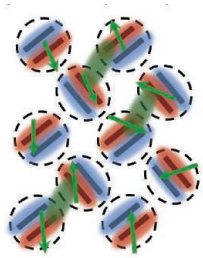
RESEARCH

The makings of both a spin and a dipole liquid

Hassan et al., *p. 1101*



IN *SCIENCE* JOURNALS

Edited by **Stella Hurtley**

TETRAPOD EVOLUTION

Out of Antarctica

When we think of Devonian tetrapods, the ancestors of all modern vertebrates, we tend to picture amphibian-like creatures emerging from the water into a wet tropical forest or swamp. Indeed, all previously described specimens of this group have been recovered from the tropics. Gess and Ahlberg now describe two fossil tetrapods from Devonian Antarctica. Thus, the distribution of tetrapods may have been global, which encourages us to rethink the environments in which this important group was shaped. —SNV

Science, this issue p. 1120

***Tutusius mlambo*, a basal tetrapod from the Late Devonian, found in what was then the Antarctic Circle**

PLANETARY SCIENCE

Measuring martian organics and methane

The Curiosity rover has been sampling on Mars for the past 5 years (see the Perspective by ten Kate). Eigenbrode *et al*. used two instruments in the SAM (Sample Analysis at Mars) suite to catch traces of complex organics preserved in 3-billion-year-old sediments. Heating the sediments released an array of organics and volatiles reminiscent of organic-rich sedimentary rock found on Earth. Most methane on Earth is produced by biological sources, but numerous abiotic processes have been proposed to explain martian methane. Webster *et al*. report atmospheric measurements of methane covering 3 martian years and found that the background level varies with the local seasons. The seasonal variation provides an important clue for determining the origin of martian methane. —BG and KTS

Science, this issue p. 1096, p. 1093; see also p. 1068

APPLIED OPTICS

Making silicon shine bright

Silicon is the workhorse of the semiconductor electronics industry, but its lack of optical functionality is a barrier to developing a truly integrated silicon-based optoelectronics platform. Although there are several ways of exploiting nonlinear light-matter interactions to coax silicon into optical functionality, the effects tend to be weak. Otterstrom *et al*. used a suspended silicon waveguide racetrack structure to stimulate the stronger nonlinear effect of Brillouin scattering and achieve lasing from silicon. The ability to engineer the nonlinearity and tune the optical response through the design of the suspended cavity provides a powerful and flexible route for developing silicon-based optoelectronic circuits and devices. —ISO

Science, this issue p. 1113

SOCIAL SCIENCE

Tipping points in social convention

Once a population has converged on a consensus, how can a group with a minority viewpoint overturn it? Theoretical models have emphasized tipping points, whereby a sufficiently large minority can change the societal norm. Centola *et al*. devised a system to study this in controlled experiments. Groups of people who had achieved a consensus about the name of a person shown in a picture were individually exposed to a confederate who promoted a different name. The only incentive was to coordinate. When the number of confederates was roughly 25% of the group, the opinion of the majority could be tipped to that of the minority. —BJ

Science, this issue p. 1116

MEDICINE

Toward more predictable birthdays

Low-cost methods for monitoring fetal development

CREDITS: (TOP TO BOTTOM) N. HASSAN *ET AL.*; MAGGIE LAMBERT-NEWMAN

Published by AAAS

could improve prenatal care, especially in low-resource settings. By measuring the levels of certain placental RNA transcripts in maternal blood, Ngo *et al*. developed two noninvasive blood tests that provide a window into the progression of individual pregnancies. In a small proof-of-concept study, the first blood test predicted fetal age and delivery date with an accuracy comparable to that of ultrasound. The second blood test, also examined in a small pilot study, discriminated women at risk of preterm delivery from those who delivered at full term. The next step will be to assess the reliability of the tests in large, blinded clinical trials. —PAK

Science, this issue p. 1133

PLANT GENETICS

Sterility in rice via toxin and antidote

Crossing wild and domestic rice often results in hybrid sterility. Such genetic barriers can prevent the movement of potentially beneficial genes from wild rice into domestic varieties. To understand the barriers preventing gene flow, Yu *et al*. mapped a quantitative trait locus (QTL) that determines sterility between wild-type and domestic rice. This QTL encodes two open reading frames (ORFs) that are both expressed during gametogenesis. The ORFs encode a toxin, which affects the development of pollen, and an antidote, which is required for pollen viability. Thus, selfish genetic elements can underlie evolutionary strategies that facilitate reproductive isolation. —LMZ

Science, this issue p. 1130

Hybrid rice varieties produce sterile pollen.

PHOTOS: (LEFT TO RIGHT) X. YU *ET AL.*; KEVIN SCHAFER/ALAMY STOCK PHOTO

ENVIRONMENTAL STUDIES

Economic rationale for fishing the high seas

Economic evaluations of high-seas fishing have been lacking, in part owing to the scarcity of data on the costs and revenues of fleets that fish in these elusive waters. Sala *et al.* wanted to quantify high-seas fishing efforts globally and assess whether and when high-seas fishing makes economic sense. They used satellite data and machine learning to track the activity of more than 3600 fishing vessels in near real time. Patterns of fishing profitability varied widely between countries, types of fishing, and distance to port. As much as 54% of present high-seas fishing grounds would be unprofitable without large government subsidies, supporting recent calls for subsidy management reforms for the high seas. —PJB

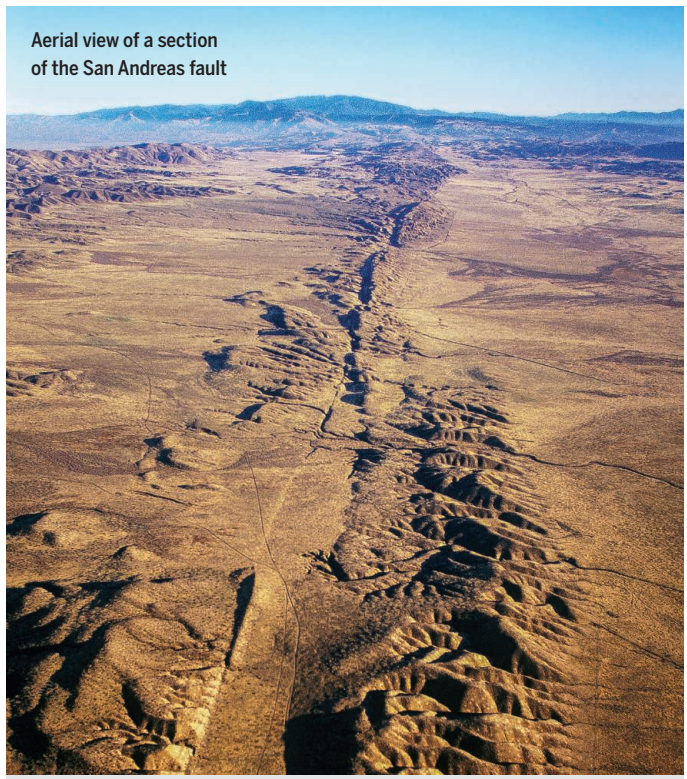
Sci. Adv. 10.1126/sciadv.aat2504 (2018).

DNA REPAIR

DNA-bound ubiquitin coordinates repair

Ubiquitylation is a posttranslational modification that reversibly alters various protein properties. Liu *et al*. discovered that Lys^{63}-linked polyubiquitin chains bound to the free ends of double-stranded DNA, bridged the broken ends of DNA, and recruited repair proteins. Ubiquitins with DNA-binding motif mutations were found in several types of tumors. When expressed in cultured cells, these mutant ubiquitins impaired the cellular response to DNA-damaging agents, suggesting that it might be possible to therapeutically exploit these mutations in some cancer patients. —LKF

Sci. Signal. **11**, eaar8133 (2018).



Aerial view of a section of the San Andreas fault

GEOPHYSICS

The San Andreas creeps along the decade

The famous San Andreas fault in California is an excellent place to understand the behavior of faults. Khoshmanesh and Shirzaei used high-resolution satellite measurements to track surface deformation along the central portion of the fault over two decades. Accurate modeling of the deformation requires shifts in the time scale of the fault's aseismic creeping behavior from yearly to decadal. The different modes of creep are important for assessing seismic hazard and may provide some clues about fault rupture. —BG

Geophys. Res. Lett. 10.1002/2018GL077017 (2018).

MOLECULAR BIOLOGY

The long and short of RNA export

Circular RNAs (circRNAs) are back-spliced RNA products that have regulatory roles in gene expression, and most circRNAs are enriched in the cytoplasm. Huang *et al*. identified protein factors that are required to export circRNAs from the nucleus to the cytoplasm. An RNA interference screen targeting some proteins that are known to export various linear RNAs in *Drosophila* cells showed that a RNA helicase is required for the cytoplasmic accumulation of circRNAs that are longer than 800 nucleotides. The two human homologs of this *Drosophila* helicase play similar roles in human cells. Surprisingly, one controls long (>1300-nucleotide)

ALSO IN *SCIENCE* JOURNALS

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GREAT APE GENOMICS

A spotlight on great ape genomes

Most nonhuman primate genomes generated to date have been "humanized" owing to their many gaps and the reliance on guidance by the reference human genome. To remove this humanizing effect, Kronenberg *et al*. generated and assembled long-read genomes of a chimpanzee, an orangutan, and two humans and compared them with a previously generated gorilla genome. This analysis recognized genomic structural variation specific to humans and particular ape lineages. Comparisons between human and chimpanzee cerebral organoids showed down-regulation of the expression of specific genes in humans, relative to chimpanzees, related to noncoding variation identified in this analysis. —LMZ

Science, this issue p. 1085

IMMUNOLOGY

Finding a role for PNECs in asthma

Pulmonary neuroendocrine cells (PNECs) are a rare cell type located in airway and alveolar epithelia and are often in contact with sensory nerve fibers. They have a wide phylogenic distribution and are found even in the relatively primitive lungs of amphibia and reptiles, suggesting a critical function. Sui *et al*. found that mice lacking PNECs have suppressed type 2 (allergic) immune responses. PNECs were observed in close proximity to group 2 innate lymphoid cells (ILC2s) around airway branch points. The PNECs enhanced ILC2 activity by secreting CGRP (calcitonin gene-related peptide). They also induced goblet-cell hyperplasia via the neurotransmitter GABA (γ-aminobutyric acid). Interestingly, human asthma patients were found to have increased PNEC numbers, suggesting a potential therapeutic target for the treatment of asthma. —STS

Science, this issue p. 1086

METABOLISM

A missing link in cholesterol absorption

Cholesterol is important for general health, but too much can build up in artery walls and cause cardiovascular disease. Low-density lipoprotein cholesterol (LDL-C) is often referred to as "bad cholesterol"; keeping LDL-C within stringent limits is recommended to reduce the risk of heart attack and stroke. Zhang *et al*. discovered that some individuals have an inherited frameshift mutation in the *LIMA1* gene (also known as *EPLIN* or *SREBP3*). The gene has not been linked to lipid metabolism before, but altered *LIMA1* was found to maintain low plasma LDL-C by reducing the absorption of cholesterol through the intestine. Pharmacological targeting through the LIMA1 pathway might thus provide a strategy to improve heart health. —PNK

Science, this issue p. 1087

ORGANIC MATERIALS

Quantum dipoles go liquid

Quantum spin liquids do not achieve an ordered magnetic state, even at the lowest temperatures. Hassan *et al*. studied an organic compound that may be both a spin liquid and a dipole liquid (see the Perspective by Powell). In the layered material κ-$(BEDT\text{-}TTF)_2Hg(SCN)_2Br$, molecules form charged dimers whose sites are arranged on a triangular lattice. The extra charge associated with each dimer can "live" on one of the two molecules in the dimer, resulting in a nonzero electric dipole moment for the dimer. Raman spectroscopy and heat capacity measurements revealed that, like spins in a quantum spin liquid, these dimers remained disordered down to the lowest temperatures. —JS

Science, this issue p. 1101; see also p. 1073

PHOTOSYNTHESIS

Antenna switches partners in the shade

A cloudy day or an overshadowing tree causes fluctuations in light that can throw off the balance of energy flow in plant photosystems I and II (PSI and PSII). Pan *et al*. solved structures of PSI bound to two light-harvesting complexes (LHCs). One LHC is permanently associated with PSI. The other LHC delivers light energy to PSII under optimal conditions but can switch to a PSI-associated state after phosphorylation by a kinase that senses the redox environment of the chloroplast. The movement of LHCs between the photosystems helps maintain even energy flux. Two chlorophyll-containing subunits are visible in the structure that connect the PSI core to each LHC. —MAF

Science, this issue p. 1109

APPLIED OPTICS

Metasurfaces for molecular detection

Although mid-infrared (mid-IR) spectroscopy is a mainstay of molecular fingerprinting, its sensitivity is diminished somewhat when looking at small volumes of sample. Nanophotonics provides a platform to enhance the detection capability. Tittl *et al*. built a mid-IR nanophotonic sensor based on reflection from an all-dielectric metasurface array of specially designed scattering elements. The scattering elements could be tuned via geometry across a broad range of wavelengths in the mid-IR. The approach successfully detected and differentiated the absorption fingerprints of various molecules. The technique offers the prospect of on-chip molecular fingerprinting without the need for spectrometry, frequency scanning, or moving mechanical parts. —ISO

Science, this issue p. 1105

CLIMATE CHANGE

Predicting changes in "extreme" precipitation

As temperatures rise, Earth's atmosphere can hold more moisture. This rise in moisture content is expected to lead to a broadly comparable rise in the intensity of the most extreme precipitation events. In a Perspective, Pendergrass explains that whether this expectation is met depends on the definition of extreme precipitation. The intensity of the most extreme events may rise more than expected, as seen for Hurricane Harvey, whereas that of less extreme events may rise less than anticipated. Atmospheric circulation changes will also affect precipitation events in ways that differ from one place to another. Clear definitions of extreme precipitation are key to anticipating and preparing for future changes in extreme events. —JFU

Science, this issue p. 1072

PLANT SCIENCE

Defense cargo shuttles in vesicles

Plants can use small RNAs (sRNAs) to interfere with virulence factor gene expression in pathogens. Cai *et al*. show that the small mustard plant *Arabidopsis* shuttles defensive sRNAs into the necrotrophic fungus *Botrytis cinerea* via extracellular vesicles (see the Perspective by Thomma and Cook). The vesicles are associated with tetraspanin proteins, which can interact and form membrane microdomains. Several dozen different sRNAs targeting the pathogenic

process were transported from *Arabidopsis* to *B. cinerea* in a selective manner. —PJH

Science, this issue p. 1126; see also p. 1070

EVOLUTIONARY COGNITION

Understanding zero

It has been said that the development of an understanding of zero by society initiated a major intellectual advance in humans, and we have been thought to be unique in this understanding. Although recent research has shown that some other vertebrates understand the concept of the "empty set," Howard *et al*. now show that an understanding of this concept is present in untrained honey bees (see the Perspective by Nieder). This finding suggests that such an understanding has evolved independently in distantly related species that deal with complexity in their environments, and that it may be more widespread than previously appreciated. —SNV

Science, this issue p. 1124; see also p. 1069

ZIKA

Zika leaves a lasting impact on the brain

Perinatal Zika virus (ZIKV) infection has been associated with brain alterations in newborns. However, whether ZIKV exposure during development has long-term neurological consequences is not completely understood. Nem de Oliveira Souza *et al*. report that newborn mice infected with ZIKV developed acute brain abnormalities. During adulthood, perinatally infected mice showed persistent viral replication, neuropathological alterations, behavioral impairments, and altered brain excitability. Blocking tumor necrosis factor–α early after infection prevented this hyperexcitability in the mouse brain. Thus, anti-inflammatory treatments might help to prevent the persistent increase in neuronal excitability induced by ZIKV infection in brain tissue. —MM

Sci. Transl. Med. **10**, eaar2749 (2018).

EMBRYOGENESIS

Modeling embryogenesis

Understanding the molecular and cellular events of early embryogenesis is crucial to improve assisted reproductive technologies and prevent genetic birth defects. Although some clarity on this process in humans has come from comparative studies in mice, differences exist, so there is a need to better model embryogenesis. In a Perspective, Rossant and Tam discuss the possibility of using nonhuman primate embryos and human stem cell–derived models to better study and understand early development. —GKA

Science, this issue p. 1075

HIV

Taking residence to defend

In HIV$^+$ individuals receiving antiretroviral therapy, CD4$^+$ T cells home to lymphoid tissues (LTs) that are a key site of HIV persistence. Studying the immune response to HIV in LTs has been a challenge. Buggert *et al.* obtained LTs from HIV$^+$ individuals and carried out comprehensive transcriptional and epigenetic analyses on CD8$^+$ T cells found there. The CD8$^+$ T cells had a signature associated with resident memory T cells. The frequency of these HIV-responsive LT-resident CD8$^+$ T cells was considerably increased in so-called elite controllers—people able to restrain their HIV infections. —AB

Sci. Immunol. **3**, eaar4526 (2018).