

Approaching a boundary.

HIGHLIGHTS OF THE RECENT LITERATURE

SPACE POLICY

A Line in the Sky

Where does airspace end and outer space begin? Space exploration has proceeded for nearly 50 years without a clear answer, but the increased use of spacecraft and satellites by many nations has spurred calls to define the boundary precisely. Harris and Harris argue that international law should establish a boundary based on the vertical distance from Earth's surface, rather than on more complicated functional criteria that could change as technology evolves. They note that airspace is heavily regulated and comes under the jurisdiction of sovereign nations, who have the authority to restrict airplane flight above their territories. In contrast,

outer space is considered to be a public realm—described in the Outer Space Treaty as “the province of all mankind”—and an orbiting object is accountable to its owners and not to the countries beneath it. At the moment, orbiting satellites can be used to observe any country, whereas aircraft can be prohibited from doing so legally. Moreover, modern satellites can image the ground with meter-scale resolution, yielding pictures as sharp as those captured by a spy plane operating in airspace. A vertical boundary definition would promote discussion of the policy issues arising from technological progress. — JB

Space Policy 22, 3 (2006).

ASTROPHYSICS

Galactic Flapping

The Milky Way's flattened disk contains vast reservoirs of hydrogen gas. Near the edges, the disk consists mostly of hydrogen, with few stars. Radio astronomical observations have revealed warping at these edges, as in a dish or saddle. Weinberg and Blitz modeled this warping phenomenon using perturbation theory calculations. Their results attribute the shape to tidal effects induced by motions of the Milky Way's small neighboring galaxies, the Large and Small Magellanic Clouds. As these satellite galaxies move in orbital loops around the Milky Way, they create trailing wakes in the Milky Way's halo of surrounding dark matter. These wakes in turn can cause the outer edges of the Milky Way's lightweight gas disk to bend and flap like a flag in the breeze. The model describes a dynamic disk, which continually changes its shape as the clouds move along their orbits. The authors further suggest that warp observations offer a useful constraint for determining dark matter distributions. — JB

Astrophys. J. 641, L33 (2006).

CHEMISTRY

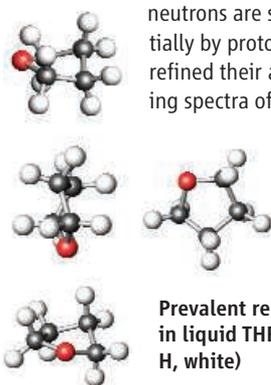
THF Up Close

Although molecules in the liquid state are in constant random motion, they appear to adopt specific average configurations that account for such properties as heat capacity and solvation.

Insight into these configurations has come mainly from theoretical simulations, whose accuracy is gauged by the extent to which bulk properties are correctly predicted. The pentagonal (CH₂)₄O tetrahydrofuran (THF) is a widely used solvent in organic synthesis because of its relatively high polarity in the absence of hydrogen bonding capacity.

Bowron *et al.* have taken advantage of progress in neutron scattering technology to probe the molecular structure of liquid THF at room temperature directly. Because neutrons are scattered preferentially by protons, the authors refined their analysis by comparing spectra of protiated and

deuterated THF, as well as a 1:1 mixture of the isotopomers. Computer modeling of



Prevalent relative orientations in liquid THF (O, red; C, black; H, white)

the data revealed a propensity for T-shaped interaction geometries, in which adjacent molecules were oriented edge to face. This arrangement leads to 2.5-Å diameter void spaces, which may account for the solvent's capacity to harbor free electrons. — JSY

J. Am. Chem. Soc. 128, 10.1021/ja0583057 (2006).

BIOMEDICINE

Only Skin Deep

Although smallpox was declared eradicated by the World Health Organization in 1980, the threat of bioterrorism means that future vaccination against this virus is being considered. However, for sufferers of atopic dermatitis, vaccination itself poses a problem because these individuals are prone to developing the condition eczema vaccinatum: an exacerbated skin infection that follows inoculation with the vaccinia virus used in smallpox vaccination.

In looking at why atopic dermatitis patients might be more susceptible, Howell *et al.* conclude that the effective control of vaccinia virus may hinge on an antimicrobial peptide called cathelicidin LL-37, which has been shown to have direct antiviral properties *in vitro*. In explant studies, patient skin had reduced LL-37 expression and allowed higher levels of viral replication than skin from normal individuals. Further experiments showed that the T helper cell type 2 cytokines interleukin-4 (IL-4) and IL-13 elevated viral replication and decreased LL-37 in normal skin, with the opposite effect seen after blocking the cytokines in skin from atopic dermatitis subjects. Mice lacking a homolog of LL-37 also showed poor control of vaccinia replication. These results suggest that as well as modulating adaptive immune responses to poxviruses, the cytokine environ-

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ment of the skin substantially influences early innate immune protection. — SJS

Immunity **24**, 341 (2006).

APPLIED PHYSICS

Optical Sifting

The separation and sorting of micrometer-scale particles by size, shape, optical properties, or some combination thereof is necessary in a broad range of applications, from fundamental lab-on-chip studies to the filtering of colloids for materials synthesis. The available techniques tend to rely on the precisely controlled microfluidic flow of particles through a separator.

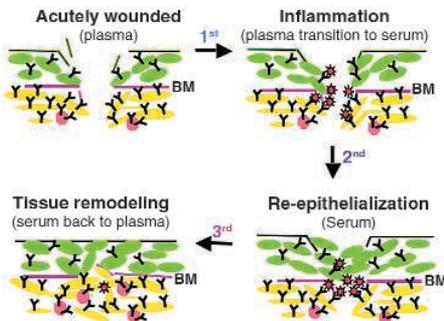
Ricárdez-Vargas *et al.* present a simple alternative method, based on reconfigurable patterns of light, that eliminates the need for a microfluidic system. Two interfering laser beams form a periodic potential energy landscape, resembling a washboard, in the liquid layer suspending the polydisperse sample of particles. The spatial periodicity of the fringes is varied to accommodate particles of different sizes. By modulating one of the laser beams with a sawtooth signal that directs an interferometer mirror, the authors effectively vibrate the potential landscape from side to side. This jiggling motion is sufficient to separate particles that are 1 to 5 μm in diameter by size: the larger ones are driven in one direction and the smaller ones in the opposite direction. Moreover, particles of similar size but different optical refractive index (such as latex and silica) can be separated by varying the intensity of the light. — ISO

Appl. Phys. Lett. **88**, 121116 (2006).

CELL BIOLOGY

A Multistep Process of Healing

Delayed wound healing is a debilitating condition affecting millions of individuals, particularly diabetics; successful wound healing requires cell migration to cover the lesion. Skin has one layer of epidermal cells and another of dermal cells. In



Skin architecture and the plasma-serum transition in wounding and healing. Epidermal cells (green), dermal cells (yellow and pink), TGF- β 3 (red), TGF- β 3 receptor (black).

intact skin, cells are bathed in plasma, but after wounding, they are exposed to serum.

Bandyopadhyay *et al.* examined the effects of the switch from plasma to serum and the role of transforming growth factor- β 3 (TGF- β 3) on the motility of primary human skin cells. They found that human serum promotes the migration of epidermal cells and inhibits the migration of dermal cells, whereas plasma promotes dermal cell migration but not that of epidermal cells. These complementary effects are modulated by the high levels of TGF- β 3 in serum and the high levels of TGF- β 3 receptors on dermal cells. In contrast, plasma has only low levels of TGF- β 3, and epidermal cells have low levels of TGF- β 3 receptors. Depleting serum of TGF- β 3 renders it plasma-like in promoting dermal cell migration. Similarly, changing the expression levels of TGF- β 3 receptor switched the motile responses as predicted. Thus, the transition from plasma to serum and then back to plasma encourages the appropriate and sequential migratory responses in epidermal and dermal cell layers during healing. — SMH

J. Cell Biol. **172**, 1093 (2006).

BIOMEDICINE

A Maestro at Work

In global surveys of proteins, from those based on sequence to those based on function, mitochondria have often lost out, in part because of the small proportion (7%) of cellular proteins that localize to this organelle. Calvo *et al.* set out to remedy this gap in proteomics by integrating their analysis over eight data sets, each of which is organized along a different dimension: mitochondrial targeting sequence, protein domain, transcriptional regulatory element, yeast homology, similarity to *Rickettsia* (the nearest living relative), coexpression, mass spectrometry, and proliferation induction. These data were used to train a Bayesian classifier, the Maestro, that when challenged with the Ensembl set of 33,860 human proteins, properly predicted 71% of the known mitochondrial proteins.

On a smaller scale, Maestro was applied to a human mitochondrial disorder—hepatic mitochondrial DNA depletion, in which the loss of mitochondrial DNA leads to organ failure—that had been mapped to a region on chromosome 2 containing 150 annotated genes. Spinazzola *et al.* sequenced the highest scoring candidates and found one, *MPV17*, for which mutations segregated with affected individuals in three unrelated families. They show that the absence of this inner mitochondrial membrane protein results in deficits in mitochondrial DNA and oxidative phosphorylation in mice. — GJC

Nat. Genet. **38**, 10.1038/ng1776; 10.1038/ng1765 (2006).

Science

Only Skin Deep

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