

the proton and other particles to a precision of about 2%—a tenth of the uncertainties a decade ago—as they reported in November.

In 2003, others reported equally precise calculations of more-esoteric quantities. But by calculating the familiar proton mass, the new work signals more broadly that physicists finally have a handle on the strong force.

Sequencing Bonanza

NEW GENOME-SEQUENCING TECHNOLOGIES that are much faster and cheaper than the approach used to decipher the first human genome are driving a boom in sequencing.

This year, using “sequencing by synthesis” technology from 454 Sequencing, which “grows” fluorescently labeled DNA on microscopic beads, researchers produced the mitochondrial genomes of extinct cave bears and of a Neandertal, and 70% of the genome of a woolly mammoth.



A preliminary draft of the full Neandertal genome is in the works. Another new technology, developed by Solexa (now part of Illumina), made its debut in the scientific literature with the descriptions of the first genomes of an Asian, an African, and a cancer patient, shedding new light on early human migrations and candidate genes that may underlie malignancies. Illumina's technology sequences DNA in massively parallel reactions on glass plates. A proof-of-concept paper by Pacific Biosciences, a company that sequences single DNA molecules, provided an exciting glimpse of even faster sequencing. Now the goal is to make it more accurate.

Costs continue to drop; at least one company boasts that genomes for \$5000 are in reach.

—THE NEWS STAFF

AREAS TO WATCH

Plant genomics. Maize got the U.S. government behind deciphering plant DNA. In 2009, expect to see the analysis of its genome published, along with a bumper harvest of DNA sequences from other plants: crops such as soybean and foxtail millet; bio-fuels plants; monkey flower, much studied by ecologists; and a primitive plant called a lycopod. Several fruits are in the works, and other projects are gaining momentum. And to understand genetic variation, hundreds of strains of the model plant *Arabidopsis* are being sequenced.

Ocean fizz. Acidification of the oceans driven by rising atmospheric carbon dioxide continues apace. The falling pH is bad news for sea creatures, from coral reefs to microscopic plankton. But the looming threat has yet to gain a poster child the likes of global warming's polar bear. Look for a rising tide of studies confirming the pervasive detrimental effects of ocean acidification, although whether more science will grab the public's attention is problematic.

Neuroscience in court. Scientists and legal scholars cringed this year when an Indian court convicted a woman of murdering her fiancé, citing electroencephalograms that purportedly revealed neural activity indicating “experiential knowledge” of the crime. Although images of anatomical abnormalities in the brain have previously been introduced as mitigating evidence during sentencing, the use of methods that measure brain activity is far more controversial. Even so, at least two companies now offer lie-detection services based on functional magnetic resonance imaging. Ready or not, neuroscience appears poised to have its day in court.

Road to Copenhagen. A 12-day international climate summit in November 2009 marks the deadline for countries to set a successor for the Kyoto treaty, which expires in 2012. Can the United States, China, and India agree to binding targets tough enough to mitigate global warming? Will the agreement include funding for developing nations to adopt Western energy technologies and adapt to a warming world? President-elect Barack Obama has pledged that the United States will take a leading role in the talks and



will push for a mandatory system. But with the world economy reeling and oil prices low, he'll face a tough crowd in the U.S. Senate, where lawmakers from coal and car states will want to block any deal that doesn't provide maximum leeway.

Darkness visible. Are particles of exotic dark matter annihilating each other in the heavens to produce high-energy cosmic rays? This year, the orbiting PAMELA particle detector and the ATIC balloon experiment reported possible signs of such annihilations. Next year, PAMELA should test the consistency of its result and ATIC's, and NASA's Fermi Gamma-ray Space Telescope, launched this June, will look for photons from dark-matter annihilations. Still, don't expect the stuff to be lured into the light by next December.

Defining species. In the 200th anniversary of Darwin's birth and the 150th of his *On the Origin of Species*, expect more clues about genes that split species into two. In 2008, researchers discovered several sources of genetic incompatibilities that prevent successful reproduction in animals as varied as nematodes and mice. Thanks to advances in genetics, gene sequencing, and protein surveying, they expect to find more and more of such “speciation genes” in coming months.

Tevatron's triumph. Researchers in Switzerland will be scrambling to get the gargantuan Large Hadron Collider up and smashing particles. But the real drama should unfold at the Fermi National Accelerator Laboratory in Batavia, Illinois, where next year the Tevatron Collider should have produced just enough data to reveal signs of the Higgs boson—if its mass is as low as indirect evidence suggests. Don't be surprised to hear shouts of “Eureka!” if not next year then in 2010, when all of next year's data are analyzed.