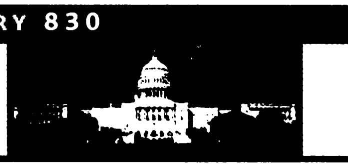
LEAD STORY 830
Lobbying for U.S. science


836
Physicist in Albania's political hot seat

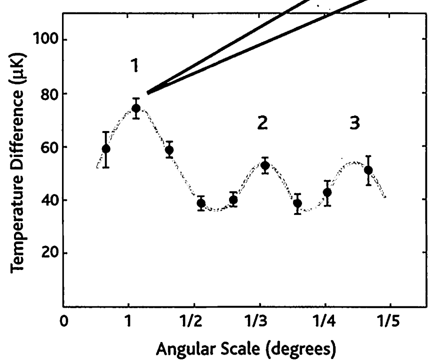
837
Ozone and the lungs

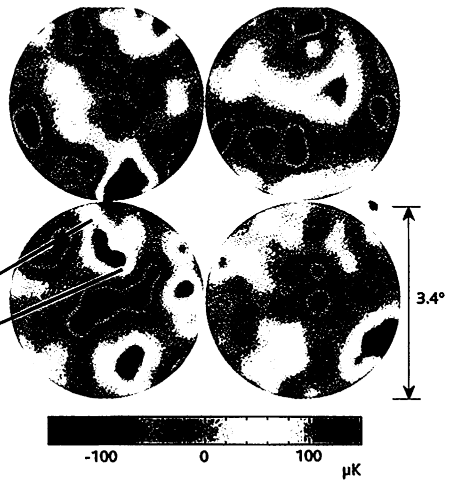
with the draft human genome sequence (www.ensembl.org). NHGRI is encouraging a bioinformatics group led by David Haussler and Jim Kent at the University of California, Santa Cruz, to do the same on their Web site (genome.ucsc.edu). "I can't give you a timetable for completion" of this work, says Haussler, but "people in the mouse community should stay tuned." —ELIOT MARSHALL

ASTROPHYSICS

Echoes of the Big Bang Put Theories in Tune

WASHINGTON, D.C.—What once was lost has now been found, and cosmologists are rejoicing. On 29 April at a meeting here of the American Physical Society,* three research groups announced that independent measurements of the cosmic background radiation had solved a troubling mystery posed by earlier data. As a result, scientists from two different branches of cosmology are putting aside their differences and are coming to a long-anticipated concord on a model of the early cosmos and the fraction of "ordinary" matter the universe contains.





Good vibrations. Size distribution of cosmic ripples shows a major peak near 1°.

"This weekend, I think, is going to be a benchmark that's going to be remembered for a long time in this field," says Andrew Lange, a physicist at the California Institute of Technology in Pasadena. Physicist Max Tegmark of the University of Pennsylvania in Philadelphia agrees. "This is like Santa Claus is arriving," he says.

What has everyone so excited is a follow-up to arguably the biggest physics story of 2000: preliminary results from BOOMERANG, a balloon-borne instrument tuned to listen for the microwave whispers from the early universe (*Science*, 28 April 2000, p. 595). Until about 300,000 years after the big bang, the universe was a roiling blob of plasma, ringing with pressure waves from the cataclysm that created it. According to the reigning acoustic model of the early cosmos, those waves caused density fluctuations in the plasma—fluctuations that now show up as ripples in the microwave background radiation that bombards us from every direction. Last year, BOOMERANG made a celebrated measurement of the characteristic size of those ripples. The data not only supported the acoustic model, but also implied that the universe is flat in a four-dimensional sense and gave some idea of its composition.

But something very important was missing. The acoustic model also predicts that overtones from the big bang should have produced smaller ripples—relatively faint second and higher peaks in the microwave spectrum. BOOMERANG heard the fundamental note loud and clear, but where scientists expected to hear overtones, there was merely an awkward silence. Although a ground-based telescope heard hints of an overtone (*Science*, 19 January 2001, p. 414), the missing second peak posed a potentially huge problem for the acoustic model.

No longer. At the meeting, BOOMERANG researchers presented their analysis of 14 times the amount of data that went into last year's result. "We see the first peak very well again, and we do see two more bumps and wiggles out here that indicate the acoustic oscillation of the early universe," said team member John Ruhl, a physicist at the University of California, Santa Barbara. At the same session, John Carlstrom of the University of Chicago presented the first results from the Degree Angular Scale Interferometer, an Antarctic telescope that uses an entirely different technique to measure the microwave background. "We see the first peak, see the second peak, and it strongly suggests a third peak," Carlstrom said. Yet another project, MAXIMA, a balloon-borne experiment similar to BOOMERANG, also sees evidence of a third peak.

"This is a really great party," beams University of Chicago physicist Mike Turner, who says that the acoustic theory has just "passed a very important test."

The new results also iron out a nagging disagreement about how much of the universe consists of so-called baryonic matter, the familiar stuff of atoms, stars, and people. Measurements of the relative abundance of various atoms in the universe give a figure of about 4% of all the mass and energy that scientists think is out there. Until this weekend, cosmic background experiments put the total at 5%—a statistically significant difference. The new, more precise cosmic background measurements bring the two methods into agreement. "The whole controversy business about baryon fraction? Forget about it," says Tegmark.

These results are just the beginning; several experiments were gathering data even as the meeting was going on. Within a year or two, scientists expect to see measurements of the polarization of the background radiation, which carries previously inaccessible information about the early universe, as well as even more precise data from the entire sky. Theorists are worried, Turner jokes. "Now our ideas get tested as soon as we write them down," he says. "We're living dangerously." —CHARLES SEIFE

QUANTUM PHYSICS

Loopy Electron Model Solves Ion Mystery

Newton's laws usually fly out the window in the subatomic realm. Unlike planets around a star, electrons don't loop around their nuclei in nice, elliptical orbits—at least according to the traditional interpretation of quantum theory. But now, an international team of scientists has shown that a nearly Newtonian set of electron orbits can explain

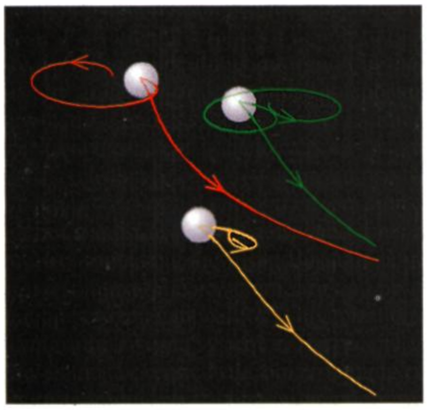
CREDITS: DASI

* 28 April–1 May.

a puzzling phenomenon that, on the face of it, should be impossible.

The affront to scientific common sense turned up in the late 1980s. Scientists had long known that if you zap an atom with a photon, its electron can pick up a packet of energy that sends it into an excited state. Like a rock raised on high, the excited electron stores the energy. Eventually, it falls back to its ground state, releasing a photon that carries the spare energy away.

Zap an atom hard enough, however, and its electron flies free, like a rock boosted beyond Earth's escape velocity. So an electron in an atom should be able to store only so much energy, even if it is hit with a huge barrage of photons. "You would expect, wffft! The atom is ionized—nothing more would happen," says Pascal Salières, a physicist with France's Atomic Energy Commission in Gif-sur-Yvette.



Neoclassical. Electron orbits à la Newton can make quantum problems solvable.

Au contraire. A little more than a decade ago, scientists experimenting with lasers discovered that atoms could absorb hundreds of photons beyond their binding energy and could emit photons with much more energy than should be allowed. "By the 1990s, there was much confusion on how to describe these phenomena," says Gerhard Paulus, a physicist at the Max Planck Institute for Quantum Optics in Garching, Germany. "It was a big controversy."

Physicists were stymied because their usual quantum problem-solving methods broke down under the extreme conditions caused by the laser. But Caltech's Richard Feynman had already suggested a totally different approach that seemed to hold the answer. Most quantum theorists had tackled the problem by using the Schrödinger equation to find the distribution of electron wave functions—smeary particle-wave beasties that inhabit a large parcel of space all at one time. Feynman, on the other hand, treated electrons as ordinary point-particles that circle their nuclei just as planets orbit their star.

But quantum weirdness took its toll: To make the method work, physicists had to take *all* possible orbits into account simultaneously, rather than just one as in classical mechanics. Ordinarily, the infinite variety of possible orbits makes Feynman's method impractical. But on page 902, Salières, Paulus, and colleagues show that the method does indeed hold the key to solving the mystery of the superionized atoms.

CREDITS: (TOP) P. SALIÈRES *ET AL.*

Using a titanium-sapphire femtosecond laser, the team zapped a sample of xenon, sending the atoms' electrons into fits. Ordinarily, the electrons would take many different paths around their nuclei. But Salières and colleagues polarized their laser beam so that most of the electrons' paths cancel one another, leaving only a handful of possible orbits around the nuclei. For instance, one path sends the electron looping around, smashing back into the atom and scattering off into the distance. By summing up the contributions for the paths, the team figured out the energy of the electrons coming off the sample, as well as the high-energy light that gets released in the process—and it matched their observations admirably well. When they adjusted the laser to emphasize certain paths over others, the spectrum changed in just the way the Feynman path method predicted.

"The elliptical case is an interesting test of this [theory]. I don't think anyone's given a good demonstration before," says Ken Kulander, a physicist at Lawrence Livermore National Lab in California who helped formulate the Feynman-based theory behind the experiment. "It really shows that you have all the information about the system in a few paths." Kulander hopes that the theory will suggest a way to boost the number of high-energy photons coming from such laser-matter interactions, perhaps yielding powerful extreme-ultraviolet lasers.

–CHARLES SEIFE

TECHNOLOGY

Liquid Crystal Displays Rub Out the Rub

The sprinkle of black magic behind making liquid crystal displays (LCDs) may finally be ready for its own vanishing act. IBM researchers report in this week's issue of *Nature* that they've come up with a way to eliminate a cumbersome and little understood step of rubbing separate layers of plastic in a display to align liquid crystals placed in between. The advance could simplify and speed display manufacture, drop costs, and help LCDs fight off emerging competition from new flat displays made with light-emitting plastics.

Not long ago, LCDs were themselves an emerging technology. The screens got their start at the now-defunct RCA Labs in the late

ScienceScope

More Is Better Marine scientists say federal officials are being too cautious when it comes to planning the future of the aging U.S. oceanographic fleet.

The government's Ocean Research Advisory Panel last week reviewed a draft plan that recommends that the United States aim for a smaller but more capable fleet of large research vessels over the next 2 decades. The U.S. currently operates 16 vessels longer than 40 meters. A discussion paper drafted by the National Science Foundation (NSF) and other agencies suggests that researchers could get by with as few as 10 new ships in light of funding constraints and the rise of buoy- and satellite-based data collection systems.

But the University-National Oceanographic Laboratory System (UNOLS), which represents ship users, says planners should recommend a "prudently larger" fleet. In a 30 March letter to NSF, UNOLS chair Robert Knox of Moss Landing Marine Laboratories in California urged fleet planners to be "realists but not defeatists. ... If ever there was a time to make strong cases for ... basic oceanographic research, it is now."

NSF's Mike Reeve says officials hope to have a revision within a couple of months "that will reflect a workable agreement."

Resigned Harvard University astronomer Margaret Geller (right) ended a 4-year tenure battle this week by submitting her resignation. Geller will remain employed by the Smithsonian at the joint Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, but she plans to stop teaching at Harvard after 1 July.

A member of the National Academy of Sciences, Geller was offered a Harvard chair but not tenure in 1997, an unprecedented arrangement (*Science*, 12 November1999, p. 1277). She held out for tenure or a salary guarantee, suspecting sex discrimination as the reason for the unusual offer. University officials rejected her request, however, saying that they would be forced to make the same deal with other Smithsonian employees.