American Association for the Advancement of Science

SCIENCE

6 July 1990
Vol. 249 ■ Pages 1–100

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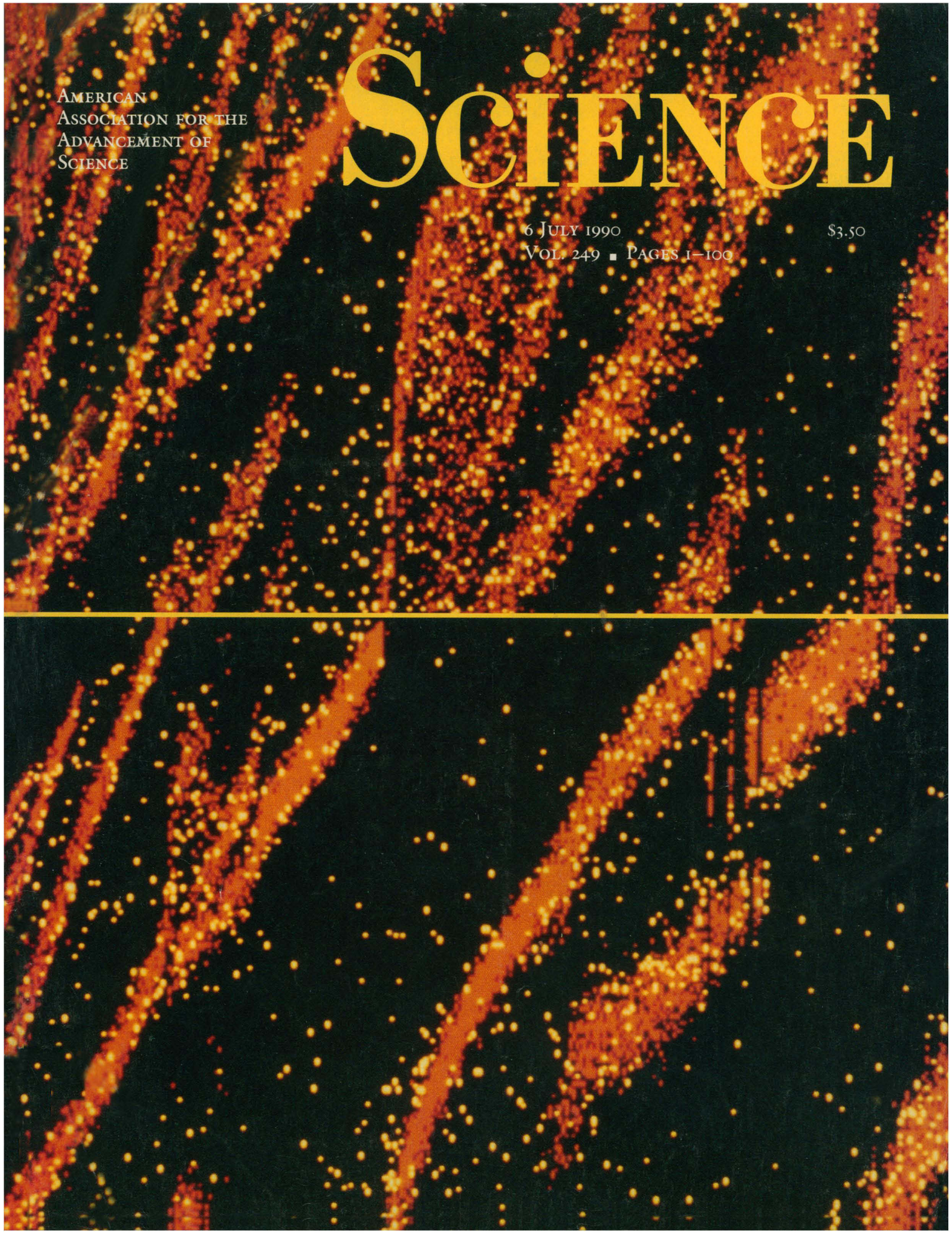

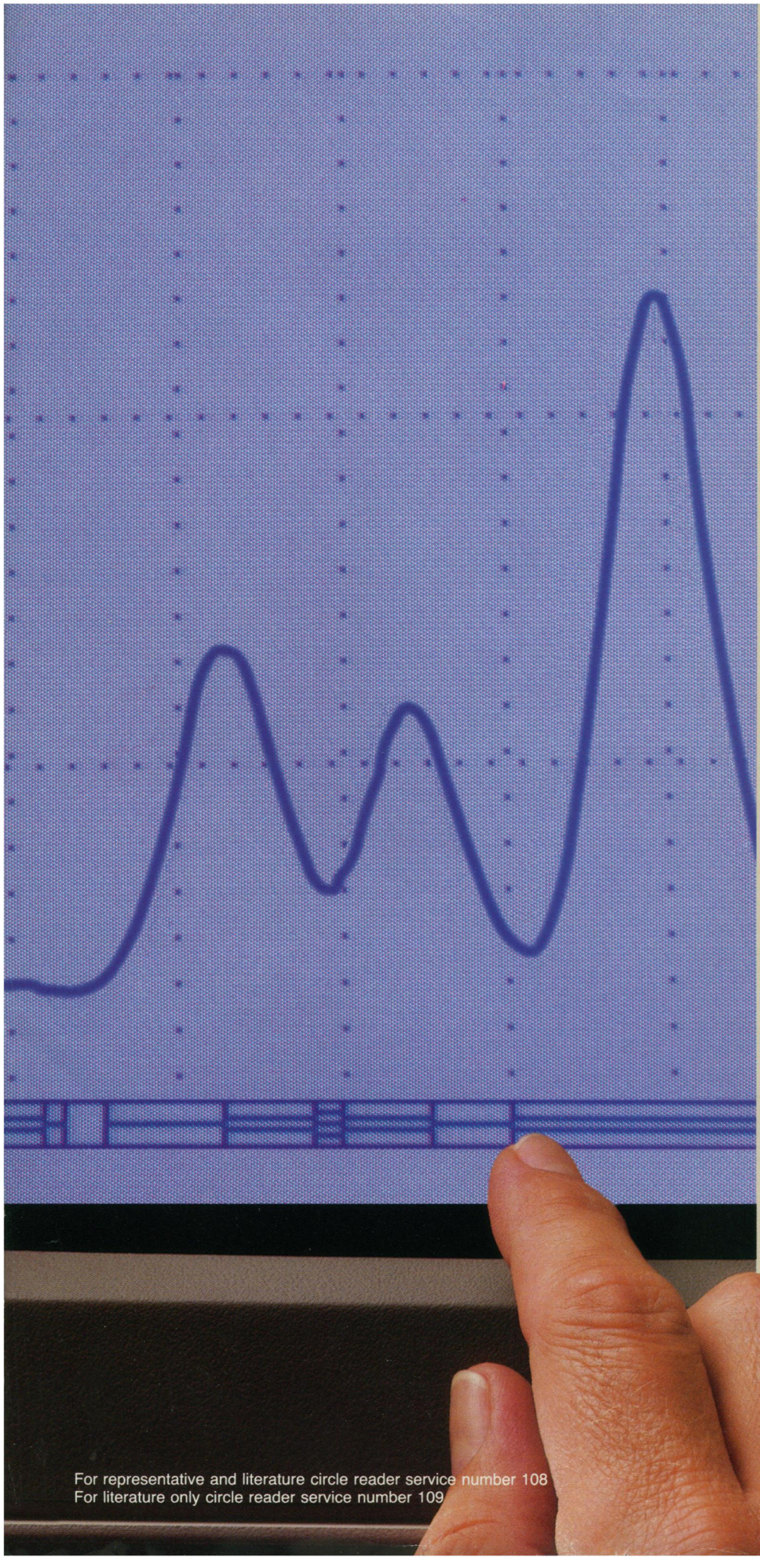

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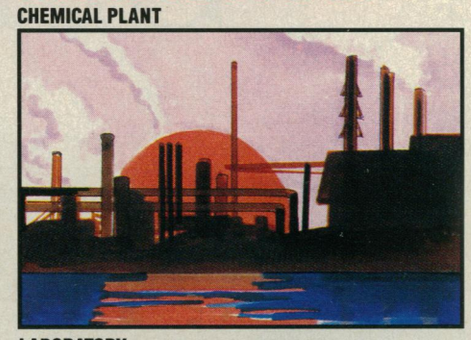

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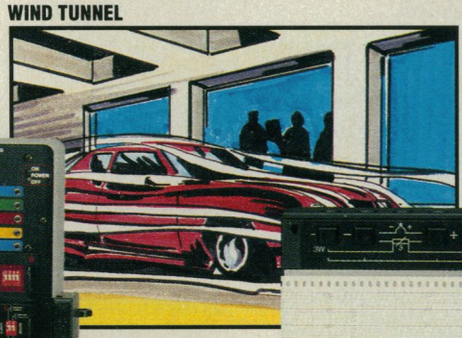

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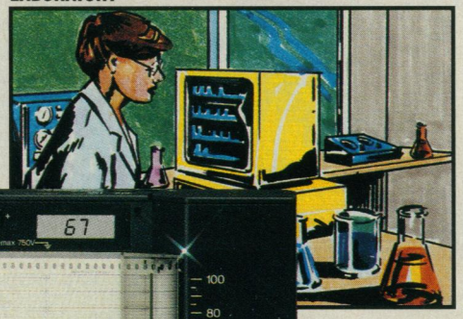

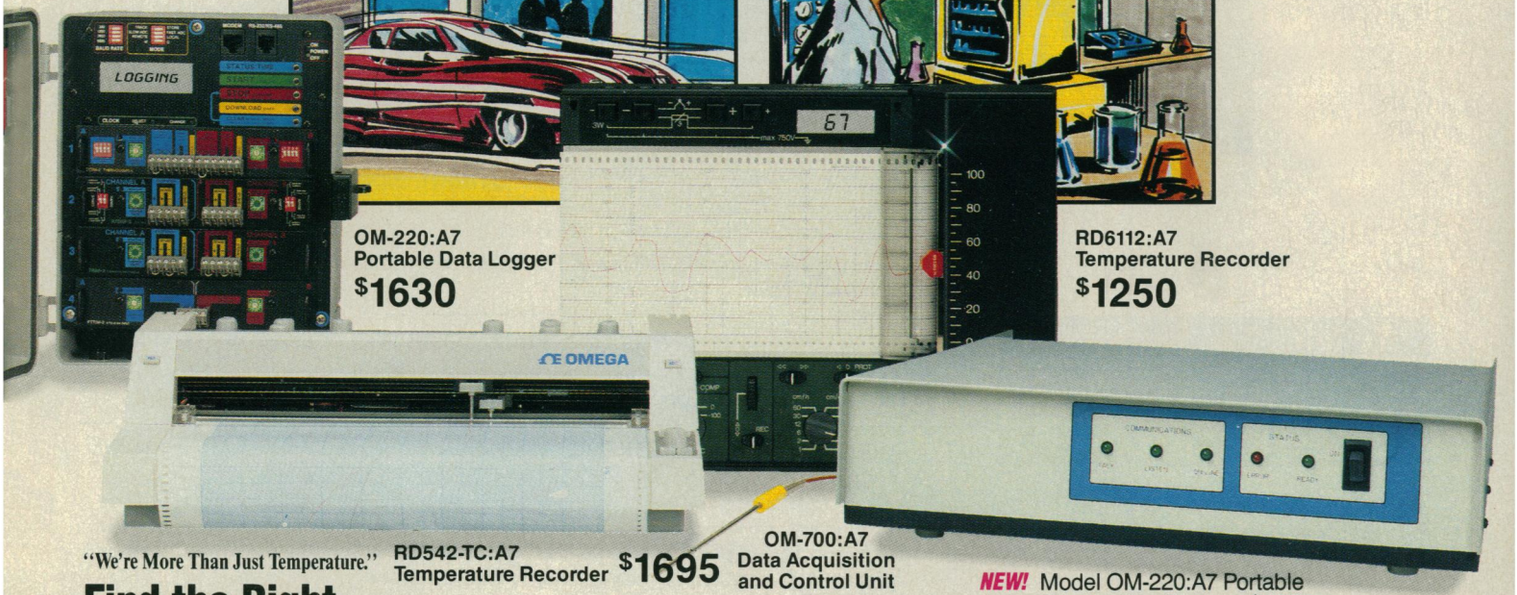

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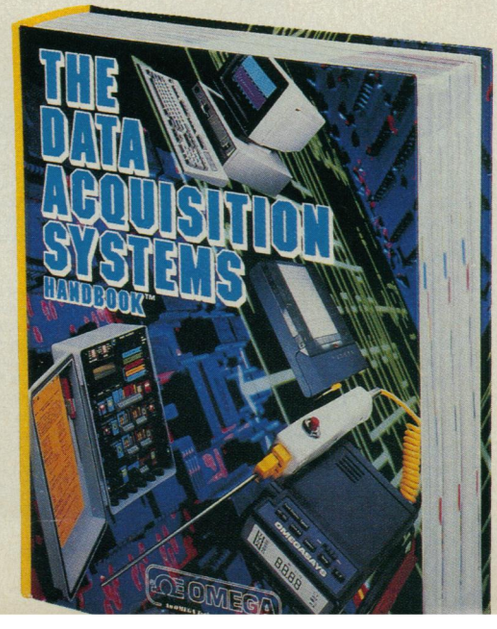

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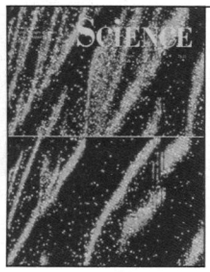
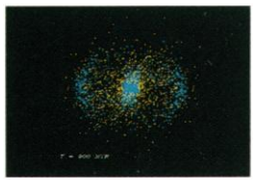
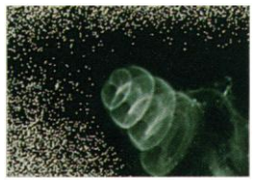


COVER Chirp entrainment by the katydid *Mecopoda* to periodic acoustic stimulation at two different stimulus intensities: plots obtained by iteration of the Poincaré map. The abscissa represents input stimulus rate and the ordinate, phase. At each stimulus rate the map was iterated 50 times: the first 10 iterations are represented by yellow dots while the last 40 iterations (steady-state) are shown in red. The plots identify regions of phase-locked response. See page 55.

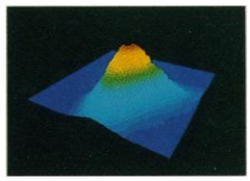
Last Year, This Is How They Won The IBM Supercomputing Competition.



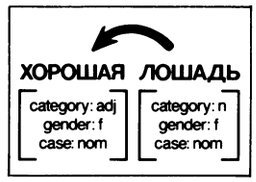
1st Place: Gas dynamics and star formation in merging galaxies.
Kevin M. Olson,
University of Massachusetts.



1st Place: 3-D reconstruction of cochlea structure.
Carl S. Brown and
Alan C. Nelson,
University of Washington.



1st Place: Stretching and bending of material surfaces in turbulence.
Stephen B. Pope and
Sharath Girimaji,
Cornell University;
Pui-Kuen Yeung,
Pennsylvania State University.



1st Place: A dependency parser for variable word order languages.
Michael A. Covington,
University of Georgia.

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Z boson developments

In 1973 their existence was predicted; a decade later they were discovered; in 1989 they were reliably generated; and now their decay properties are being studied. Discovery of Z bosons (and W bosons), the vectors of nature's weak nuclear force, was crucial to validation of the standard model of high-energy physics. In his review of the state of Z boson art, Chanowitz describes the theoretical and experimental pathways that led to the prediction and discovery of Z bosons and the progress already made in searches for new particles and in defining quark-lepton families (page 36). The unified theory is tested and extended by this work and new theories and insights will be forthcoming from the continued interplay of experimentation and prediction. Accelerators of the future, such as the Large Hadron Collider and the Superconducting Super Collider, may shed brighter light on elementary particle physics and on the events that occurred immediately after the Big Bang.

Mechanochemical protein

Kinesin is a protein that can convert chemical energy (stored in adenosine tri-phosphate) into mechanical force. Described as a "molecular motor," kinesin is thought to be a participant in the intracellular motility that occurs in association with mitosis, organelle transport, and the extension of endoplasmic reticulum. How is the activity of this molecule explained in terms of its molecular structure? Yang *et al.* prepared a number of truncated kinesin molecules and evaluated their ability to induce microtubule movement in an in vitro assay (page 42). The experiments showed that a 447–amino acid segment of the head domain of kinesin contained the elements needed for generating force and for inducing microtubule motility. The observations are consistent with a rotating head model of action that has been proposed for the related molecular motor myosin: when the head of myosin binds to actin, it undergoes conformation and orientation changes that promote movement of the motor along the actin filament. The relevant head region has recently been shown to be conserved among proteins related to kinesin; therefore, it is likely that these proteins use similar structural motifs for carrying out their related mechanochemical functions.

Storms, lightning, and videotape

Television cameras have for the first time captured a rarely observed phenomenon, an upward flash of lightning (page 48). The flash looked like two fountains and lasted for 30 milliseconds. The discharge originated some 14 kilometers above the earth at the top of storm clouds and rose another 20 kilometers or so into the stratosphere. Upward lightning flashes have been observed only infrequently (usually by airline pilots) and differ in appearance from lightning flashes that travel from cloud to cloud or downward to the earth. Franz *et al.* suggest that the twin discharges originated from areas of intense positive charge at the cloud tops; dipoles are typically set up in clouds, and flashes either upward or downward serve to dissipate accumulated charge. Upward discharges might be the causes of unexplained transient flashes recorded during vigorous thunderstorms associated with hurricane Hugo. Through upward flashes, thunderstorm energy can get transferred into the magnetosphere.

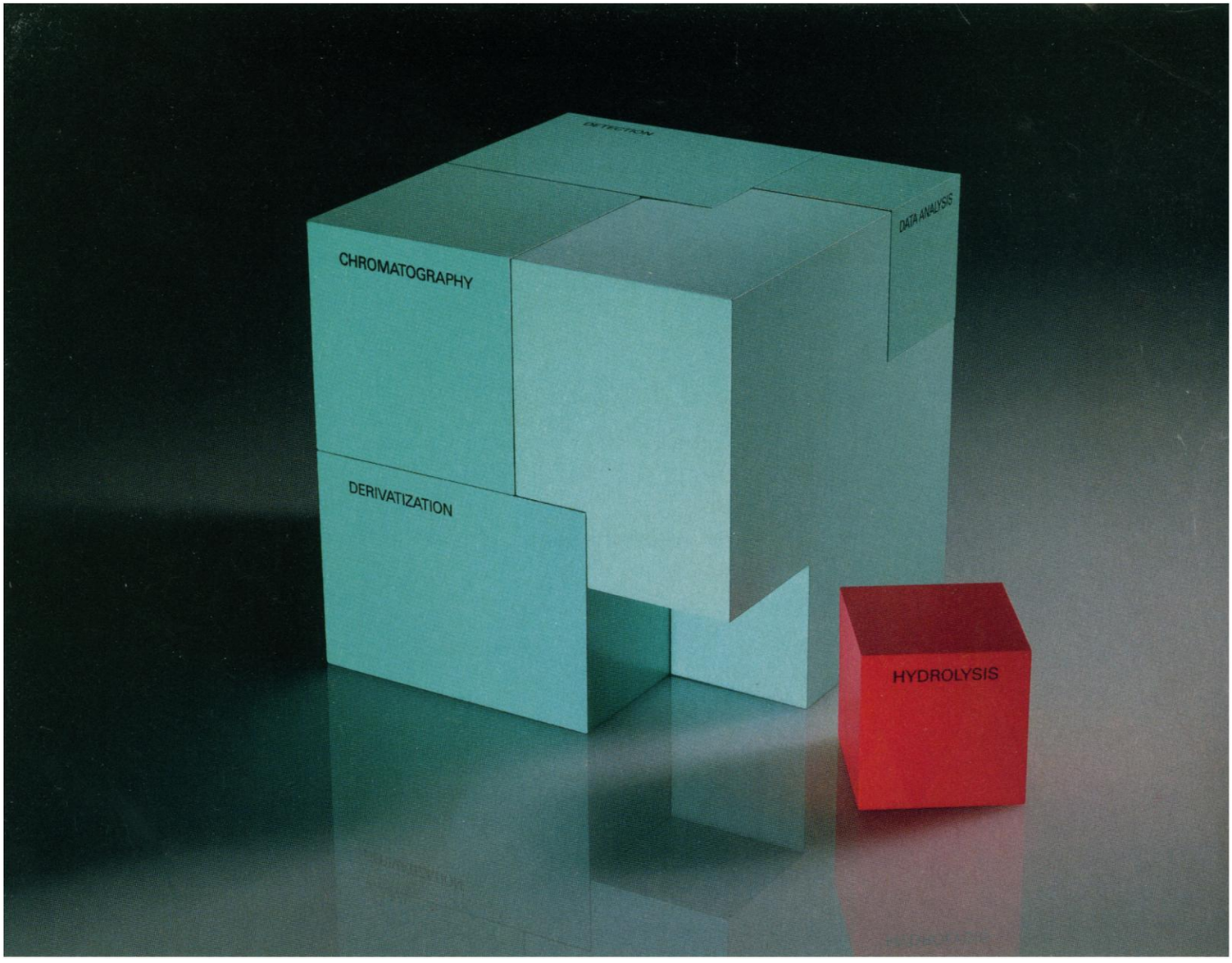
Isotopic clues to weathering and climate

In the geologic record, diverse clues can be found to ancient climate conditions and their effects. One such clue is described by Capo and DePaolo who studied variations in the ratio of strontium isotopes in calcium carbonate-rich sediments (page 51). Overall during the past 2.5 million years, the ratio of ^{87}Sr to ^{86}Sr increased. During three periods that were approximately 0.8 million years apart the ratio increased very rapidly whereas at most other times the ratio was stable or dropped. How do these ratio changes relate to paleoclimate and weathering? The episodes of rapid increase are best accounted for by accelerated chemical weathering of continental rocks. Precipitation and erosion release strontium from rocks and the rivers then carry the strontium to the oceans; riverine input has a higher $^{87}Sr/^{86}Sr$ than does input from other sources. The rate of weathering is a reflection of climate, and changes in the weathering rate serve as a proxy for climate change. On the longer time scale, the strontium record shows that the rate of weathering increased significantly along with the initial development of glacial cycles about 2.4 million years ago.

Synchronized singers

Crickets, cicadas, and katydids coordinate their chirps; fireflies flash in synchrony. These rhythmic synchronous insect behaviors have long been observed, but the phase locking has continued to be a mysterious phenomenon. Sismondo has now recorded Malaysian katydid songs and has mathematically analyzed the process of synchronization (page 55). The chirps of katydids are generated by their wings. The number of wing strokes per chirp varies between and is diagnostic of different species. Depending on the ambient temperature, the katydids chirped every 1.5 to 3.0 seconds. The synchronization of pairs of katydids could be accounted for by a mathematical formulation that considered duetting males as coupled oscillators. Once the pattern for synchronization was understood in theory, entrainment of pairs could be brought about experimentally with computer-iterated genuine chirps. The mathematical models that account for synchronization of chirping are thought likely to also account for the coordination of other forms of insect communication.

■ Ruth Levy Guyer



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