

Gathering Airm Schemes for Averting Asteroid Doom

Cosmic exponential billiards. The kinetic-energy cookie cutter. The big kerplunk. These are not new rides at the local amusement park. Rather, they were topics of discussion for 140 astronomers, physicists, and engineers who met late last month at Lawrence Livermore National Laboratory to discuss the risks posed by an asteroid or comet crashing into Earth and how this catastrophe could be averted. And far from being light-hearted, the meeting saw an escalation of concern about these cosmic collisions and a proliferation of possible defenses.

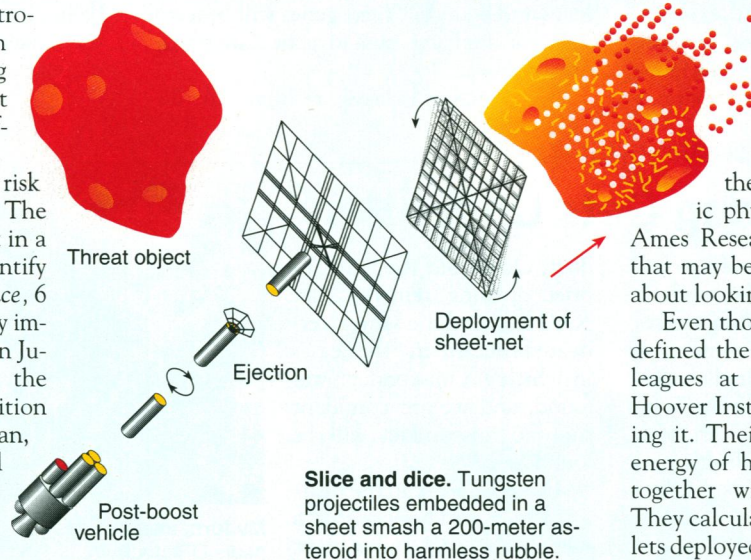
The idea that humanity is at risk from an asteroid impact isn't new. The Livermore meeting* was the latest in a 4-year series of gatherings to identify hazards and suggest defenses (*Science*, 6 March 1992, p. 1204). But the fiery impact of comet Shoemaker-Levy 9 on Jupiter last summer ratcheted up the sense of urgency. So has a redefinition of the threat, says Gregory Canavan, a physicist at Los Alamos National Laboratory and one of the organizers of the meeting: "Heretofore most of the attention has been given to objects a kilometer or larger in diameter." Lately, he says, "it's been recognized that objects that are 100 meters to a kilometer in size impact more frequently and also [cause] significant losses."

Yet smaller asteroids may be easier to fend off without blasting them with nuclear weapons, an issue that divided earlier meetings. As a result, physicists and engineers at the meeting—many of them veterans of the nuclear weapons and "Star Wars" programs, which have fallen on hard times in recent years—were quick to propose non-nuclear schemes for dispatching these threats by chopping them to bits or nudging them off course.

Other researchers would still rather invest in detection systems to identify potentially threatening objects than in defenses. But there's little dispute about the existence of the hazard. From a variety of evidence, including the frequency of impacts on the moon's pock-marked face and estimates of the number of asteroids and comets that follow orbits intersecting our own, planetary geologist Eugene Shoemaker of the U.S. Geological Survey and the Lowell Observa-

tory (co-discoverer of the comet that bears his name) has estimated that Earth can expect a visit from a 1-kilometer object about once every 100,000 years. "And frequency goes as the inverse square of the diameter," he says, so a 200-meter object should arrive about every 4000 years.

How to detect the larger objects was a



focus of earlier workshops, resulting in a proposal to the National Aeronautics and Space Administration (NASA) for a detection network called Spaceguard. As Shoemaker and his colleagues now envision it, Spaceguard—an expansion of a small existing effort—would consist of automated charge-coupled devices mounted on a handful of 1- to 2-meter telescopes. In the space of 10 years, the instruments could locate 90% of the asteroids a kilometer and more in diameter that cross Earth's orbit, says Shoemaker, at a cost of about \$4 million per year. These instruments could also spot Earth-crossing asteroids in the 100- to 200-meter size range, Shoemaker says, "but that's going to be a long haul. We'll find huge numbers of these things, but there's a huge number to find"—perhaps several hundred thousand of them.

That abundance is one reason why smaller asteroids have become the major focus of concern. Jack Hills, an astrophysicist at Los Alamos National Laboratory, presented another: They can cause a disproportionate amount of damage if they land in an ocean—the big kerplunk. Hills built a computer model to study the response of the ocean to an impact. He found that a 200-meter object could set off waves 10 to 20 meters high in

the deep ocean. That may not sound impressive, but when these deep-water waves approached the shoreline, they grew by more than an order of magnitude on average, creating towering swells that would inundate coastal areas like New York City and Rhode Island. "It certainly made me nervous when we started seeing some of these calculations coming out," Hills says.

The estimated return interval for 200-meter objects means that on average, says Hills, "the Earth should see a major tsunami event on some coastline every 4000 years, where several thousand kilometers of coast would be devastated." Such cataclysms should blanket inland areas with debris, like the de-

posits left by a giant impact 65 million years ago that may have killed off the dinosaurs. One problem is that tsunami deposits from smaller impacts haven't been spotted in the geologic record. But atmospheric physicist Owen Toon of NASA's Ames Research Center in California says that may be because "nobody ever thought about looking for them" until recently.

Even though researchers haven't yet fully defined the threat, Lowell Wood and colleagues at Lawrence Livermore and the Hoover Institution have a plan for countering it. Their scheme relies on the kinetic energy of hypervelocity projectiles, strung together with strong, lightweight fibers. They calculate that a lattice of tungsten bullets deployed from a rocket could penetrate a 200-meter asteroid and slice it into 1-meter rubble, which would burn up when it hit Earth's atmosphere. Canavan dubbed this proposal the "kinetic-energy cookie cutter."

It was just the beginning of the non-nuclear defense schemes unveiled at the meeting. Other participants spoke of deflecting asteroids by crashing rockets into them or by heating their surfaces with a solar collector. The vapor jet from a superheated spot could provide enough thrust to steer the object away from a collision course, argued the author of this idea, H. Jay Melosh of the University of Arizona.

To deal with the largest objects, hydrogen-bomb pioneer Edward Teller of Lawrence Livermore and the Hoover Institution was ready with a scheme labeled "cosmic exponential billiards" by Livermore Associate Director at Large John Nuckolls, one of the workshop organizers. Teller's idea is to collide a small asteroid into a large, threatening one to bump it off course or shatter it. This Brobdingnagian carom shot, Teller says, would require a smaller asteroid with an orbit that carries it close to the dangerous one. Then, perhaps with well-placed explosions, "we can try to deflect the [smaller] object gently, and maybe we have to push several times so that the two collide," Teller says. "That will prob-

*Planetary Defense Workshop, 22–26 May, sponsored by DOE, NASA, and USAF Space Command.

ably break up the big one into little pieces.”

Teller's scheme might call for nuclear explosives, but Canavan says the new focus on objects that could be warded off without nukes led to “a surprising amount of consensus. ... People could see pieces of a real [defensive] program falling together.” Canavan estimates that a program to defend Earth against small and large objects would cost between \$50 million and \$200 million a

year—and one Russian scientist, Vadim Simonenko of the Russian Federal Nuclear Center at Chelyabinsk-70, proposed that the United States and Russia undertake the project together. Teller, for one, welcomed the idea, telling *Science*, “I am all for it.”

Whether asteroid defense will ever get off the ground in these days of tight funding is questionable, of course, and some asteroid specialists don't see the urgency. Says Shoe-

maker, “I don't lie awake at night worrying whether we're going to be wiped out by an impact.” But as humans continue to monitor a sky teeming with hazards, they may one day detect an object headed our way. If it's a big one, Edward Teller may get a chance to dust off his billiards skills.

—David K. Hill

David K. Hill is a science writer in San Francisco.

FRANCE

AIDS Expert Charged in HIV-Blood Case

PARIS—A wave of recriminations resulting from the contamination of France's blood supply with HIV in the mid-1980s continues to engulf prominent researchers. Last week, it was the turn of Jean-Baptiste Brunet, an internationally respected AIDS expert, who was charged with “complicity in poisoning.” The charge drew an immediate response from 19 of France's leading AIDS figures, who issued a public letter in support of Brunet. The signatories include the Pasteur Institute's Luc Montagnier and several other researchers who first isolated HIV in the early 1980s, as well as leaders of two French AIDS advocacy organizations. “I can't see anything that Brunet did wrong,” Montagnier says. “He has dedicated 14 years of his life to AIDS.”

The affair, which has been rumbling on for 8 years, has already seen two French doctors sent to jail. (One of them, Michel Garretta, former director-general of France's National Center for Blood Transfusion, was given an early release last month from the 4-year sentence he received in 1992.) But for many AIDS researchers, both in France and elsewhere, the charging of Brunet—who since 1987 has directed the European Center for the Epidemiological Moni-

toring of AIDS near Paris—is the single most shocking development. “I was very surprised to hear that of all people Brunet was picked out,” says Peter Piot, director of the Joint U.N. Program on HIV/AIDS based in Geneva. “In Europe he was one of the first to ring the alarm bell.”

The detailed accusations against Brunet have not been made public. The French press has, however, speculated that they arise from complaints filed with the French court system by patients, particularly hemophiliacs, who became infected with HIV from contaminated blood and blood products. These complaints accuse Brunet of having delayed for 2 months in early 1985 notifying the health ministry about data showing that a small but disturbing percentage of blood taken from Parisian blood donors was contaminated with HIV. At the time, Brunet was an adviser to the ministry. Brunet told *Science* that he has decided to make no public comments while his case is pending. But in a letter published last October in a French medical journal, he branded the accusations as totally false and argued that he had kept health authorities completely informed of everything he learned.

The affair entered a dramatic new phase last fall, with the charging—also with complicity in poisoning—of a number of politicians, scientists, and physicians who in early 1985 were allegedly involved in decisions to keep an HIV-antibody test manufactured by the American firm Abbott off the market while the French firm Diagnostics Pasteur readied its own version (*Science*, 14 October 1994, p. 222). The list includes former French Prime Minister Laurent Fabius, internationally known cell biologist François Gros, who was scientific counselor to Fabius when the crucial decisions were made, and Louis Schweitzer, currently chief executive officer of the carmaker Renault, who was Fabius's chief of staff in 1985.

Until now, French AIDS researchers have mostly kept their heads down while the scandal broadened. But the charges against Brunet may now jolt them into action. Luc Montagnier says he plans to organize a meeting to bring together everyone involved in the case—plaintiffs, hemophiliac associations, AIDS organizations, scientists, politicians, and journalists—to try to reach some kind of settlement and bring the criminal prosecutions to an end. “What I am proposing now,” Montagnier told *Science*, “is to really stop this.”

—Michael Balter

GERMAN-U.S. EXCHANGES

Meeting Seeks to Link Young Scientists

BERLIN—About 70 young German and American scientists will meet later this month in the ornate Albrechtsberg Castle near Dresden—a city devastated a half-century ago by Allied bombing raids—in an attempt to strengthen links between researchers in the two countries. The first annual German-American Frontiers of Science Symposium is sponsored by the German-American Academic Council Foundation, founded last year as part of a broad initiative by German Chancellor Helmut Kohl to improve cooperation among Germans and Americans in the sciences and humanities at a time when fewer and fewer leading German researchers appear to be maintaining close ties with their counterparts across the Atlantic. “We've tried to bring together many of

the most promising young scientists in each field, who will have an important role in both research and policy,” says Kurt Maass, of the Bonn-based Alexander von Humboldt Foundation, who helped organize the conference. “We want to create a lasting network.”

The meeting is modeled on the U.S. National Academy of Sciences' (NAS's) widely praised Frontiers of Science symposia, which have attracted dozens of talented young U.S. scientists each fall since 1989 to the academy's Arnold and Mabel Beckman Center in Irvine, California. The von Humboldt Foundation has taken a lead role—along with the NAS, the Max Planck Society, and the German Academic Exchange Service—in organizing the Dresden conference, which will bring together outstanding scientists under

age 45. The symposium sessions—mainly developed by the participating scientists themselves—range from gravitational lensing, through surface science, to mathematical computation and visualization. Each session features both speakers and discussion leaders. “This symposium should offer these scientists the opportunity to discuss exciting progress and possibilities for further research in their discipline, and at the same time strengthen their interdisciplinary and international contacts,” says Manfred Osten, general secretary of the von Humboldt Foundation. Organizers are already planning another German-American conference next summer in Woods Hole, Massachusetts, with the following year's symposium to take place back in Germany.

—Robert Koenig

Robert Koenig is a journalist based in Berlin.