

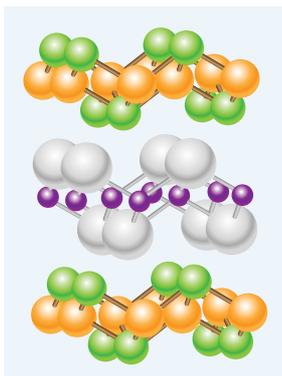
Breakthrough of the Year

New High-Temperature Superconductors

PHYSICISTS DISCOVERED A SECOND FAMILY OF HIGH-TEMPERATURE superconductors, materials that carry electricity without resistance at temperatures inexplicably far above absolute zero. The advance deepened the biggest mystery in condensed-matter physics.

In February, a group in Japan reported the first material, fluorine-doped lanthanum iron arsenic oxide ($\text{LaFeAsO}_{(1-x)\text{F}_x}$), which is superconducting up to a “critical temperature” of 26 kelvin. Within 3 months, four groups in China had replaced the lanthanum with elements such as praseodymium and samarium and driven the temperature for resistance-free flow up to 55 kelvin. Others have since found compounds with different crystal structures and have bumped the critical temperature up to 56 kelvin.

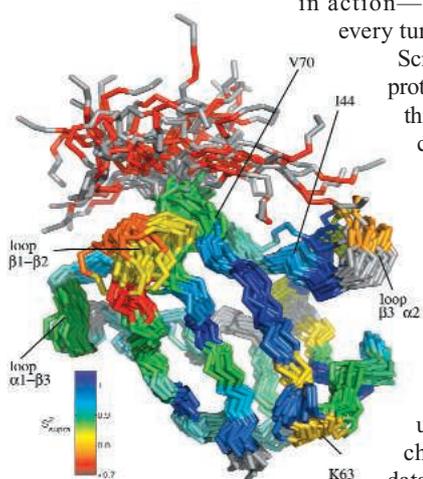
For a critical temperature, that’s not so hot. The record is 138 kelvin for members of the other family of high-temperature superconductors, the copper-and-oxygen, or “cuprate,” compounds discovered in 1986. Still, the iron-based materials have created a stir, in part because they might help solve the enduring mystery of how the cuprates work. The \$64,000 question is whether the two families work the same way. So far, evidence points in both directions.



Watching Proteins at Work

AFTER STUDYING PROTEINS FOR MORE THAN A CENTURY, BIOCHEMISTS pushed the boundaries of watching the molecules in action—and received surprises at every turn.

Scientists have long debated how proteins bind to their targets. Most think the shape of a target molecule forces a protein to wiggle into a complementary profile. But it's also possible that proteins in solution wiggle among many slightly different conformations until one finds its target. Computational biologists in Germany and the United States offered bold new support for that upstart idea when they crunched extensive experimental data and showed how one long-studied protein seems to dance among dozens of conformations. In another surprise, a U.S. team tracked individual proteins and found that a single random molecular event can switch a bacterial cell from one metabolic state to another.



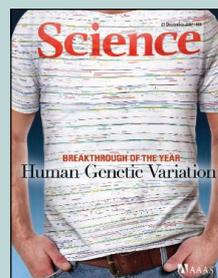
Zooming out to the large scale, proteomics researchers in Germany simultaneously monitored the abundance of up to 6000 proteins in yeast cells and quantified how the expression of individual proteins differed between two different cell types. Their technique could lead to new insights into development and disease. Finally, proteomics researchers in Sweden revealed that different tissues in the body likely get their unique characteristics by controlling not which proteins are expressed but how much of each gets made.

Water to Burn

RENEWABLE ENERGY SOURCES, SUCH AS WIND AND SOLAR POWER, have plenty going for them. They’re abundant and carbon-free, and their prices are dropping. But they’re part-timers. Even when the sun is shining and the wind is blowing, there is no good way to store excess electricity on an industrial scale. Researchers in the United States reported this year that they’ve developed a new catalyst that could begin to change that picture.

The catalyst, a mixture of cobalt and phosphorus, uses electricity to split water into hydrogen and oxygen. Hydrogen can then be burned or fed to fuel cells that recombine it with oxygen to produce electricity. Researchers have known for decades that precious metals such as platinum will split water. But platinum’s rarity and high cost make it impractical for large-scale use. The cobalt version isn’t all the way there yet, either—it still works too slowly for industrial use—but just getting a cheap and abundant metal to do the job is a key step. Now, if researchers can speed it up, on-again-off-again renewables could have a future as fuels that can be used anywhere at any time.

SCORECARD



A smashing start

The Large Hadron Collider came on smoothly in just a few hours, in keeping with *Science*'s observation that the European particle physics lab, CERN, has a knack for getting new machines running quickly.

Nine days later, the enormous particle smasher wrecked so bad that it will be down until summer, fulfilling *Science*'s warning that a mishap could take the machine out of action for months.

Micromanagers

MicroRNA work surged in 2008, as efforts to use the molecules to understand and modify disease edged forward. The first successful microRNA manipulation in primates lowered cholesterol in African green monkeys, and the molecules slowed virus replication in ailing mice. Companies are rushing to

Rating last year's Areas to Watch

(For this year's predictions, see page 1773.)