been deciphered as well. These sequences should provide clues about how vertebrates evolved.

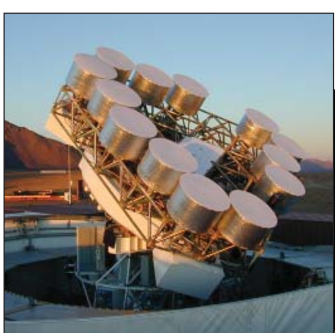
In addition, the sequences of microbial genomes keep pouring in: another strain of anthrax and a bacterium called *Shewanella*, useful for bioremediation, to name just two. And the flood of genome sequences shows no sign of abating: Work has begun on chimp, corn, and poplar. The honey bee, dog, cow, chicken, and sea urchin are supposed to be up next.

#4

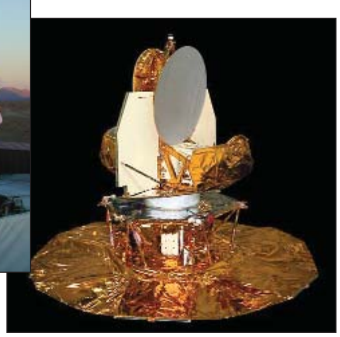
Cosmic twist. Even though it's less than 3° above absolute zero, the cosmic microwave background (CMB) is very, very hot. In 2002, astronomers and physicists watched the end of the tale of the beginning of the universe.

Discovered in 1965 by Arno Penzias and Robert Wilson of Bell Laboratories in New Jersey, the CMB is the remnant of a time, 400,000 years after the big bang, when free-streaming nuclei and electrons finally cooled and formed atoms. As the electrons settled down into their orbitals, high-energy light, liberated from its cage of matter, streamed forth. Stretched and attenuated by 14 billion years of travel, the CMB appears as a faint but ubiquitous microwave static coming from all regions of the sky.

In 2000 and 2001, airborne and ground-based microwave telescopes generated exquisitely detailed pictures of fluctuations in the CMB, fluctuations that reveal not only the universe's past but its future. Not only did these fluctuations give rise to the agglomerations of galaxies that we see today, but they also revealed the "curvature" of the universe, which shows that the universe will expand forever, rather than recollapsing in a big crunch. In May, the Cosmic Background Imager (CBI), a microwave telescope high atop the Andes mountains in Chile, put an exclamation point on those observations by detecting "peaks"—characteristic patterns in the fluctuations—that revealed structures far smaller than other telescopes had yet seen. In January 2003, other physicists are expected to reveal the first results from the Microwave Anisotropy Probe (MAP), an orbiting satellite that will be the ne plus ultra of fluctuation detection until the end of the decade.



CBI



MAP

But the real CMB triumph this year was the first detection of polarization by the Degree Angular-Scale Interferometer team at the University of Chicago. The discovery of this faint signal heralds the beginning of a new chapter in CMB research—one that might reveal the state of the universe when it was a minuscule fraction of a second old by revealing the subtle scarring caused by gravitational waves during the birth of the cosmos.

#5

Fast moves. If action flicks seem to be getting faster these days, just wait. This year, laser physicists succeeded in making the first-ever movies in which individual frames were measured in attoseconds, or billionths of a billionth of a second. The new high-speed filmmaking techniques are expected to spawn a new genre of cinema devoted to tracking the motion of electrons around atoms.

Laser physicists have been refining their

Scorecard 2002

In which we take our lumps for predictions made last year

Stem cells abroad. The raging political debates of previous years died down in 2002, as more countries settled on regulations governing work with human embryonic stem cells. The pace of headline-grabbing scientific breakthroughs has also slowed as the relatively young field works to decipher the complex mechanisms controlling cell fate—and some scientists complain that access to human embryonic stem cells is still frustratingly slow.

Proteomics. Fundamental advances in figuring out protein interactions have begun to migrate to medical and biotech applications as hoped. Proteomics companies announced this year that they had discovered novel proteins that appear to be linked to diseases such as cancer and asthma. These companies are now developing novel therapeutics to target the proteins and diagnostics capable of tracking them. Actual drug products based on proteomics have yet to emerge. But developing a new drug typically takes more than a decade. Meanwhile, basic research on mapping biologically important proteins continues. In May, the Human Proteome Organisation, a group seeking to keep proteomics from being locked up in proprietary interests, outlined five initial projects. The U.S. National Institutes of Health, meanwhile, announced an initiative in October to spend $157 million over 7 years to create 10 new proteomics centers.

Eyes on the sky. It's been a very good year for astronomical viewing. Optical systems that automatically adapt to visual conditions have come into their own (see Runner-Up item on p. 2301). Solid discoveries have been popping out of the Sloan Digital Sky Survey this year on quasars (*Science*, 28 June, p. 2317), globular clusters (*Science*, 14 June, p. 1951), and brown dwarfs (*Science*, 4 January, p. 64). And member nations of the International Virtual Observatory Alliance (www.ivoa.net) have ramped up demonstration projects linking the world's astronomical instruments.

Next in genetics. The multiple genes involved in diabetes, cancer, and other complex diseases continue to elude researchers. Some progress was made—a diabetes gene here, a Hirschsprung's disease gene there—but now geneticists are pinning their hopes for progress on the HapMap, a major multiyear undertaking to map variation in stretches of human DNA called haplotypes.

Optical clocks and constants. Last year, the future for clocks and reference standards based on high-frequency optical emissions from atoms looked bright. But the hands on the clock of progress have slowed: Translating the basic breakthroughs in optical physics to practical applications has proven harder than expected. Given the lead times in the field of metrology, the future of optical clocks may still light up in the long term.

Visualization. Powerful computing and clever imaging are combining to create better snapshots of cells and molecules. One technique, cryoelectron tomography, has yielded unprecedented views of cellular machinery (see Runner-Up item on p. 2301). New methods of fluorescent imaging produced dramatic scenes of protein translocation in single cells (*Science*, 8 March, p. 1910), and a new variant of green fluorescent protein offered a novel tool for tracking intracellular protein dynamics. And new initiatives, such as the MIT School of Engineering and Whitehead Institute's proposed center for bioimaging, are seeking to join supercomputing with state-of-the-art imaging methods.

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