

posals for just such an agency, with startup funding of \$200 million.

Whether the administration will officially adopt the PCAST recommendations is unclear. "PCAST isn't the administration, it's an advisory panel," a congressional staff member involved in the DHS discussions said.

So the report by itself isn't a "full reversal" of White House policy on the structure of R&D in the DHS. But, the staff member said, it is likely to influence how the administration supports the role of R&D in the House and Senate DHS bills.

JIM DAWSON

Solar and Space Physics Get a Detailed 10-Year Plan

An array of large, medium, and small spacecraft, including the canceled solar probe flight into the Sun's atmosphere, should be launched over the next 10 years as part of a "time ordered" mix of projects to better understand the Sun and the Sun-Earth environment, according to a National Research Council report. Put together over 18 months by a 15-member solar and space physics survey committee, the report lays out a literal flow chart of NASA, NSF, and National Oceanic and Atmospheric Administration (NOAA) projects based on "scientific importance, technological readiness, and synergy among different programs," said committee member James Burch of the Southwest Research Institute in San Antonio, Texas.

The report, released in early

▶ A comprehensive National Research Council study weaves a decade's worth of projects together into a tapestry that could reveal the answers to some of the most difficult questions in solar and space physics.

August, contains recommendations for programs separated into three basic categories: moderate programs (mostly space missions costing between \$250 and \$400 million); small programs (costing less than \$250 million); and "vitality" programs that are not missions per se, but recommendations to improve solar theory, modeling, information, and education programs to reenergize the field.

The report also calls for NASA to

restore the \$650 million solar probe mission, which was canceled last year. That mission was designed to put a spacecraft within four solar radii of the Sun's surface, and is viewed as having "especially high scientific value," said committee chairman Louis Lanzerotti, a physicist with Bell Laboratories, Lucent Technologies, in Murray Hill, New Jersey.

Although the solar probe mission is important, the committee realized that there is no money for the project in NASA's budget, Lanzerotti said, so the committee took two approaches to recommending the flight. "The solar probe is the highest priority as a major mission, but you can't do the solar probe at the same time you do all of the other missions unless you have an add-on of funding," he said. Without extra money, the committee concluded, the solar probe would have to move from the front to the end of the line of committee-endorsed projects. For all of the recommended projects, the committee provided alternative flow charts based on whether the solar probe mission gets new funding and goes early or moves to the back of the queue.

The report, titled *The Sun to the Earth, and Beyond: A Decadal Research Strategy in Solar and Space Physics*, was inspired by the well-

Gell-Mann Meets Muster Mark, Honors Hamilton

*Three quarks for Muster Mark!
Sure he hasn't got much of a bark
And sure any he has it's all beside the mark.*
—James Joyce, *Finnegans Wake*

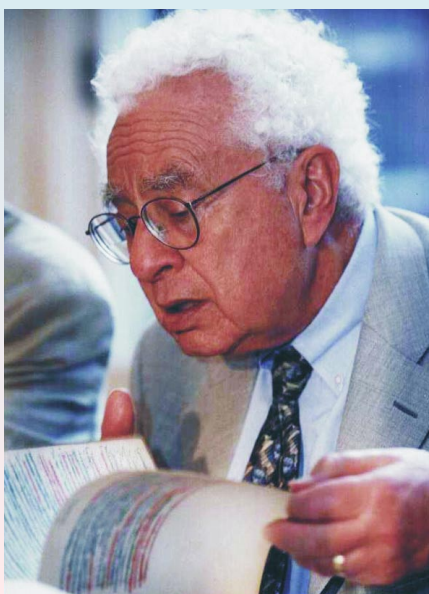
There may be no better-known lines of poetry than these, at least among physicists, thanks to Murray Gell-Mann's having dubbed the elementary constituents of matter "quarks." Gell-Mann had come up with the sound "kwork," but then adopted the spelling in James Joyce's *Finnegans Wake*, partly because "the number three fitted perfectly the way quarks occur in nature," as Gell-Mann writes in *The Quark and the Jaguar: Adventures in the Simple and the Complex* (W. H. Freeman, 1994).

In Dublin this spring, Gell-Mann got a privileged peek at some of Joyce's original manuscripts. In 1941, after Joyce died, a friend, Paul Léon, broke into the author's Paris apartment and salvaged his papers, including handwritten notes for *Finnegans Wake* and *Ulysses*. The papers, but not Léon, survived the war. They surfaced recently when Léon's son Alexis was sifting through his father's belongings, and were purchased in May by the National Library of Ireland for roughly

\$12.2 million.

Gell-Mann will be back in Ireland this month to deliver the Royal Irish Academy's inaugural Hamilton Lecture at Trinity College Dublin. "They are celebrating Hamilton's quaternions, which are beautiful and mathematically interesting, even though they never proved to be of that much use for physics," says Gell-Mann. "But Hamilton did wonderful

work rewriting mechanics and optics in ways that made them look quite analogous. He foreshadowed quantum mechanics." The lecture is part of Hamilton Day, which will be celebrated on 16 October, the date on which, in 1843, William Rowan Hamilton scratched his formulas for quaternion algebra onto a stone on Broome Bridge outside Dublin. "Hamilton is Ireland's most eminent scientist," says the academy's Pauric Dempsey. "But Irish scientists don't have the same profile that writers have. On the street, people talk about Joyce and Yeats and Beckett. We want to build up Hamilton Day to raise the profile of math and science in Ireland." **TONI FEDER**



SHANE O'NEILL/JASON CLARKE PHOTOGRAPHY

MURRAY GELL-MANN peruses James Joyce's blue-and-red handwritten notes for *Ulysses*.

known astronomy and astrophysics decadal report. "I'm the chair of the solar and space physics committee of the [National Academy of Sciences] space studies board," Burch said, "and my committee felt that the astronomy and astrophysics report [most recently published in 2001] was a very powerful report and had it right. Their recommendations usually get done because both the [federal] agencies and Congress feel the recommendations are from the academy and ought to guide the programs. In solar and space physics, it hadn't been happening that way. We felt like a study needed to be done that was national in scope."

After discussions among several scientists in the solar and space physics community and NASA officials, Ed Weiler, NASA's associate administrator for space science, wrote a letter to the NAS, asking that the study be done. The NAS then appointed five independent panels to make recommendations on heliospheric physics; solar wind and magnetosphere interactions; atmosphere-ionosphere-magnetosphere interactions; solar theory, modeling, and data exploration; and education and society. After reviewing the panel recommendations, the survey committee set the priorities for the final report.

Fundamental questions

The report said that there are long-standing and fundamental scientific questions about the physics of the Sun, the interplanetary medium, and the space environments of Earth and the planets. To answer those questions, the committee delineated five challenges that should be at the center of solar and space physics research for the next decade:

- understanding the structure and dynamics of the Sun's interior, the generation of solar magnetic fields, the origin of the solar cycle, the causes of solar activity, and the structure and dynamics of the corona
- understanding heliospheric structure, the distribution of magnetic fields and matter throughout the solar system, and the interaction of the solar atmosphere with the local interstellar medium
- understanding the space environments of Earth and other solar system bodies and their dynamical response to external and internal influences
- understanding the basic physical principles manifest in processes observed in solar and space plasmas
- developing near real-time predictive capability for understanding and

Physics Olympiad Held in Bali, US Stays Home

Welcoming students from 70 countries, Indonesian President Megawati Sukarnoputri kicked off the 33rd International Physics Olympiad in Nusa Dua, Bali, in July, by saying that the event "can be a positive means for increasing people's attention, understanding, and mastery of basic science." Her comments marked the first time the event has been opened by a head of state.

Vietnam's Ngoc Duong Dang earned the highest individual score. The People's Republic of China, with four gold medals and one silver, had the top overall team score for the third straight year. But Iran's team was the only one to win five gold medals. Back home, Iran's team is being recognized for its accomplishments: Members are exempt from both university entry exams and the military, and will meet with Iranian President Seyed Mohammad Khatami.

As usual, the competitors tackled both theoretical and experimental problems. One of this year's experimental problems required that they determine the unknown optical components inside a sealed box by probing optical signals from two slits in the box.

Originally scheduled to be held in Bandung, about 200 km southeast of Jakarta, the Olympiad was moved to Bali and delayed a week because of floods and security concerns. But the move was not enough to reverse the US team's no-show decision. Heeding a State Department warning against nonessential travel to Indonesia, the US team's sponsors—the American Association of Physics Teachers and the American Institute of Physics—kept their team home. Instead, the US team members attended a ceremony in their honor at NASA headquarters in Washington, DC.

The five US students who would have competed in Indonesia are Pavel Batrachenko of John Marshall High School in Rochester, Minnesota; Steven Byrnes and Sean Markan of Roxbury Latin School in Boston; Benjamin Schwartz of Staples High School in Westport, Connecticut; and David Simmons-Duffin of Shaker Heights High School in Shaker Heights, Ohio. AIP and AAPT presented them with medals and scholarships.

Next year's Olympiad will be held in July in Taipei, Taiwan. **ANTHONY TWEED**



DURING DOWNTIME, students took part in a kite festival on the beaches of Bali (bottom). Stamps commemorating the Olympiad (top) were issued by Indonesia's postal service.

33RD IPhO ORGANIZING COMMITTEE

quantifying the impact on human activities of dynamical processes at the Sun, in the interplanetary medium, and in Earth's magnetosphere.

To help meet those challenges, the committee looked at all of the federal support for solar and space physics research and then brought the programs together into a coordinated planning strategy. "The existence of ongoing NSF programs and facilities in solar and space physics, of two complementary mission lines in the NASA Sun-Earth Connection program (Living with a Star, and Solar Terrestrial Probes), and of . . . activities in NOAA and the Department of Defense helps facilitate such an approach," the report said.

This integrated systems approach

creates a tapestry of interwoven projects that will, if done in the appropriate order, augment each other, Lanzetta said. Although the report gives priority rankings to missions and facilities, he said, it doesn't mean that the lower-ranked items are less important. "It is a time-oriented ranking."

The interconnectedness of the rankings is apparent in the report's overview of some of the recommended projects: "As a key first element . . . the committee endorsed three approved NASA missions, Solar-B, STEREO, and [the] Solar Dynamics Observatory [SDO]. Together with ongoing NSF-supported solar physics programs and facilities as well as the start of the Advanced Technology Solar Telescope [ATST], these missions constitute a

synergistic approach to the study of the inner heliosphere that will involve coordinated observations of the solar interior and atmosphere and the formation, release, evolution and propagation of coronal mass ejections toward Earth."

Later in the decade, overlap from the SDO, ATST, Magnetospheric Multiscale project (a cluster of four spacecraft), Frequency Agile Solar Radio telescope, and NSF's Relocatable Atmospheric Observatory "will form the intellectual basis for a comprehensive investigation of magnetic reconnection in the dense plasma of the solar atmosphere and the tenuous plasmas of geospace."

NOAA's role should grow

The committee also recommended that NOAA be responsible for operating the next satellite that collects solar wind data at the L1 Lagrangian point. NASA's ACE spacecraft currently has that task. The L1 recommendation is one in a series of recommendations that would increase NOAA's role in developing better monitoring and predictive abilities related to space weather. The National Space Weather program was established in the mid-1990s to study the Sun-Earth interaction and environment, but given the vulnerability of the US electrical power system and other systems to disruption by solar activity, more needs to be done, the report says.

NASA, NSF, and the other agencies affected by the report were expected to be briefed in September and hadn't yet reacted to the recommendations, Lanzerotti said. Burch noted that science missions in the report "may not be exactly what [the federal agencies] want to do or the sequence they want to do them in, but I think overall it's going to be very helpful."

In addition to the projects, the committee recommended programs to improve technology so "future science objectives" in solar and space physics can be met. NASA is urged to "assign high priority to the development of advanced propulsion and power technologies required for the exploration of the outer planets, inner and outer heliosphere, and local interstellar medium." Finally, the report does something few other science overview reports have done—it gives specific cost estimates for each of the projects recommended. The committee allowed \$650 million for the solar probe mission, and the Geospace Network project is estimated at \$400 million.

The price for the multi-spacecraft Solar Wind Sentinels mission is set at \$300 million, while the Small Instrument Distributed Ground Network, an NSF program to provide ionospheric and upper atmospheric measurements, should cost about \$5 million per year.

"We felt it was mandatory to make reasonable costing estimates," Lanzerotti said. "There is no question we could fall on our face on some of these costs, but we've also said if something really gets outrageous [in cost], then we'll have to rethink where it fits in the queue of projects." **JIM DAWSON**

NAS Finds No Flaws in Nuclear Treaty

The National Academy of Sciences has issued a report concluding that the "main technical concerns raised about the Comprehensive Nuclear Test Ban Treaty (CTBT)... are all manageable." *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty* was written over a two-year period by 11 members of the NAS committee on international security and arms control. The panel of scientists, arms control experts, and former national laboratory and industry executives was chaired by John Holdren of Harvard University. The report concludes that "verification capabilities for the treaty are better than generally supposed, adversaries could not significantly advance their nuclear weapons capabilities through tests below the threshold of detection, and the United States has the technical capabilities to maintain confidence in the safety and reliability of its existing weapons stockpile without periodic tests." The State Department is currently evaluating the report, which is available at <http://www.nap.edu/html/ctbt>.

The report was commissioned by the Clinton administration to look at questions that arose when the US Senate refused to ratify the CTBT in October 1999. The US was among the first of 165 nations to sign the 1996 CTBT, which will come into force after ratification by the 44 countries that currently possess either nuclear weapons or nuclear reactors. To date, 31 of these countries have ratified the CTBT, including France, Russia, and the UK. The Bush administration, though, has made clear that it does not intend to push for ratification by the Senate. The current administration views the treaty as unverifiable and as constraining the US's ability to

develop and test new nuclear weapons, especially new low-yield tactical warheads that could destroy hardened targets such as underground bunkers. The Bush administration requested \$15.5 million in the 2003 defense budget to analyze options for developing such weapons.

In addition to prohibiting nuclear test explosions in the atmosphere, underground, under the oceans, and in space, the CTBT would establish a network of several hundred monitoring stations using seismological, hydroacoustic, infrasound, and radionuclide sensors to help monitor compliance, and would provide for inspections of suspected test sites. The CTBT would permit R&D and design activities by the nuclear weapons states, but outlaw experiments that produce a nuclear explosion.

The report's conclusion that the US can maintain the weapons stockpile without nuclear testing differs from the conclusion of the Bush administration's nuclear posture review. That classified document asserts that the US may have to resume testing to maintain the reliability of its nuclear stockpile and calls for a reduction from years to months in the preparation time needed to resume testing. The US has not performed a nuclear test in 10 years, although it has conducted at least 17 subcritical tests—the most recent in August—which are allowed under the CTBT.

The solution to dealing with age-related defects in weapons, says the NAS report, is rigorous surveillance coupled with the remanufacture of warheads to their original specifications when problems are discovered. In fact, the safety and reliability of the stockpile are better now than when testing ceased, says the report, which calls for revamping the Department of Energy's manufacturing capabilities and further strengthening evaluations of the warheads. If unforeseen problems should emerge in the stockpile that could not be resolved without nuclear tests, the US would still have the option of withdrawing from the treaty, the report notes.

The network of monitoring stations within the CTBT verification regime is the only system through which the US can confirm "with high confidence in all environments" that no tests with yields above 1–2 kilotons are being conducted anywhere. In some cases of particular potential concern, such as Russia's Novaya Zemlya test site, even lower yields—down to 10 tons—could be "reliably detected," according to the report.