THIS WEEK IN Science

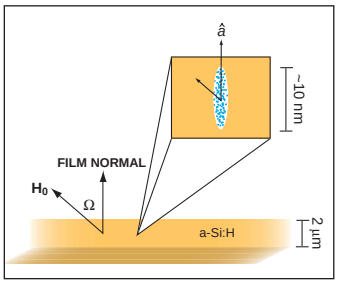
edited by Phil Szuromi

Catalysts Caught in Action

Many industrial catalysts consist of a precious metal on an inorganic support, as well as "promoters," species that are not active on their own, but enhance reaction rates or product selectivity. Often these catalysts are transformed greatly under reaction conditions, but many surface-sensitive techniques, including transmission electron microscopy (TEM), are usable only under vacuum conditions. Hansen *et al.* (p. 1508; see the Perspective by Campbell) were able to perform high-resolution TEM studies of an ammonia-synthesis catalyst (ruthenium supported on boron nitride with a barium promoter) by using an environmental cell and differential pumping. Under reaction conditions, they find that the ruthenium particles coalesce to an optimum size (~2 nanometers in diameter) and become partially coated with barium, which appears to act as an electronic promoter.

1505 NMR Signatures of Nanoscale Confinement

Dipole interactions are ubiquitous in gases and liquids, but with a few exceptions, are difficult to use in a diagnostic manner—these interactions usually sum to zero in the bulk. Baugh *et al.* (p. 1505; see the Perspective by Warren) now show that nanoscale confinement of a gas orders the intermolecular interactions and leads to dipole-dipole effects that can be seen in nuclear magnetic resonance. Studies of hydrogen trapped in the nanovoids of amorphous silicon show line broadening and peak position shifts as a function of the angle of the sample to the applied magnetic field. Such effects could be used to characterize the shape, size, and volume fraction of nanovoids.



Bridging a Route Toward Organic Magnets

The general approach taken so far for the preparation of organic-based materials exhibiting magnetic behavior has involved the substitution of magnetic ions, or the use of radical ions, where the resultant exchange coupling between these isolated spins results in weak magnetic behavior at very low temperatures. Rajca *et al.* (p. 1503) pursued a macromolecular approach that exploits through-bond interactions in a conjugated polymer. The polymers contained macrocyclic groups with large spin moments that are bridged with cross-links that have a smaller spin moment, and this coupling of spins between macrocycles and cross-links could be designed to give rise to antiferromagnetic or ferromagnetic behavior. These polymers exhibit reorientation of their magnetization in small magnetic fields at temperatures below 10 K.

Magma Source for Mt. Vesuvius

Determining the hazard associated with Mt. Vesuvius requires an understanding of its subsurface structure. Auger *et al.* (p. 1510) have found a large sill of magma mixed with solid rock about 400 square kilometers in area, at about 8 kilometers in depth beneath Vesuvius. The sill, which probably formed by pooling magma in an extensional regime, represents an important source of magma for the next eruption.

Colossal Crocodiles

Several species reached tremendous size during the Cretaceous, including a giant crocodile, *Sarcosuchus imperator*, which had a body length of up to 13 meters. Sereno *et al.* (p. 1516) describe new fossils of this giant predator that provide information on its habitat, growth, and evolution. Unlike most other large crocodiles that fed on fish in the ocean, the largest of crocodiles evidently lived in rivers and fed on dinosaurs as well as fish. It apparently achieved its large size by extended growth over 50 to 60 years.

Recovering from Catastrophe

Catastrophic events such as hurricanes can provide large-scale, ready-made experiments in ecology (see the Perspective by Brooks and Smith). Schoener *et al.* (p. 1525) document the effects of a massive hurricane on the occurrence of a common lizard species on 66 islands in the Bahamas archipelago. Before the hurricane, island area was the best predictor of the presence of lizard populations. Just after the hurricane had passed, altitude was the better predictor, but during the next 2 years, island area gradually resumed its dominance. Restoration of the species-area distribution resulted from overwater dispersal and from hatching of eggs that survived inundation during the hurricane. In a separate biogeographical contribution, Ricklefs and Bermingham (p. 1522) examined the dynamics of landbird species composition in the Lesser Antilles over an evolutionary time scale. Periodic catastrophic events have effectively prevented an equilibrium between colonization and extinction, and thus the bird fauna has never been in a steady state.

From Hormones to Genes in Plants

The receptor for the plant hormone known as cytokinin is a histidine kinase. Sakai *et al.* (p. 1519) now demonstrate that a target for this receptor kinase is the response regulator ARR1, which contains DNA binding domains that can be put to good use in activating downstream target genes. The receptor and the response regulator together act as a two-component system that transduces hormone detection into transcriptional regulation.

Separated in Time Rather Than Space

The oxygen that cyanobacteria release during photosynthesis is anathema to nitrogen fixation, but most cyanobacteria have resolved this problem by differentiating specialized cells called heterocysts. *Trichodesmium* is a ubiquitous cyanobacterium that makes a significant contribution to marine nitrogen fixation, but it does not possess heterocysts. Instead, as Berman-Frank *et al.* (p. 1534; see the news story by Pennisi) have discovered, it partitions photosynthesis and nitrogen fixation temporally within the

CREDIT: BAUGH *ET AL.*

Published online in *Science* Express

CONTINUED ON PAGE 1415

photoperiod. When nitrogen fixation is maximal, photosystem II activity is minimal; nevertheless, linear photosynthetic electron transport still appears to be needed.

Nuclear Attack on Cancer

Alpha particles are high-energy helium nuclei that are extremely potent cell-killing agents. Monoclonal antibody–mediated targeting of these particles to tumor cells has been investigated as an anticancer therapy, but the short half-life of the particles has limited the success of this approach. McDevitt *et al.* (p. 1537) developed a molecular-sized generator that produces atoms that emit alpha particles and then targeted the generator itself to the tumor cells. Treatment of mice bearing solid or disseminated cancers with a single nanocurie level dose of these constructs induced durable tumor regressions. In principle, such atomic "nanogenerators" could be used for treatment of a wide range of human cancers.

A Change for the Worse

In addition to generating immunity toward infection, dendritic cells (DCs) direct tolerance to the body's own antigens. Abnormal behavior of DCs might lead to autoimmunity, but no direct links have been established. Blanco *et al.* (p. 1540) now offer a connection by showing increased activity of DCs in the blood of patients with the antibody-mediated autoimmune disease, systemic lupus erythromatosus (SLE). In culture, serum from SLE patients induced peripheral blood monocytes to differentiate into DCs, which could provoke vigorous responses from naïve CD4 T cells. Of the potential serum factors that might have induced this effect, the cytokine interferon-α was essential, thus establishing a possible target in therapies for SLE.

CREDIT: KANG-DECKER *ET AL.*

Assembling Acrosomes

During spermiogenesis (the events from spermatid to spermatozoan), many proacrosomic vesicles coalesce into a single acrosomic vesicle that covers much of the cell's nuclear surface. Defects in acrosome development or function result in fertility problems. Kang-Decker *et al.* (p. 1531) report the identification of a protein involved in acrosome formation. When the Hrb protein was eliminated from mice via homologous recombination, infertile but otherwise normal males developed because the proacrosomic vesicles failed to form a single acrosomic vesicle. In addition, spermatozoa decreased in number and displayed reduced motility—likely the result of the midpiece and tail defects.

Hot Choices

Animals can make rational choices among several options by weighing up the advantages and disadvantages of each, but the neural pathways that confer this decision-making ability are largely unknown. In a series of experiments with *Drosophila* in a flight simulator, Tang and Guo (p. 1543) have determined that part of the fly brain called the mushroom body is necessary for choice behavior in these organisms. Flies were conditioned (using heat as punishment) to choose a particular flight path in response to either a color or shape cue and then were tested with contradictory cues after training. As the salience of the color and shape cues altered, normal flies could change their preferences, whereas flies with mutant or ablated mushroom bodies could not.

Memory-Making Events?

Nerve cells communicate with one another through specialized cell-cell junctions called synapses, and changes in how efficiently information is transferred across these junctions are believed to underlie memory. Antonova *et al.* (p. 1547) examined the clustering of proteins at synapses in culture as they underwent simulated learning. Within minutes of the teaching stimulus, the amount of a key protein required for sending information, synaptophysin, increased on the presynaptic side of the synapse, and there was a parallel increase in GluR1, the postsynaptic receptor that received the information. The change was unexpectedly rapid (appearing within 5 to 10 minutes) and depended on an intact actin cytoskeleton, which suggests that this clustering may reflect the conversion of silent synapses into active ones.