Making magnetic atoms interact

Two magnets interact with each other through a force that depends on the distance between them and on their mutual orientation. How do these long-range dipolar forces affect the behavior of a system of many magnets? Baier et al. used a gas of erbium atoms, which have a large magnetic moment, to answer this question. The gas—which they “housed” in an optical lattice—underwent a transition from a superfluid to an insulating state, revealing the presence of dipolar interactions through the orientation dependence of various properties. — JS

Denisovan DNA retained in Melanesians

Modern humans carry remnants of DNA from interbreeding events with archaic lineages, such as Neandertals. However, people from Oceania also retain genes from a second ancient lineage, the Denisovans. Vernot et al. surveyed archaic genomic sequences in a worldwide sample of modern humans, including 35 individuals from the Melanesian Islands. All non-African genomes surveyed contained Neandertal DNA, but a significant Denisovan component was found only in the Melanesians. Reconstruction of this genetic history suggests that Neandertals bred with modern humans multiple times, but Denosivans only once, in ancestors of modern-day Melanesians. — LMZ

Oncogene control of antitumor immunity

Recent clinical success of cancer immunotherapy has intensified interest in how tumors normally evade the immune response. Whether and how oncogenes contribute to this process are not well understood. In a study of mice, Casey et al. found that the MYC oncogene, which is aberrantly activated in many human cancers, up-regulates the expression of genes encoding proteins that dampen the antitumor response. These include two proteins that are often overexpressed on tumor cells and that serve as immune checkpoints. One of them (PD-L1) sends to the immune system a “don’t find me” signal, and the other (CD47) sends a “don’t eat me” signal. Thus, therapies aimed at suppressing MYC may help promote an immune response against tumors. — PAK
ASTROCHEMISTRY
Making ribose in interstellar ices
Astrobiologists have long speculated on the origin of prebiotic molecules such as amino acids and sugars. Meinert et al. demonstrated that numerous prebiotic molecules can be formed in an interstellar-analog sample containing a mixture of simple ices of water, methanol, and ammonia. They irradiated the sample with ultraviolet light under conditions similar to those expected during the formation of the solar system. This yielded a wide variety of sugars, including ribose—a major constituent of ribonucleic acid (RNA). — KTS
Science, this issue p. 208

POLITICAL SCIENCE
Not just turnout, but turnaround matters
In the last several U.S. presidential elections, the campaign mantra has focused on making sure that voters already aligned with one’s candidate do get out to vote. There is a long history of unsuccessful efforts to change people’s attitudes. Nevertheless, Broockman and Kalla conducted a field experiment showing that Miami voters shifted their attitudes toward transgender individuals and maintained those changed positions for 3 months (see the Perspective by Paluck). — GJC
Science, this issue p. 220; see also p. 147

BIOPHYSICS
How biomolecules fold
In order to fold, biomolecules must search a conformational energy landscape to find low-energy states. There are peaks in the landscape where the molecules must occupy unstable conformations for a short time. Neupane et al. used optical tweezers to observe these transition paths directly for single nucleic acid and protein molecules (see the Perspective by Wolynes). They measured a distribution of times taken to cross the transition path and found that the shape of the distribution agrees well with theory that assumes one-dimensional diffusion over the landscape. — VV
Science, this issue p. 239; see also p. 150

CARDIOVASCULAR DISEASE
Dissolving away cholesterol
Atherosclerosis-driven cardiovascular disease is one of the most common causes of death worldwide. Existing therapies do not treat all patients effectively. Cyclodextrin, a common FDA-approved substance, is already used as a solubilizing agent to improve drug delivery. Zimmer et al. found that cyclodextrin solubilizes cholesterol, removes it from plaques, dissolves cholesterol crystals, and successfully treated atherosclerosis in a mouse model. Because cyclodextrin is already known to be safe in humans, this drug is now a candidate for testing in patients with atherosclerosis. — YN

PALEONTOLOGY
Time scale of the peopling of the Americas
Peopling of the Americas was a late event in human expansion that has been shrouded in uncertainty. Llamas et al. analyzed the mitochondrial genomes of 92 pre-Columbian skeletons from 8600 to 500 years ago to shed light on human migration into the Americas. These immigrants from Asia were briefly isolated in the Bering Land Bridge during the last major ice age that lowered sea levels to permit the crossing. Starting about 16,000 years ago, these peoples rapidly spread along the west coast of the Americas. Interestingly, a mass extinction of these peoples on the west coast of South America appears to coincide with the time of European incursions. — PLY

CELL MIGRATION
Consumed by your own attraction
Cell migration is a fundamental biological phenomenon. Cells follow gradients of chemotactants whether generated by secretion or breakdown of other cells, or from diffusion of drugs or small molecules. Tweedy et al. investigated the possibility that cells can self-generate gradients by comparing observations of Dictyostelium cells grown under agarose containing folate as the attractant. Once Dictyostelium was added to a well cut into a sheet of folate-containing agarose, a dense leading edge of migrating cells soon formed that traveled under the agarose. Behind the front of directionally moving cells, cell activity was random, because the chemotactant had been completely consumed by the folate deaminase activity of the leading cells. This kind of cell behavior may be widespread and may explain the behavior of cells during development, cancer, wound healing, and immune responses. — CA
PLOS Bio. 10.1371/journal. pbio.1002404 (2016).

PHYSICS
Making sense of transport in WSe<sub>2</sub>
Among materials that have a structure similar to that of graphene, but without a band gap, transition-metal dichalcogenides—such as MoS<sub>2</sub> and WSe<sub>2</sub>—are the most prominent examples. Much of what we know about their electronic properties has come from optical measurements; the more traditional transport experiments have proven trickier. Fallahazad et al. studied the behavior of electrons in monolayers and bilayers of WSe<sub>2</sub> subjected to an external magnetic field. As they tuned the field, the researchers observed characteristic oscillations in the transport properties. Analyses of these oscillations suggested that...
ELECTRONICS
Assembling nanocrystal devices
A wide range of materials can be grown as high-quality colloidal nanocrystals, with properties spanning from conductors to semiconductors and insulators. Although these materials have been included in electronic devices, they usually only form a single component within the device. Choi et al. took a variety of solution-processable colloidal nanocrystals to form all of the device components. Through the development of the right materials, interfaces, and processing steps, they constructed an all-colloid field effect transistor. — MSL
Science, this issue p. 205

QUANTUM CRITICALITY
Describing an exotic magnetic transition
Phase transitions can be caused by temperature fluctuations or, more exotically, by quantum fluctuations at zero temperature. To describe some of these quantum phase transitions, researchers came up with a complex theory called deconfined quantum criticality. However, subsequent numerical simulations were inconsistent with some of the predictions of the theory, leading to a debate on its validity. By using quantum Monte Carlo simulations, Shao et al. show that it is possible to reconcile numerics with the theory for a specific model of 2D quantum magnetism. — JS
Science, this issue p. 213

CLIMATE CHANGE
A more sensitive climate system
How much global average temperature eventually will rise depends on the Equilibrium Climate Sensitivity (ECS), which relates atmospheric CO₂ concentration to atmospheric temperature. For decades, ECS has been estimated to be between 2.0°C and 4.6°C, with much of that uncertainty owing to the difficulty of establishing the effects of clouds on Earth’s energy budget. Tan et al. used satellite observations to constrain the radiative impact of mixed phase clouds. They conclude that ECS could be between 5.0°C and 5.3°C—higher than suggested by most global climate models. — HJS
Science, this issue p. 224

CLIMATE CHANGE
Looking to the past to understand the future
About 60 million years ago, carbon dioxide concentration in Earth’s atmosphere rose sharply, resulting in severe climatic changes that may in some ways mirror Earth’s future climate. In a Perspective, Alley explains that the consequences of these climatic changes were severe. Consequences included dwarfing of land mammals, ecosystem disruptions, ocean acidification, and loss of coral reefs. The carbon dioxide rise during the Paleocene-Eocene Thermal

CANCER GENOMICS
Single-cell expression profiles of melanoma
Tumors harbor multiple cell types that are thought to play a role in the development of resistance to drug treatments. Tirosh et al. used single-cell sequencing to investigate the distribution of these differing genetic profiles within melanomas. Many cells harbored heterogeneous genetic programs that reflected two different states of genetic expression, one of which was linked to resistance development. Following drug treatment, the resistance-linked expression state was found at a much higher level. Furthermore, the environment of the melanoma cells affected their gene expression programs. — LMZ
Science, this issue p. 189

TRANSCRIPTION
How bacteria switch between tracks
Bacterial riboswitches prevent the formation of full-length messenger RNA, and hence proteins, via transcriptional termination in response to metabolites. However, identifying riboswitches within the genome has previously required comparative analysis, which may miss species- and environmentally specific responses. Dar et al. developed a method called term-seq to document all riboswitches in a bacterial genome, as well as their metabolite counterparts (see the Perspective by Sommer and Suess). The method revealed a role for pathogenic bacterial riboswitches in antibiotic resistance. Thus, transcription may be one way pathogens fend off antibiotic attack. — LMZ
Science, this issue p. 187; see also p. 144

CANCER
Macrophages block tumors’ spread
Tumors constantly communicate with their surrounding tissue and the immune system. One way tumors likely do this is by secreting extracellular vesicles (EVs), which can carry bits of the tumor to distant sites in the body. Pucci et al. tracked EVs in tumor-bearing mice and people and studied how they affect cancer progression. They found that EVs disseminate through lymph to nearby lymph nodes, where a specialized population of macrophages largely block any further travel. This barrier breaks down, however, as cancer progresses and also in the face of certain therapies. The EVs can then penetrate lymph nodes, where they interact with B cells that promote further tumor growth. — KLM
Science, this issue p. 242

METABOLISM
Taking control of cellular NAD⁺ concentrations
Cellular concentrations of the nicotinamide adenine dinucleotide (NAD⁺) are critical for proper metabolism and are often altered in aging and disease. To enable better understanding of these processes, Titov et al. altered the concentration of NAD⁺ in particular cellular compartments. They did this through expression of a bacterial enzyme targeted to specific compartments of human cells in culture. Their experiments emphasize the important role of the electron transport chain in redox transfer of electrons to NADH, rather than proton pumping, in mitochondrial pathogenesis. — LBR
Science, this issue p. 231

ALSO IN SCIENCE JOURNALS

Edited by Stella Hurtley

QUANTUM HALL EFFECT
All is well with particle-hole symmetry
In an external magnetic field, the energy of an electron in a two-dimensional system takes discrete values, called Landau levels. At high enough fields, all electrons in a solid can fit in the lowest Landau level. If exactly half of that level is filled with electrons, standard theory predicts that a special fermion liquid phase will form that makes a distinction between the filled and empty states (particles and holes). A recent conjecture, in contrast, predicted a liquid consisting of massless Dirac particles that respects the symmetry between particles and holes. Geraedts et al. used sophisticated numerical methods to provide strong evidence for this conjecture. — MSL
Science, this issue p. 197

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Maximum (PETM) occurred over a longer time scale than that caused by fossil fuel burning today, which gave ecosystems more time to adjust to climate changes. Thus, the consequences of current and future global warming may be even more severe than those seen in this distant mirror. — JFU

Science, this issue p. 151

**ION CHANNELS**

**Opening when the signal is strong enough**

Intracellular calcium mediates many critical cellular and physiological processes. By acting as a channel that releases Ca\(^{2+}\) from the endoplasmic reticulum, the inositol trisphosphate (IP\(_3\)) receptor (IP\(_3\)R) increases intracellular calcium. The IP\(_3\)R consists of four subunits, with each subunit having a binding site for IP\(_3\). Alzayady et al. found that channel activity required IP\(_3\) bound at each of these four binding sites. This requirement ensures that cells do not discharge calcium unless the signal to do so is strong enough and shapes the calcium signal produced by activation of the receptor (see Taylor and Knöczny). — NRG