Math prizes: Fields for further study

The surprising discovery of deep, hitherto hidden links among vastly different mathematical fields is one of the strongest threads that tie together the research of three young mathematicians who this week were each awarded a Fields Medal. To mathematicians, this award, named for Canadian mathematician John C. Fields, carries the prestige, if not the monetary value, of a Nobel Prize.

Michael H. Freedman, 35, of the University of California at San Diego, was honored for his work on classifying four-dimensional shapes or manifolds, part of the study of topology (SN:7/17/82,p.42). Freedman's methods for constructing the startling variety of forms possible in four-dimensional space was a key element in the solution to this problem. His research brought together powerful ideas in both geometry and algebra.

Simon K. Donaldson, 29, of Oxford University in England, although also studying four-dimensional manifolds, took a very different approach. To provide a new geometric tool, he borrowed methods from theoretical physics — a set of nonlinear differential equations widely used for describing electromagnetic effects and other phenomena. Together with Freedman's work, his results revealed that four-dimensional space has more than one possible structure.

"When Donaldson produced his first few results on four [-dimensional] manifolds," says Oxford's Michael Atiyah, a previous Fields Medal winner, "the ideas were so new and foreign to geometers and topologists that they merely gazed in bewildered admiration. Slowly the message has got across and now Donaldson's ideas are beginning to be used by others in a variety of ways."

Says Donaldson, "New ideas, once developed, have a life of their own."

West German Gerd Faltings, 32, now at Princeton (N.J.) University, solved the Mordell conjecture, a long-standing problem concerning polynomial equations (SN:7/23/83,p.58). His success depended on finding connections between number theory and algebraic curves.

Also awarded this week at the International Congress of Mathematicians, held in Berkeley, Calif., was the Nevanlinna Prize. This prize goes to mathematicians who make significant contributions to the theory that underlies computer science.

This year, the recipient was Leslie G. Valiant, 37, of Harvard University. Valiant's research encompasses a wide variety of topics in computer science, ranging from the development of rapid methods for recognizing sentences in languages described by context-free grammars (SN:11/16/85,p.314) to general ideas about what can and cannot be computed within a "reasonable" time.

Unlike a Nobel Prize, the mathematics awards go only to individuals who are less than or equal to 40 years of age. This emphasis on youth is designed to encourage recipients to continue their research while recognizing novel ideas that open up new mathematical fields for others to explore.

All four prizewinners note that hard work, persistence and luck played important roles in their discoveries. But, says Donaldson, "the main point of doing this is to have fun." — *I. Peterson*

Inner workings of cystic fibrosis

Cystic fibrosis, the most common fatal genetic disease in Caucasians, is beginning to reveal its secrets. Last year, geneticists found chromosomal markers for the disease (SN:10/19/85,p.244). Now it is the biochemists' turn: Researchers have found a defect in cell function of people with cystic fibrosis.

Since Paul Quinton of the University of California at Riverside discovered in 1983 that sweat gland cells of cystic fibrosis victims are not very permeable to chloride ions, researchers have focused on the channels that carry chloride across cell membranes. Now they have shown the problem to be at the level of what *controls* the channel, not at that of the channels themselves, according to a report in the Aug. 1 SCIENCE by researchers at the University of Alabama at Birmingham and in the July 31 NATURE by researchers at the University of Iowa in Iowa City and Case Western Reserve University in Cleveland.

Normal chloride movement pulls water from the tissues to the lung lining; without this water, mucus in the lungs is too thick and sticky, and interferes with normal lung function. One in 2,000 U.S. Caucasians is born with the disease, and half die by age 21. Current therapy consists of chest pounding to loosen the lung secretions, and antibiotics for the frequent lung infections.

The two groups independently found that the channels in cystic fibrosis patients' cells failed to respond to a chemical that usually stimulates chloride movement. The channels sit in the cell membranes, and when the cells were disrupted and just the membranes were tested, the channels responded properly, indicating that the problem lies in the cell's control over the channel.

"Nothing's different tomorrow from what it was yesterday for cystic fibrosis patients," says Iowa's Michael J. Welsh. "But if we can find out the basic defect, we might be able to develop a rational therapy." — *J. Silberner*

Lungs hurt most by ozone-acid synergy

The federal air-quality standard for ozone — the primary irritant in smog — was developed primarily from human health-effects data showing that the chemical might aggravate existing respiratory problems. But new research by scientists at the University of California at Davis suggests the current ozone standard (SN:6/28/86,p405) may be based on studies that underestimate the pollutant's real-world risk. The Davis researchers have shown in rats that ozone's effects on health are magnified in the presence of acidic air-pollution aerosols such as sulfuric acid and ammonium sulfate. And most researchers agree that people are more likely to encounter ozone in the presence of acidic aerosols than by itself.

Though the level of aerosols used in this study was 100 times higher than what tends to occur outdoors, Davis's Darren Warren says a study now under way is using concentrations of both ozone and an acid aerosol — in this case, sulfuric acid — typical of southern California pollution. "And we have preliminary data showing that these ozone and aerosol concentrations also cause a synergistic effect," he told SCIENCE NEWS.

Unlike ozone, acid aerosols are not governed by national air-quality standards. In fact, studies by the Davis researchers and others have shown that at urban levels, acid aerosols alone do not cause noticeable lung damage. But reasoning that the acids might exacerbate the respiratory risk posed by their smoggy companions — such as ozone — the Davis team began comparing lung damage in rats caused by ozone alone and by ozone together with otherwise nondamaging levels of acid aerosols.

In the July TOXICOLOGY AND APPLIED PHARMACOLOGY, Warren, Daniel Guth and Jerold Last report that ammonium sulfate, the most common acidic aerosol in smog, indeed interacts synergistically with ozone at concentrations of ozone common in the Los Angeles basin — 0.2 parts per million in air. The two most sensitive biochemical indicators of this effect were elevations in the protein content of lavage (material washed from the lung) and the rate at which lung tissue increased its synthesis of collagen.

Exposure to ozone and ammonium sulfate elevated lavage-protein content 26 percent above the level found in animals exposed to ozone only. According to Warren, elevated lavage-protein content signals inflammation — one sign of ozone damage. Exposure to both pollutants elevated collagen synthesis 22 percent above the increase caused by ozone alone. Collagen synthesis rate can be a clue to developing ozone toxicity, since

fibrosis of the lung – an excess of connective tissue such as collagen – occurs in advanced stages of ozone toxicity. Finally, the number of fibroblasts – cells that make collagen – was three times higher in lung tissue of rats that had been exposed to both pollutants than in those exposed to just ozone.

According to David McKee of Research Triangle Park, N.C., project officer for the Environmental Protection Agency's ozone air-quality review, this synergism and the type of lung effects reported by the Davis group "are of sufficient importance to raise a flag of concern. It really is worth paying attention to." *– J. Raloff*

Return to the *Titanic:* Gash is dashed

Scientists who recently returned to the wreckage of the *Titanic* (SN:7/19/86,p.37) found no evidence in the luxury liner's hull of an immense gash long thought to have been the result of a fatal collision with an iceberg. Instead, it appears that the hull's steel plates buckled, popped their rivets and separated from adjoining plates in the region where the gash was supposed to be; this allowed water to seep in and sink the ship.

Photos: ©1986 Woods Hole Ocean. Inst.

Alvin, *with Jason Jr. on its bow, is lowered into the ocean (left). Bollards, used to secure mooring lines, and a railing on* Titanic*'s bow (right).*

"We saw absolutely no evidence of a large gash in the starboard side [of the bow]," said expedition leader Robert D. Ballard at a press conference at the National Geographic Society in Washington, D.C., last week. Plate separation on the hull, he added, fits into survivors' accounts that at first they were unaware an accident had occurred. "Rivets could pop without much notice," explained Ballard.

The scientists also took a closer look at the ship's stern, which lay 2,000 feet away from the bow section. This area, where many passengers assembled as the vessel sank, "was a carnage of debris," said Ballard. It was twisted so that it faced the same direction as the bow and much of the inside ribbing of the hull was exposed, perhaps peeled away by increasing water pressure as the *Titanic* headed for its grave. The remains of the stern were too damaged to permit safe exploration inside.

The two halves of the liner separated soon after the iceberg collision, according to Ballard, but it is not possible to tell if the ship broke while still on the surface.

The hull and other steel objects were heavily rusted and in some places covered by what Ballard calls "rusticles." Extensive wooden areas of the ship and other organic material were almost completely disintegrated, but copper, brass, glass and ceramic artifacts were beautifully preserved.

Salvage operations appear to be out of the question, said Ballard. Both the stern and the bow hit the ocean floor with a great impact that created sizable craters, and the two sections are now embedded in sediment. In addition, according to the researchers, artifacts strewn throughout the field of debris are mostly from the third-class section and not of great value.

"I don't see the economics of a salvage operation," said Ballard. "The *Titanic* is protecting itself."

The chief purpose of returning to the *Titanic* was to test a new, remote-controlled video camera called Jason Jr., which was tethered to the three-man submersible vehicle known as *Alvin*. With its 12 cameras and other imaging devices, *Alvin* spent a total of 33 hours exploring the ship on 11 dives. The lawnmower-size Jason Jr. was released four times from its nest on *Alvin*'s bow, and on three dives it took photographs inside the *Titanic*. Though the robot suffered a number of mechanical problems at the 12,500-foot depth of the sunken vessel, the scientific team, which operated out of the Woods Hole (Mass.) Oceanographic Institution, returned with hours of videotape and 57,000 still photographs.

The scientists hope to assemble about 100 photographs into a mosaic of the 882-foot-long *Titanic*. In the darkness of the ocean floor, the whole wreck cannot be viewed at once. Said Ballard, "It's like you're in a forest at night with a flashlight, and you look up at a sequoia tree and say, 'Great bark.' "

– B. Bower

Five-fold increase in Superfund money

House and Senate conferees agreed last week to spend $9 billion to continue cleaning up hazardous-waste sites during the next five years. This new Superfund program is designed to be stronger than the original $1.6 billion program – which technically expired last fall – by requiring that:

- the U.S. Environmental Protection Agency (EPA) begin at least 375 new cleanup projects through 1991
- cleanups meet state and federal environmental and health standards
- the statute of limitations be extended to allow people harmed by exposure to toxic wastes to sue many years after exposure, if they do not become aware of their injuries right away
- $500 million be targeted for repairing leaking underground tanks containing motor fuel
- federal agencies releasing toxic chemicals (mainly the defense and energy departments) now fall under the Superfund program
- large chemical manufacturers report annually the substances they routinely release into the environment and store in underground tanks, and help their neighbors respond to any emergency leakage. Exempt from this provision are power companies, hazardous-waste facilities and, during the first year, chemical companies releasing less than 75,000 pounds of hazardous wastes. In the second year, chemical companies that release less than 50,000 pounds are exempt, and in the third, those that release less than 25,000 pounds are exempt.

Still unanswered is the question of where the $9 billion comes from. House conferees suggested raising more than $7 billion through taxes on chemical manufacturers, but senators have not yet responded.

The lack of a firm funding provision is a major flaw in the compromise, according to the environmental groups that have banded together to lobby for a tougher law. As long as there is a chance that a major share of the costs may have to be met by the taxpayers, there is a danger that Congress may not fully fund the program each of the five years, according to Rick Hind, an environmental lobbyist for the U.S. Public Interest Research Group (U.S. PIRG) in Washington, D.C. "This is a classic area where environmental laws break down," Hind says. "You succeed in getting legislation but no money to implement it."

The funding mechanism must be worked out before the House and Senate vote on the compromise bill. That vote is expected in the next two months.

Although environmentalists are pleased that the new program is to be