EDITORS' CHOICE

edited by Gilbert Chin

ASTROPHYSICS

One Pulse Leads to Another

A gamma ray burst (GRB) is an extremely energetic and short-lived fireball, whose origin is not understood. In a series of three papers, Ruffini *et al.* describe a new model for GRB formation based on an electromagnetic black hole. They propose that a massive star collapses because of gravity and forms a black hole with a strong electric field. Electron and positron pairs are created in the condensing material, and these pairs collide, releasing a pulse of plasma outward. This pulse expands at nearly the speed of light and collides with the baryonic matter left over from the progenitor star, creating a second pulse containing electron and positron pairs as well as photons, baryons, and electrons. Eventually, the density of the material in the pulse reaches a level where the gamma ray radiation can be detected by observers.

The baryonic matter continues to accelerate outward, reaching ultrarelativistic speeds, into the interstellar medium, and a high-speed collision with any structure in the interstellar medium would then create an afterglow. If a second star is lurking near the electromagnetic black hole, the accelerated baryonic matter would trigger a supernova upon collision.

Thus, this model, without positing unusual physical properties of the progenitor, can account for many of the recent observations of GRBs, particularly their afterglows and the correlation with some supernovae. If GRBs do form from electromagnetic black holes, then astronomers will be able to use GRBs as standard candles to estimate cosmic distances and probe the properties of the early universe. — LR

Astrophys. J. **555**, L107; L113; L117 (2001).

MATERIAL SCIENCE

Shaken and Stirred to Order

The fabrication of structured materials usually can be described as top-down or bottom-up, reflecting utilization of a lithographic patterning approach or self-assembly technique, respectively. The self-assembly of smaller objects into larger entities is particularly attractive due to the anticipated capacity to form three-dimensional structures rapidly and cheaply. Although self-assembly has proven successful for subunits of nanometer and millimeter sizes, the fabrication of three-dimensional structures with periodicity on the scale of optical wavelengths (i.e., micrometer-sized subunits) has been difficult to realize.

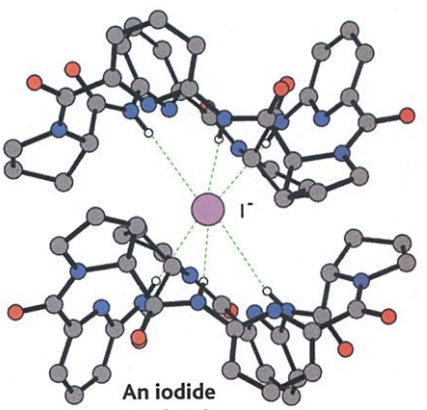
Clark *et al.* describe a hybrid technique using lithographically patterned, 10- to 30-micrometer–sized polyhedral metal plates, the faces of which have been functionalized with a monolayer of either hydrophobic or hydrophilic molecules. When placed in water and agitated, the pieces assemble themselves into ordered three-dimensional arrangements. Controlling the geometry and chemical properties of each face is expected to provide a broad parameter space that will allow a tailoring of flexibility and the interactions between pieces in the final structure. — ISO

J. Am. Chem. Soc., 10.1021/ja010641.

CHEMISTRY

Anion Capture

Anions in biological systems often are captured and bound by hydrogen bonds alone. In contrast, artificial systems for anion complexation in water generally require stronger forces, such as electrostatic interactions, to overcome the high solvation energy of many anions.



An iodide sandwich.

Kubik *et al.* describe a ligand (made from proline and 6-aminopicolinic acid) that works in spite of the absence of such strong interactions. Their system resembles a molecular capsule, with two identical cyclic hexapeptides assembling to form a cavity that holds the anion and shields it from solvent. Complexes of halides and sulfate were detected, and a crystal structure of the complex with iodide showed that there are no direct interactions between the peptides. Instead, the assemblage is stabilized entirely by hydrogen-bonding interactions between the anion and the N-H groups of the ligands. This system may serve as a model for the recognition of anions by natural receptors and as a complement to the established recognition of cations by the other portion of the peptide bond, the carbonyl group. — JU

Angew. Chem. Int. Ed. **40**, 2648 (2001).

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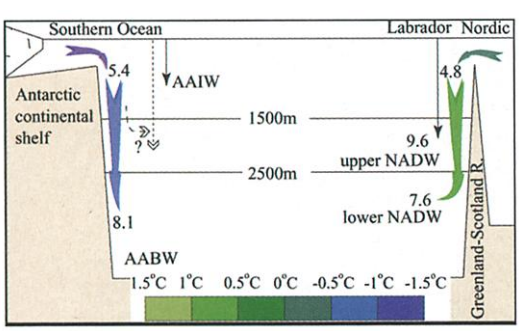
CLIMATOLOGY

No Deepwater Slowdown?

The deepest waters of the ocean—North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW)—originate from polar surface waters that sink and then spread over the ocean bottom toward the opposite poles, redistributing heat, salinity, and nutrients. Formation rates of NADW and AABW have varied considerably over glacial-interglacial cycles, and it has been proposed that during the 20th century the production of AABW may have slowed as part of a 1500 year–long cycle of iceberg rafting.



Deep water formation.

Orsi *et al.* compare measurements of CFCs and radiocarbon, and observations from current meters, in AABW and NADW to show that ventilation rates from the poles are comparable and that they provide no evidence of a recent reduction in AABW formation. Their analysis does not rule out the possibility that significant variability in formation rates has occurred since the Little Ice Age 500 years ago or that global warming will affect the rates in the future. — HJS

Geophys. Res. Lett. **28**, 2923 (2001).

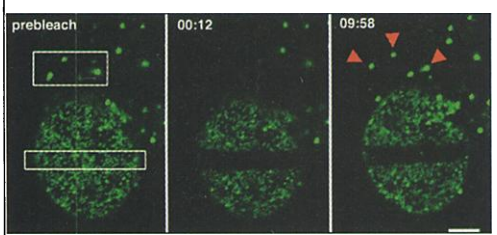
SOURCE: (LEFT) ORSI ET AL., *GEOPHYS. RES. LETT.* 28, 2923 (2001); (RIGHT) KUBIK ET AL., *ANGEW. CHEM. INT. ED.* 40, 2648 (2001).

CELL BIOLOGY

Stable, yet Dynamic

The nucleus of eukaryotic cells is surrounded by a double membrane, the nuclear envelope (NE), which contains nuclear pore complexes (NPCs) that allow nucleocytoplasmic movement of proteins and RNAs during interphase. The nuclear envelope breaks down during mitosis, releasing the nuclear contents and enabling segregation of replicated chromosomes into the two daughter cells.

Daigle *et al.* examined the characteristics of NPCs in situ using fluorescently tagged nuclear pore proteins. In interphase, the pores were remarkably still; no disorderly pore movement was observed although large arrays of NPCs moved en bloc as the nucleus changed shape. In addition, fluorescence recovery after photobleaching (FRAP) measurements revealed that almost no turnover of NPC components occurred. However, during mitosis, NPCs completely disassembled and were then recruited to chromatin near the end of mitosis at anaphase. This malleable network of nuclear pores is likely to be important in maintaining intranuclear structure and function. — SMH



NPCs are stable in the nucleus (lover box) and mobile in the cytoplasm (red arrowheads).

J. Cell Biol. **154**, 71 (2001).

MICROBIOLOGY

Microbial Alchemy

Submarine thermal venting systems are a cauldron of exotic life forms. They have considerable economic potential, because extant and ancient hydrothermal systems are foci of precious metal deposits. Bacteria are well known to be associated with economically important iron and zinc deposits, and living bacterial mats on and within hydrothermal vents are known to contain high concentrations of silver salts.

Kashefi *et al.* have now shown that, in vitro, several species of thermophilic iron-reducing Archaea and Bacteria can precipitate purple colloidal gold onto their cell surfaces from 1.5 mM Au(III) bicarbonate buffered solution. Generally, hydrogen is the preferred electron donor, at least for the archaean *Pyrobaculum islandicum* and the bacterium *Thermotoga maritima*, but not all Fe(III) microorganisms reduce Au(III), which suggests that a specific hydrogenase at the bacterial cell surface may be responsible. — CA

Appl. Environ. Microbiol. **67**, 3275 (2001).

BIOTECHNOLOGY

Detecting Body Odors

Apart from perfumers and oenophiles, humans generally exhibit a undiscriminating sense of smell, unlike many other mammals. Nevertheless, the possibility that human odors may influence behavior does exist, and volatile components in urine underlie the known preference of mice to mate with individuals possessing a different set of major histocompatability complex (MHC) antigens.

Montag *et al.* have developed an artificial nose consisting of two volatile-detecting modules: A quartz microbalance measures mass, and a semiconducting metal oxide–based gas sensor monitors reaction with oxygen. This so-called electronic nose (e-nose) was able to categorize urine samples from mice in a MHC-dependent manner. It also could discriminate human serum samples collected from subjects with a range of human leukocyte antigen (HLA) haplotypes. — GJC

Proc. Natl. Acad. Sci. U.S.A., 10.1073/pnas.161266398.

ECOLOGY/EVOLUTION

Neatness Counts

The reproductive behavior of the three-spined stickleback, *Gasterosteus aculeatus*, is familiar to many biologists. In this species, the male builds a tunnel-shaped nest on a stream or pond bed, and entices gravid females to lay their eggs therein; he then guards and fans the fertilized eggs until they hatch. The nest itself, as well as the male's courtship behavior, might be a reliable indicator to females of the male's quality. Stickleback nests are constructed from filamentous algae and other plant material, glued together with a glycoprotein secretion from the kidney, whose production is androgen-dependent. Barber *et al.* show that the compactness (density) and neatness (scarcity of loose ends) of the nest correlate positively with relative weight of the kidney and negatively with spleen size (an indicator of immunological stress). They suggest that the nest might therefore function as a condition-dependent male ornament that is assessed, in some fashion, by potential mates. — AMS

Behav. Ecol. **12**, 390 (2001).

CREDITS: DAIGLE *ET AL.*, *J. CELL BIOL.* **154**, 71 (2001)