science-advisory roles in their own countries, rather than just ceremonial roles."

Biochemist Ernst-Ludwig Winnacker, head of Germany's DFG granting agency, thinks the IAC "would be very useful." Winnacker, who attended the Davos meeting, adds: "The question is whether the U.N. or other international organizations would take advantage of it." Whether policy-makers will seek advice on burning scientific questions remains to be seen, but the Davos participants were upbeat. Says Alberts: "We all agreed that the world needs much more advice from scientists." –ROBERT KOENIG

MATERIALS SCIENCE

New Material Promises Chillier Currents

A moth frying on a bug lamp proves, suicidally, that an electrical current heats. But a current can also cool, if it runs through the right stuff. A handful of exotic semiconductors wick away heat while conducting electricity, and heat pumps fashioned from them chill solid-state lasers, radiation detectors, and fancy picnic coolers. Easily miniaturized and free of moving parts, such heat pumps offer clear advantages over mechanical refrigerators.

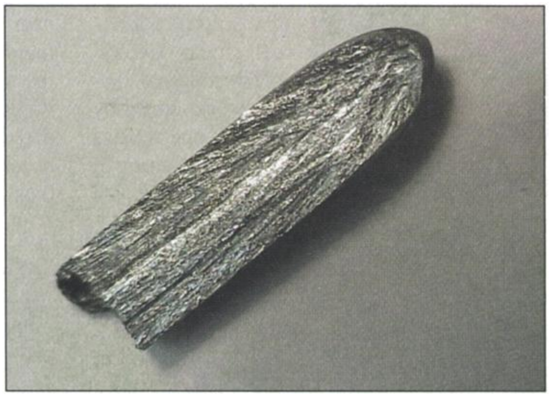
Unfortunately, good thermoelectric materials are few and far between; research labs haven't turned up a promising new one for decades. Now a team led by Mercouri Kanatzidis, a chemist at Michigan State University in East Lansing, may have broken the impasse with a concoction of bismuth, tellurium, and cesium. "This is the first material that suggests we can do as well as or better than the materials we've had for the last 30 years," says Frank DiSalvo, a chemist at Cornell University in Ithaca, New York.

As Kanatzidis and colleagues report on page 1024, the new material (chemical formula $CsBi_4Te_6$) cools nearly as efficiently as the best material currently available. But whereas its decades-old rival conks out at –50° Celsius, the new stuff keeps working to roughly –100°C. It therefore promises to improve the performance of laser diodes, infrared detectors, and other electronic devices that run best cold. Researchers cheered the newcomer's arrival. "Kanatzidis is doing some super work in this field," says Galen Stucky, a chemist at the University of California, Santa Barbara.

Semiconductors come in two breeds, n-type and p-type. A thermoelectric heat pump consists of a chunk of one butted against a chunk of the other. In the n-type, electrical current is carried by negatively charged electrons, which, thanks to an awkward historical convention, are considered to flow in the direction opposite to the current. In the p-type, current is carried by positively charged "holes," the shadows of absent electrons, which flow in the same direction as the current. When current flows out of the n-type semiconductor and into the p-type semiconductor, both the electrons and the holes stream away from the border between the two materials. Like steam whistling out of a teakettle, the fleeing holes and electrons carry away heat, cooling the junction.

Of course, for the heat pump to work, the electrons and holes must usher heat away faster than it can flow back. And that means thermoelectric materials must have high electrical conductivity and low thermal conductivity. It also means each electron or hole must carry a healthy dollop of heat. Unfortunately, the three properties are closely connected and often work against one another. For example, boosting the electrical conductivity too high leaves wimpy electrons and holes that carry only tiny amounts of heat.

Kanatzidis and his team set out to systematically improve upon the best material available, a compound of bismuth, antimony, tellurium, and selenium. The researchers first synthesized a potassium, bismuth, and selenium compound with promising properties. They then tried to replace the potassium and selenium atoms with heavier cesium and tellurium atoms, to make a softer substance that would better damp heat-carrying vibrations. But things didn't go quite as planned. The new material took on a surprising crystal structure, which, however, performed even better than expected. "In some ways, it's a little bit of serendipity," Kanatzidis says. But others credit more than luck. "I don't think this is so much an accident as it is his very clever way of looking at things," Stucky says.



Chilly crystal. The new thermoelectric material carries away heat while it conducts electricity along its needlelike grains.

CREDIT: M. KANATZIDIS/MICHIGAN STATE UNIVERSITY

The new material needs fine-tuning, Kanatzidis says. He and his team have not yet

ScienceScope

Entrepreneurs Wanted Japan's Ministry of Education (Monbusho) hopes that new legislation can achieve what its lobbying could not—spur technology transfer by allowing national university professors to serve as officials of private corporations.

Last year Monbusho officials thought they had government-wide support to exempt professors from the National Civil Service Law, which prevents civil servants from simultaneously holding private sector positions. But the National Personnel Agency refused to allow economist Iwao Nakatani of Hitotsubashi University in Tokyo to accept a seat on the Sony Corp. board of directors (*Science*, 18 June, p. 1905). Nakatani resigned his professorship to join Sony's board, then went back to the university as a part-time lecturer, a position not subject to the regulations. The incident led Prime Minister Keizo Obuchi to set up an intragovernmental study group, which drafted a reform proposal that was presented to legislators this week. "This time, we really have the backing of the entire government," says a Monbusho official.

Molecular biologist Shiro Kanegasaki, who had to retire last year from the University of Tokyo before starting the Effector Cell Institute, sees the proposed law as a boon to entrepreneurs. "A lot of younger bioscience and medical researchers would be quite happy to have a role" in the private sector, he says.

Strength in Numbers In a leap ahead for Dutch science, the Netherlands Organization for Scientific Research has decided to buy a new national supercomputer that will be more powerful than any other in Europe. The $14 million machine, a Scalable Node-1 from hardware producer SGI, has over 1000 parallel processors and is able to perform a trillion calculations per second. That's almost 100 times faster than Holland's current top number cruncher.

Some 120 research groups will use the new machine—due to be up and running in November—to model everything from bone growth to the birth of galaxies. Chemist Evert Jan Baerends of Amsterdam's Free University, who uses supercomputers to model interactions between molecules, says the new machine will be "a big step upward."

Contributors: Dennis Normile and Martin Enserink

optimized the levels of dopants, impurities added to control the numbers of electrons and holes. But even as it stands, the new material has promise, because it outperforms the competition at temperatures below zero degrees Celsius. "People are desperate to find a material that will work much below room temperature," Kanatzidis says, "so it can take over where the other material leaves off."

–ADRIAN CHO

ASTRONOMY

Fine Details Point to Space Hydrocarbons

On Earth, it's hard to avoid polycyclic aromatic hydrocarbons, or PAHs. Made up of two or more fused benzene rings, they turn up in cigarette smoke, car exhausts, or just about anywhere that hydrocarbons burn at high temperature. But for nearly 2 decades, astronomers have argued about whether these molecules are as ubiquitous in space as they are here at home. They were puzzled by the fact that certain interstellar gas clouds in regions of space too cold to produce thermal emissions nonetheless produce characteristic emission bands in their infrared spectra. These bands look teasingly similar to the emissions bands produced by PAHs, but they are not exactly the same, and the failure of chemists to reproduce precisely the observed spectra in the laboratory has led some astronomers to argue that the emission bands are caused by small solid particles, such as soot or hydrogenated amorphous carbons. But astronomers picking over data obtained by Europe's Infrared Space Observatory (ISO), who met in Madrid last week,* believe they have evidence that clinches the case for PAHs in space.

ISO, a 60-centimeter infrared telescope launched by the European Space Agency in November 1995, made over 26,000 observations before it ran out of the liquid helium needed to cool its telescope and detectors in April 1998. One of its tasks was to solve the riddle of PAHs. Some astronomers have suggested that PAHs could form in the atmospheres of carbon-rich stars and be ejected into interstellar space when the stars die. In the cold of space, such molecules would sometimes be struck by ultraviolet photons, causing the carbon atoms in the benzene rings to vibrate. Changes in vibrational energy are emitted as infrared light—a process called relaxation—just as sound is emitted from a gong when it is struck. Because of the numerous different shapes and sizes of PAHs, their spectra are dominated by bands of emissions, rather than discrete peaks.

Critics of this model argue that the emission bands just don't match those of PAHs in the lab. "The spectroscopy obtained [in lab experiments] with solid materials, such as anthracite, give a better spectral agreement," says Cécile Reynaud of France's Atomic Energy Commission in Saclay. PAH supporters counter that in cold interstellar space, there is simply not enough heat to produce thermal emissions from such solid particles. "With 15 degrees [kelvin], you won't have emission in the near infrared," says Alexander Tielens of the University of Groningen in the Netherlands. Very little ultraviolet radiation will cause relaxation in PAHs, however, so this could still occur even in the frigid environs of interstellar clouds.

Cold gaze. ISO spotted strong evidence for polycyclic aromatic hydrocarbons.

Now, a team led by Christine Joblin of the CNRS Space Study Center for Radiation in Toulouse, France, believes it has convincing evidence. By studying the high-resolution spectra obtained with ISO's short-wave infrared spectrometer, they found that the emission bands are made up of a forest of sharp peaks. "This structure cannot be explained by solids—one expects wide and smooth bands—and we can explain this structure by assuming that we are dealing with a family of molecules," says Joblin.

To finally settle the matter, chemists will have to duplicate this detailed emission structure in the laboratory. Pascale Ehrenfreund of Leiden University in the Netherlands says finding laboratory spectra of PAHs that match astrophysical spectra is just a matter of getting the right mix of ingredients. But "if you have a family of 200 molecules, it is very difficult to pick the right ones on Earth. … You need a lot of laboratory studies in order to really make a perfect fit," she says.

Douglas Hudgins and his colleagues in the Astrochemistry Laboratory at NASA's Ames Research Center in Moffet Field, California, are attempting to do just that. And Hudgins believes that the ISO data will make his work much easier. "Up to this point, the quality of our laboratory spectra was much, much better than the quality of available astronomical data," but now the ISO spectra should make comparisons much sharper, says Hudgins. So will ISO data settle the matter? "Absolutely … I think there is overwhelming evidence supporting molecular PAHs and PAH ions in space."

–ALEXANDER HELLEMANS

Alexander Hellemans writes from Naples, Italy.

* ISO Beyond the Peaks. The 2nd ISO workshop on analytical spectroscopy, 2–4 February, Villafranca del Castillo, Madrid, Spain.

PLANETARY METEOROLOGY

Deep, Moist Heat Drives Jovian Weather

The weather on Jupiter is awesome but frustratingly mysterious. Great jets of 750-kilometer-per-hour wind girdle the planet, marking off distinctive, dark and light bands of clouds. And oval "storms" of various sizes and hues roll between the jets, ranging from small, short-lived eddies hundreds of kilometers wide to huge, long-lived swirls. The grandest of these ovals, the 20,000-kilometer Great Red Spot, has been at it at least since Galileo's day 300 years ago. But what, meteorologists have wondered, makes it all go? The sun bathes the jovian cloud deck in feeble light, while deep-seated heat energy that has lingered since the planet formed seeps out. Which of those two energy sources predominates in driving Jupiter's weather engine? And how does that energy get bundled into the small eddies on which the jets and spots feed?

In two papers in this week's issue of *Nature*, researchers provide an answer: Deep heat funneled upward by local storms is a major driver of jovian weather. They show that much if not all of the deep heat escaping the interior flows up through towering thunderstorms. These disturbances can go on to become small eddies that eventually give up their energy to storms such as the Great Red Spot. "Where these little guys come from has always been the question," says planetary meteorologist Timothy Dowling of the University of Louisville in Kentucky.

Lightning, captured by the imaging system aboard the Galileo spacecraft orbiting Jupiter, was the key to running down jovian weather's major energy source. On Earth and apparently on Jupiter, lightning and the water-fueled engine that drives thunderstorms are intimately connected. In a terrestrial thunderstorm, water vapor in rising warm air condenses. The condensation releases more heat that pushes the rising air upward even harder. This "moist convec-

CREDIT: ESA