通过一个称为直觉玩家的计算认知模型来解释这些能力，该模型基于快速且扁平（深度受限）的目标导向概率模拟机制。

这项研究为理解人们如何快速评估、行动并针对新问题提出建议提供了见解，并可为设计更灵活、更类人的人工智能系统提供启示——这些系统不仅能确定如何解决新任务，还能判断某个任务是否值得被思考。

▲ Abstract :

Here we use novice gameplay to study how people reason about new problem settings. Through a series of large-scale behavioural studies with over 1,000 participants and 121 two-player strategic board games (almost all novel to our participants), we show that people are systematic and adaptively rational in how they play a game for the first time or evaluate a game (for example, how fair or how fun it is likely to be) before they have played it even once. We explain these capacities via a computational cognitive model that we call the 'Intuitive Gamer': a model based on mechanisms of fast and flat (depth-limited) goal-directed probabilistic simulation. Our work offers insights into how people rapidly evaluate, act and make suggestions when encountering novel problems, and could inform the design of more flexible and human-like artificial intelligence systems that can determine not just how to solve new tasks but also whether a task is worth thinking about at all.

地球科学Earth Science

Anatomy of a seafloor spreading event captured by in situ seismogeodesy

解析原位地震大地测量记录的海底扩张事件

▲ 作者 : Jean-Yves Royer, Jean-Arthur Olive et al.

▲ 链接 :

<https://www.nature.com/articles/s41586-026-10785-0>

▲ 摘要 :

研究者报告了在洋中脊段对一次裂谷事件进行的首次原位观测。该观测结合了水声、直达路径测距和海底压力测量，并辅以重复的海底地形测绘。此次事件始于2024年4月26日，位于南纬37°附近的东南印度洋脊轴部，距离跨洋脊轴和邻近阿姆斯特丹转换断层布设的仪器仅两个月。

事件起始于沿轴向谷快速迁移的伸展性地震群，导致谷底沉降4米，并产生超过1米的跨谷水平伸展。

研究者将其解释为席状岩浆储库的排空过程，该储库沿洋脊轴供给传播的岩墙。这些岩墙最终在约16天内导致约1.6亿立方米熔岩在海底喷发，同时诱发谷壁正断层的同震与非同震滑动，并最终触发相邻转换断层的地震活动。

因此，由岩浆过程诱导的大规模非地震滑动可能是洋中脊正断层累积位移的主要机制，这可以解释其长期存在的地震亏缺现象。

▲ Abstract :

Here we report the first, to our knowledge, in situ observation of a rifting event at a MOR segment that

combines hydroacoustic, direct-path ranging and bottom-pressure measurements, with repeated seafloor mapping. This event started on 26 April 2024 at the axis of the Southeast Indian Ridge (SEIR) near 37 ° S, two months after instruments had been deployed across the ridge axis and nearby Amsterdam transform fault (TF). The event began as a rapidly migrating swarm of extensional seismicity along the axial valley. It caused 4 m of subsidence of the valley floor and more than a metre of horizontal extension across the valley. We interpret this as the deflation of a sill-like reservoir feeding propagating dykes along the ridge axis. The dykes eventually led to the outpouring of about 160 million m³ of lava at the seafloor in about 16 days, while inducing both seismic and aseismic slip on valley-bounding normal faults and finally triggering seismic activity on the abutting TFs. Large-scale aseismic slip induced by magmatic processes could therefore be the primary mechanism by which MOR normal faults accrue their displacement, which would account for their well-documented seismic deficit.

Global high-resolution mapping of seagrass to support conservation

用于支持保护的全球高分辨率海草分布制图

▲ 作者：Jianghai Peng, Jiwei Li et al.

▲ 链接：

<https://www.nature.com/articles/s41586-026-10704-3>

▲ 摘要：

研究者呈现了全球首套10米空间分辨率的清澈浅海沿岸海草分布图及其变化分析。该成果基于475万张哨兵2号MSI卫星影像，涵盖两个时期（2019至2020年，及2023至2024年）。

利用经精心整理参考数据训练的深度学习分类器，研究者在全球范围内识别出148506平方公里的海草，其中包括5961平方公里的潮间带和142545平方公里的潮下带区域。全球69%的海草面积集中在巴哈马、古巴、美国、澳大利亚和印度尼西亚五国，然而仅21%的海草区域位于海洋保护区内。

在研究覆盖的4年间，共有5969平方公里（占4%）的海草消失，另在热带地区有6221平方公里（占4.2%）的海草由密集覆盖退化为稀疏覆盖。研究结果识别出海草草甸热点与脆弱区域，可为保护及气候政策提供信息支持。

▲ Abstract：

Here we present, to our knowledge, the first global 10-m spatial resolution maps and change analysis of seagrass extent in clear, shallow coastal waters, derived from 4.75 million Sentinel-2 MSI satellite images for two periods (2019 – 2020 and 2023 – 2024). Using a deep-learning classifier trained on curated reference data, we identified 148,506 km² of seagrass globally, including 5,961 km² of intertidal and 142,545 km² of subtidal areas. Sixty-nine per cent of global seagrass extent is concentrated in The Bahamas, Cuba, the USA, Australia and Indonesia, yet only 21% of seagrass areas are located within marine-protected areas. Over the 4 years of the study, 5,969 km² (4%) of seagrass was lost, and an additional 6,221 km² (4.2%) was degraded from dense to sparse cover in tropical regions. Our findings identify seagrass meadow hotspots and

vulnerable regions to inform conservation and climate policy.

生物学Biology

Plastoglobules compartmentalize nitrogen assimilation in maize

玉米中质体小球区室化氮同化过程

▲ 作者：Di Chen, Lulu Gao et al.

▲ 链接：

<https://www.nature.com/articles/s41586-026-10610-8>

▲ 摘要：

研究者表明，玉米叶肉细胞叶绿体中的质体小球（PGs）作为代谢枢纽，协调氮素的利用。质体小球对氮响应的动态变化是植物物种间保守的特征。

研究者鉴定了两种关键酶——亚硝酸还原酶2（ZmNIR2）和谷氨酰胺合成酶1（ZmGLN1），它们通过叶绿体转运肽和疏水区域特异性地靶向质体小球。重组ZmGLN1的冷冻电镜分析显示其形成十聚体复合物，能够与ZmNIR2形成代谢通道以提升效率。

在两种NIR和六种GLN酶中，ZmNIR2和ZmGLN1是主要定位于质体小球的组分，协调亚细胞器水平的氮同化，并决定氮利用效率。栽培种质中ZmNIR2剪接的遗传变异产生了一种靶向质体小球的异构体ZmNIR2T1，该异构体可提高氮利用效率。

这项研究确立了质体小球作为初级氮同化的中心区室，为开发高氮利用效率作物以保障全球粮食安全提供了一条有前景的途径。

▲ Abstract：

Here we show that plastoglobules (PGs) in the chloroplasts of mesophyll cells function as a metabolic hub that orchestrates nitrogen utilization in maize. Nitrogen-responsive dynamics of PGs represent a conserved feature across plant species. We identify two key enzymes, nitrite reductase 2 (ZmNIR2) and glutamine synthetase 1 (ZmGLN1), specifically targeted to PGs by a chloroplast transit peptide and hydrophobic region. Cryogenic electron microscopy analysis of recombinant ZmGLN1 shows a decameric complex, enabling a metabolon with ZmNIR2 for enhanced efficiency. Among two NIR and six GLN enzymes, ZmNIR2 and ZmGLN1 are the primary PG-localized components that orchestrate sub-organellar nitrogen assimilation and dictate nitrogen use efficiency. Genetic variation in ZmNIR2 splicing in cultivated germplasm generates a PG-targeted isoform (ZmNIR2T1) that boosts NUE. Our work establishes PGs as a central compartment for primary nitrogen assimilation, providing a promising strategy to develop high-NUE crops for global food security.

作者：李言 来源：科学网微信公众号

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