is smart, competent, and adept at giving Goldin what he wants," says the official.

Elachi says he's "very confident" he can do more with less. He's also hoping that the launch of a new Mars orbiter in April, and additional Mars missions in 2003, will boost morale at the battered lab.

–ANDREW LAWLER

HIGH-ENERGY PHYSICS

Nuclei Crash Through The Looking-Glass

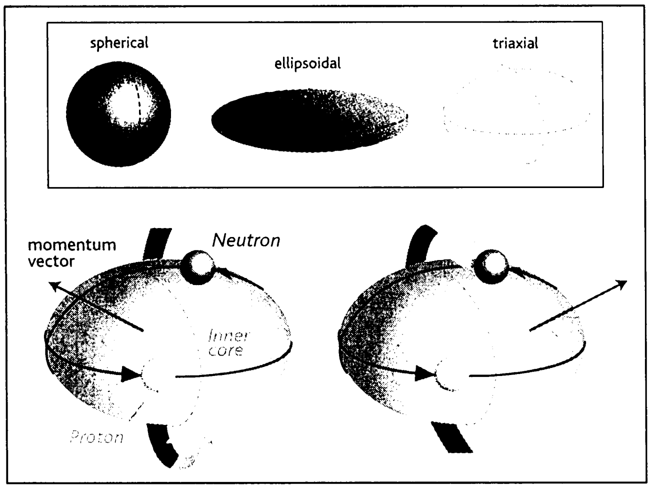
Gloves do it. Toupees do it. Even twists of DNA do it. And now, for the first time, physicists have discovered that atomic nuclei come in right- and left-handed models, too. In the 5 February issue of *Physical Review Letters (PRL)*, a team of researchers from the State University of New York (SUNY), Yale, the University of Tennessee, and Notre Dame reports observations of rapidly spinning nuclei morphing into mirror-image forms. In the process, the physicists also uncovered solid evidence that a long-disputed feature of nuclear anatomy really does exist.

"These results are causing quite a stir among nuclear structure physicists," says Rod Clark of Lawrence Berkeley National Laboratory in California. Although more work is needed to nail down the conclusions, Clark says, "it is tremendously difficult to come up with an alternative interpretation" of the findings.

The discovery springs from work by Stefan Frauendorf, a nuclear theorist at the University of Notre Dame in Indiana. In 1997, Frauendorf and colleagues were exploring the possible properties of atomic nuclei with a hypothetical feature called triaxial symmetry. In theory, nuclei can have varying degrees of symmetry, from spherical to ellipsoidal to triaxial, depending on how the neutrons and protons arrange themselves. An ellipsoidal nucleus resembles an American football; a triaxial nucleus is similar, but squashed. "It actually looks a bit like a kiwi fruit," says Krzysztof Starosta, lead author of the *PRL* paper and a visiting professor at SUNY, Stony Brook.

Frauendorf, also a co-author of the *PRL* paper, suggested that certain triaxial nuclei should come in left- and right-handed varieties. His calculations showed that the development of handedness, which physicists call chiral symmetry breaking, should occur in rapidly rotating "odd-odd" nuclei—those containing both an odd number of neutrons and an odd number of protons.

Much as electrons in an atom pair up to form shells surrounding the nucleus, the protons and neutrons in the center of the atom pair up, like with like, to create their own structures inside the nucleus. In an odd-odd nucleus, however, one neutron and one proton are left over. In some cases, these "valence nucleons" orbit at right angles to each other outside the nuclear core made up of the other protons and neutrons, just as valence electrons whiz around the electronic shells of an atom. Meanwhile, the core is spinning, too (see figure).



Doubles match. In some atomic nuclei with triaxial symmetry, a lone proton and neutron whizzing around a whirling nuclear core give different nuclei mirror-image values of momentum.

According to Frauendorf, those three motions—of the two valence nucleons and the triaxial core—should create a chiral effect. Added together, they give the nucleus its overall momentum. But because the core can spin in either of two directions with respect to the orbiting particles, the overall momentum can take on two different values, too. Those values, Frauendorf said, establish the left-handed and right-handed states.

The catch was that nobody knew whether triaxial nuclei really exist. Nuclei with three distinct axes of symmetry had been predicted in the 1960s and hotly debated ever since, but no one had definitively observed one. Some physicists suspected that the triaxial shape might be a fleeting oscillation of the nucleus, too unstable to have a measurable effect.

To find out, Starosta and his collaborators looked at gamma rays, a kind of radiation that atomic nuclei emit after being excited to high-energy spin states. If the nuclei were triaxial and were undergoing chiral symmetry breaking, the gamma rays ought to cluster into pairs of closely related frequencies known as doublets—evidence that the energy levels of the nuclei had split into pairs of right- and left-handed states.

The collaborators focused their efforts on odd-odd nuclei of cesium, lanthanum, praseodymium, and promethium. Using accelerators at SUNY and Yale, they shot beams of heavy ions—carbon, boron, and magnesium—into targets of tin and antimony. The smashups initiated fusion reactions that created excited nuclei of just the right type and pumped them up to the right spin states. As the nuclei settled down, they emitted a panoply of gamma rays with various energies. The telltale clustering was there; by sorting out doublets, the physicists confirmed the existence of chiral symmetry breaking.

The next step, Starosta says, is to see whether odd-odd nuclei of other elements also form mirror images: "We started probing the nuclei around atomic mass 130 because the theory pointed us there, but we will be searching in other mass regions now." Clark says understanding how these complex nuclear structures behave may spill over to other fields as well. "The ideas and methods for understanding nuclei, molecules, metallic clusters, and atomic condensates all feed off of each other," he notes.

–DAVID VOSS

ATMOSPHERIC CHEMISTRY

Stratospheric 'Rocks' May Bode Ill for Ozone

It looks as if the infamous antarctic ozone hole—the springtime thinning of the protective stratospheric layer—has reached its natural limits, but atmospheric chemists worry about the ozone over the Arctic. It, too, thins in springtime as the rising sun spurs the chlorine and bromine from humanmade chemicals to destroy ozone. Although no real "hole" has opened over the Arctic, that could change in the coming greenhouse era. And on page 1026 of this issue of *Science*, a team of researchers studying the Arctic stratosphere reports the discovery of bizarre particles in clouds there that could make arctic ozone more vulnerable to changing climate.

The discovery came during a January 2000 research flight nearly to the North Pole, report atmospheric chemist David Fahey of the National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado, and 26 colleagues from more than a dozen institutions in North America and Europe. An instrument on NASA's highflying ER-2 coughed out what looked like disastrous noise as it measured nitrogen-containing gases.

On closer inspection, however, the

ILLUSTRATION: J. MOGLIA

noise turned out to be humongous particles containing nitric acid. The polar stratospheric cloud (PSC) particles that form in the extreme cold of polar winter generally run a few tenths of a micrometer to a micrometer in diameter and are made of water and nitric and sulfuric acids. But these new, oversized particles, more than 3000 times the usual mass, ranged from 10 micrometers to 20 micrometers. "These things are rocks" compared with the usual PSC particles, says Fahey. They are most likely made of solid nitric acid hydrates. Atmospheric chemists aren't sure yet how they formed, says Fahey; "no one was expecting to see" such large particles.

The discovery of PSC rocks is catching researchers' attention because of their potential role in removing nitrogen from the stratosphere. All PSCs provide surfaces where chlorine and bromine can be liberated from their inactive forms to enter their ozone-destroying forms. But PSCs that contain nitric acid can also play an indirect role in ozone destruction by taking nitrogen out of circulation. Because nitrogen can tie up chlorine and bromine in inactive, harmless forms, when it becomes tied up in PSCs—a process called denitrification—more chlorine and bromine can remain active to destroy ozone. And because PSC rocks fall far faster than feathery-light PSC particles, the rocks can efficiently ferry nitrogen out of some layers of the stratosphere.

Researchers had found denitrified air over the poles before, but there was no evidence to prove how it was happening. The discovery of PSC rocks is "the first time we've clearly seen reactive nitrogen being stripped from the polar arctic stratosphere," says James Anderson of Harvard University. The rocks are so big that they sink 1.5 kilometers per day compared with 0.1 kilometer per day for ordinary PSCs, Fahey and his colleagues calculate. Although relatively rare, the particles are so massive that in only a few days, their sinking could have removed about half the nitric acid above an altitude of 20 kilometers. "The removal is more widespread than we expected," says Anderson. Last year it seemed to cover an area the size of the United States.

"Now the most important question is how this system will respond to greenhouse loading," says Anderson. Fahey and his colleagues point out that the atmospheric models used to simulate denitrification are now obviously inaccurate, because they don't properly account for rocks. By allowing more chlorine and bromine to remain in their active forms, denitrification could help keep ozone destruction going over the Arctic even after PSCs disappear in the spring. And increased greenhouse gases would likely enhance that process: Although they keep heat in lower down, greenhouse gases cool the stratosphere by radiating heat to space, encouraging the cold that leads to denitrification. Also, levels of stratospheric water vapor are rising along with greenhouse gases, which would also encourage the formation of the water-rich PSC rocks.

Pretty but dangerous. Polar stratospheric clouds with "rock" particles may destroy more arctic ozone.

CREDIT: ARC/NASA

Denitrification "doesn't portend massive ozone losses" like the Antarctic's, notes Susan Solomon of NOAA, Boulder. But Fahey and his colleagues do note that it could delay recovery of ozone over the Arctic as chlorine and bromine emission controls take effect. "If you want to calculate the response of the Arctic to climate change," says Fahey, "the existence of these large particles says you need a rather sophisticated model." The next step in building such a model will be figuring out how rocks start to grow in the first place.

–RICHARD A. KERR

GENOME RESEARCH

Progress for the 'Mouse Gene Encyclopedia'

TOKYO—The imminent publication of the draft sequences of the human genome will be a major milestone in the history of biology. But many researchers regard having the sequence as the first, not the last, step in understanding how the genome works. It's also necessary to identify the genes, which constitute only a small fraction of the human genome sequence, and determine what they do. An international consortium led by Yoshihide Hayashizaki of the RIKEN Genomic Sciences Center in Yokohama, Japan, has now provided the first installment of what promises to be a key resource for filling this gap.

Beginning in 1995, the group set out to produce a complete set of complementary DNA (cDNA) copies of all the mouse genes transcribed into messenger RNAs—that is,

ScienceScope

The Ideas of March The new chair of the House Science Committee is promising to move quickly to get his panel involved in the three E's—education, energy, and the environment. Representative Sherwood Boehlert (R–NY) last week said that the panel, which oversees the gamut of U.S. nonbiomedical civilian science, will hold hearings on the topics beginning next month. He also promised scientists that he will be "your staunchest ally and your fairest critic."

After ascending to the panel's top spot last month (*Science*, 12 January, p. 222), Boehlert outlined his agenda in a 31 January speech to the Universities Research Association, a group of 89 research institutions. First priority, Boehlert said, will be to examine ways to improve precollege math and science education—from creating incentives for top students to teach, to examining the impact of standardized tests on learning. On energy, he'd like to shore up support for research into renewables. And his committee will become "a central forum to learn about the science behind" environmental controversies such as global warming and genetic engineering, he vowed. Hearings will include diverse points of view, he added, "unlike those at which [lawmakers] don't want to be confused by the facts."

Talent Hunt The new InterAcademy Council (IAC) research organization—an international version of the study-producing U.S. National Research Council (*Science*, 19 May 2000, p. 1149)—has gotten its first assignment. Science academy presidents meeting in Davos, Switzerland, last week decided that the IAC's inaugural study should focus on developing better ways to promote scientific talent and research capacity, especially in developing countries. The presidents—led by IAC cochairs Bruce Alberts, president of the U.S. National Academy of Sciences, and Indian Academy president Goverdhan Mehta—also hired law professor Albert Koers of the University of Utrecht in the Netherlands as the group's executive director.

The study, to be funded by a Sloan Foundation grant and written by an e-mail–linked expert panel nominated by member academies, "will focus on developing young scientific talent worldwide," says Koers. A final product is due later this year. The IAC will have a small "core staff" in Amsterdam to help coordinate such projects, he added, but otherwise will be run as "a virtual organization."

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