Mathematics

Tying together math and macromolecules

Writhing numbers, tangle calculus, knot invariants and flexible graphs. These mathematical terms would appear to have little to do with molecular biology. Nevertheless, over the last few years, a fruitful collaboration has sprung up between a few mathematicians interested in topology, especially knot theory, and some molecular biologists struggling to understand the geometry and behavior of DNA molecules (SN: 5/21/88, p.328). Now the National Science Foundation is about to fund a program at the University of California, Berkeley, designed to help mathematicians and biologists develop mathematical tools and a common language for solving problems in molecular biology.

"The informal collaborations worked so well that we thought there were a lot of other people out there who could also benefit," says Berkeley molecular biologist Nicholas R. Cozzarelli, who directs the new program. In the first year, six mathematicians and four biologists will participate in the program, investigating topics such as recognizing patterns in protein sequences, developing new techniques for genetic mapping, tracking energy flows as DNA molecules untangle and shift in position, and analyzing enzyme actions. The program will receive $2 million over the next five years, with the cost shared between the National Science Foundation's mathematics and biology divisions. It includes plans for sponsoring a number of meetings involving both biologists and mathematicians to assess and propagate research results and to define new problems worthy of investigation. The program will also provide direct support for some interdisciplinary research and for a number of graduate students and postdoctoral fellows.

"We're not really after converting mathematicians to become biologists or biologists to become mathematicians," Cozzarelli says. "What we're after is facilitating collaboration — so that there is a constant interplay between mathematics and biology, a give-and-take between theory and experiment." The idea is to exploit the mathematics to interpret and suggest experiments and to use experiment and biological questions to suggest areas for mathematical research.

Major-league factoring on a low budget

There's more than one way to crack a tough number. Last month, a group of researchers, using dozens of computers scattered across three continents, split a particularly difficult 100-digit number into its two prime-number factors (SN: 10/22/88, p.263). A few weeks later, William R. (Red) Alford of the University of Georgia in Athens finished factoring a 95-digit number. Although he didn't set a new factoring record, Alford managed to accomplish the factorization using about 100 personal computers — the most humble members of the computing family — to collect the data he needed. Only four years ago, the best anyone could do, even with a supercomputer, was to factor a hard 71-digit number.

Although Alford used the same factoring method as the international group, his success depended on a highly sophisticated computer program designed to push each microcomputer to its limit. With no network connecting the machines, Alford himself carried data-packed floppy disks from computer to computer, taking four months to gather the information he needed to do the final factoring step on a larger computer. For the final step, he had access to a newly developed algorithm for dealing with large matrices, which allowed him to complete the last step in half the time the larger international group needed to complete factoring its 100-digit number.

Alford's 95-digit number comes from a list of "most wanted" factorizations. The number, which turns out to have a 44-digit and a 52-digit factor, is the 95-digit remainder after dividing $2^{332} + 1$ by the numbers 17 and 11,953.

Space Sciences

Jonathan Eberhart reports from Austin, Tex., at the annual meeting of the American Astronomical Society's Division for Planetary Sciences

Hiding the atmosphere of Mars

The major constituent of the Martian atmosphere is carbon dioxide, and scientists have assumed that there ought to be something in the "soil" and polar caps that serves as a buffer, or reservoir, to maintain the atmospheric supply. Yet the leading candidate, carbonate rock, has unaccountably remained elusive. Now researchers have discovered a mineral on Mars that may fill the bill.

Called scapolite, it is somewhat rare on Earth, where it usually forms by heat-processing of carbonate rocks, often at points of contact with volcanic rocks. It has also been found in basaltic igneous rocks that have been altered by fluids rich in carbon dioxide.

Its presence on Mars was detected by Roger N. Clark and Gregg A. Swayze of the U.S. Geological Survey (USGS) in Golden, Colo., together with other colleagues. They found it during observations in August and September with a new spectrometer mounted to NASA's 3-meter infrared telescope on Mauna Kea, Hawaii. The researchers suggest that the precision of the near-infrared spectra yielding the new find may have been aided by the fact that Mars was closer to Earth than it had been in nearly 20 years.

In order to identify minerals with spectral absorption bands that might match the Martian data, the scientists examined spectra of hundreds of minerals, consulting the USGS digital spectral database. The Mars data revealed five bands that matched the spectrum of scapolite. The researchers suggest that one possible source of scapolite on Mars could have been carbon dioxide combined with calcium plagioclase, probably produced by volcanoes in the ancient Martian past.

Glimpsing the atmosphere of Pluto

When Pluto passed in front of a star on June 9, astronomers watching the event could readily tell that the planet had an atmosphere, since the starlight took about half a minute to fade out and reappear rather than simply blinking off and on as it crossed Pluto's edge (SN: 6/19/88, p.391). Now they have had time to see what the atmosphere is like, based on what Richard P. Binzel of the Massachusetts Institute of Technology calls "the most exciting observations of Pluto that have ever been made."

Proportionately, the atmosphere lies far thicker upon its planet than does Earth's, notes James L. Elliot of MIT. The starlight began to fade when it was about 1,462 kilometers from Pluto's center, and was gone completely at 1,143 km. This is thus Pluto's maximum radius, on top of which lies a layer of atmosphere 319 km deep. (Observations of recent "mutual eclipses" between Pluto and its moon Charon suggest about the same radius.)

Past spectral measurements indicate that methane seems to be a major constituent of the atmosphere, though there may also be a substantial amount of spectrally undetectable components such as nitrogen, as is the case on Saturn's big moon Titan. The pressure at the bottom of this deep atmosphere, however, is tiny: At the level where the starlight is down to only half its original brightness (more easily identified than Pluto's actual surface), the pressure of a pure methane atmosphere would be about 0.78 microbars, says Edward W. Dunham of MIT, compared with about 1 bar — or 1 million microbars — on Earth.

The reason so little pressure is represented by such a deep atmosphere, Elliot points out, is simply that a tiny amount of gas has expanded outward in Pluto's low gravity. At present, the planet is nearly at midsummer, when the sun's heat causes the gas to expand. At midwinter, when Pluto is farthest from the sun, most of the gas freezes out onto the surface. This freezing, Elliot calculates, probably reduces the already minuscule atmospheric surface pressure to a mere 250th of its present amount.