Physics

Probing an atomic rise and fall

The scanning tunneling microscope is a remarkably sensitive instrument for tracing the atomic structure of surfaces, revealing the positions of individual atoms. A recent theoretical study suggests that the needle-like probe used in such a microscope may also be handy for monitoring vibrations. Like a microphone, which transforms mechanical energy in the form of sound waves into electrical energy, the probe converts position information into an electrical signal. As part of an electronic sensor, the tunneling probe could be used to detect minute changes in a surface atom's vertical position.

A tunneling microscope uses the tiny electric current flowing between a probe tip and a sample only a few atomic diameters away to trace out a contour map of the sample's surface atoms. As the probe scans the surface, its vertical height is continually adjusted to keep the current constant. Used as a vibration detector, the probe, instead of moving back and forth, would stay in one place, responding to and recording any rise and fall of the surface.

The tunneling probe has one great advantage over other electromechanical devices such as microphones, says Mark F. Bocko of the University of Rochester (N.Y.). In a microphone, electrical noise in the circuitry can propagate back through the microphone, distorting any acoustic signals the microphone picks up. A microphone's sensitivity is limited by the quality of the electronic gear connected to it. In contrast, the tunneling probe shows very little "back action." That means the device remains extremely sensitive to vibrations, even when connected to a noisy amplifier.

Bocko and his collaborators discuss the theoretical limits governing the sensitivity of tunneling probes in the Aug. 8 PHYSICAL REVIEW LETTERS. The group is now assembling a special scanning tunneling microscope to test the theory and determine precisely how much effect a tunneling probe has on the object being monitored.

Collisions at high energy

The Tevatron collider at the Fermi National Accelerator Laboratory in Batavia, Ill., flings protons against antiprotons at collision energies adding up to 1.8 trillion electron-volts. Completed last year and billed as the world's most powerful particle accelerator, the collider is starting to provide data for researchers, who sift through the debris from head-on collisions in search of exotic subatomic particles (SN: 9/28/85, p.202; 3/22/86, p.180).

The researchers are looking for evidence of the "top" quark, a rapidly decaying subatomic particle and the only member of the quark family not yet detected. A reported sighting in 1984 could not be confirmed, and particle physicists now suspect the top quark has a mass, expressed in energy terms, of at least 100 billion electron-volts — roughly 100 times a proton's mass. The Fermilab collider is the only operating particle accelerator able to reach this energy range. Even so, only about 1 in a billion proton-antiproton collisions provides enough energy to create such a massive particle. Earlier this month, collider operators raised the collision rate to 50,000 collisions per second, significantly increasing the chances of discovering the top quark.

In West Germany last month, for the first time, operators of the new 30-billion-electron-volt electron-proton collider at the Deutsches Elektronen-Synchrotron stored an electron beam in the accelerator's recently completed electron ring. The next step is to install special superconducting magnets designed for accelerating protons. Both proton and electron rings should be ready for collision experiments in 1990. This facility, located in Hamburg and known as the Hadron Electron Ring Accelerator, will be the world's first high-energy electron-proton collider.

Science & Society

New survey prompts radon health alert

Responding to results of a new Environmental Protection Agency survey indicating the indoor radon problem is more serious and widespread than previously suspected (SN: 9/17/88, p.180), the Public Health Service announced on Sept. 12 a "national radon health advisory."

According to Assistant Surgeon General Vernon J. Houk, an estimated 5,000 U.S. lung cancers among nonsmokers each year are believed due entirely to indoor radon exposure. Among smokers, where radon exposure can elevate lung cancer risk 15-fold over normal, the problem is even more serious — accounting for roughly 15,000 additional deaths annually. These statistics indicate that indoor radon's human toll "probably exceeds by 10 times the problem of outdoor air pollution," Houk says. And like deaths from smoking, radon's toll is "largely preventable," he adds.

To identify persons at risk, the new health advisory recommends homes be tested for radon, and radon-reduction measures be implemented when elevated levels are found. In the meantime, Houk advises homeowners with high radon levels to "prohibit smoking in your house." Radon's toxic decay products — known as "daughters" — attach to respirable particles, such as those in cigarette smoke. Once inhaled, radioactive daughters piggybacking on these particles are deposited in the lung. So by polluting indoor air, he notes, smokers can elevate the radon risk of nonsmokers. At a press conference last week, Houk called upon physicians and other health professionals to get this message out and "become the leaders in radon-exposure reduction."

Nature's zapping of America

Radon is not the only natural background radiation to which North Americans are exposed. But it is far and away the largest source — on average contributing at least two-thirds of any individual's background radiation dose, according to a new report by the Bethesda, Md.-based National Council on Radiation Protection and Measurements (NCRP). The remaining natural background-radiation dose comes from cosmic rays, external gamma radiation (primarily from uranium, thorium and potassium in soil and rock) and other inhaled or ingested radionuclides.

NCRP estimates the average U.S. total from these sources at 260 to 300 millirems per year. Canadian doses are estimated to be about 20 percent lower, largely because data show Canada's indoor radon concentrations to be lower. Though these estimates are about 33 percent higher than those NCRP published in 1975, it's not because background radiation exposures are thought to have increased. Rather, they reflect the use of better data and NCRP's move to compute radon's role on the basis of indoor rather than outdoor measurements, explains John H. Harley, the Hoboken, N.J., consultant who chaired NCRP's scientific committee authoring this report.

The committee estimates the current average U.S. indoor-radon concentration at 1 picocurie per liter of air. EPA's recent indoor radon surveys, while "interesting," do not affect this number, Harley says, because those data "are worthless as far as exposure [estimates] are concerned." By intentionally collecting data under the conditions where radon levels will be highest — in winter or in basements — these screening surveys tend to overestimate potential exposure. However, he adds, because of the greater variability in indoor radon concentrations, NCRP's radon average is a less reliable gauge of individual exposure than estimates it's publishing for other natural sources. In natural gamma sources, for example, "a [dose] that's three times the average is practically unheard of," he says. "But with radon, a number 10 or even 100 times the average can occur."

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