EDITORS' CHOICE

edited by Gilbert Chin

APPLIED PHYSICS

A Better Optical Switch

One of the limiting parameters in optical communication is the rate at which light pulses can be manipulated or gated. At present, all-optical switching technology, in which a control light pulse is used to gate a signal pulse, can offer response times of several hundreds of femtoseconds with a switching energy typically of tens of picojoules. However, the relatively low on-off ratio, around 14 decibels (dB), may compromise the ability to send the information reliably.

Takahashi *et al.* describe a scheme in which this on-off ratio can be enhanced significantly to about 40 dB for similar switching energies and response times. They exploit the spin-polarized state of a nonlinear optical material, a multiple quantum-well, induced by a circularly polarized pump beam. When a linearly polarized signal beam, composed of right- and left-handed circularly polarized light, is reflected off a region of the material, only the component with the same polarization state as the pump beam experiences the refractive index change, thus allowing just one component to be reflected. — ISO

Appl. Phys. Lett. **77**, 2958 (2000).

IMMUNOLOGY

Re-appraising Rhesus Antigens

Proteins collectively referred to as Rhesus blood group antigens, have become familiar for the threat they pose to developing fetuses. This arises when the immune system of a mother lacking Rh antigens becomes exposed to paternal Rh antigens expressed by the fetus, eliciting a potentially lethal antibody response.

Decades after the first immunological description of Rh antigens, Marini *et al.* assign a possible physiological role for these proteins in the transport of ammonium ions. Earlier studies had identified sequence homology between Rh genes, which encode polypeptide complexes expressed on red blood cells, and ammonium transport proteins (Mep) in yeast. On this basis, Marini *et al.* tested the ability of Rh genes to complement Mep-deficient yeast mutants, with the result that expression of Rh polypeptides restored the ability of these cells to grow with ammonium sulfate as the sole source of nitrogen. — SJS

Nature Genet. **26**, 341 (2000).

CLIMATOLOGY

Wind Over the Arctic

The polar sea ice reflects much of the incoming solar radiation in the summer and insulates the underlying sea in the winter. It also influences the salinity of the ocean waters and thereby affects water density and thus ocean circulation. Satellite and submarine observations have shown that Arctic sea ice cover and dynamics are highly variable on a decadal time scale and that, on average, the sea ice cover has decreased by several percent per decade.

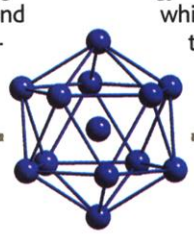
Two modeling studies attempt to shed light on the underlying mechanisms. Hilmer and Lemke use a sea ice model forced with past wind and temperature records for the period of 1958 to 1998. The simulation shows a pronounced decadal variability in sea ice cover and obtains an overall reduction in sea ice of about 4% per decade. In agreement with observations, the largest thinning is seen to occur in the eastern Arctic.

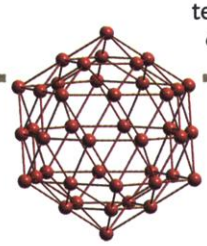
Maslowski *et al.* used a regional, coupled ice-ocean model, which they force with realistic atmospheric data for the period from 1979 to 1993. Large-scale changes in sea ice and upper-ocean circulation are observed between the beginning and the end of the study period, also in agreement with observations. The two studies show that atmospheric variability alone can strongly affect the Arctic Ocean system, with wind forcing apparently playing a large role. — JU

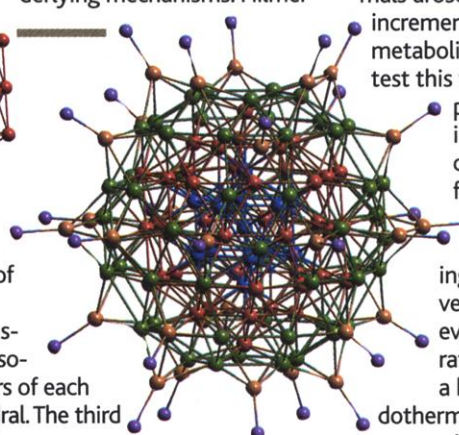
Geophys. Res. Lett. **27**, 3751; 3743 (2000).

CHEMISTRY

Pd_{145} Reveals Its Secrets

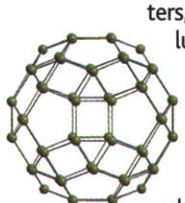






Small clusters of atoms containing a few hundred atoms may form structures that differ from those of their bulk counterparts. A well-known example is the formation of icosahedral clusters; this structure cannot be extended in all directions (a prerequisite for the formation of regular crystals) because of strain, but at small sizes it may be energetically advantageous.

Tran *et al.* have prepared high-quality crystals of highly symmetric clusters, each containing 145 palladium atoms. Their high-resolution crystal structure shows that the inner two layers of each cluster (blue, red), formed by 55 atoms, are icosahedral. The third layer (green), formed by 60 atoms, has a regular and more complex symmetry unlike that of C_{60}, and represents a complete layer in one of two proposed cluster growth routes for the 55-atom icosahedron. The remaining 30 palladium atoms (orange) cap the square faces in the third layer and bind a triethylphosphine ligand (purple). About 60 disordered carbon monoxide molecules surround the cluster. The level of structural detail obtained by the authors is unprecedented for a large metal cluster and provides insights into the forces stabilizing metal clusters. — JU



SOURCE: TRAN *ET AL.*, *AGNEW. CHEM. INT. ED.* **39**, 4121 (2000).

Agnew. Chem. Int. Ed. **39**, 4121 (2000).

EVOLUTION

A Thermal Puzzle

It has been proposed that endothermy in birds and mammals arose through beneficial increments in the resting metabolic rate. Bennett *et al.* test this thermoregulatory hypothesis by quantitating the effects of increasing three- to four-fold the metabolic rate of an ectotherm by feeding *Varanus* lizards a very large meal. This elevated metabolic rate—similar to that of a hedgehog, an endotherm of the same size—was maintained for at least 24 hours postprandially, but had very little impact on increasing or stabilizing body temperature. Without a thermoregulatory benefit, the increase in metabolic rate is a net cost to the animal, suggesting

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that the turbocharged metabolism characteristic of endothermic organisms initially arose for some other, as yet obscure reason and that thermoregulation was a subsequent, secondary benefit. — AMS

Evolution **54**, 1768 (2000).

ASTROPHYSICS

Primordial Beryllium?

Hydrogen, helium, and lithium are the elements usually thought to have formed directly from the Big Bang. Beryllium (Be) and boron, however, are thought to be secondary elements formed from supernovae by spallation reactions between cosmic rays, alpha particles, and protons and heavier nuclei such as carbon, oxygen, and nitrogen in the interstellar medium.

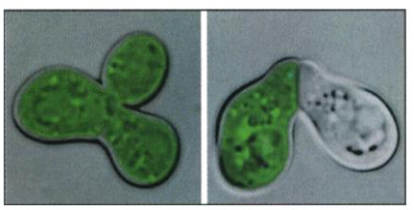
Primas *et al.* have estimated the abundance of Be from spectra of the very metal-poor star G 64-12 obtained with the high-resolution ultraviolet and visible echelle-grating spectrograph (UVES) on the Very Large Telescope (VLT). The abundance of Be in G 64-12 (the most metal-poor star in which Be has been measured) is greater than that predicted by evolutionary models for secondary element formation. These results suggest that a new mechanism for primordial formation of Be may be needed and that the nucleosynthetic process of the Big Bang may need to be updated. — LR

Astron. Astrophys., in press (astro-ph/0009482).

CELL BIOLOGY

Fusion Shmoo-sion

When two yeast cells mate, they must overcome the barrier of the cell wall and then coordinate leak-free fusion of their plasma membranes. Although proteins that peel away the cell walls have been identified, finding those involved in promoting the membrane fusion event has been difficult. Heiman and Walter used a proteomics-based approach to identify a protein termed Prm1. They developed a computer program to sieve a composite database of published gene expression profiles of yeast cells, and they looked for predicted membrane proteins induced during mating. In experimental work, Prm1 was observed to localize at the tip of the mating projection, while in cells lacking Prm1, more than half of mating pairs failed to fuse even though their plasma membranes remained tightly apposed. It is not yet clear whether Prm1 is a 'fusase' or acts in support of such a molecule, but further study may clarify the details of the fusion process. — SMH



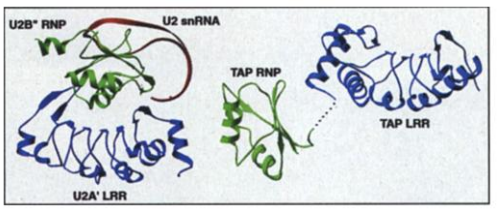
Fusion of yeast plasma membranes allows mixing of the cytoplasm (green).

J. Cell Biol. **151**, 719 (2000).

MOLECULAR BIOLOGY

Betwixt Cup and Lip

In eukaryotic cells, RNAs are synthesized in the nucleus and then transported into the cytoplasm (to function, for instance, as enzymes or to be translated into polypeptides). Many RNAs are modified after synthesis and before transport in processes such as polyadenylation, editing, and splicing; how the signals indicating that processing is complete are coordinated with those mediating transport is not yet understood.



The previously determined structure of U2B″-U2A′-RNA (left) and the two domains of the CTE-binding fragment of TAP (right).

Earlier work has shown that the simian type D retrovirus encodes a constitutive transport element (CTE) that serves to circumvent the customary checks and enables the unspliced genomic RNA to slip through the transport pathway into the cytoplasm, a requirement for proper retroviral replication. Liker *et al.* now describe the crystal structure of the CTE-binding fragment of human TAP (the homolog of yeast messenger RNA export factor Mex67p). They observe two domains: one is a ribonucleoprotein or RNP domain, and the other is a leucine-rich repeat or LRR domain. Of particular interest is the structural similarity of these with the heterodimer of the RNA splicing factors U2B″ and U2A′. Taken together with mutagenesis results, this is highly suggestive of a common mode of RNA recognition in which the LRR acts on the RNP domain to promote RNA binding, to incompletely spliced cellular mRNA in the case of U2B″-U2A′, and to the CTE element of retroviral genomic RNA in the case of TAP. — GJC

EMBO J. **19**, 5587 (2000).

CREDITS: (TOP) LIKER *ET AL.*, *EMBO J.* **19**, 5587 (2000); (BOTTOM) HEIMAN AND WALTER, *J. CELL BIOL.* **151**, 719 (2000).