

ASTRONOMY

Study in Contrasts

In order to image exoplanets directly, it helps to increase the contrast between the extremes of the bright stellar host and any faint companion. Close *et al.* report the use of an advanced adaptive optics system to observe HD142527, a young star that hosts a disk of gas and dust, whose well-studied morphology includes a large gap that sparked discussion of active planet formation there. The authors confirm the presence of a companion at only 12 times the Earth-Sun distance, detecting it in visible light emitted by gas accreting onto it. This lower-mass stellar companion orbits the primary star just at the inner edge of the gap, implying partial responsibility for clearing its neighborhood, just as planets are thought to do in other cleared disks. At the specific wavelength of light where gas accretion releases energy, the brightness difference between the two bodies is less pronounced than at other wavelengths, where the difference instead depends largely on their extremely distinct temperatures. The detection of this accreting companion in visible light should encourage more searches for planets that are still accumulating gas in their formation phase, when observers can take advantage of the favorable contrast levels. — MMM

Astrophys. J. Lett. **781**, 10.1088/2041-8205/781/2/L30 (2014).

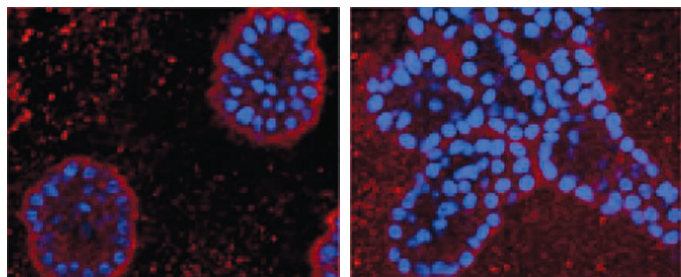
CANCER

Negative Reinforcement

About 15 to 20% of breast cancers are classified as "triple negative," so called because these tumors do not express three key proteins that are biomarkers and/or drug targets for breast cancer: the estrogen receptor, the progesterone receptor, and HER2 (a member of the epidermal growth factor receptor family). Triple-negative tumors are aggressive and more likely to

metastasize than other breast cancers, and there is no effective treatment. To acquire new insights into the biology and possible therapy of these tumors, Feigin *et al.* looked for aberrant expression of G protein-coupled receptors, cell signaling proteins that have been successfully targeted for treatment of other disorders such as depression. An orphan receptor called GPR161 was found to be overexpressed in triple-negative but not in other breast cancer types. In cell culture, high expression levels of GPR161

induced proliferation of mammary epithelial cells, disrupted the acinar structures formed by these cells, and enhanced their invasive capacity. GPR161 was shown to activate the mTORC1/S6K signaling pathway. These



observations suggest that GPR161 dysfunction contributes to the development of triple-negative breast cancers. — PAK

Proc. Natl. Acad. Sci. U.S.A. **10.1073/pnas.1320239111** (2014).

PHYSICS

Frustrated Magnetism

In magnetic materials, ions positioned on the lattice sites attempt to minimize their energy by aligning their spins; in some cases, however, the configuration of the lattice makes it impossible to minimize the local energy on all sites at the same time—a situation known as geometrical frustration. Besides spin, charge and orbital degrees of freedom can also be associated with frustration. In the compound CuIr_2S_4 , which has Ir ions of mixed valence, a charge order sets in below 230 K with alternating octamers of Ir^{3+} and Ir^{4+} , and a spin-singlet ground state has been predicted to occur. Kojima *et al.* use a technique sensitive to magnetism, muon spin rotation spectroscopy, to detect a glass-like disordered paramagnetic state below ~ 100 K instead of the expected spin singlet. The authors find that the magnetism is associated with Ir^{4+} ions in specific locations and that even a minute substitution of Cu by Zn (which also notably reduces the charge order) leads to its disappearance. As this small substitution, equivalent to a single hole per 12 Ir octamers, influences the electronic state in such a dramatic way, the authors hypothesize the existence of interoctamer correlations, which may stabilize the glass-like ground state. — JS

Phys. Rev. Lett. **112**, 087203 (2014).

EDUCATION

Owning the Experience

An essential component of a successful undergraduate research experience is project ownership. Currently, measurements of project ownership take place on a project-based level at individual institutions, with no real protocol for standardization or the integration of data into a larger database. Hanauer and Dolan address this issue with the development of the Project Ownership survey (POS). Three main components—specification of the undergraduate research experience, assessment of degrees of project ownership, and emotive scales—form the basis of the Web-based POS. Fully analyzed to determine its dimensionality, reliability, and validity, the 16-item POS showed high internal consistency and was able to differentiate between students

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who studied in traditional versus research-based laboratory courses, making it a valuable tool that can be used to further assess the features of an undergraduate research experience that may encourage students to pursue a degree in science. Furthermore, wide use of the POS may enable the scientific community to characterize the broad range of research experiences taking place across institutions, allowing for the identification and proliferation of successful features of undergraduate research experiences that enhance project ownership. — MM

CBE Life Sci. Educ. **13**, 149 (2014).

NEUROSCIENCE

Neurons' New Birthday

Mice generate new olfactory neurons throughout adult life. Although humans seem not to generate new olfactory neurons in adulthood, the site at which those new neurons are born, the lateral ventricle wall, seems to generate neurons in both mice and humans. Ernst *et al.* use carbon-14 dating from nuclear bomb test exposures to compare the birth dates of neurons to the birth dates of the people being analyzed. The results show that unexpectedly, some striatal neurons are generated after birth. Calculations indicate that neurogenesis from the lateral ventricle wall in the adult human supplies interneurons in the striatum. — PJH

Cell **156**, 1072 (2014).

GENETICS

Tweaking a Switch

Transcription factors regulate gene expression by binding to specific chromosomal operator sites.

Many transcription factors are repressors, with transcription turned off when the repressor is bound.

A simple operator occupancy model assumes that the level of repression is determined only by the equilibrium binding of the repressor to its operator. Hammar *et al.* have now used a single-molecule chase assay to directly test this in living cells.

They measured the time that the lac repressor protein LacI remained bound to the natural lacO₁ operator and to a stronger, artificial lacO_{sym} operator. It is assumed that transcription is turned off during this time, so this is termed τ_{off} . They also measured the average time that the operators remained unbound so that transcription can be on (τ_{on}). The repression ratio in the simple occupancy model would be given by $RR = (\tau_{\text{on}} + \tau_{\text{off}})/\tau_{\text{on}}$. The calculated repression ratios were

compared with repression ratios measured based on an enzymatic reporter assay, thus monitoring protein expression rather than repressor binding. There was agreement for the lacO₁ operator, but for the lacO_{sym}, more repression was seen than would be expected based on a simple occupancy model. This could be accounted for either by promoter-specific cooperative interactions between LacI and RNA polymerase or simply by transcription initiation driving the system out of equilibrium; fast transcription initiation could lead to the synthesis of transcripts before the repressor has equilibrated with DNA. Such effects need to be considered in examining mechanisms of gene regulation. — VV

Nat. Genet. **10**.1038/ng.2905 (2014).

CHEMISTRY

Accommodating Hosts

The binding of smaller, more rigid guest molecules by larger, more flexible host biomolecules (such as substrates and enzymes) can lead to induced fit: changes in the host structure to accommodate the guest. However, the binding of two large biomolecules can involve structural changes in both partners and is called mutually induced fit. Sawada *et al.* report a synthetic system in which two small molecules both act as hosts and make structural changes during binding. One host, calix[4]arene, has four phenyl rings that can form a conformer that has a cone-shaped binding surface, but this structure

is in rapid equilibrium with other conformers created as the phenyl rings flip down.

The other host was formed from a triangular ligand L (formed from three pyridine and pyrimidine rings bound to a central pyrimidine ring) reacting with a Pd complex in aqueous solution. Two structures formed, mainly Pd₆L₃ trigonal pyramids (94%) but also Pd₈L₄ tetragonal pyramids (6%). When these two hosts were mixed in solution, the calix[4]arene shifted entirely to the cone structure, and the second host shifted entirely to the minority tetragonal pyramid structure to create an extensive binding surface. Furthermore, this host trapped a nitrate ion, which neither host alone could do. — PDS

J. Am. Chem. Soc. **10**.1021/ja500376x (2014).

