THIS WEEK IN Science

edited by Phil Szuromi

Binary Black Holes

Models of galactic evolution suggest that black-hole binary systems should be found in quasars and radio galaxies and that they are created during the merging of galaxies. **Sudou *et al.*** (p. 1263) measured elliptical motion in the core of radio galaxy 3C 66B and infer that this motion is caused by a supermassive black-hole binary system. These high-resolution results are consistent with the presumed merger history of giant elliptical galaxies like 3C 66B.

Dipoles in Cold Metal Clusters

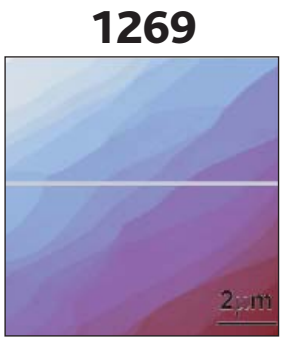
A number of bulk ionic materials are ferroelectric—an applied electric field shifts atoms in the lattice and creates a permanent dipole moment. Metals generally cannot be polarized in this way because their conduction electrons neutralize the induced fields. **Moro *et al.*** (p. 1265) now report that certain metals like niobium, in the form of small atomic clusters (3 to 100 atoms), show a normal response at room temperature but a substantial ferroelectric response under cryogenic conditions (~20 K) that corresponds to dipole moments up to several Debye. They account for this effect in terms of a quantum mechanical model in which the charge carriers adopt an asymmetrical distribution that cannot fully relax.

Metals Up Close

The effect of defects and faults on the structure and mechanical behavior of metals is the subject of two reports. Defects can affect the mechanical behavior of metals through their control of crystallite size. **Lucadamo and Medlin** (p. 1272) now show that defects also control the local packing of the atoms. High-resolution electron microscopy revealed that atoms around defects in gold, a face-centered cubic metal, are hexagonally close packed. The authors use dislocation theory to extend their analysis to a number of grain-boundary orientations. Nanocrystalline metals can be much harder than coarser-grain conventional metals, and their deformation mechanisms can change from that of dislocation slip to one in which there is deformation twinning that forms through stacking faults. This behavior has been seen in simulations of nanocrystalline aluminum, despite the high energy required to form stacking faults in this metal. **Chen *et al.*** (p. 1275 ✂; see the Perspective by **Bilde-Sørensen and Schiøtz**) now confirm these results and observed twinning in transmission electron micrographs when the aluminum grain size was sufficiently small.

Electronics Made Transparent

The development of transparent electronics, which could find use in multilevel displays, relies on the use of wide band-gap semiconductors. However, previous efforts to produce high-quality devices, specifically transistors, have generally failed because of the poor electronic properties of the materials. **Nomura *et al.*** (p. 1269; see the Perspective by **Wager**) have developed a high-temperature technique for preparing high-quality transparent oxide semiconductors. They use this material with a rare-earth oxide as the gate dielectric to fabricate transparent transistors that are insensitive to visible light. The devices exhibit on-off ratios exceeding 10^6 and electron mobilities of ~80 square centimeters per volt per second.



Question of Degrees

The only reconstruction that has been performed on satellite-based data of temperature changes in the middle to upper troposphere during the past 30 years showed minimal temperature change over that interval. **Santer *et al.*** (p. 1280) present a new tropospheric and stratospheric temperature reconstruction, based on the same data as the earlier version, to show that substantial warming of the troposphere has occurred from 1979 to 2001. They identify a "fingerprint" of combined anthropogenic and natural factors that are consistent with the new analysis showing tropospheric warming but not with the old one, which shows virtually no overall warming. They discuss the implications of observational uncertainty for climate-change detection studies. ✂

From Stem Cells to Oocytes

Mouse embryonic stem cells can differentiate into cells of all three embryonic germ layers—endoderm, mesoderm, and ectoderm. However, they had not been observed to give rise to germ cells in vitro. **Hübner *et al.*** (p. 1251; see the cover and the 2 May news story by **Vogel**) isolated a population of cells that express a germ line–specific gene and followed the fate of these cells in cultures to establish conditions whereby they differentiate toward a germ-cell lineage. These in vitro differentiating germ cells go through meiosis to form mature oocytes and subsequently develop into blastocyst-like structures. Hence, these cells are totipotent rather than pluripotent, as was previously suggested. ✂

Male-Fertility Factor

During meiosis, the number of chromosomes in gametes is cut in half so that subsequent fusion of egg and sperm can reconstitute the full chromosomal complement. **Crackower *et al.*** (p. 1291) show that when the factor Fkbp6 is inactivated in mice, fertility and meiosis of females is normal, but males are infertile. Similarly, a spontaneous mutation of Fkbp6 in rats produces a male-sterile phenotype. This work shows that Fkbp6 functions in chromosomal pairing and is crucial for sex-specific fertility.

Keeping the Signals Fresh

For cells to remain responsive to stimuli such as light or odor, activated G protein–coupled receptors (GPCRs) must be rapidly desensitized. G protein–coupled receptor kinases (GRKs) play a role in regulating G protein signaling by interacting both with GPCRs and with heterotrimeric G proteins. **Lodowski *et al.*** (p. 1256) have determined the structure of GRK2 complexed to G

CONTINUED ON PAGE 1199

CREDITS: (TOP TO BOTTOM) NOMURA *ET AL.*; LUCADAMO AND MEDLIN

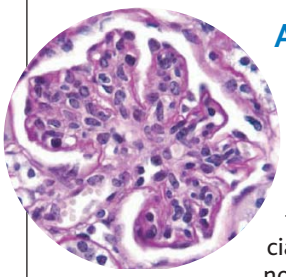
protein βγ subunits (Gβγ). The three signaling domains of GRK2 act together to recruit GRK2 to the membrane and orient it to facilitate phosphorylation of GPCRs. This orientation would allow GRK2 to simultaneously bind the GPCR and Gβγ and Gα subunits and provide a mechanism for efficient attenuation of heterotrimeric G protein signaling.

Putting DNA Sequences Back to Work

Repetitive *Alu* sequences are part of the nonprotein coding "junk" DNA, but mutations in these sequences can form coding exons. Although this process is associated with disease in some cases, it also is a way for the genome to evolve. **Lev-Maor *et al.*** (p. 1288; see the Perspective by **Makalowski**) have assembled a database of "exonized" *Alu* elements and identified the particular sequences and positions that can allow the crucial splicing to occur. They tested their proposed mechanism in a mini-gene construct and found that a single mutation can result in exonization.

Infectious Synapse

Dendritic cells (DCs) may play a role in host-pathogen interactions. For example, certain proteins expressed on DCs, such as DC-SIGN, can stimulate the efficiency of infection of target cells by the human immunodeficiency virus (HIV). **McDonald *et al.*** (p. 1295) visualized individual particles of HIV in living cells and found that DC-associated HIV was recruited to the site of contact with target cells such as T cells. Simultaneously, the HIV receptor and coreceptor were recruited to the contact site. This recruitment effectively concentrates HIV, its receptor, and its coreceptor and presumably facilitates infection.



1298

Avoiding Protein Pile-Ups

The glomerular basement membrane (GBM) is a filtration barrier in the kidney that permits the loss of excess water while preventing the loss of valuable proteins. Several human renal diseases are characterized by an accumulation of immune complexes in the GBM, but **Kim *et al.*** (p. 1298) suggest that this condition may not be caused by immune dysfunction associated with disease pathology. Rather, the authors observed abnormal protein accumulation in the GBM of mice deficient in CD2AP, an adaptor protein expressed in podocytes that comprise the GBM. CD2AP-deficient podocytes were defective in degrading endocytosed material. Susceptibility to human renal disease may be determined in part by the intrinsic capacity of the GBM to clear proteins that the kidney normally encounters.

Getting Around a Block in the Opposing Lane

A method for the unambiguous analysis of DNA replication on the leading and the lagging strands in *Escherichia coli* has been developed by **Pagès and Fuchs** (p. 1300). They find that when a specific lesion that transiently arrests DNA replication is placed on one strand, it does not inhibit replication on the other. The normally coordinated leading and lagging strand replicase system in vivo is uncoupled, and replication proceeds through specialized "repair" polymerases.

Time-Traveling Butterflies

Monarch butterflies fly enormous distances during their seasonal migrations by using the Sun for navigation. How can the butterflies compensate for the Sun's change in position throughout the day? **Froy *et al.*** (p. 1303; see the news story by **Pennisi**) show that the butterfly's circadian clock supplies a "time-of-day" input to the navigation system so that the correct direction can be maintained. Without a functioning clock, the butterflies become disoriented. Ultraviolet light drives the Sun-position system and visible light drives the time-of-day system.

CREDIT: KIM *ET AL.*

Putting DNA Sequences Back to Work

Science **300** (5623), 1197.
DOI: 10.1126/science.300.5623.1197i