EDITORS' CHOICE

edited by Gilbert Chin

PHYSICS

A Clearer View of Cold Atoms

The sharpening of atomic energy levels with decreasing temperature is the motivation for using atoms cooled to just a fraction above absolute zero as the detection medium for metrological applications. Ultracold atom "fountains" already have been used in atomic clocks and in gravimeters and gravity gradiometers. However, the cooling process provides a thermal cloud of warmer atoms that surround the cold-atom core, and as detection of the atoms usually relies on monitoring fluorescence or absorption transitions between energy levels, these thermal atoms broaden the spectra and reduce sensitivity.

McGuirk *et al.* have used a balanced detection system in which the cold-atom cloud is separated into two equal populations and the differential fluorescence from atom states in each population cancels, thus reducing technical noise sources such as those associated with fluctuations in the probe laser amplitude and frequency. They also used a modulation transfer technique that selects only those atoms that are stationary, which would differentiate the cold atoms from the surrounding thermal cloud. This approach could lead to an improvement in the signal-to-noise ratio by nearly one order of magnitude. — ISO

Opt. Lett. **26**, 364 (2001).

CLIMATOLOGY

Beat Generation

Many records of North Atlantic climate show that the cold conditions that prevailed during the last glacial period were interrupted by rapid shifts to warmer conditions and nearly equally rapid returns back to cold. This pattern is commonly considered to have been caused by reversals of the ocean's thermohaline circulation. These events were neither periodic nor stochastic (random); while they often occurred at intervals of approximately 1500 years, they sometimes skipped a beat or two and recurred instead at an integral multiple of 1500 years.

Alley *et al.* suggest that "stochastic resonance" may underlie this pattern. In this scenario, a weak, periodic forcing of 1500 years, not strong enough itself to trigger a reversal of oceanic thermohaline circulation, interacts with random forcing events that originate with the extensive ice sheets that covered so much of the high-latitude Northern Hemisphere. When a random event of sufficient strength occurs at the right time within the periodic cycle, the combination changes ocean circulation and triggers a climate reversal. The statistical distributions of rapid climate changes recorded in the GRIP and GISP2 ice cores from Greenland appear to be consistent with this hypothesis. — HJS

Paleoceanography **16**, 190 (2001).

DEVELOPMENT

Male Order Growth Factor

The mechanisms that determine whether a fetus develops into a male or a female is a central question in embryology and has been debated for centuries. We now know that in mammals the primordial tissue that gives rise to the gonads passes through an "indifferent" stage, during which time it retains the potential to develop into either an ovary or a testis. However, the signaling pathways involved in this developmental decision, which establishes the sexual future of the organism, are not fully understood.

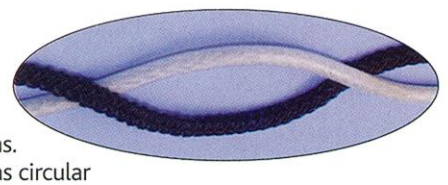
Important progress is reported by Colvin *et al.*, who have identified a new player in sex determination. In the course of characterizing mice deficient in fibroblast growth factor 9 (FGF9), which die at birth of lung abnormalities, the authors noted that a high percentage of the pups were female. Closer inspection revealed that about half of the phenotypically female mice were in fact genotypically XY males that had undergone sex reversal during development. The absence of FGF9 appeared to disrupt several early steps in development of the testis, including Sertoli cell differentiation, gonadal cell proliferation, and mesonephric cell migration. The evolutionary conservation of FGF signaling pathways raises the possibility that they may function in sex determination in many species. — PAK

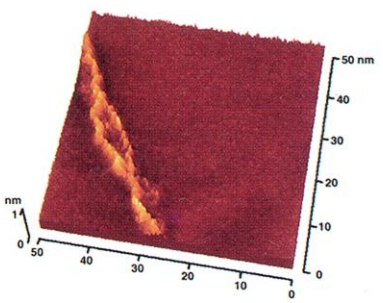
Cell **104**, 875 (2001).

POLYMER SCIENCE

Seeing Superstructure

Polymers with π-conjugated backbones tend to form helical superstructures that can alternate between left- or right-handed forms. Bulk probes such as circular dichroism can reveal the net handedness of these polymers, but measuring the structural details underlying helicity and understanding how it can switch will require direct methods. Shinohara *et al.* synthesized a polyphenylacetylene that has both main-chain and side-chain chirality. Using scanning tunneling microscopy (STM), they resolved two helical chains that intertwined with quaternary or interchain helical interactions to form a right-handed superhelix with a pitch of 2 nanometers. This structure was readily altered by the STM, so further work will aim at fixing polymers to the substrate to probe superhelicity in more detail and to image transitions between right- and left-handed helices. — MSL





An STM image (above) and a string model of a superhelical polymer.

SOURCE: SHINOHARA *ET AL., J. AM. CHEM. SOC.*, IN PRESS

J. Am. Chem. Soc., in press.

GEOLOGY

Canary Islands and Atlantic Tsunamis

Recently, giant submarine landslides, including some more than 20 kilometers long, have been recognized around Hawaii. Some slides may be responsible for generating large Pacific Ocean tsunamis. Krastel *et al.* have now identified a large number of submarine slides in the Canary Islands in the central Atlantic Ocean off the coast of Africa. Like Hawaii, the Canary Islands are volcanic in origin, although the magmas that formed the islands are richer in silica and water than those of Hawaii. The authors used sidescan sonar to map

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twelve landslides that apparently formed within the past 2 million years, some of which are near the youngest islands. Several of the slides may have volumes approaching 1000 cubic kilometers. The abundance of landslides exceeds that recognized on Hawaii, likely because of the steeper slopes and more varied rocks of the Canary volcanoes. Evidence for past landsides suggests a greater tsunami threat for the Atlantic region than had been realized from previous studies. — BH

J. Geophys. Res. **106**, 3977 (2001).

CONSERVATION BIOLOGY

Risk Analysis

Conservation and land use planners often desire information about the vulnerability of populations and of species to extinction—so-called population viability analyses (PVA). However, for most species there are insufficient existing data for such analyses, and so there is a need for a reliable method that can categorize species according to their extinction risk. Using population time-series data from the Global Population Dynamics Database for more than 750 species (representing mammals, birds, marine fish, and butterflies and moths), Fagan *et al.* identify three broad categories according to the class of population dynamics exhibited. They find that nonlinear effects are so pronounced for most populations that, during a 100-year period, extinction is the likely outcome unless inward dispersal of new individuals can replenish them. — AMS

Ecol. Lett. **4**, 132 (2001).

CELL BIOLOGY

Reversal of Fortune

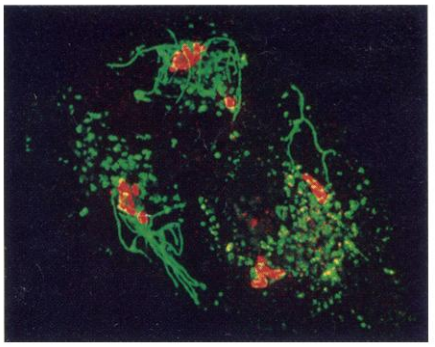
Cholera toxin is composed of two polypeptides linked by a disulfide bond. In order to intoxicate target intestinal epithelial cells, a fragment of the A chain, A1, must be transported across one of the host cell membranes to gain access to the cytosol. In the cytosol, A1 goes on to attack the cellular signal transduction apparatus and to stimulate opening of chloride channels, resulting in massive chloride and water secretion. The entry process for the toxin has been very well studied. However, Tsai *et al.* have now uncovered an unanticipated, critical step in cholera toxin activation. An enzyme in the endoplasmic reticulum, protein disulfide isomerase, appears to act as a kind of redox-regulated chaperone for incoming toxin (an assembly of five B chains and the disulfide-linked A1 and A2 peptides), promoting disassembly, reduction, and unfolding in order to allow translocation of the killer A1 chain across the membrane and into the cytosol; this sequence of steps recapitulates the biosynthesis of the toxin, except in reverse order. — SMH

Cell **104**, 937 (2001).

MICROBIOLOGY

Of Invaders and Islets

Salmonella bacteria enter cells lining the gut and survive within a membrane-bounded vacuole. Normally, organisms that invade cells are attacked by host lysosomes (which contain degradative enzymes), but *Salmonella* manages to thwart attack by preventing its vacuole from fusing with a lysosome. A few hours after entry, the *Salmonella*-containing vacuole forms an extensive network of tubular filaments, possibly for nutrient uptake, but no one knows how this happens.



Lysosomal glycoproteins labelling *Salmonella*-induced filaments (Sifs, green), with *Salmonella typhimurium* (red), in Henle epithelial cells.

Salmonella typhimurium has two syringe-like delivery systems, which it uses to inject virulence determinants into the host cell. These are encoded by two major gene clusters called pathogenicity islands and by other minor regions or islets. Brumell *et al.* show that a protein called SifA, which is key to the formation of the tubular filaments, is one of the virulence determinants injected by the bacterium. Although its mode of action remains unknown, SifA is essential for the survival of *Salmonella* during systemic infection when it colonizes host macrophages that normally are aggressively protective. SifA appears to be one of a family of proteins encoded by pathogenicity islets, sharing conserved motifs required for injection into the host cell, and that operate in concert to modulate host-cell function. — CA

Cell. Microbiol. **3**, 75 (2001).

CREDITS: JOHN H. BRUMELL AND B. BRETT FINLAY