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Device-independent quantum key distribution over 100 km with single atoms

单原子设备无关量子密钥分发突破100公里距离

▲ 作者：Bo-Wei Lu, Chao-Wei Yang et al.

▲链接：

https://www.science.org/doi/10.1126/science.aec6243

▲ 摘要：设备无关量子密钥分发（DI-QKD）是量子互联网的关键应用之一。研究者实现了两个单原子节点通过100公里光纤连接的DI-QKD。为提高纠缠速率，研究者利用单光子干涉实现纠缠预示，并通过量子频率转换降低光纤损耗。此外，基于里德堡态的定制化发射方案在不引入噪声的前提下抑制了光子反冲效应对原子的影响。

实验实现了高保真度的原子—原子纠缠，并在长达100公里的光纤距离上获得了正的渐进密钥率。在11公里距离下，经过624小时实验成功制备了120万个预示贝尔纠缠对，针对一般攻击的有限长度安全密钥提取率估计达到每事件0.112比特。这项成果缩小了原理性量子网络实验与实际应用之间的差距。

▲ Abstract：Device-independent quantum key distribution (DI-QKD) is a key application of the quantum internet. We report the realization of DI-QKD between two single-atom nodes linked by 100 – kilometer (km) fibers. To improve the entangling rate, single-photon interference is leveraged for entanglement heralding, and quantum frequency conversion is used to reduce fiber loss. A tailored Rydberg-based emission scheme suppresses the photon recoil effect on the atom without introducing noise. We achieved high-fidelity atom-atom entanglement and positive asymptotic key rates for fiber lengths up to 100 km. At 11 km, 1.2 million heralded Bell pairs were prepared over 624 hours, yielding an estimated extractable finite-size secure key rate of 0.112 bits per event against general attacks. Our results close the gap between proof-of-principle quantum network experiments and real-world applications.

地理科学Earth Sciences

Continental mantle earthquakes of the world

全球大陆地幔地震

▲ 作者：Shiqi Wang and Simon L. Klemperer et al.

▲链接：

https://www.science.org/doi/10.1126/science.adz4367

▲ 摘要：大陆地幔地震（CMEs）及其对大陆流变结构的意义已吸引地球物理学家关注逾半个世纪。尽管这类地震的存在已无争议，但在全球范围内的识别仍较为有限。通过对比地震的Sn波与Lg波振幅比与邻近地震的比值，可有效区分大陆地幔地震，且该方法具备全球普适性，突破了传统技术的局限。

研究者提供了远超以往孤立探测与推测范围的全球大陆地幔地震分布图。结果显示，大陆地幔地震在全球广泛存在，同时呈现区域性分布规律，反映了局部岩石圈结构与构造历史的差异。该成果突显了大陆地幔地震在理解大陆演化及全球构造动力学中的关键价值。

▲ Abstract：Continental mantle earthquakes (CMEs) and their implications for the rheological structure of continents have fascinated geophysicists for more than half a century. Existence of these earthquakes is no longer debated, but their identification remains sparse across the globe. Comparing the Sn and Lg seismic wave amplitude ratio (Sn/Lg) of an earthquake with that of nearby earthquakes distinguishes CMEs and, unlike previous methods, can be applied globally. We present a global distribution of CMEs that extends well beyond previous individual detections and areas of speculation. CME occurrence is widespread globally yet patterned regionally, reflecting local lithospheric structure and tectonic history. Our results highlight the value of CMEs for understanding continents and global tectonics.

医学Medicine

DNA origami vaccines program antigen-focused germinal centersDNA

折纸疫苗可实现抗原聚焦的生发中心编程

▲ 作者：Anna Romanov, Grant A. Knappe et al.

▲链接：

https://www.science.org/doi/10.1126/science.adx6291

▲ 摘要：激活生发中心（GCs）中罕见的亚优势前体B细胞是疫苗接种以产生针对HIV的广谱中和抗体（bnAbs）的核心目标。在蛋白质纳米颗粒支架上进行多价免疫原展示可以促进此类反应，但也会产生支架特异性B细胞，理论上可能限制bnAb前体细胞在GC中的扩增。

研究者合理设计了一种基于DNA折纸技术的病毒样颗粒（DNA-VLPs），其展示了一种靶向胚系的HIV包膜蛋白免疫原，且未引发支架特异性抗体反应。与最先进的临床蛋白质纳米颗粒相比，这些DNA-VLPs在人类化小鼠模型中提高了表位特异性GC B细胞相对于脱靶B细胞的扩增，并增强了bnAb谱系B细胞的扩增。因此，最小化脱靶反应可促进bnAb前体激活，表明DNA-VLPs是一种前景广阔的疫苗平台。

▲ Abstract：Priming rare subdominant precursor B cells in germinal centers (GCs) is a central goal of vaccination to generate broadly neutralizing antibodies (bnAbs) against HIV. Multivalent immunogen display on protein nanoparticle scaffolds can promote such responses, but it also generates scaffold-specific B cells that could theoretically limit bnAb precursor expansion in GCs. We rationally designed DNA origami – based virus-like particles (DNA-VLPs) displaying a germline-targeting HIV envelope protein immunogen, which elicited no scaffold-specific antibody responses. Compared with a state-of-the-art clinical protein nanoparticle, these DNA-VLPs increased the expansion of epitope-specific GC B cells relative to off-target B cells and enhanced expansion of bnAb-lineage B cells in a humanized mouse model of CD4 binding site priming. Thus, minimizing off-target responses enhances bnAb priming and indicates that

DNA-VLPs are a promising vaccine platform.

Antifibrotic drug finerenone restores fertility in premature ovarian insufficiency

抗纤维化药物非奈利酮可恢复早发性卵巢功能不全患者的生育能力

▲ 作者：Zexiong Lin, Yuan Li et al.

▲链接：

https://www.science.org/doi/10.1126/science.adz4075

▲ 摘要：目前，针对早发性卵巢功能不全（POI）所致的不孕症尚无有效治疗方法，因为患者体内缺乏对激素有反应的窦卵泡。通过筛选美国食品药品监督管理局（FDA）已批准的药物库，研究者确定非奈利酮（一种肾脏疾病治疗药物）有望用于恢复POI患者的生育能力。

非奈利酮能促进老年小鼠的卵泡发育，并在POI患者口服后恢复其窦卵泡发育，从而获得成熟卵母细胞及胚胎。机制研究表明，非奈利酮可减少卵巢间质的纤维化沉积，缓解胶原蛋白对卵泡发育的抑制。

基于这一发现，研究者还鉴定出其他FDA批准的口服抗纤维化药物，它们可能成为治疗POI相关不孕症的潜在选项。我们的研究提示，卵巢间质（而非卵泡本身）是治疗的关键靶点，并为POI相关不孕症提供了潜在的治疗方向。

▲ Abstract：Currently, no effective treatment exists for infertility associated with premature ovarian insufficiency (POI) because affected patients lack hormone-responsive antral follicles. By screening a Food and Drug Administration (FDA) – approved drug library, we identified finerenone, a kidney disease medication, as a promising drug for restoring fertility in POI. Finerenone stimulated follicle development in aged mice and restored antral follicle development in patients with POI following oral administration, resulting in mature oocytes and embryos. Mechanistically, finerenone reduced fibrotic deposition in the ovarian stroma, alleviating collagen-mediated suppression of follicular development. Building on this insight, we identified additional FDA-approved oral antifibrotic drugs as potential treatments for POI-related infertility. Our findings highlight the ovarian stroma—rather than the follicles themselves—as the key therapeutic target and offer potential therapeutic leads for POI-related infertility.

生物学Biology

Gapless pangenome analyses reveal fast Brassica rapa subspeciation

无缺口泛基因组分析揭示甘蓝型油菜亚种的快速形成过程

▲ 作者：Wei Ma, Yuanming Liu et al.

▲链接：

https://www.science.org/doi/10.1126/science.ady7590

▲摘要：甘蓝型油菜包含多种形态类型和亚种，是研究植物多样化和亚种分化的理想模型。研究者对1720份甘蓝型油菜种质进行了基因组重测序，并针对7个经历强烈形态分化、具有重要农艺性状的优良亚种，重新组装了11个端粒到端粒的无缺口完整基因组。

研究者识别出6992个未知基因、110个完整的（近）着丝粒以及5个与甘蓝型油菜形态类型、亚种分化及芸薹属物种进化相关的新型卫星序列。基于这11个无缺口基因组和20个已发表基因组构建的泛基因组，揭示了甘蓝型油菜各亚种间的结构变异和基因多样性。通过泛基因组全关联分析，发现基因BrLH1控制叶球形成。

研究进一步表明，在甘蓝型油菜的短期栽培历史中，卫星序列、（近）着丝粒和基因均发生了结构变化，这些变化推动了其快速的亚种分化和形态类型形成，为芸薹属作物育种提供了宝贵资源。

▲ Abstract：Brassica rapa (Br) encompasses many morphotypes and subspecies, so it is a good model with which to investigate plant diversification and subspeciation. Here, we resequenced the genomes of 1720 Br accessions and de novo assembled 11 representative telomere-to-telomere gapless genomes for seven elite subspecies that underwent intensive morphotypification and developed distinct agronomic traits valued to agriculture. We identified 6992 unknown genes, 110 complete (peri)centromeres, and five new satellites associated with Br morphotypes and subspecies and Brassica species evolution. The pangenome, built on 11 gapless and 20 published genomes, reveals structural variations and gene diversities among Br subspecies. Pangenome-wide association studies uncovered that the gene BrLH1 controls leaf-head formation. We show that structural changes have occurred in satellites, (peri)centromeres, and genes, contributing to fast subspeciation and morphotypification during the short history of Br cultivation, providing invaluable resources for Brassica breeding.

动物学Zoology

Evidence for representation of pretend objects by Kanzi, a language-trained bonobo

证据表明语言训练倭黑猩猩坎兹具备表征“假装对象”的能力

▲ 作者：Amalia P. M. Bastos

▲链接：

https://www.science.org/doi/10.1126/science.adz0743

▲摘要：次级表征使人类思维能够超越当下现实，生成与真实世界分离的想象、假设或替代可能性，从而支持许多高阶认知能力，如心理状态归因、未来情景模拟和假装行为。

研究者通过实验证明，非人灵长类动物能够表征假装对象。坎兹（一只接受符号语言训练的倭黑猩猩）在支架式假装互动中，能根据语言提示准确定位假装对象（如空容器间“倾倒果汁”）的

位置。通过三项实验，研究者概念性地重复验证了这一发现，并排除了关键替代解释。

研究结果表明，形成假装对象的次级表征能力至少存在于经文化驯化的类人猿认知潜能中，且这一能力可能追溯至600万至900万年前共同的进化祖先。

▲ Abstract：Secondary representations enable our minds to depart from the here-and-now and generate imaginary, hypothetical, or alternate possibilities that are decoupled from reality, supporting many of our richest cognitive capacities such as mental-state attribution, simulation of possible futures, and pretense. We present experimental evidence that a nonhuman primate can represent pretend objects. Kanzi, a lexigram-trained bonobo, correctly identified the location of pretend objects (e.g., “ juice ” poured between empty containers), in response to verbal prompts in scaffolded pretense interactions. Across three experiments, we conceptually replicated this finding and excluded key alternative explanations. Our findings suggest that the capacity to form secondary representations of pretend objects is within the cognitive potential of, at least, an enculturated ape and likely dates back 6 to 9 million years, to our common evolutionary ancestors.

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