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COVER

The large-scale structure of the universe is believed to be weblike, as revealed in this supercomputer simulation. The image shows a three-dimensional isosurface of the baryonic material (gas) in a volume that is 175 by 130 by 175 million light years on a side. A rich cluster of

galaxies has formed at the center of the volume. Material continually accretes onto the cluster along the filamentary structures, giving rise to the stormy infracluster conditions discussed in the Review beginning on p. 400. [Image: Chris Loken, University of Missouri-Columbia]

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THIS WEEK IN SCIENCE

edited by PHIL SZUROMI

Stormy clusters

Clusters of galaxies are huge, gravitationally bound systems composed of about 1 percent visible galaxies, 15 percent intracluster gas, and 84 percent unseen matter (some form of dark matter that holds the entire cluster together). Burns (p. 400) reviews observations and modeling of these clusters which indicate that clusters have structure; complicated clumps of galaxies are woven together by irregular filaments, sheets, or walls into a weblike pattern with huge, empty void spaces (see cover). High, nonequilibrium temperatures and high relative velocities between galaxies indicate that clusters have collided, increasing the stormy conditions within the clusters. Many more collisions will occur until clusters will settle down into spherical balls of galaxies and gas in equilibrium with their dark matter.

Strange matter

Strange matter can be described as a soup of quarks, which are the elementary particles that make up protons and neutrons. Cheng et al. (p. 407) have developed a model for the unusual hard x-ray burster GRO J1744-28 (discovered by the Compton Gamma-Ray Observatory) that includes the formation of some strange matter. In their model, a star that accretes too much mass can cause the "crust" of the star to crack, and the released mass is converted to strange matter that subsequently produces a fireball that expands outward. The relativistically expanding fireball interacts with the surrounding interstellar medium, which then creates shock waves that produce a burst of x-ray radiation. The intensity, duration, and spectrum of the modeled x-ray burst

T cell specificity and cathepsins

The repertoire of CD4⁺ T cells that eventually circulate through the body are a result of careful culling to prevent autoreactivity or immunodeficiency. This selection process is initiated by major histocompatibility complex class II-expressing antigen presenting cells (APCs) in the thymus: The cortical epitheliuim initiates maturation of those T cells with helpful specificities, and the hematopoietically derived APCs identify autoreactive T cells that will ultimately die. Nakagawa et al. (p. 450; see the commentary by Creswell p. 394) have found that the cysteine protease cathepsin L is critical for the degradation of the invariant chain (Ii) of class II—but only in thymic cortical epithelium. Because Ii occupies the peptide binding site of class II molecules, the cathepsin L-deficient cortical epithelium was apparently unable to present the appropriate peptides to developing T cells. The lack of a positive selection signal led to a reduction in the number of mature CD4⁺ T cells. The activity of the various cathepsin family proteases was different in different tissues, so this result may offer some explanation for how stimulation of T cells by different types of APCs can have different consequences: The array of peptides that ultimately are presented may depend on the activity of the particular cathepsin active in that particular APC.

is consistent with recent observations of GRO J1744-28, which indicate that the x-ray burster may be associated with a strange star.

Refractory inclusions: All together then

Calcium and aluminum-rich inclusions (CAIs) found in carbonaceous chondrites and more rarely in ordinary chondrites have been inferred to represent some of the first solid particles formed in the solar nebula. The abundances of oxygen isotopes in CAIs from carbonaceous chondrites have been used to determine their spatial and temporal origin in the solar nebula. Now, McKeegan et al. (p. 414) measured the oxygen isotopic abundances of three CAIs from ordinary chondrites. They found a similar enrichment of oxygen-16 in the ordinary chondrite CAIs as had been found in the carbonaceous chondrite CAIs. This result suggests that the CAIs in all chondrites formed in a similar and restricted region of the solar nebula. Because ordinary chondrites are assumed to have been formed in a different region of the solar nebula than the carbonaceous chondrites, these CAIs must be distributed unevenly into different parts of the solar nebula.

Carbonates tainting meteorites

The Tatahouine meteorite fell in southern Tunisia on a limestone hill slope covered with a sandy soil on 27 June 1931. Samples were recovered that day and again in 1994. Barrat et al. (p. 412) compared the samples and found that the 1994 fragments contained carbonate within the fractures, whereas the 1931 fragments did not. They measured the carbon isotopes of the carbonates and found the isotopic data consistent with contamination from the sandy soil in which the samples were recovered.

Stranded crust

The Kerguelen Plateau, one of Earth's largest oceanic plateaus, formed during the opening of the Indian Ocean when India and Australia rifted away from Antarctica. Hassler and Shimuzu (p. 418) used osmium isotope data to show that the plateau is underlain by pieces of Precambrian continental lithosphere. One possibility is that a piece of Gondwanaland was delaminated and stranded in the Indian Ocean during rifting.

Optimizing operators

In many coherent spectroscopic methods, such as nuclear magnetic resonance (NMR), the experimentalist wants to maximize the observed signal to shorten the data collection process. Such measurements are made on ensembles of quantum states rather than pure states, and the observables have imaginary parts that correspond to the action of non-real-valued,



or non-Hermitian, operators. Thus the methods that would optimize Hermitian operators will in general not lead to the best solution. Glaser *et al.* (p. 421; see the commentary by Warren, p. 398) describe a gradient-based procedure for optimizing these transformations that also has applications in applied mathematics and control theory.

(Continued on page 355)

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1. "The I.M.A.G.E Consortium: An Integrated Molecular Analysis of Genomes and their Expression", Lennon, G.G., Auffray, C., Polymeropoulos, M., and Soares, M.B. [1995] Genomics.

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(Continued from page 353)

Hydrogen from solar cells

Splitting water into hydrogen and oxygen with sunlight is one of the most important goals of photoelectrochemistry. However, the *p*-type semiconductors most suitable for hydrogen generation often cannot produce sufficient voltage bias to actually perform the reaction. Khaselev and Turner (p. 425; see the news story by Service, p. 382) have made the sunlight do double duty—a *p*-type GaInP₂ layer adsorbs visible light to perform the electrochemistry that generates hydrogen, and it is sandwiched to a GaAs junction that adsorbs near-infrared light to generate an electrical potential that gives the p-GaInP₂ electrode sufficient bias. The authors report an efficiency greater than 12 percent.

Tracked in the GI tract

Understanding the events that occur immediately (within days or weeks) after infection with the human immunodeficiency virus (HIV) could be important in understanding and preventing the cascade of events that follow and lead to disease. Veazey *et al.*



(p. 427) studied SIV (simian immunodeficiency virus) infection of macaques and found that before changes are apparent in peripheral lymphoid tissues (which are the most extensively studied tissues in HIV infection), the lymphoid tissues of the gastrointestinal tract are the major site of SIV replication and CD4⁺ T cell loss.

Clathrin and AP3 adaptor complex

Different classes of clathrincoated vesicles are used in receptor-mediated endocytosis at the cell surface and to sort secretory and lysosomal proteins



upon export from the Golgi complex. Adaptor proteins appear to mediate the sorting of membrane proteins into clathrin coats. Two types of adaptor (AP-1 and AP-2) are well known at the two sites. A third class of adaptors (AP-3) was identified recently with a role in signal-mediated protein sorting to endocytic compartments but was not thought to interact with clathrin. Dell'Angelica et al. (p. 431) now show that the AP-3 complex does in fact interact with clathrin on Golgi and endosome-associated coats.

Stress and potassium channels

Stress causes many changes in organismal physiology. Xie *et al.* (p. 443) examined the effects of stress hormones on the expression of a class of potassium channels in rat adrenal chromaffin tissue. Reductions in the level of the stress-related hormone adrenocorticotrophic hormone led to changes in the levels of alternatively splice variants of the messenger RNA that encoded a calcium and voltage-activated potassium channel. This process would be expected to alter the excitability properties of the chromaffin cells and thus how they secrete catecholamines which would have further effects on many other organs, including the heart.

Soil and CO₂

The effects of elevated \overline{CO}_2 on below-ground ecosystem processes and biota is reported by Jones *et al.* (p. 441). Using model ecosystems created in the Ecotron facility, they identified alterations in community composition, exemplified by changes in fungi and Collembola species, and in biogeochemistry, as indicated by enhanced cellulose decomposition. The work suggests that that rising atmospheric CO_2 concentrations may significantly impact long-term feedback in soil processes.

Back and forth

Development in higher plants alternates between diploid and haploid generations. Grossniklaus *et al.* (p. 446) have identified in *Arabidopsis* a genetic mutant that particularly affects the haploid gametophyte generation. The gene, *medea*, resembles genes encoding members of the Polycomb group of proteins, some of which regulate expression of homeotic genes in *Drosophila*.

Technical Comment Summaries

Counting the Fingers of Birds and Dinosaurs

A. C. Burke and A. Feduccia studied the embryonic development of fingers and wrists in extant amniotes (egg-laying animals) (Reports, 24 Oct., p. 666) and concluded that the three digits seen in birds are not homologous to the three digits seen in theropod dinosaurs. In an accompanying Perspective (p. 597), R. Hinchliffe wrote in favor of "[evolutionary] convergence (rather than common origin) as an explanation of the similarities between the structure of the forelimb of theropods and the wing of [the ancient bird] *Archaeopteryx.*"

S. Chatterjee defends the birds-from-dinosaurs idea by reviewing work in several disciplines. He describes the "topographic position" of the digits in embryos as they develop and discusses ways that "digital reduction" could have occurred through evolution (in many species, fingers were reduced from five to two or three). He concludes that a "synthesis of both neontological and paleontological data" supports the theropod origin of birds. J. P. Garner and A. L. R. Thomas question "assumptions" made in the report and describe how the developmental data therein are actually "entirely consistent with a theropod origin of birds."

In response, Burke, Feduccia, and Hinchliffe discuss each point of criticism and describe how the theropod hand most likely developed (in the embryo) in a fashion consistent with the highly conserved pattern of development among amniotes. They maintain that the birds-from-dinosaurs idea is "inconsistent with the observations and current evidence of comparative embryology."

The full text of these comments can be seen at www.science mag.org/cgi/content/full/280/5362/355a

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NATO Science

Programme

Programme Changes -1998

Overview

Following a wide-ranging review of the NATO Science Programme, the NATO Science Committee has decided that the Programme will in future provide assistance primarily for scientific collaboration between NATO-country scientists and scientists in NATO's Partner countries, including those participating in the Mediterranean Dialogue. 1998 will be a year of transition, when support will initially be available for both NATO and NATO-Partner collaboration, but will progressively move during the year towards support for exclusively NATO-Partner collaboration. Applications for support in 1999 will only be considered if they involve collaboration between NATO-country scientists and Partner-country scientists. NATO countries and Partner countries eligible for support under the Programme are listed below.

The New Programme

The NATO Science Programme now offers support for scientific collaboration in general science, and in a number of Priority Areas, between NATO-country scientists and scientists in NATO's Partner countries. The following types of collaborative activity are supported: Advanced Study Institutes (ASIs), Advanced Research Workshops (ARWs), Collaborative Research Grants (CRGs), Linkage Grants (LGs), Expert Visits (EVs) and Networking Infrastructure Grants (NIGs). Support for applied industrial and environmental R&D projects in Partner countries, in collaboration with NATO country counterparts, is also available under the Science for Peace (SfP) Programme. Notes for Applicants and specific application forms for these activities are available from the Scientific Affairs Division, or at the NATO science web site.

The Priority Areas in 1998 are Environmental Security, High Technology, Disarmament Technologies, Science and Technology Policy, and Computer Networking.

NATO Science Fellowships are also supported. While precise eligibility criteria vary from country to country, fellowships are generally available to both Partner scientists and NATO scientists. Science Fellowships are administered in NATO countries, and contact information for National Fellowships Administrators is available from the Scientific Affairs Division or at the NATO science web site.

Application Deadlines

• The annual deadlines for receipt of applications in areas of **General Science** for the different types of activity are:

Advanced Study Institutes & Advanced Research Workshops: 1 February & 1 July

Collaborative Research Grants, Linkage Grants & Expert Visits: 31 March, 15 August & 30 November

- The annual deadlines for receipt of applications in **Priority Areas**, for all types of activity, are 15 January, 15 May and 15 September.
- The remaining 1998 deadline for receipt of proposals under the Science for Peace Programme is 15 May.

Spotlight on Changes

Applications for Intra-Alliance **Collaborative Research Grants** will no longer be accepted for support after the published deadline of 31 March 1998. For the subsequent published deadlines of 15 August and 30 November 1998 for General Science CRGs, only applications for collaboration between scientists in NATO and Partner countries will be considered for support. Further support criteria are specified in current Notes for Applicants.

Applications for Intra-Alliance **Advanced Study Institutes** will no longer be accepted for support after the published deadline of 1 July 1998. For the subsequent published deadlines of 1 February 1999 and 1 July 1999 for General Science ASIs, only applications for ASIs having two co-directors, one from a NATO country and one from a Partner country, will be considered for support. Further support criteria are specified in current Notes for Applicants.

As regards ASI applications submitted for the deadline of 1 July 1998, preference will be given to those with a more balanced participation of ASI students between NATO and Partner countries, that is with 40-50% coming from Partner countries. The ASI may be held in either a NATO country or a Partner country.

Scientific Affairs Division NATO 1110 Brussels, Belgium NATO Science Web Site - http://www.nato.int/science

NATO countries: Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, United Kingdom, United States.

<u>Partner countries eligible for support</u>: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, the former Yugoslav Republic of Macedonia¹, Turkmenistan, Ukraine, Uzbekistan

Mediterranean Dialogue countries eligible for support on a case-by-case basis: Egypt, Israel, Jordan, Mauritania, Morocco, Tunisia

¹ Turkey recognises the Republic of Macedonia with its constitutional name.

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