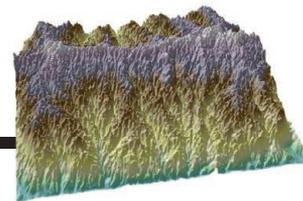


RESEARCH

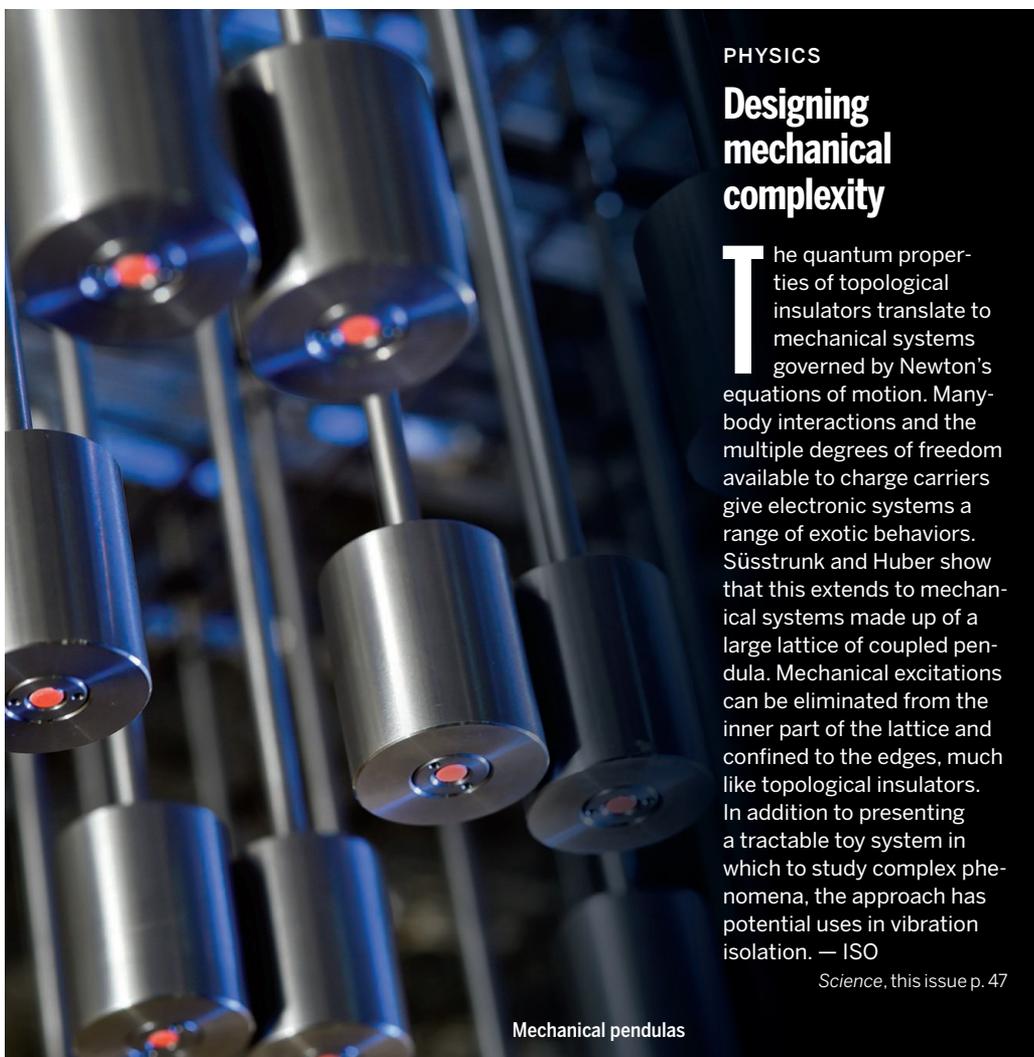
Landscape evolution in a sandbox

Sweeney et al., p. 51



IN SCIENCE JOURNALS

Edited by Nick Wigginton



Mechanical pendulums

PHYSICS

Designing mechanical complexity

The quantum properties of topological insulators translate to mechanical systems governed by Newton's equations of motion. Many-body interactions and the multiple degrees of freedom available to charge carriers give electronic systems a range of exotic behaviors. Süsstrunk and Huber show that this extends to mechanical systems made up of a large lattice of coupled pendula. Mechanical excitations can be eliminated from the inner part of the lattice and confined to the edges, much like topological insulators. In addition to presenting a tractable toy system in which to study complex phenomena, the approach has potential uses in vibration isolation. — ISO

Science, this issue p. 47

BRAIN STRUCTURE

The best way to fold a mammalian brain

As mammalian brains grew larger through evolution, the organization and folding of brains changed too. In a series of statistical analyses comparing a large number of mammalian species, Mota and Herculano-Houzel found that brain folding

is not simply a phylogenetic consequence of brain mass increase (see the Perspective by Striedter and Srinivasan). The exposed surface of the cortex scales across all mammals and across individuals as a single power law of the product of total cortical surface and the square root of cortical thickness. — PRS

Science, this issue p. 74; see also p. 31

INFLUENZA

Immunological mistaken identity

The incidence of narcolepsy increased after the global vaccination campaign against the 2009 A/H1N1 influenza pandemic, but only in some countries. Ahmed *et al.* examined the protein content of the vaccines used by country.

One notable peptide within an influenza protein (nucleoprotein A) shared residues with human hypocretin receptor 2, which has been linked to narcolepsy. Patients who developed narcolepsy after being vaccinated produced antibodies that cross-reacted to both the influenza and the hypocretin receptor 2 epitopes. The vaccine used in countries without new narcolepsy cases contained lower levels of nucleoprotein A. — ACC

Sci. Transl. Med. **7**, 294ra105 (2015).

METALLOPROTEINS

Nickel pincers as enzyme cofactors

Organometallic nickel complexes long synthesized in the laboratory exist naturally in enzymes as well. Desguin *et al.* determined the structure and metal-binding residues of the Ni-containing active site in bacterial lactate racemase (see the Perspective by Zamble). A dithiodinicotinic acid mononucleotide derivative cofactor binds Ni through sulfur and carbon bonds, resembling synthetic nickel pincer complexes. Genes encoding accessory proteins involved in the synthesis of this cofactor are widely distributed in other bacteria, suggesting its involvement in other enzymes. — NW

Science, this issue p. 66; see also p. 35

PLANT VOLATILES

Stop to smell the roses

Some roses smell beautiful, yet others only look beautiful. Magnard *et al.* leveraged this distinction to study the

biosynthesis of geraniol, a monoterpene alcohol in rose scent (see the Perspective by Tholl and Gershenzon). Enzymes known for geraniol synthesis in other plants, such as basil, did not seem to provide that function for roses. Instead, a diphosphohydrolase, which functions in the cytoplasm of cells in rose petals, generates the geraniol emitted by fragrant roses. Identification of the enzyme and its gene enables marker-assisted breeding to put the perfume back into beauty. — PJH

Science, this issue p. 81; see also p. 28

PLANT GENOMICS

Signatures of adaptation in the field

Adaptation to the environment is critical for the survival of all species. For crops, this can be confounded or enhanced by farmers and breeders selecting for particular traits. To determine the associations between genes and local environments, Lasky *et al.* performed a global genetic survey of nearly 2000 regional varieties of domesticated sorghum. Regional environmental stresses such as climate and soil type were major determinants of adaptation. Enhancing sorghum (a staple crop for 500 million people in sub-Saharan Africa and Asia) and other crops may



Sorghum genomes show signs of adaptation

PHOTOS: (LEFT TO RIGHT) DSZC/ISTOCKPHOTO; ALEX WILD

be possible based on marker-assisted selection of adaptive traits. — BJP

Sci. Adv. 10.1126/sciadv.1400218 (2015).

CONSERVATION

Focused on protecting a few

The illegal ivory trade threatens the persistence of stable wild elephant populations. The underground and covert nature of poaching makes it difficult to police. Wasser *et al.* used genetic tools to identify the origins of elephant tusks seized during transit (see the Perspective by Hoelzel). The majority of source animals were part of just a few wild elephant populations in Africa—and just two areas since 2006. Increased focus on enforcement in a few such areas could help interrupt poaching activities and restore wild elephant populations. — SNV

Science, this issue p. 84; see also p. 34

POROUS MATERIALS

Laser patterning polymer membranes

Porous materials are useful for membranes, filters, energy conversion, and catalysis. Their utility often depends on the ability to finely control both the pore sizes and their connectivity. Tan

et al. prepared porous thin films of block copolymers mixed with phenol-formaldehyde resins (resols) on silicon substrates using a simple laser process. On exposure to ultraviolet light, rapid heating of the substrate causes polymerization of the resols and decomposition of the block copolymer. This method allows direct patterning of the films on a local scale, with tunable pore sizes and size distributions. — MSL

Science, this issue p. 54

IN OTHER JOURNALS

Edited by **Kristen Mueller** and **Jesse Smith**



Many *Dictyostelium discoideum* band together to form a stalk and fruiting body

EVOLUTION

Trench warfare keeps cheaters rare

When starving, thousands of normally solitary *Dictyostelium discoideum* amoebae band together to form a slug, which then differentiates into a stalk and fruiting body. The cells of the stalk die, allowing the cells at the top of the fruiting body to form spores and disperse. “Cheater” amoebae avoid forming the stalk and dying. To determine whether cheating provides amoebae with a selective advantage in nature, Ostrowski *et al.* studied ~150 positions in amoebae genomes that influence cheating. The genomes maintained a balanced mixture of sequence variation at many of these positions. This indicates that cheaters remain rare because they are engaged in a form of evolutionary “trench warfare” with cooperator amoebae, which results in a stalemate between the two. — GR

Curr. Biol. 10.1016/j.cub.2015.04.059 (2015).

PHYSICS

Probing beyond the Standard Model

The Standard Model of physics presents an inventory of the known fundamental particles and how they interact in order to describe the world around us. But observations, such as that

of the preponderance of matter over antimatter, suggest that the Standard Model is incomplete. Experiments with large particle colliders and measurements using smaller-scale precision atom-based techniques are under way in attempts to fill in the holes of the picture. Parker *et al.* describe one such cold

ALSO IN SCIENCE JOURNALS

Edited by Nick Wigginton

OCEANOGRAPHY

Carbon emissions and their ocean impacts

Anthropogenic CO₂ emissions directly affect atmospheric chemistry but also have a strong influence on the oceans. Gattuso *et al.* review how the physics, chemistry, and ecology of the oceans might be affected based on two CO₂ emission trajectories: one business as usual and one with aggressive reductions. Ocean warming, acidification, sea-level rise, and the expansion of oxygen minimum zones will continue to have distinct impacts on marine communities and ecosystems. The path that humanity takes regarding CO₂ emissions will largely determine the severity of these phenomena. — HJS

Science, this issue p. 45

ORGANIC CHEMISTRY

Elaborate amines from commodity olefins

Fine spatial control over the formation of carbon-nitrogen bonds is essential to the synthesis of many pharmaceutical and agrochemical compounds. Yang *et al.* synthesized a copper catalyst that shows exceptional discrimination between similar substituents in the addition of N-H bonds across the C-C double bonds of simple olefins. In particular, the catalyst favors one of two mirror-image products that differ in the relative orientations of methyl and ethyl groups. This selectivity fosters the use of readily available commodity olefins in the preparation of complex chiral amines. — JSY

Science, this issue p. 62

BIOMECHANICS

The curious tale of the square tail

Appendages in animals are typically round, but the seahorse tail has a square cross section.

Porter *et al.* hypothesize that this shape provides better functionality and strength than a round cross section (see the Perspective by Ashley-Ross). Three-dimensional printed models show that square cross section shapes behave more advantageously when subjected to compressive forces. By allowing greater deformation without damage and accommodating twisting deformations, square appendages passively return to their original configurations. The added flexibility of the square cross section enhances the tail's ability to grasp objects. — MSL

Science, this issue p. 46; see also p. 30

SULFUR CHEMISTRY

An unexpected gaseous sulfur species

Sulfuric acid plays a central role in both industrial and atmospheric contexts. As such, the behavior of SO₃ mixtures in gas phases has been studied for over a century. In gas-phase experiments on wet SO₃ and formic acid, Mackenzie *et al.* discovered a previously unrecognized covalent adduct: formic sulfuric anhydride, or HC(O)OSO₃H. The combination of microwave spectroscopy and theoretical calculations reveals its structural properties. The compound may play a role in the nucleation of atmospheric aerosols by serving as an intermediate to H₂SO₄ formation. — JSY

Science, this issue p. 58

PRESYNAPTIC NETWORKS

Tracing cells that project to one neuron

Feature extraction is a prominent characteristic of cortical neurons involved in the early stages of sensory processing. Wertz *et al.* retrogradely marked an injected neuron and its direct inputs to reveal the network mechanisms that mediate

their response. Neurons within each presynaptic network layer of single direction-selective cells showed similar motion direction preferences. In some networks, layer-specific functional modules were identical to the orientation preference of the postsynaptic neuron. Presynaptic neurons, however, displayed a general bias toward the stimulus feature that elicited a response in the postsynaptic neuron. — PRS

Science, this issue p. 70

GREEN CHEMISTRY

Synthesizing more sustainable plastics

Zeolites can help synthesize cheaper plastic precursors from biologically sourced feedstocks. Producing sustainable plastics must compete with more cost-effective petrochemical-based synthesis routes. Dusselier *et al.* developed a zeolite-based strategy to catalyze the transformation of microbially produced lactic acid into lactide, a difficult-to-synthesize precursor of biodegradable polylactic acid plastics. The selectivity of nearly 80% is based on active site spatial confinement in the zeolite micropores. This step substantially simplifies current high-cost synthesis routes and generates nearly zero waste using current reactor technologies. — NW

Science, this issue p. 78

SELENOPROTEINS

Clearing out selenoprotein garbage

Our DNA consists of codons that code for 20 different amino acids. Another amino acid, selenocysteine, is also found in several human selenoproteins. Selenocysteine is incorporated through the recoding of a stop codon, but failures in this process result in premature termination of protein synthesis. Lin *et al.* showed that the

potentially dangerous truncated proteins formed in such cases are specifically degraded by a protein quality surveillance system. The surveillance system can specifically recognize the truncated ends of the various prematurely terminated selenoproteins and target their destruction. — GR

Science, this issue p. 91

DENGUE VIRUS

An antibody to lock dengue virus out

Mosquito-borne dengue virus (DENV) is a growing public health threat. Nearly 400 million people are infected annually, and no vaccine is currently available. Fibriansah *et al.* report that a human antibody (2D22) specific for DENV serotype 2, when given therapeutically, can protect mice from a lethal form of this virus. Structural analysis revealed that 2D22 binds across multiple DENV envelope proteins, which probably blocks the ability of these proteins to assemble into the orientation necessary for viral entry. The epitope where 2D22 binds to the virus may therefore represent a potential vaccine target. — KLM

Science, this issue p. 88

NEUROSCIENCE

Keeping immature neurons excited

After birth, signaling by the neurotransmitter GABA in the brain switches from excitatory to inhibitory. GABA mediates both responses by binding to ligand-gated ion channels that conduct Cl⁻. The opening of these channels depends on the concentration of Cl⁻ in neurons. Friedel *et al.* identified phosphorylation events in the K⁺-Cl⁻ cotransporter KCC2 that depended on the activity of the kinase WNK1. These phosphorylation events inhibited KCC2 activity and contributed to the

depolarizing effect of GABA-mediated signaling in immature rat neurons by maintaining a high intracellular Cl^- concentration. — NRG

Sci. Signal. **8**, ra65 (2015).

GEOMORPHOLOGY

Landscape evolution in a sandbox

The long-term response of hills and valleys to changes in climate depends on a variety of physical factors. Sweeney *et al.* performed tabletop erosion experiments as a function of rainfall and uplift: variables that are impossible to precisely control in nature (see the Perspective by McCoy). Ridge and valley spacing are set by the balance of sediment moving down hillslopes or being washed out of valleys by rivers. Landscapes therefore evolve as a response to climate change altering erosion rates. — BG

Science, this issue p. 51;
see also p. 32

STRUCTURAL VIROLOGY

Retroviral capsids in their native form

Capsid proteins of retroviruses form protective lattices around viral RNA molecules. But what controls how individual full-length capsid proteins assemble to shield the viral genome? Obal *et al.* and Gres *et al.* report high-resolution crystal structures of the full-length capsid proteins from bovine leukemia virus and HIV-1, respectively. Both studies help reveal the dynamic nature of capsid protein assembly and how individual capsid proteins interact in the lattice. The findings may have relevance for antiretroviral drug design. — KLM

Science, this issue p. 95 and 99