

# RESEARCH

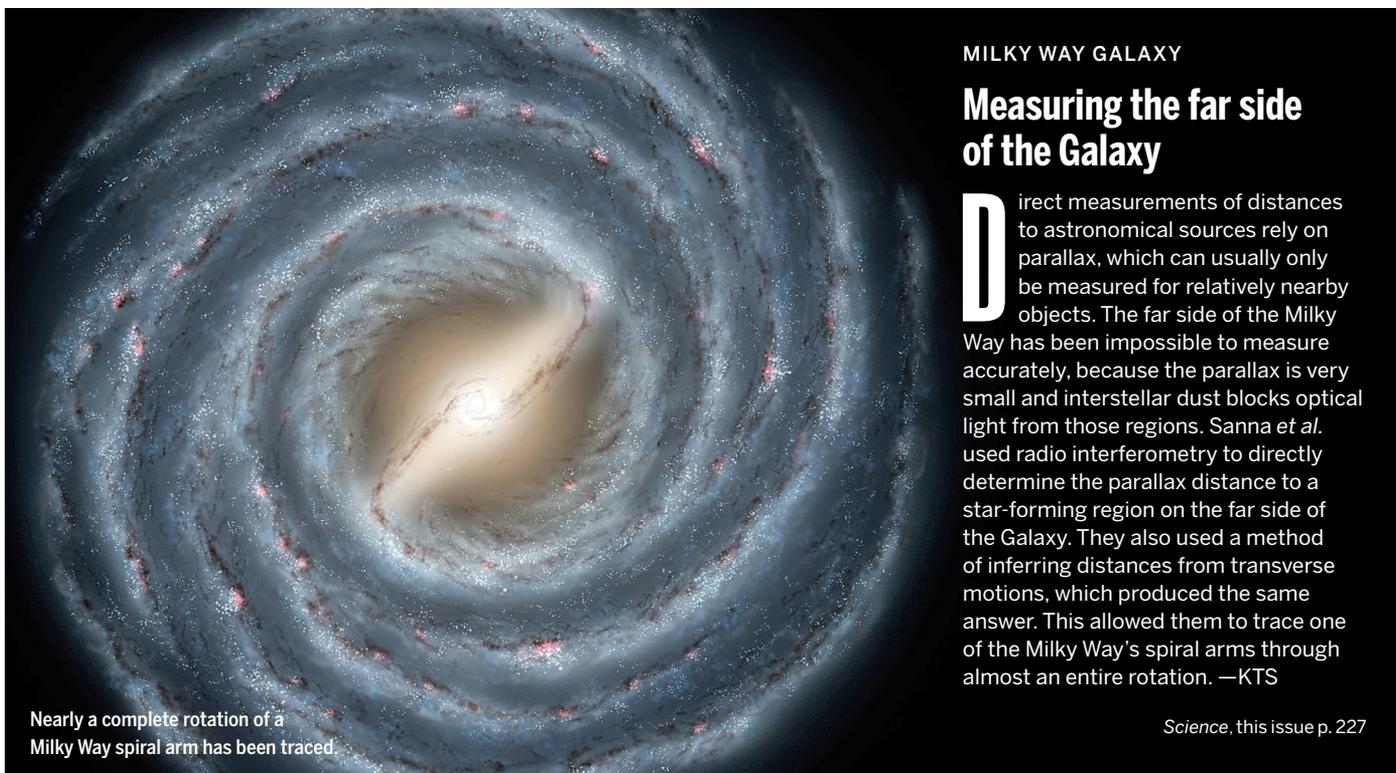
Scanning tunneling microscopy visualizes halogen bonding

Han et al., p. 206



## IN SCIENCE JOURNALS

Edited by Stella Hurtley



### MILKY WAY GALAXY

## Measuring the far side of the Galaxy

**D**irect measurements of distances to astronomical sources rely on parallax, which can usually only be measured for relatively nearby objects. The far side of the Milky Way has been impossible to measure accurately, because the parallax is very small and interstellar dust blocks optical light from those regions. Sanna *et al.* used radio interferometry to directly determine the parallax distance to a star-forming region on the far side of the Galaxy. They also used a method of inferring distances from transverse motions, which produced the same answer. This allowed them to trace one of the Milky Way's spiral arms through almost an entire rotation. —KTS

*Science*, this issue p. 227

Nearly a complete rotation of a Milky Way spiral arm has been traced.

### SINGLE-CELL ANALYSIS

## 3D gene expression blueprint of the fly

When looking at populations of cells, features such as cell heterogeneity and localization are masked. However, single-cell sequencing reveals cellular heterogeneity and rare cell types. At the onset of gastrulation, the fly embryo consists of about 6000 cells with distinct gene expression profiles. Karaiskos *et al.* developed an algorithm to generate an interactive three-dimensional (3D) “virtual embryo,” with the expression of more than 8000 genes per cell measured for most cells (see the Perspective by Stadler and Eisen). The virtual embryo offers insights

into developmental mechanisms—from local expression of regulators such as transcription factors and long noncoding RNAs to spatial modulation of signaling pathways. —BAP

*Science*, this issue p. 194;  
see also p. 172

### QUANTUM SYSTEMS

## Mechanical systems at the quantum level

A number of platforms are being pursued for developing technologies that exploit the enhanced sensing and measurement capabilities of quantum mechanics. Hybrid systems offer the flexibility of combining and optimizing different platforms. Hong

*et al.* combined optomechanical control of motion and single-phonon counting techniques to probabilistically generate a single-phonon Fock state within a nanomechanical resonator. Chu *et al.* used electromechanical coupling to address a bulk piezoelectric resonator with a superconducting quantum circuit. Both approaches hold promise for developing hybrid quantum technologies. —ISO

*Science*, this issue p. 203, p. 199

### PROGRAMMED MATERIALS

## 3D texture morphing for camouflage

Some animals, such as cephalopods, use soft tissue to change

shape reversibly for camouflage and object manipulation. Pikul *et al.* used fixed-length fiber mesh embedded in a silicone elastomer to transform a flat object into a 3D structure by inflating membranes (see the Perspective by Laschi). Painted models of rocks and plants were also created that could be morphed to fully blend into their surroundings. —MSL

*Science*, this issue p. 210;  
see also p. 169

### CANCER

## A signature event for organoids

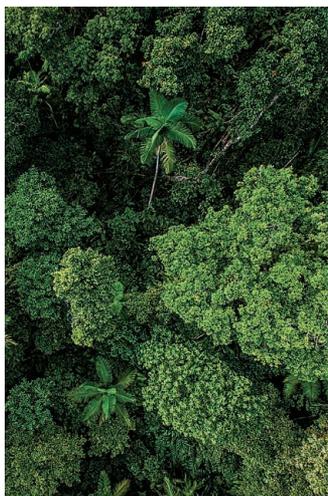
Human cancer genomes harbor cryptic mutational signatures that represent the cumulative

effects of DNA damage and defects in DNA repair processes. Knowledge of how specific signatures originate could have a major impact on cancer diagnosis and prevention. One approach to address this question is to reproduce the signatures in experimental systems by genetic engineering and then match the signatures to those found in naturally occurring cancers. Drost *et al.* used CRISPR-Cas9 to delete certain DNA repair enzymes from human colon organoids. In a proof-of-concept study, they show that deficiency in base excision repair is responsible for a mutational signature previously identified in cancer genome sequencing projects. —PAK

*Science*, this issue p. 234

## CARBON CYCLE Forests out of balance

Are tropical forests a net source or net sink of atmospheric carbon dioxide? As fundamental a question as that is, there still is no agreement about the answer, with different studies suggesting that it is anything from a sizable sink to a modest source. Baccini *et al.* used 12 years of MODIS satellite data to determine how the aboveground carbon density of woody, live vegetation has changed throughout the entire tropics on an annual basis. They



Twelve years of data show that tropical forests are a net carbon source.

find that the tropics are a net carbon source, with losses owing to deforestation and reductions in carbon density within standing forests being double that of gains resulting from forest growth. —HJS

*Science*, this issue p. 230

## REPRODUCTIVE BIOLOGY Fever, TRPV channels, and birth defects

Cardiac and craniofacial birth defects are common, but many cannot be attributed to specific mutations. An environmental trigger associated with these birth defects is maternal fever during the first trimester. Using chick and zebrafish embryos, Hutson *et al.* found that hyperthermia activated temperature-sensitive TRPV1 and TRPV4 ion channels in neural crest cells, which give rise to the tissues affected by the birth defects. Transiently activating either of these channels in neural crest cells in chick embryos resulted in cardiac and craniofacial birth defects similar to those induced by fever. —WW

*Sci. Signal.* **10**, eaal4055 (2017).

## BRAIN IMAGING Newborn brain imaging made easier

Electroencephalography (EEG) and functional neuroimaging can be used to elucidate brain functions and reveal abnormalities. However, it is challenging to use these technologies at the bedside, owing to their size, lack of portability, and cost. Demene *et al.* developed a portable, customized, and noninvasive system called fUSI (functional ultrasound imaging) that is capable of continuous video-EEG recording and fast ultrasound imaging of the brain microvasculature of newborn babies. They demonstrated the value of fUSI for bedside monitoring by applying it to observe brain activity and neurovascular changes in two neonates with abnormal cortical development. —MM

*Sci. Transl. Med.* **9**, eaah6756 (2017).

## IN OTHER JOURNALS

Edited by **Sacha Vignieri**  
and **Jesse Smith**

### ECOLOGY

## Coffee plants benefit from ant dung

Ants and the plants on which they live have evolved to benefit from their close relationship. Plants provide nesting space and food for the ants, which in turn defend the plant against herbivory. In coffee plants, Pinkalski *et al.* show a previously undescribed aboveground uptake of nutrients provided by weaver ants. Nitrogen in the ants' food was traced using isotopic labeling, allowing the authors to observe that nitrogen in the ants' excretion was absorbed through leaves and translocated throughout the plant. Leaves from plants that hosted ants contained more nitrogen than those that did not. It is not yet known how widespread this phenomenon is, but it may be that canopy fertilization, as well as protection from herbivory, earns ants their keep in relationships with plants. —ECM

*J. Ecol.* **10**, 1111/1365-2745.12841 (2017).



## HEALTH DISPARITIES For diabetes screening, race matters

Type 2 diabetes is diagnosed and monitored by a blood test for HbA1c, a modified form of hemoglobin produced when blood glucose is high. HbA1c levels can be influenced by genetic variants unrelated to glucose homeostasis. To examine whether such variants affect the reliability of the HbA1c test, Wheeler *et al.* studied 60 genetic variants in nearly 160,000 people of different ancestries. They identified a specific variant that, by shortening the lifespan of red blood cells, reduced HbA1c levels irrespective of blood glucose. This variant occurs almost exclusively in individuals of African ancestry. The results suggest that about 650,000 African Americans with type 2 diabetes may be misdiagnosed as healthy if they are screened solely by the HbA1c test. —PAK

*PLOS Med.* **10**, 1371/journal.pmed.1002383 (2017).

## CANCER Blood test for early-stage cancer

Cancer cells release circulating tumor DNA into the bloodstream, which can sometimes be used to measure tumor progression and treatment response. Chan *et al.* sought to address whether so-called "liquid biopsies" could be used to diagnose cancer before an individual had symptoms. They used nasopharyngeal cancer as a model, which is known to be associated with Epstein-Barr virus (EBV) infection. By screening EBV DNA in the plasma from more than 20,000 Chinese men, the researchers were able to accurately detect early-stage nasopharyngeal cancer in this high-risk population. In a 3-year study, the blood test increased the patient survival rate to 97%, compared with around 70% in a historical cohort. —PNK

*N. Engl. J. Med.* **10**, 1056/NEJMoa1701717 (2017).

## IMMUNOLOGY

**Light- and dark-zone death dynamics**

Germinal centers (GCs) are areas within lymphoid organs where mature B cells expand and differentiate during normal immune responses. GCs are separated into two anatomic compartments: the dark zone, where B cells divide and undergo somatic hypermutation, and the light zone, where they are selected for affinity-enhancing mutations after interacting with T follicular helper cells. Mayer *et al.* studied apoptosis reporter mice and found that both GC zones experience very high rates of apoptosis (see the Perspective by Bryant and Hodgkin). However, the underlying mechanisms were distinct and microanatomically segregated. Light-zone B cells underwent apoptosis by default unless they were rescued by positive selection. In contrast, apoptotic dark-zone B cells were highly enriched among cells with genes damaged by random antibody-gene mutations. —STS

*Science*, this issue p. 193;  
see also p. 171

## CATALYSIS

**A radical route from methane to methanol**

The conversion of methane into chemicals usually proceeds through high-temperature routes that first form more reactive carbon monoxide and hydrogen. Agarwal *et al.* report a low-temperature (50°C) route in aqueous hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) for oxidizing methane to methanol in high yield (92%). They used colloidal gold-palladium nanoparticles as a catalyst. The primary oxidant was O<sub>2</sub>; isotopic labeling showed that H<sub>2</sub>O<sub>2</sub> activated methane to methyl radicals, which subsequently incorporated O<sub>2</sub>. —PDS

*Science*, this issue p. 223

## SURFACE CHEMISTRY

**Visualizing halogen bonding**

Even though halogen atoms are highly electronegative, a noncovalent bond can form between an electron donor and a halogen atom in a covalent bond. Such interactions are facilitated by the formation of electron-depleted regions in the halogen's covalent bond, a situation least likely for fluorine atoms. Han *et al.* used noncontact scanning tunneling microscopy with submolecular resolution to explore how the size and polarizability of halogens affect complex formation by halogenated benzene molecules adsorbed on a silver surface (see the Perspective by Neaton). With the help of density functional theory, they show how several weak interactions, including van der Waals forces, electrostatic repulsions, and halogen bonds, affect structure. —PDS

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see also p. 167

## ORGANIC SYNTHESIS

**A gram-scale route to bryostatin**

Scientists once accumulated 14 tons of the red, bushy, tufted sea creature *Bugula neritina* to extract 18 grams of bryostatin 1. The macrocyclic organic compound is under study for treatment of HIV, cancer, and Alzheimer's disease but has proven frustratingly scarce. Wender *et al.* report a 29-step chemical synthesis of bryostatin 1 that proceeds in 4.8% overall yield and provides gram quantities of the compound (see the Perspective by Lanman). Intermediates along the pathway can be straightforwardly modified to produce analogs, two of which were prepared en route and studied in vitro. —JSY

*Science*, this issue p. 218;  
see also p. 166

## BIOCATALYSIS

**Teaching an enzyme to switch sites**

There has been a recent flurry of activity in modifying enzymes to conduct unnatural chemical reactions more cleanly or selectively than synthetic chemical catalysts. Hammer *et al.* now report application of a cytochrome P450 variant to an oxidation that has largely eluded efficient catalysis. They used directed evolution to mutate the enzyme so that it placed oxygen at the less substituted carbon of the C=C double bond in styrenes, forming aldehyde products. They thereby attained opposite site selectivity to that of the widely used palladium-catalyzed Wacker-Tsuji oxidation. —JSY

*Science*, this issue p. 215

## DISORDERED PROTEINS

**An expanded view of disordered proteins**

Disordered proteins sample an ensemble of conformations, but it has remained unclear how compact these conformations are in water. Polymer physics relates the radius of gyration ( $R_g$ ) to solvent quality, with more chain collapse occurring in poorer solvents. Riback *et al.* developed an analysis scheme that allows them to extract solvent quality and  $R_g$  from a single small-angle x-ray scattering measurement. Applying this method, they found that even disordered proteins with low net charge and high hydrophobicity remain expanded in water. —VV

*Science*, this issue p. 238

## FUNGAL INFECTION

**Type III interferons prime neutrophils**

Type I interferons (IFNs) have a well-established role in antiviral immunity. Espinosa *et al.*

found that type III IFNs (IFN- $\lambda$ s) play an essential role in driving antifungal responses. They studied immune responses to *Aspergillus fumigatus* in mice lacking receptors for type I or type III IFNs. Monocyte-derived type I IFNs were key drivers of IFN- $\lambda$  production. Although the authors could not pin down the sources of IFN- $\lambda$ s, they identified neutrophils as the functional target of IFN- $\lambda$ s. Selective deletion of IFN- $\lambda$  receptor in neutrophils caused mice to succumb to *Aspergillus fumigatus* infection. —AB

*Sci. Immunol.* **2**, eaan5357 (2017).