Earth Sciences

Richard Monastersky reports from Baltimore at the American Geophysical Union's spring meeting

Monitoring the sounds of silence

In February, the Soviet Union permitted U.S. scientists to install a second phase of seismic monitoring equipment near the Soviet nuclear testing site in eastern Kazakhstan. This installation is part of a cooperative project between the Soviet Academy of Sciences and the private, Washington, D.C.-based Natural Resources Defense Council (NRDC) to demonstrate that seismic equipment can reliably verify whether nuclear tests are being conducted — a provision that would be an important part of a future ban on nuclear testing.

Also as part of the agreement, the first phase of identical monitoring equipment was installed at the same time near the U.S. testing site in Nevada. Scientists from both sides had planned to work together in the construction and operation of each of the sites. However, diplomatic problems have thus far prevented Soviet scientists from helping in Nevada.

The project began last year during the unilateral Soviet moratorium on nuclear testing (SN: 7/26/86, p.55). Since the resumption of testing, the Soviets have enforced a long-standing policy of secrecy by requiring NRDC to turn off the equipment for the duration of the blasts. However, even without measuring the actual explosions, U.S. scientists will be able to use data from these seismometers to indirectly determine the strength of Soviet tests, says Holly Eissler from the Scripps Institution of Oceanography in La Jolla, Calif.

Soviet tests are routinely recorded by seismometers around the world. But lack of knowledge about the geology of the Kazakhstan test site limits how accurately scientists can estimate the yield of these explosions, says Eissler, who is a member of the U.S. team that constructed the Soviet stations.

By recording mining blasts from quarries located near the test site, U.S. scientists can infer details about the local rock, as well as learn how seismic waves attenuate when they pass through that site.

Ants and the atmosphere: No picnic

When atmospheric scientist Tom Graedel heard that his colleagues could not account for much of the formic acid found in the atmosphere above the Amazon, he thought the answer might lie underfoot.

Graedel has been studying whether ants could be a significant source of the formic acid found globally in atmospheric gas and precipitation. Scientists are concerned about formic acid because it provides most of the acidity for the acid rain that falls on remote areas.

From his investigation, Graedel estimates that formicine ants may account for as much as half of the atmospheric formic acid, placing them on a par with industrial contributors to atmospheric formic acid.

Formicine ants are one of the most numerous classes of ants, accounting for more than 10 percent of the world ant population, says Graedel, a researcher at AT&T Bell Laboratories in Murray Hill, N.J. Roughly 10 to 15 percent of the ant's body weight is devoted to a reserve of formic acid, which serves for both defense and communication.

Working with zoologists from Cornell University, Graedel estimated the flux into the atmosphere of ant-produced formic acid by multiplying the number of formicine ants in the world by the amount of formic acid that each ant carries. He then divided this number by a time scale for how much formic acid each ant releases during its lifetime.

With this formula, Graedel estimates that ants release about 2×10^{13} grams of formic acid per year. Chemical reactions that take place in the atmosphere produce roughly the same amount of formic acid. These reactions rely on precursors, such as formaldehyde and certain hydrocarbons, which are mainly emissions from human sources.

Physics

Getting vibes from cosmic strings

Cosmic strings are defects in the structure of the universe, defects in space itself. They are leftovers from an earlier phase of cosmic existence in which space, the "vacuum," had different properties. In modern physics, space can have properties analogous to those of matter, and it can undergo phase changes similar to the freezing or boiling of material substances. Cosmic strings are analogous to the crystal defects that occur when some liquid doesn't freeze exactly right.

The strings form loops carrying masses of 10^{22} grams per centimeter of length and electrical supercurrents of 10^{20} amperes. Weird as these strings sound, we may actually be seeing evidence of them, say three scientists residing in Princeton, N.J., Arif Babul and Bohdan Paczynski of Princeton University Observatory and David Spergel of the Institute for Advanced Study. In the May 15 ASTROPHYSICAL JOURNAL LETTERS they suggest that the bursts of high-energy gamma rays from unknown sources in the sky that detectors record from time to time may be from superconducting cosmic strings. This is the latest of several suggestions about the origin of these mysterious gamma rays.

As cosmic strings oscillate, certain fast-moving parts of them called "cusps" should produce narrow, well-directed beams of gamma rays that could give an observer crossing their path the effect of sharp bursts. If the energies and other parameters are right, we should see something like 100 such bursts a year. The cusps should also produce neutrinos and neutrons, and these, striking the upper atmosphere, should produce showers of secondary particles just as ordinary cosmic rays do. Babul, Paczynski and Spergel suggest that archival records of the world's cosmic ray shower detectors be searched for evidence of showers coincident with gamma ray bursts, which are recorded by orbiting satellites.

Astrometric interferometer successful

In astronomy, interferometry means combining signals received from a given star at two or more different points in order to use correlations between the received signals for more accurate measurement of stellar positions and dimensions than is possible with a single telescope. The correlations can involve variations in the amplitude, intensity or phase of the signal. Interferometry, often used in radioastronomy, is only beginning to be used in optical astronomy. It was hindered in the past by technical difficulties due to the effect of atmospheric turbulence on visible light.

A pioneer phase-coherence interferometer for visible stars, Mark II, located at the Mt. Wilson observatory in Pasadena, Calif., has succesfully measured the positions of five stars to an accuracy of 3 arcseconds and tracked them over wide angles (greater than 20°) as the earth rotated. According to the astronomers involved, it shows that with improvements phase-coherence interferometry will be useful for measuring stellar positions.

The interferometer gathers light from a star at two mirrors 3.1 meters apart and combines the two beams with a "beam splitter" (which here combines beams instead of splitting them) and then measures the coherence of their phases. On the way to the beam splitter one signal goes through a variable optical delay circuit intended to compensate both for the rotation of the earth during tracking and changes in atmospheric turbulence. The report is in the May ASTRONOMICAL JOURNAL by Michael Shao and M. Mark Colavita of the Smithsonian Astrophysical Observatory in Cambridge, Mass., D. H. Staelin of Massachusetts Institute of Technology, K. J. Johnston and R. S. Simon of the Naval Research Laboratory in Washington, D.C., and J. A. Hughes and J. L. Hershey of the U.S. Naval Observatory in Washington, D.C.