Physics

Catching microwaves in a random trap

Two physicists have managed to trap individual photons of microwave radiation inside a copper tube containing a jumble of aluminum spheres. This result marks the first observation of "photon localization in a random three-dimensional sample," say Azriel Z. Genack and Narciso Garcia of Queens College of the City University of New York in Flushing.

The researchers studied the effect by sending microwaves at a frequency between 18.5 and 19.5 megahertz down the length of a 7.3-centimeter-wide copper tube partially filled with aluminum and Teflon balls roughly the size of unpopped popcorn kernels. Two detectors situated 2.5 centimeters apart at one end of the copper tube recorded the intensity of the emerging beam. Close scrutiny of the intensity measurements, made by the pair of detectors as the tube rotates, reveals remarkable fluctuations, which can be interpreted as evidence of photon trapping. These "localized" photons behave as if they were particles caught for long periods of time at particular sites among the metal spheres. However, this trapping occurs only for a narrow range of microwave frequencies and certain concentrations of aluminum balls.

The precise mechanism responsible for causing the trapping remains unknown. "The results of Genack and Garcia should hasten us towards understanding the physics of waves in disordered media," concludes physicist J.B. Pendry of Imperial College in London, England, in a commentary in the June 6 NATURE. Genack and Garcia originally reported their results in the Apr. 22 PHYSICAL REVIEW LETTERS.

Shaking up powder physics

Shaking and tapping a container of flour to compress the powder into a smaller volume is a familiar kitchen technique. But scientists have until now lacked theoretical models that explain on a microscopic level how and why this volume change occurs — and why, in some instances, shaking and tapping can actually *increase* a powder's volume. In the July 15 PHYSICAL REVIEW LETTERS, Anita Mehta of the Cavendish Laboratory in Cambridge, England, and G.C. Barker of the AFRC Institute of Food Research in Norwich, England, report success in modeling what happens to individual grains in a pile of powder subjected to vibration.

In their theoretical model, the researchers represent a granular pile as an assembly of grain clusters. Strong vibrations carrying sufficient energy can force the ejection of a grain from one cluster, which leads to its subsequent capture by a neighboring cluster. In contrast, the energy of weak vibrations goes into the reorganization of grains within a cluster to minimize voids. Three-dimensional computer simulations based on this model reveal how these two energy-dependent competing effects determine a vibrated pile's final slope and roughness, and change a powder's bulk properties and collective behavior. The results show that for a given type of vibration, differences in the vibration intensity can promote grain reorganizations that change the powder's volume. Small vibrations tend to decrease a powder's volume, whereas large vibrations force a substantial restructuring of the powder that may typically lead to an increased volume.

Controlled reflections of light

A team of scientists at Sandia National Laboratories in Albuquerque, N.M., has constructed the first electrically controlled semiconductor mirrors that can receive and reflect light waves at 1.06 micrometers, a wavelength generated by a commonly used commercial laser. Such devices — called reflectance modulators — may prove useful for making optical connections in computers or for sending messages from a remote location using low power.

Science & Society

Rating environmental impact studies

Many governments withhold their approval of projects, funding or regulatory permits for activities that might adversely affect the environment, until they have formally obtained and reviewed an assessment that predicts the new project or activity threatens little environmental harm. However, few attempts have been made to audit the reliability of forecasts contained in these environmental assessments. In fact, Ralf C. Buckley says his new analysis of Australia's track record with environmental assessments represents "the first national-scale audit for any country." And in the recently released May AMBIO, he concludes that "in Australia at least . . . improvement is clearly needed."

Buckley, director of the Center for Environmental Management at Bond University in Brisbane, reports that adequate monitoring data exist to test the predictions contained in only about 3 percent of the roughly 1,000 Australian environmental impact statements generated to date. He analyzed the approximately 200 major and 175 subsidiary predictions and focused on those 68 that proved the most pivotal. Forecasts in this small but important subset proved "less than 50 percent accurate on average and [occasionally missed the mark by] over two orders of magnitude," he says.

Primary predictions such as those describing anticipated air or water emissions proved more accurate (52 percent) than secondary predictions such as those forecasting air or water quality (39 percent). Only 33 percent of the analyzed predictions proved more severe than actual impacts; 53 percent proved less severe.

Tobacco researchers say smoking harms

Most scientists funded by the tobacco industry's Council for Tobacco Research (CTR) believe cigarette smoking "causes a wide range of serious, often fatal, diseases," according to a survey reported in the July AMERICAN JOURNAL OF PUBLIC HEALTH. This conflicts with the industry's description of the scientific community "as divided on the question, and [it] indicates the industry does not accept the opinions even of scientists whose research it funds," write Ronald M. Davis, director of the Centers for Disease Control's office on smoking and health, in Rockville, Md., and his colleagues at Roswell Park Cancer Institute in Buffalo, N.Y.

Davis and his co-workers mailed questionnaires to all 179 U.S. researchers funded by the New York City-based CTR in 1989. Seventy-seven completed the surveys, or 46 percent of those for whom the team obtained correct addresses. No major differences (in credentials, affiliation or research focus) distinguished those who did respond from those who didn't.

Among the respondents, 94 percent agreed that passive smoking was "harmful to the nonsmoker," 91 percent attributed most lung cancers to smoking, and all but one researcher described smoking as addictive. Respondents also ranked smoking prevention and smoking cessation as deserving the highest research priority. "None of CTR's active research projects relate to these topics," write Davis and his co-workers.

CTR awards peer-reviewed grants and assures recipients they will receive full scientific independence. However, Davis and his co-authors argue, CTR's "misuse" of this science as "a public relations vehicle" should raise major ethical questions among grantees who believe smoking is harmful — such as whether they should continue to indirectly further the tobacco industry's aims by accepting its money.

"I find no possible moral compromise in pursuing scientific inquiry and tapping all available sources of funding," counters Thomas Lauria of the Tobacco Institute in Washington, D.C. As of 1988, he notes, CTR spent more than $150 million on independent research.