Editors' Choice

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ASTROPHYSICS: EXPLOSIONS NEAR AND FAR

Our universe appears to be undergoing a period of accelerated expansion driven by dark energy. This phenomenon was brought to the fore in 1998, when distant type Ia supernovae--bright transient events that mark the explosion of an accreting white dwarf star--were observed to be dimmer than they would be in the absence of acceleration. The conclusion rests on the assumption, actively debated over the past decade, that the properties of type Ia supernovae are independent of their distance from the observation point; the dimming in that context may be attributed reliably to cosmic acceleration and not to systematic differences characterizing distant supernovae. Sullivan *et al.* contribute to this discussion by compiling spectra of type Ia supernovae spanning the past 9 gigayears. They constructed and compared the mean ultraviolet spectra, which are sensitive to the composition of the progenitor stars and the physics of the explosion, for supernovae at short, intermediate, and long distances. Although the strength of some spectral features varies with distance, the variation can be explained by a relative increase in explosions of younger stars in the distant, younger universe, a trend that has been seen in previous studies and for which it should be possible to correct. Thus, type Ia supernovae may be useful as tools to study the expansion history of the universe. -- **MJC**

Astrophys. J. **693**, L76 (2009).

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ECOLOGY: BUT THE BUTTER'S MELTED

American lobsters (*Homarus americanus*) are iconic representatives of North America's northeastern Atlantic Ocean. The abundance of American lobster has experienced severe swings, but the cause of changes in their population is unknown. Recently the lobster fishery in southern New England has collapsed, while at the same time lobster populations in the Gulf of Maine have expanded massively. Wahle *et al.* use a time series analysis to create a larval settlement index that could predict the number of near-harvestable clawed lobsters. Their findings suggest that the way lobster populations vary significantly over time may be due to the combined effects of shell disease and a decline in the settlement of larvae. Because lobster larvae are typically transported over great distances before settlement, local outbreaks of shell disease cannot solely explain population demographic changes. Being better able to predict population density fluctuations and developing strategies to counteract predicted declines will be important in assessing the future viability of lobster fisheries. -- **LMZ**

Mar. Ecol. Prog. Ser. **376**, 185 (2009).

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BIOMEDICINE: BRITTLE BONES

Osteoarthritis occurs when the cartilage that covers the surface of bones at joints becomes degraded, resulting in pain and decreased mobility. The biomechanical properties of cartilage come from an extracellular matrix comprising proteoglycans embedded in a meshwork of collagen fibrils. Pathological changes in cartilage start at the molecular level and eventually lead to macroscopic structural and functional damage. Early detection of cartilage damage is important, both for diagnosis and to understand the mechanisms involved in disease progression with the goal of developing therapies. Indentation-type atomic force microscopy (IT-AFM) can measure the compressive stiffness of porcine articular cartilage at the micrometer and nanometer scales. Now Stolz *et al.* have used IT-AFM to monitor the development of an osteoarthritis-like condition in collagen-IX knockout mice. At the micrometer scale, no morphological changes were observed in articular cartilage of mutant as compared to control mice until 6 months of age. However, nanometer-scale IT-AFM showed disease-associated changes in fibril thickness and nanostiffness in mice as young as 1 month old. The biomechanical changes that occur during normal aging are distinct from pathological changes associated with disease progression. The success of IT-AFM in detecting these early changes suggests that it could serve as a useful diagnostic nanotool; the next step will be to develop such a minimally invasive surgical tool. -- **VV**

Nat. Nanotechnol. 10.1038/nnano.2008.410 (2009).

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APPLIED PHYSICS: RAISING ONLINE SPEED LIMITS

The appetite for faster and faster Internet connections with greater and greater information-transfer capacity continues unabated. With the likes of high-definition television, music and video streaming, and social networks all contributing to a 60% annual growth in Internet traffic, the increasing demand for information capacity is putting strain on present information-handling capabilities. In order to avoid a worldwide-wait scenario reminiscent of the dial-up era, optical engineers are developing information-processing technologies aimed at terabit-per-second capabilities, which will be able to pump data through optical fibers straight to the home. Galili *et al.* have developed an optical switch that heads toward this goal. The authors present a chalcogenide glass chip, exploiting the material's nonlinear property of four-wave mixing to produce an all-optical switch that can demodulate a 640-Gbit/s optical signal into a series of 10-Gbit/s tributaries. The demonstration of such high-speed and error-free signal processing indicates that Internet starvation might be staved off, at least for the time being. -- **ISO**

Opt. Express **17**, 2182 (2009).

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IMMUNOLOGY: BUILDING A BRAIN INVASION

For good reason, our bodies tightly limit the access of immune cells to the brain, where they could do untold harm. However, during certain infections and autoimmune diseases, immune cells can gain access to the brain and cause tissue damage and destruction. In order to better understand how immune cells access the brain and move within it during an infection, Wilson *et al.* used multiphoton microscopy to visualize the behavior of $CD8^+$ T cells in cerebral cortex slices taken from mice with encephalitis that resulted from *Toxoplasma gondii* infection. Similar to T cell movements previously observed in lymph nodes, infiltrating $CD8^+$ T cells could be seen to use reticular fiber conduits to move within the brain. In contrast to the lymph node reticular networks that are present in the steady state, the conduits in the brain were observed only in infected mice, suggesting that in immune-privileged tissues such as the brain, scaffolds for lymphocyte motility are induced only under inflammatory conditions. -- **KLM**

Immunity **30**, 300 (2009).

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CELL BIOLOGY: READING THE SIGNS

Posttranslational modifications are one of many ways to control the activity of proteins. Ubiquitin is a small molecule that is covalently attached to target proteins and regulates the function of many different biological processes. In yeast, up to 20% of proteins can be conjugated to ubiquitin, and all seven

conserved lysine (K) residues in ubiquitin itself can be used to form both branched and linear polypeptide chains. These different combinations are thought to mark proteins for different cellular fates. The most abundant chain is linked through K48, which targets the associated proteins for degradation by the proteasome. K63-linked ubiquitin chains were previously thought to regulate proteasome-independent functions in vivo, such as DNA repair. Now, Saeki *et al.* have found that K63-linked ubiquitin can also target proteins to the proteasome. Using *Saccharomyces cerevisiae*, they studied the topology of the ubiquitin chains formed by the E3 ubiquitin ligase Rsp5, which is known to regulate both proteasome-dependent and -independent functions. In vitro, Rsp5 was found to generate only K63-linked ubiquitin chains, which were then unexpectedly recognized by the proteasome. Further in vivo studies showed K63-linked ubiquitin chains bound to the proteasome, suggesting that, like K48-linkages, K63-links may also have an extensive role in regulating protein degradation. -- **HP***

EMBO J. **28**, 359 (2009).

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CHEMISTRY: STEP BY STEP

In surface-catalyzed reactions, there are often myriad steps between the first contact of the reagents with the surface and the ultimate desorption of the final products. Characterization of these intermediate stages can help to unravel the reaction mechanism and thereby aid development of improved catalysts. Although scanning tunneling microscopy (STM) has been used to follow a number of reactions of adsorbed species on metal surfaces, there are few examples of such studies on metal oxides. Matthiesen *et al*. studied the oxidation by O_2 of adsorbed hydrogen atoms on a (110) surface of titanium dioxide using time-lapsed STM images and density functional theory calculations. The data provide evidence for several intermediate species--HO_2, H_2O_2, and H_3O_2--on the way to the formation of water. The coadsorption of water helps to promote hydrogen diffusion and thus allow these reactions to proceed at low temperatures (200 K). -- **PDS**

ACS Nano **3**, 10.1021/nn8008245 (2009).

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