EDITORS' CHOICE

edited by Gilbert Chin

PHYSICS

A Cool Timepiece

Modern watches keep time by counting the vibrations of a quartz crystal. In a similar manner, atomic clocks keep time by counting the vibrations of excited cesium atoms. As a rule, the stability of a clock is expected to improve as the frequency used to keep time increases. Just as most watches drift off and need to be reset occasionally, so too do atomic clocks, albeit on much longer time scales and with much smaller adjustments. The key to improved timekeeping is to use a frequency standard that is stable. Wilpers *et al*. show that using a cold ensemble of neutral calcium atoms as the frequency standard provides superior stability and comparable accuracy to the best single ion traps and microwave standards currently available. — ISO

Phys. Rev. Lett. **89**, 230801 (2002).

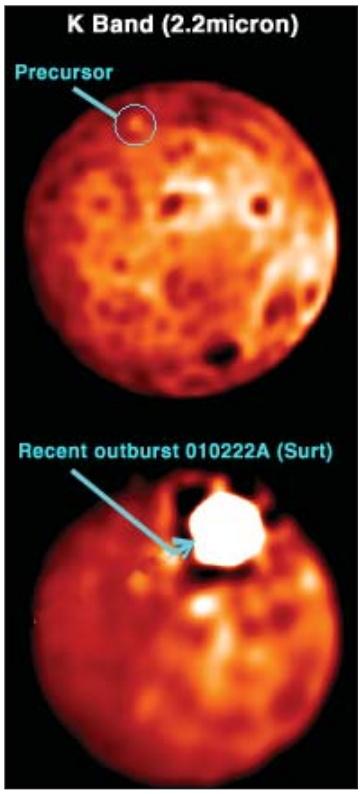
GEOCHEMISTRY

Less Ice, More Melting

Reducing pressure on a hot system tends to enhance melting; this decompression-induced melting has been proposed as a major pathway for producing magma in the mantle, which in turn leads to increased volcanism. An elegant test of this coupling, allowing inferences about the mechanism, is possible in regions where volcanism is abundant and where a rapid drop in pressure occurred when the major ice sheets melted during the last deglaciation. An ideal locale is Iceland, the most volcanically active region at high latitudes. Here, major ice sheets that were a kilometer thick melted abruptly after about 12,800 years ago, leading to a local decrease in pressure of 100 bars or more.

Maclennan *et al*. have compiled a history of the volume and composition of well-dated volcanic rocks. This record shows that after deglaciation, eruption rates increased markedly for less than 2000 years, then dropped by more than an order of magnitude. Magmas were richer in MgO, indicating higher melting rates in the mantle beneath Iceland. The timing of the peak in volcanic activity and its composition imply that melting was extensive enough that, in the mantle, magmas were flowing in channels and fractures. — BH

Geochem. Geophys. Geosyst. **3**, 10.1029/2001GC000282 (2002).



Infrared images collected two days apart, showing the beginning (upper) of the Surt eruption (lower).

PLANETARY SCIENCE

Hot Images

Io, the smallest and closest Galilean satellite of Jupiter, is littered with active volcanoes, which result from the internal heating generated by tidal interactions with Jupiter and Europa. Data from spacecraft such as Voyager 1 and Galileo have revealed many details of Io's tidal heating, volcanic processes, and composition.

Marchis *et al*. have combined the adaptive optics on the 10-meter Keck II telescope in Hawaii with a new deconvolution algorithm to obtain high-resolution infrared images. The ability to detect features as small as 100 kilometers allowed the observation of several eruptions, including the brightest outburst ever observed from the Surt volcano in February 2001. This eruption covered an area of 800 square kilometers, with temperatures ranging from 1030 to 1475 K; the high temperatures suggest that the eruption started with large fire fountains and that the magma was silicate-rich, like terrestrial magmas. The total thermal output was about 8×10^{13} watts, almost equal to the average global heat flow from Io. — LR

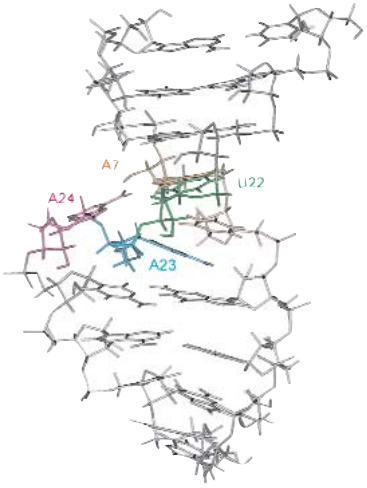
Icarus **160**, 124 (2002).

STRUCTURAL BIOLOGY

Sticking Out

The eukaryotic spliceosome, a complex of RNA molecules and proteins, catalyzes the removal of noncoding regions (introns) from pre-messenger RNA (pre-mRNA). During spliceosome assembly, parts of the pre-mRNA and the U2 small nuclear RNA (snRNA) form a short, base-paired double helix in which a single unpaired adenosine, the so-called branch site, is nearly opposed to a conserved pseudouridine (ψ) residue on the U2 snRNA. The 2′ OH of the unpaired adenosine acts as the nucleophile in the first cleavage reaction of splicing.

Using NMR spectroscopy, Newby and Greenbaum determined the solution structures of ψ-containing and unmodified duplexes. In the ψ duplex, the branch site adenosine is extruded into the minor groove, where it makes hydrogen bonds to a Watson-Crick base pair in the helix. The backbone of the intron strand is kinked such that the 2′ OH is exposed and accessible for recognition and catalysis, whereas the unmodified duplex had the branch site adenosine stacked within a continuous A-type helix. However, additional data uncovered a dynamic character in the region of the branch site, suggesting that the ψ residue helps to stabilize a structure that exists transiently in the unmodified duplex. Consistent with this, deletion of the enzyme that makes pseudouridine residues in yeast produces cells with a growth deficiency but is not lethal. — VV



The extruded adenosine (A24) in a ψ-modified duplex.

Nature Struct. Biol. 10.1038/nsb873 (2002); *Proc. Natl. Acad. Sci. U.S.A.* **99**, 12697 (2002).

NEUROSCIENCE

A Signal Mixing Bowl

The parahippocampal region of the brain is important for the integration of memory-related information. Tracing and lesion studies have provided a wealth

CONTINUED ON PAGE 1851

CREDITS: (LEFT) MARCHIS *ET AL.*, *ICARUS* **160**, 124 (2002); (RIGHT) NEWBY AND GREENBAUM, *NATURE STRUCT. BIOL.* 10.1038/NSB873 (2002)

of morphological data and delineated a cascade of synaptic transactions that carry information from the neocortex to the hippocampus. However, because of difficulties in accessing this region, not much is known about the electrophysiological correlates of these connections. The in vitro isolated guinea pig brain preparation allows for the precise positioning of electrodes in the different subfields that form the parahippocampal region.

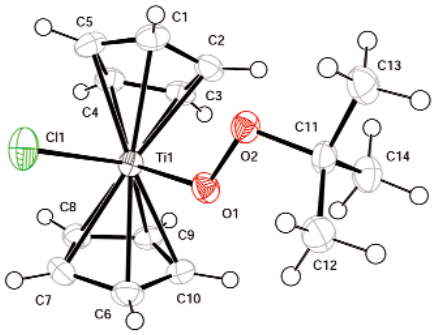
Biella *et al.* analyzed the propagation of electrical activity from the temporal neocortex to the perirhinal and the entorhinal cortices. Information flow from perirhinal areas 35 and 36 to the superficial layers of the entorhinal cortex is not extensive and is spatially scattered. The propagation of this activity is also under strong inhibitory control within the perirhinal cortex. This organizational pattern may facilitate the selection and integration of simultaneously presented inputs from the neocortex. — PRS

J. Neurosci. **22**, 9972 (2002).

CHEMISTRY

Cutting Peroxides Without Oxidation

The binding of organic peroxides to metal centers occurs naturally as well as in industrial processes. Subsequent reactions often break the O–O bond in oxidation processes that can be "heteroleptic" (creating two ions) or "homoleptic" (spliting the electrons of the bond evenly to create two radicals). DiPasquale *et al.* report on a Ti(IV) complex (**1**), $Cp_2Ti(OO^tBu)Cl$ (where Cp is η^5-C_5H_5 and ^{t}Bu is *tert*-butyl) that reacts with triethylphosphine (PEt_3) to form the phosphinite Et_2PO^tBu in near-quantitative yield. The authors argue for a mechanism in which the O–O bond undergoes homolysis so that



The titanium peroxide complex 1.

the $\cdot O^tBu$ group reacts with PEt_3 to form the product and an ethyl radical. Homolysis is supported by the finding of a positive activation entropy. The other product, $Cp_2Ti(O\cdot)Cl$, is unexpectedly stable and does not go on to oxidize PEt_3 to Et_3PO. — PDS

J. Am. Chem. Soc. 10.1021/ja028500a (2002).

BIOCHEMISTRY

Six Steps to Health

First isolated about five decades ago, coenzyme Q (a substituted quinone attached to a long hydrophobic tail) serves as a carrier of electrons between membrane-bound enzyme complexes in the mitochondrion, the site of oxidative phosphorylation. Recent findings have linked reactive oxygen species (perhaps an inevitable consequence of the confluence of dioxygen and electrons) in the mitochondrion to aging and spurred commercial interest in the potential health benefits of exogenous antioxidants, such as coenzyme Q and ascorbic acid. Lipshutz *et al.* have devised a simple six-step synthesis of coenzyme Q, starting from readily available materials and culminating in an overall yield of 64%. — GJC

J. Am. Chem. Soc. 10.1021/ja021015v (2002).

HIGHLIGHTED IN *SCIENCE*'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

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Keeping One's Distance

Root hairs, tubular structures that emerge from plant root epidermal cells, grow through localized exocytosis of the cell wall matrix, a process involving actin-dependent delivery of Golgi-derived vesicles to the hair tip. During active growth of *Arabidopsis* root hairs, the nucleus remains at a fixed distance from the tip; in mutants with branched hairs, the nucleus moves between the growing branches. The mechanism underlying nuclear positioning is not known, and Ketelaar *et al.* have used time-lapse photography and optical trapping of the nucleus to investigate this question. Restraining nuclear movement resulted in cessation of growth at the point when the apex of the root hair reached the largest separation normally observed. Pharmacological analysis indicated that microtubules were not involved, whereas fine filamentous actin in the subapical region was required to maintain growth. On the other hand, bundling of actin filaments (by the protein villin) served to keep the nucleus from approaching the growing tip too closely. — EA

Plant Cell **14**, 2941 (2002).