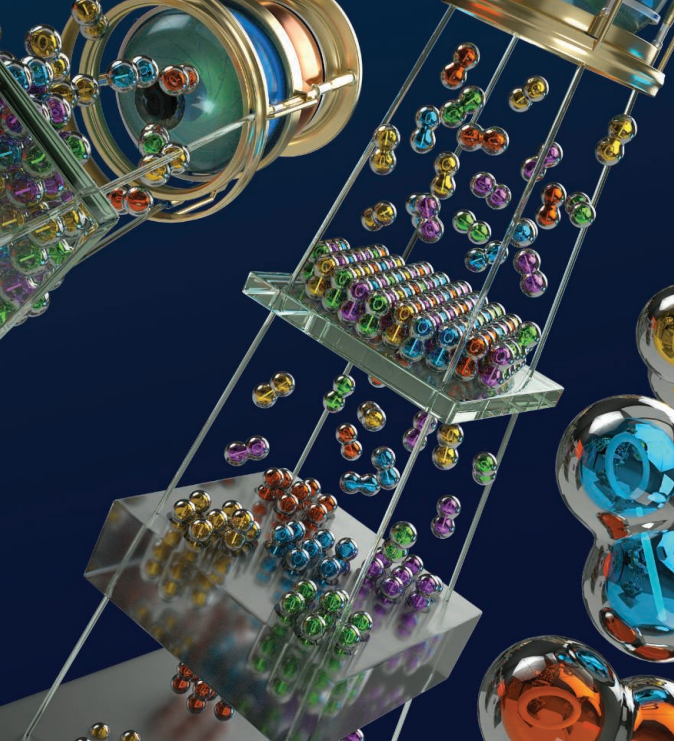


CREDITS (TOP TO BOTTOM): PHOTOGRAPH BY ERIK LUCERO/UNIVERSITY OF CALIFORNIA, SANTA BARBARA; VAROON *ET AL.*

<< Quantum Simulation and Computers

A digital quantum simulator is a device that can be programmed and reprogrammed to simulate any other quantum system efficiently (see the Perspective by **DiVincenzo**). **Lanyon *et al.*** (p. 57, published online 1 September) show that the ability to control and manipulate the interactions between a series of trapped ions has the potential to create a powerful quantum simulator. A series of six trapped and laser-cooled calcium ions were used to simulate complex dynamics associated with interacting spin systems. Quantum computers offer the possibility of solving problems that cannot be tackled by classical computers. **Mariantoni *et al.*** (p. 61, published online 1 September) integrated a series of superconducting circuits and elements to construct a rudimentary machine where quantum information travels back and forth between storage elements and processing elements.

Rolling in the Deep

The global carbon cycle involves a constant exchange between oceans, biota, and the atmosphere. A large portion of the carbon cycle, however, extends deep into Earth's solid interior, and exchange occurs over much longer time scales. **Walter *et al.*** (p. 54, published online 15 September; see the Perspective by **Harte**) show evidence, through the analysis of a unique set of Brazilian diamonds, that the deep carbon cycle extends further into Earth than previously anticipated. The isotopic signature of diamonds suggests that they formed from carbon that originated from subducted oceanic crust, but tiny mineral inclusions trapped within the diamonds reveal that they must have passed through the lower mantle before being sent back up to Earth's surface.

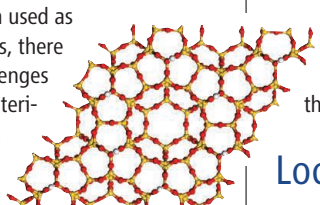
3D Ultracold Anderson Localization

Random scatterers in a disordered medium may scatter a propagating wave in such a way that destructive interference occurs, effectively stopping the propagation; this phenomenon, known as Anderson localization (AL), has been observed for light, acoustic, and matter waves. In one and two dimensions (1D and 2D), AL may occur no matter how weak the disorder, whereas in 3D, an energy scale called the mobility edge separates the states that are localized from those that continue to propagate. Ultracold atomic gases offer the opportunity to vary the amount of disorder systematically and to observe the effects of that variation on AL. AL has been observed in 1D cold atom systems; now, **Kondov *et al.*** (p. 66) observe AL in a 3D system and extract the behavior of the mobility edge and localization length as a function of disorder.

Looking into the Crab

The Crab pulsar is a spinning neutron star located in the Crab Nebula, the remnant of a supernova explosion recorded on Earth in 1054 CE. It is one of the most widely studied objects in astronomy; yet the origin of its pulsed emission is not completely understood, particularly at the highest energies. The **VERITAS Collaboration** (p. 69) reports the detection of pulsed emission above 100 gigaelectron volts from the Crab pulsar. This result challenges current pulsar models, which do not predict pulsed emission at these energies.

Reworking Zeolites



While zeolites have been used as membranes and catalysts, there are still substantial challenges in processing zeolitic materials into extended sheets. **Varoon *et al.*** (p. 72) show that a polymer can be used to exfoliate zeolite particles into flakes and control their deposition onto a substrate. Packing of the exfoliated sheets allows the production of membranes with enhanced filtration properties, compared with a mixture of isotropically oriented nanoparticles.

Algae to the Rescue

A number of new battery chemistries may allow for greater charge storage beyond what is currently possible with lithium-metal systems. However, during charge-discharge cycles, volume changes can degrade the anode. Previous attempts to create a Li-Si battery have used a high fraction of binder material to stabilize Si. **Kovalenko *et al.*** (p. 75, published online 8 September) show that alginate, a natural polysaccharide extracted from brown algae, works as an excellent binder and can stabilize nanometer-sized Si powders.

Liquid Crystal Gels

In liquid crystals, the weak interactions between the anisotropic molecules can give rise to long-range ordering and influence the optical and rheological properties. The orientation of the molecules can be further biased by the addition of a second material to the liquid crystal. **Wood *et al.*** (p. 79) now describe gels or soft solids that form in concentrated colloid-liquid crystal composites. The mechanical properties of the gels arise from the formation of particle-stabilized defects, which form a percolated network throughout the liquid crystal.

Local Adaptation Revealed

As climate changes, it is important to understand how species have adapted to their current environment at the genetic level (see the Perspective by **Savolainen**). **Fournier-Level *et al.*** (p. 86) examined local adaptation of single-nucleotide polymorphisms in *Arabidopsis thaliana*, by mapping fitness as a phenotype for the plant *A. thaliana* in a number of different populations, and provide insights into the process of local adaptation. **Hancock *et al.*** (p. 83) take a comple-

Continued on page 13

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mentary approach by using genome scans to identify local adaptation and predict fitness in the field. The work suggests that populations of *A. thaliana* are best adapted to their locations on a continental scale via adaptation of specific genetic loci.

Genomic Antiquities

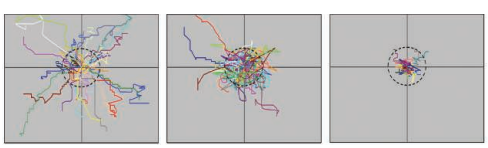
It is likely that many human populations are the descendants of modern and archaic hominids. **Abi-Rached *et al.*** (p. 89, published online 25 August) examined the *HLA-A*, *HLA-B*, and *HLA-C* genes (which play central roles in immune defense and placental reproduction) of archaic Denisovan and Neandertal individuals and modern humans. Population genetic evidence suggests that interbreeding between archaic and modern hominids introduced an allele of *HLA-B* that subsequently reached appreciable frequency in some modern human populations. Thus, admixture probably introduced advantageous genetic alleles that may have been involved in shaping the immune system of modern humans.

Locks Open Up Human Migration

There has been much speculation on how early modern humans dispersed after leaving Africa and how they moved across Asia. To address this question, **Rasmussen *et al.*** (p. 94, published online 22 September; see the cover) sequenced the genome of an Aboriginal Australian from a 100-year-old lock of hair. The sequence would suggest that eastern Asians were the first to populate Australia and that modern Australian Aborigines are descended from that early dispersal. Furthermore, the genomes of three Han Chinese were sequenced and compared with the previously sequenced genomes of Europeans and Africans, to infer the history and dispersal patterns associated with the more recent origins of modern east Asians and Europeans. Aboriginal Australians probably arose from the same ancestral population as Eurasians, at a time before the Asian and European populations diverged.

Nerves and T Cells Connect

Links between the nervous system and the immune system are becoming better understood (see the Perspective by **Trakhtenberg and Goldberg**). The vagus nerve, which originates in the brainstem and innervates major organs, including the spleen and the gut, regulates physiological responses to stress, injury, and infection. Electrical stimulation of the vagus nerve reduces the production of inflammatory cytokines and inflammation-associated pathology, primarily by acting on cytokine-producing macrophages in the spleen. Working in mice, **Rosas-Ballina *et al.*** (p. 98, published online 15 September) found that a subpopulation of helper T cells produced acetylcholine in the spleen and were necessary and sufficient for vagus-nerve–mediated inhibition of proinflammatory cytokine production. In order to prevent immune-related pathology that is induced by tissue damage, the poststroke brain produces signals that result in immunosuppression. In a mouse model of stroke, **Wong *et al.*** (p. 101, published online 15 September) found that stroke induced changes in natural killer T cell movement in the liver and altered the range of cytokines they secrete toward a more immunoregulatory profile. These changes were dependent on noradrenergic signaling.



CREDIT: WONG *ET AL.*

You Are What You Eat

Different members of the human gut microbiota have distinct and characteristic influences on health and disease. **Wu *et al.*** (p. 105, published online 1 September; see the Perspective by **Gophna**) attempted to characterize the dietary and environmental variables that affect the microbiota in a pair of studies on humans. In one study, stool samples were taken for microbial sequencing from 99 volunteers whose long-term dietary preferences were known and defined. In another study, 10 people were segregated and put on controlled diets, and their stools were sampled at 1 and 10 days after recruitment. In the long-term study, three distinct microbiomes were apparent, which had characteristic signature organisms: A *Bacteroides*-dominated community was associated with people who ate animal protein and saturated fats, *Ruminococcus* tended to be linked with alcohol intake and polyunsaturated fat consumption, and—finally—*Prevotella* was found in people who enjoyed a carbohydrate-based diet. Although dietary perturbation in the short-term study caused a transient change in the respective enterotype, there were no marked shifts from one enterotype to another.

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