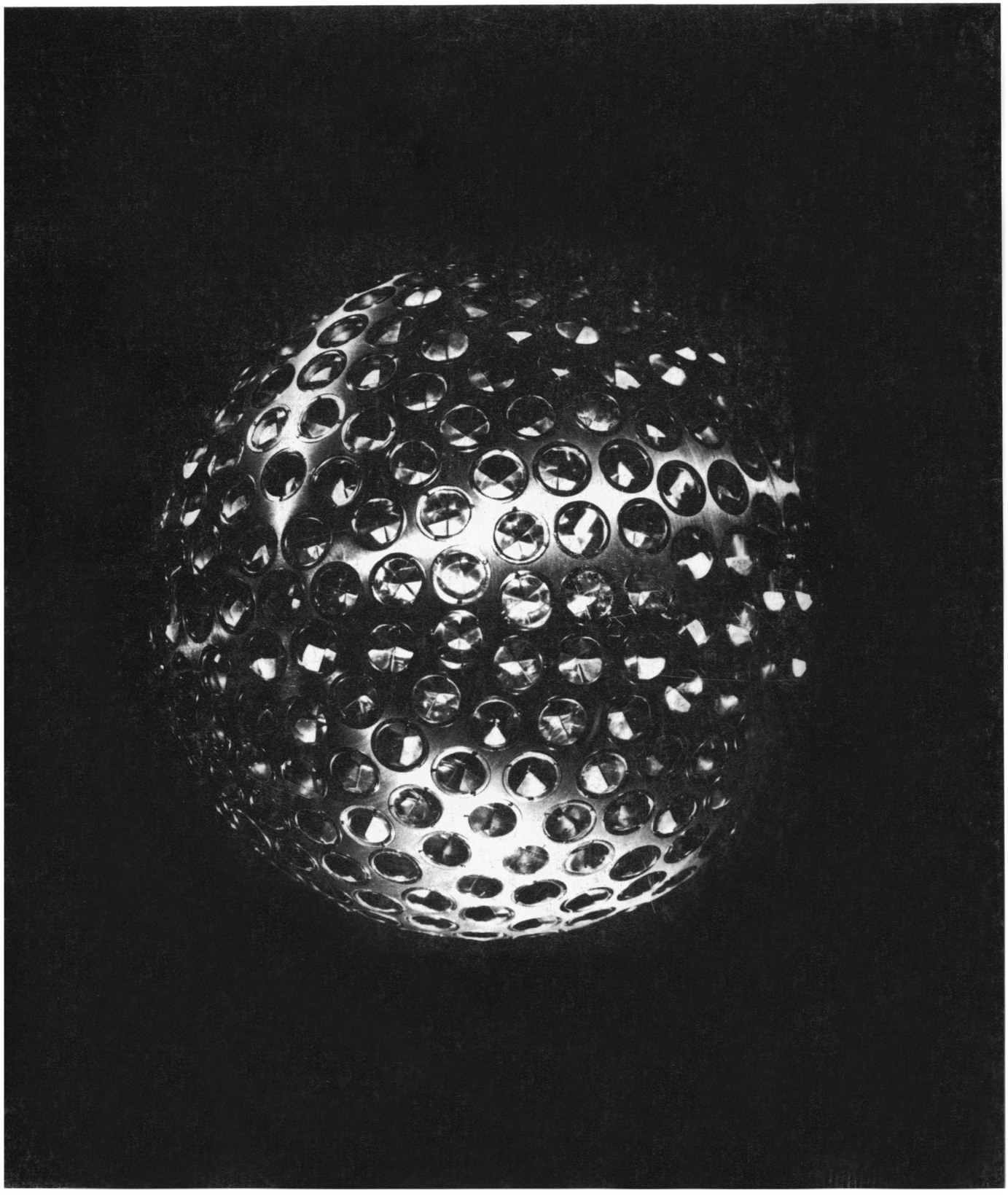
SCIENCE

25 June 1976

Volume 192, No. 4246

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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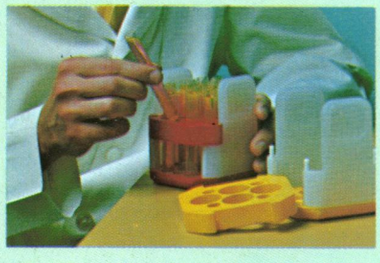

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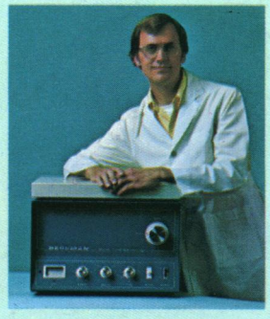

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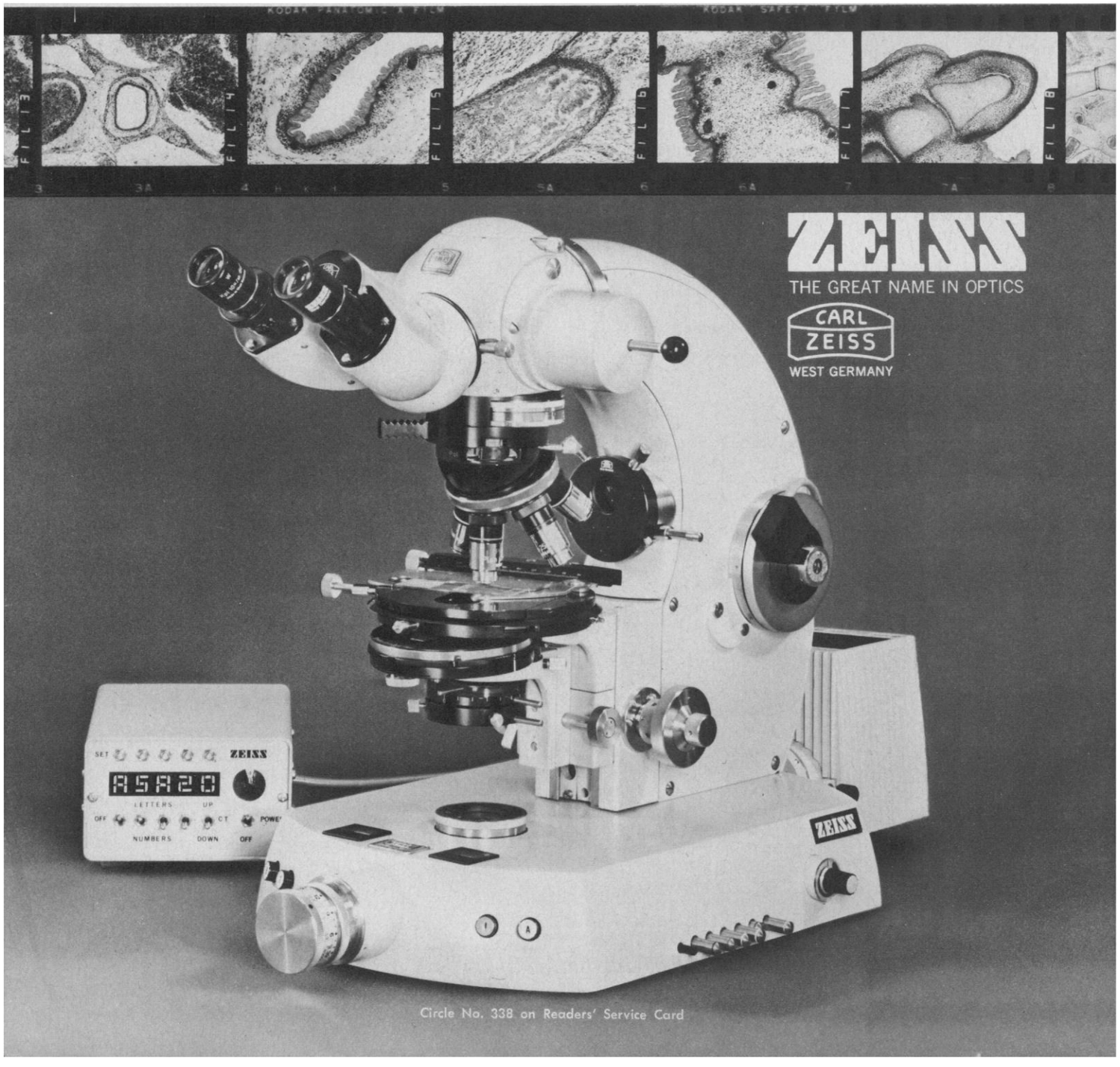

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25 June 1976

Volume 192, No. 4246

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COVER

Laser geodynamic satellite, Lageos. The satellite, whose actual diameter is 2 feet, has 426 retroreflectors on its exterior. Data from the satellite should aid in the development of techniques for the prediction of earthquakes. See page 1293. [Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Maryland]

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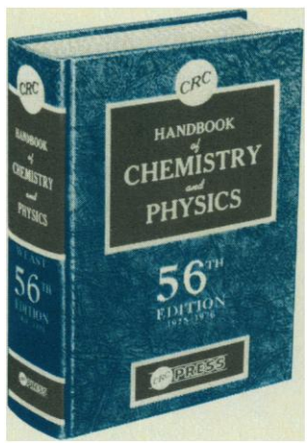

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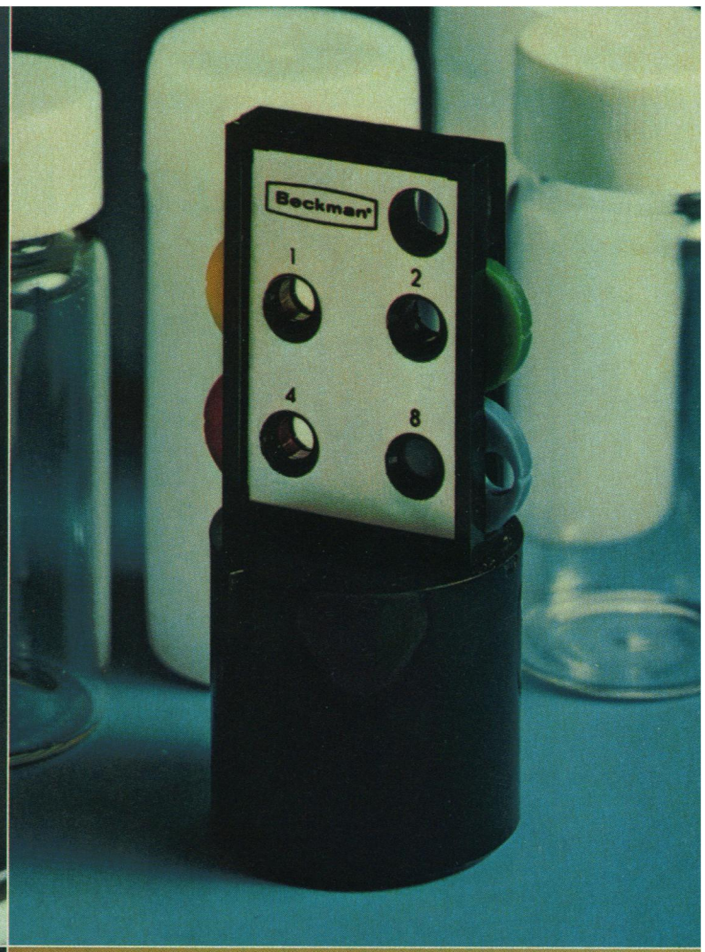
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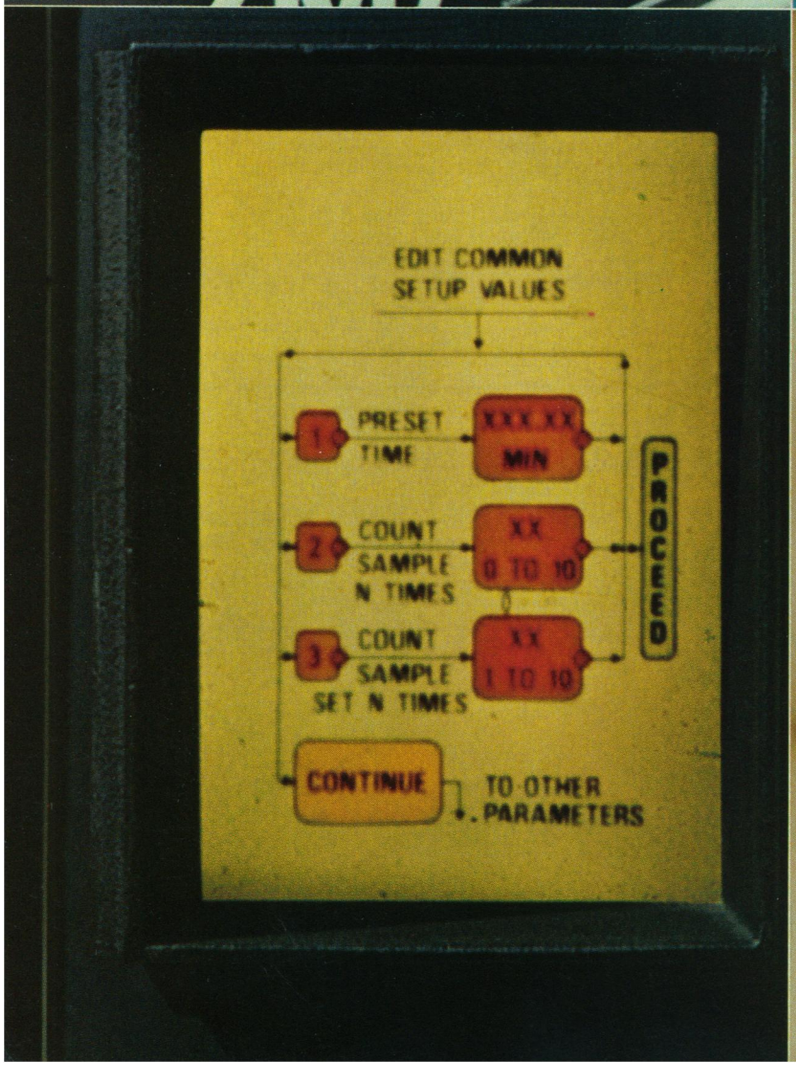
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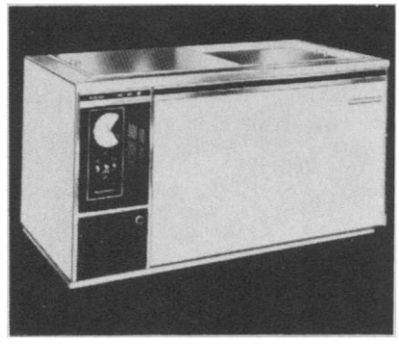

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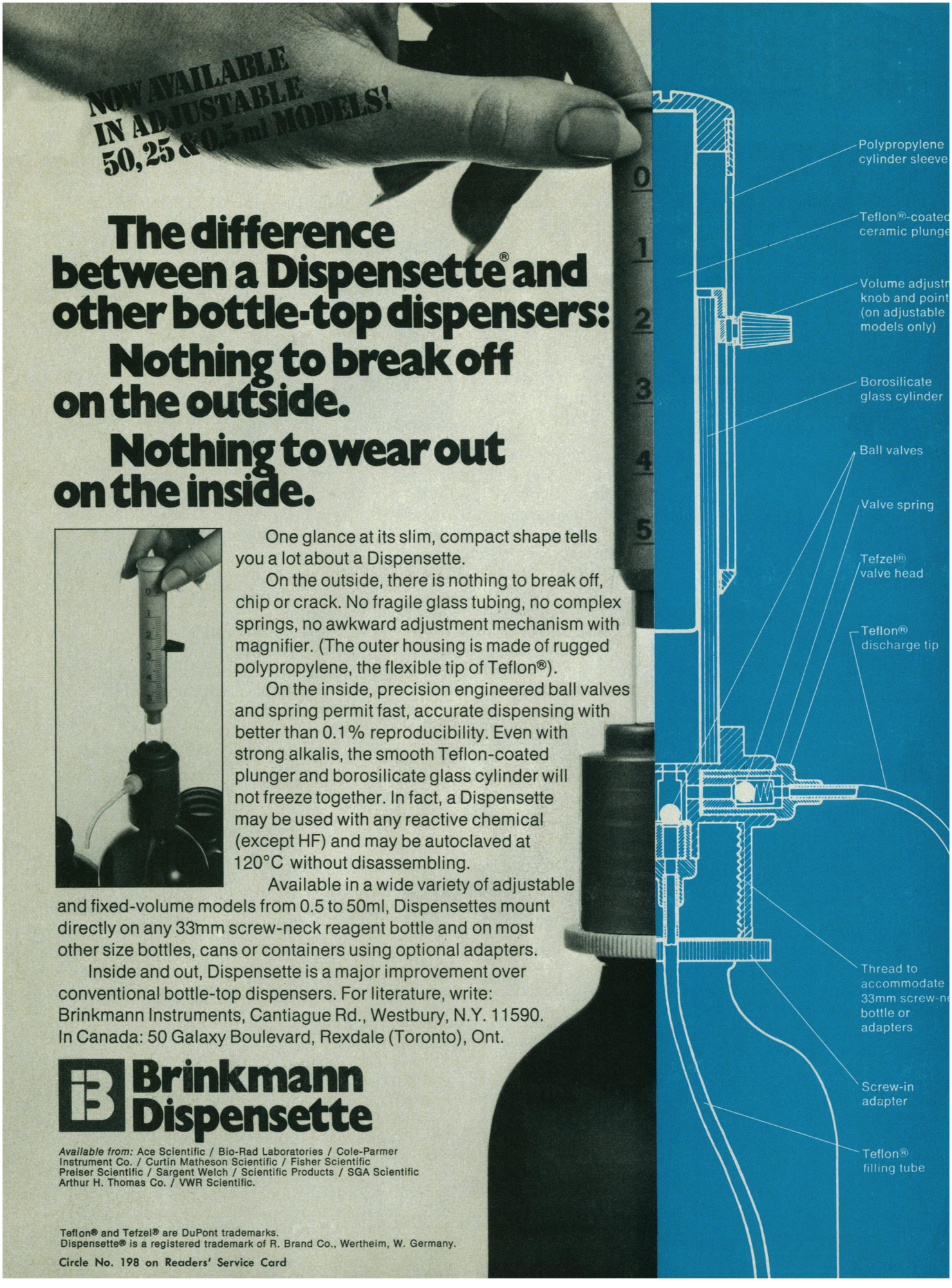

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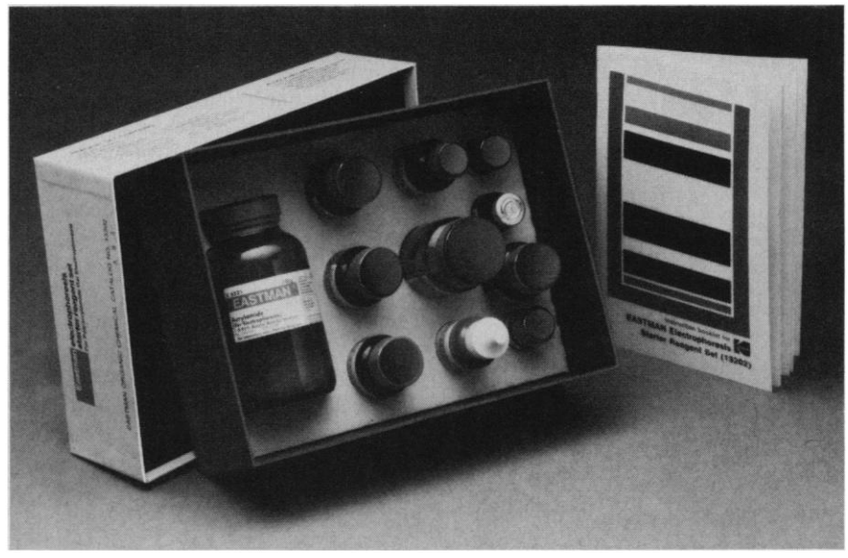

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LETTERS

PBB Incident

Luther J. Carter's article "Michigan's PBB incident: Chemical mix-up leads to disaster" (News and Comment, 16 Apr., p. 240) drives home the message that we can no longer be so casual with the stream of exotic chemicals flowing into commerce. In the future we must look to better living through responsible chemistry and effective control.

Carter refers to my role and that of George Fries in identifying PBB (polybrominated biphenyl) as the Michigan contaminant. I wish to acknowledge the unselfish and productive efforts of our veterinarian, the late Ted F. Jackson, who worked hand in hand with us on the problem right down to the wire, and of Al Furr, formerly with the National Animal Disease Center, Ames, Iowa, who brought new meaning to the phrase "Rocky Mountain High" by discovering the late emerging peaks characteristic of PBB in gas chromatograph analysis of our feed.

FREDERIC L. HALBERT
Route 2, Box 252,
Delton, Michigan 49046

Energy Conservation and Credibility

Philip H. Abelson's editorial "Energy diplomacy" (30 Apr., p. 429) implies some fault in the public for not being "conservation-minded." We have just completed a survey of public perceptions and attitudes concerning energy-related problems. The survey was conducted by professional interviewers using an open-ended format and involved a statistically valid sample of a metropolitan population of 350,000 persons.

Our findings indicate that the public is behaving with extraordinary internal consistency. If they believe that the United States and the world will run out of effective supplies of oil and natural gas in the next 50 years, or that there is an energy-related problem which goes beyond waste in our society or manipulated (by government or big business) shortages, they respond with a variety of conservation adjustments including plans to buy a smaller car, drive less, turn down heat, use less electricity, and so forth. Indeed, they have been acting on these beliefs for the last 2 years.

The problem is that they do not believe there is or will be a supply problem. When asked whom they trusted for energy information, 21 percent said no one, and 20 percent said they did not know whom to trust. Only 9 percent believe the information put forth by the federal government. If we consider the contradictory statements to which they have been exposed, the public is responding in a realistic manner.

Given the internal consistency of behavior, changing the public's perception of the reality of the problem should have immediate effects on conservation behavior. The fault lies with decision-makers and leadership, not with public unwillingness to make necessary changes. Current references to the public's unwillingness to conserve energy appear to be not unlike the "blaming the victim" syndrome in the literature on poverty.

PHYLLIS T. THOMPSON
JOHN MACTAVISH
Urban and Environmental Studies Institute,
Grand Valley State Colleges,
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Swine Flu: Quantifying the "Possibility"

We need better rules for translating everyday language into quantities and vice versa, especially in the area of probability. Philip M. Boffey (News and Comment, 14 May, p. 636) reports that President Ford, in referring to the campaign against swine flu, spoke of an epidemic as a "very real possibility." Boffey consulted at least four experts and reports their responses concerning the probability of a swine flu epidemic in the 1976–77 season as being, respectively, 2 percent, 10 percent, 35 percent, and "less than even," which I translate as "less than 50 percent." The 2 percent responder regarded his number as plucked out of the air; we were not told how the others regarded theirs.

Boffey then says, "Those probability estimates, though far lower than the official rhetoric of the campaign would lead one to expect, do not necessarily mean that the vaccination campaign is a foolish endeavor." I wish to address the question of whether the estimates are far lower than the official rhetoric should have led us to expect. Since Boffey emphasizes Ford's concern about the " 'very real possibility' of a dangerous epidemic in the United States next fall and winter," I regard the phrase "very real possibility" as the official rhetoric needing quantification. Boffey has done the fieldwork of consulting experts for their guesses. Judith Selvidge (*1*) found, from responses of Harvard Business

School students to a questionnaire, that for the median student the word "possibility" in probability estimation had a value of 20 percent (with quartiles of 10 and 50 percent). Thus about half the students thought "possibility" meant 20 percent or less. Cliff (*2*), in his article "Adverbs as multipliers," found that the multiplying effect of "very" is about 1.25. I have no way of knowing the multiplicative effect of "real," but "decidedly" has a factor of 1.16, "unusually" of 1.28, and "extremely" of 1.45. I personally would consider "decidedly" as similar to "real" in multiplicative effect. This would give as a median estimate $1.16 \times 1.25 \times 20 = 29$ percent (with quartiles of 14 and 73 percent). (A more careful effort would require a transformation that would keep all percentages between 0 and 100.) Is not 29 percent one reasonable summary of the four estimates 2, 10, and 35 percent and "less than even"? If so, the official rhetoric seems to be right in line with the reported probability estimates, at least for the populations studied. I would like to see us much better able to make translations of the sort Boffey tries to make, and to encourage others to inform us of work done in this area of quantifying everyday language.

FREDERICK MOSTELLER
Department of Statistics,
Harvard University,
Cambridge, Massachusetts 02138

References

1. J. Selvidge, "Assigning probabilities to rare events," thesis, Harvard University (1972).
2. N. Cliff, *Psychol. Rev.* **66**, 27 (1959).

Antiviral Agent: Abbott Tests

The article "Chemotherapy: Antiviral agents come of age," by Thomas H. Maugh II (Research News, 9 Apr., p. 128), attributes to some anonymous investigators the suggestion that Abbott Laboratories is not pursuing the investigations of phosphonoacetic acid as actively as it might because "it is not a patented drug, but rather is in the public domain."

We wish Maugh had reviewed these suggestions with us before he reported them in *Science*, particularly in light of the evidence cited below.

The facts are that Abbott Laboratories has been actively investigating phosphonoacetic acid for some time now to establish safety evidence required both by our own scientific standards and by the Food and Drug Administration before clinical testing can be done. Sound animal studies prior to human testing represent a responsible approach to the development of a potential new therapeutic agent and should not be interpreted as "reluctance" on Abbott's part to undertake clinical studies.

The unjustified conclusion by Maugh and his anonymous "investigators" is also based on a false premise—that phosphonoacetic acid is not a patented drug. Abbott Laboratories does have a *method* patent on this agent covering its use in herpes simplex infections—U.S. Patent No. 3,767,795 (1973). This, too, is a fact which Maugh could—and should—have checked before his article was published.

We believe that Abbott Laboratories has made many significant contributions to virus research and is deserving of more accurate representation.

JOHN H. BIEL
Abbott Laboratories,
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Moral Periodic Table

It is very encouraging to see the interest recently directed to the moral qualities of the element plutonium (News and Comment, 23 Apr., p. 356; Letters, 21 May, p. 738). There is little doubt that the singular properties of this metal as a poison, together with its origin in the nuclear caldron and its unique explosive qualities, justify some moral questions or at least some moralization. But why limit ourselves to the baneful transuranics? We should be grateful to the National Council of Churches for originating the concept of a moral periodic table, to which some further additions suggest themselves. Gold is clearly connected with the most known immoral tendencies and has been accused of being the root of all evil. Sulfur, while good when compounded in sulfa drugs, is clearly evil as a component of pollutants and such obnoxious compounds as mercaptans, and historical tradition gives good reason for supposing elemental sulfur to be the main constituent of Hell. Oxygen, however, is more difficult to rank; it is at once the supporter of Life and the element of Fire. The difficulty is even greater when one considers its allotropic modification, ozone, which is simultaneously a main component of smog and also our sole protection from the carcinogenic effects of solar ultraviolet. Perhaps the Council will issue a ruling on this question.

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25 June 1976, Volume 192, Number 4246 **SCIENCE**

More Laws, More Complexity

In front of the Archives building in Washington, D.C., is an inscription, "What is past is prologue." This is an especially appropriate motto for a building in a city dominated by lawyers. To them precedent is compelling. Laws once enacted are rarely repealed. The inexorable tendency is to build a more complex structure on the framework already existing.

An example of long-term trends is the evolution of major federal health laws. Since 1935, more than 100 such laws have been enacted. At the beginning of the period the rate of enactment averaged between one and two a year. The laws tended to be simple and brief. With time, this changed.

During the past decade the rate of enactment has increased markedly and the laws tend to be lengthy and complex. A recent draft of a proposed National Health Insurance Act is 200 pages long. The tendency toward complexity is exacerbated by the federal administrative agencies. For the purpose of implementing legislation, the bureaucrats prepare regulations which often far exceed in complexity the legislation passed by Congress.

Individually, most of the laws have laudable goals. But in practice, the administration of the laws never measures up to the good intentions of Congress. Moreover, it is one thing to cope with a single law. It is another to cope with the cumulative effect of more than 100 laws with their often conflicting administrative regulations.

In Washington, as more bills are passed without cleaning out and reorganizing ones that came before, the complexity necessarily grows. Some examples follow.

Subsidies for hospital construction involve different legislation from that for mental health clinics or neighborhood health centers. Provisions for the organized or subsidized payment of medical bills for individuals are scattered among numerous programs geared to different population groups and different diseases.

Even before the many social programs initiated by the Kennedy and Johnson administrations, there were federal or state health programs for veterans, servicemen, servicemen's dependents, Native Americans, merchant seamen, immigrants, and recipients of public assistance or of workmen's compensation benefits; and there were temporary disability insurance, medical rehabilitation services, maternal and child care health services, and school health services.

A number of factors combine to enhance the likelihood of further federal actions. One is an organizational factor. Washington has increased its machinery for the generation of new legislation. It has become a factory for the mass production of more complicated and more numerous laws.

The relationship of Congress to the Administration has changed significantly. In the past, Congress had few staff people who were technical experts and depended on the Executive agencies to provide information. But friction between President Nixon and the Democratic Congress led to a situation in which Congress found it necessary to have more experts on its own staff. Today there are about 17,000 staff people on Capitol Hill, including 218 associated with committees engaged in medicine-related topics. Staff members acquire influence by being useful to their patrons. Any ideas they may have are placed at the disposal of the congressmen. The staff gets much of its feeling of satisfaction from its ability to manipulate behind the scenes, to make things happen, and to create change.

While every politician professes to be a man for all seasons, he is often best equipped for vote-getting. Many committees and subcommittees with special responsibilities in areas such as advanced technology or medicine have not one member with training in the field. The professional staff aides on such committees consequently are in position to do the thinking, the homework, and to a very large degree the decision-making. Today, there exists in Washington a Fifth Estate, invisible but enjoying power derived from preparation of new legislation. More laws and more complexity are in store.—PHILIP H. ABELSON

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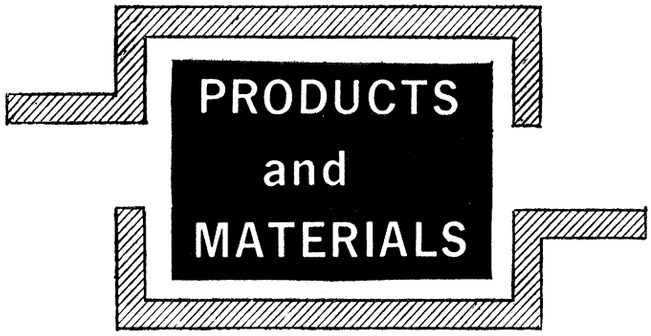

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Flowmeters

Series FM 150 flowmeters have aluminum side and back panels and a heavy, clear plastic window for protection from impact. Models are available for panel mounting which will convert to bench mounting by attaching a stand which includes a spirit level and leveling screws for vertical alignment. These flowmeters have a 150-millimeter Pyrex tube which is fluted for accuracy and reproducibility. Each tube contains two spherical metering floats, one of Pyrex and one of stainless steel. Scientific Gas Products. Circle 740.

Newly offered instrumentation, apparatus, and laboratory materials of interest to researchers in all disciplines in academic, industrial, and government organizations are featured in this space. Emphasis is given to purpose, chief characteristics, and availability of products and materials. Endorsement by *Science* or AAAS is not implied. Additional information may be obtained from the manufacturers or suppliers named by circling the appropriate number on the Readers' Service Card (on pages 1282A and 1366A) and placing it in the mailbox. Postage is free.

—RICHARD G. SOMMER

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Literature

Tools for Physiology is a catalog devoted to instruments for kymography, electrophysiology, and various other disciplines. Phipps & Bird. Circle 728.

Hematofluorometer is an instrument that will measure the amount of zinc protoporphyrin in whole blood in 10 seconds. Environmental Sciences Associates. Circle 732.

Plasticware for the Laboratory describes a complete line of laboratory apparatus and containers. Interex. Circle 733.

Deuterated Solvents lists solvents, shift reagents, and reference solvents for nuclear magnetic resonance spectroscopy. Crescent Chemical. Circle 743.

Research Chemicals includes 40,000 listings of organic and inorganic chemicals. Pfaltz & Bauer. Circle 744.

Glassware Washers and their advantages are the subject of a pamphlet. Labconco. Circle 745.

Flowmeters for Industry and the Laboratory includes whole assemblies and replacement parts. Fischer & Porter. Circle 746.

Flexi-Dry Freeze Dryer describes an instrument that is applicable to all freeze-drying techniques. FTS Systems. Circle 747.

Equipment for Reactors, Accelerators, and Laboratories is included in a 1976–77 catalog. Reactor Experiments. Circle 748.

Sonifier Cell Disruptor lists design specification and applications. Branson Sonic Power. Circle 750.

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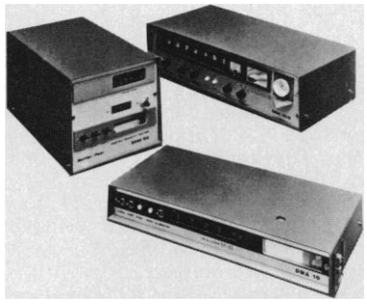

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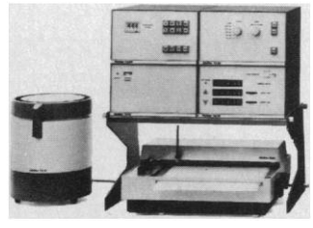

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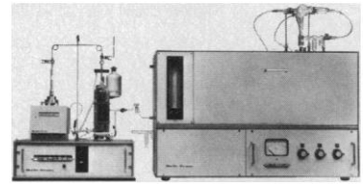

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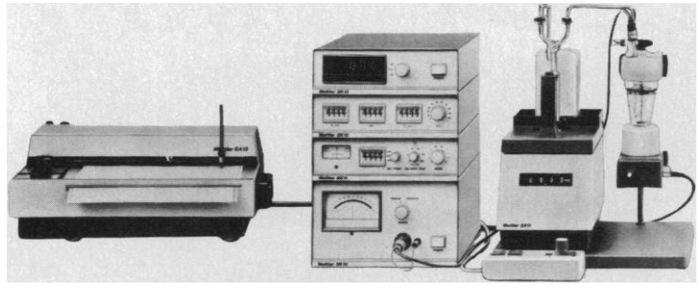

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BOOKS RECEIVED

(Continued from page 1327)

Advances in Bile Acid Research. Papers from a meeting, Freiburg im Breisgau, Germany, June 1974. S. Matern, J. Hackenschmidt, P. Back, and W. Gerok, Eds. Schattauer, Stuttgart, 1975. xx, 448 pp., illus. Paper, DM 58.

Advances in Human Genetics. Vol. 6. Harry Harris and Kurt Hirschhorn, Eds. Plenum, New York, 1976. xvi, 382 pp., illus. $32.50.

Advances in Magnetic Resonance. Vol. 8. John S. Waugh, Ed. Academic Press, New York, 1976. xii, 266 pp. $25.50.

Advances in the Study of Behavior. Vol. 6. Jay S. Rosenblatt, Robert A. Hinde, Evelyn Shaw, and Colin Beer. Academic Press, New York, 1976. xvi, 284 pp., illus. $19.50.

Aging, Carcinogenesis, and Radiation Biology. The Role of Nucleic Acid Addition Reactions. Proceedings of a conference, Williamsburg, Va., May 1975. Kendric C. Smith, Ed. Plenum, New York, 1976. xii, 562 pp., illus. $39.50.

Aldehydes—Photometric Analysis. Vol. 3. Eugene Sawicki and Carole R. Sawicki. Academic Press, New York, 1976. xiv, 342 pp., illus. $26.75. The Analysis of Organic Materials, vol. 9.

Applied Mechanics: Statics. Charles E. Smith. Wiley, New York, 1976. xiv, 200 pp., illus. $11.95.

Atlas of the Light Scattering Characteristics of Microparticles. Philip J. Wyatt, Ed. Science Spectrum, Santa Barbara, Calif., 1975. Variously paged. $95.

Atomic Masses and Fundamental Constants 5. Proceedings of a conference, Paris, June 1975. J. H. Sanders and A. H. Wapstra, Eds. Plenum, New York, 1976. xxxiv, 682 pp., illus. $42.

Basic Electric Circuits. Donald P. Leach. Wiley, New York, ed. 2, 1976. xiv, 638 pp., illus. $14.95.

BASIC for Everyone. Thomas Worth. Prentice-Hall, Englewood Cliffs, N.J., 1976. xii, 350 pp., illus. Paper, $8.95.

The Biology of Parasitic Spirochetes. Papers from a symposium, Minneapolis, June 1975. Russell C. Johnson, Ed. Academic Press, New York, 1976. xiv, 402 pp., illus. $18.50.

Blood Vessels. W. J. Cliff. Cambridge University Press, New York, 1976. x, 214 pp., illus. $25. Biological Structure and Function, 6.

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Contemporary Organic Chemistry. Andrew L. Ternay, Jr. Saunders, Philadelphia, 1976. xx, 994 pp., illus. + appendix + index. $20.75. Student Guide and Solutions Manual. Robert F. Francis. vi, 442 pp., illus. Paper, $5.95. Saunders Golden Sunburst Series.

Crystals, X-rays and Proteins. Dennis Sherwood. Halsted (Wiley), New York, 1976. xxii, 702 pp., illus. $35.

DeFunis v. Odegaard. Race, Merit, and the Fourteenth Amendment. Ivor Kraft. Uncommon Lawyers Workshop, Sacramento, Calif., 1976 (available from the author, California State University, 6000 Jay St., Sacramento). 228 pp. Paper.

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McIntyre and C. F. Mills, Eds. Plenum, New York, 1975. xii, 324 pp., illus. $25. Environmental Science Research, vol. 7.

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Energy Resources and Supply. J. T. McMullan, R. Morgan, and R. B. Murray. Wiley-Interscience, New York, 1976. xii, 508 pp., illus. $29.95.

The Eruption and Occlusion of Teeth. Proceedings of a symposium, Bristol, England, Apr. 1975. D. F. G. Poole and M. V. Stack, Eds. Butterworths, Boston, 1976. xiv, 316 pp., illus. $37.95.

Experiments in Sociology. Dwight G. Dean and Donald M. Valdes. Prentice-Hall, Englewood Cliffs, N.J., ed. 3, 1976. iv, 156 pp. Paper, $5.75.

The Facts of Life. An Essay in Feelings, Facts, and Fantasy. R. D. Laing. Pantheon (Random), New York, 1976. xii, 156 pp. $7.95.

Fine Particles. Aerosol Generation, Measurement, Sampling, and Analysis. Proceedings of a symposium, Minneapolis, May 1975. Benjamin Y. H. Liu, Ed. Academic Press, New York, 1976. xiv, 838 pp., illus. $34.50.

The Force of Knowledge. The Scientific Dimension of Society. John Ziman. Cambridge University Press, New York, 1976. x, 374 pp., illus. $15.95.

Fourier Analysis of Time Series. An Introduction. Peter Bloomfield. Wiley, New York, 1976. xiv, 258 pp., illus. $18.95. Wiley Series in Probability and Mathematical Statistics.

Gradient Optimization and Nonlinear Control. Lawrence Hasdorff. Wiley-Interscience, New York, 1976. xvi, 264 pp., illus. $19.50.

Health Care Delivery Systems. Evaluation Criteria. J. W. LaPatra. Thomas, Springfield, Ill., 1975. xiv, 358 pp., illus. $21.50.

Heredity, Evolution, and Society. I. Michael Lerner and William J. Libby. Freeman, San Francisco, ed. 2, 1976. xxii, 432 pp., illus. $13.95.

High Life Expectancy on the Island of Paros, Greece. Jeff Beaubier. Philosophical Library, New York, 1976. xvi, 144 pp. $10.

Host Defense against Cancer and Its Potentiation. Proceedings of a symposium, Tokyo, 1975. Den'ichi Mizuno, Goro Chihara, Fumiko Fukuoka, Tadashi Yamamoto, and Yuichi Yamamura, Eds. University Park Press, Baltimore, 1975. xviii, 446 pp., illus. $42.50.

The Hot-Blooded Dinosaurs. A Revolution in Palaeontology. Adrian J. Desmond. Dial, New York, 1976. 238 pp., illus. $12.95.

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RESEARCH NEWS

(Continued from page 1324)

data. The same sort of impact on optical spectroscopy is forecast by adherents of coherent optical transients. Recently, in fact, Richard Brewer and Stephen Grossman of the IBM Research Laboratory, San Jose, California, have obtained Doppler-free spectra with the aid of an on-line computer with a fast Fourier transform algorithm to convert transient signals from the time domain to normal spectra in the frequency domain. The experimenters were able to simultaneously resolve several closely spaced spectral lines and map out coherent transients for each line.

There is a wide variety of coherent transient effects whose ability to distinguish between collisional processes derives from the fact that each decays at a different rate because each is sensitive to a different dephasing process that disrupts the perfect coherence induced in the gas by the coherent laser light.

For example, when coherent light from a laser at the frequency for resonant absorption is suddenly turned on, the quantum mechanical wave functions of each particle in a collection of atoms or molecules evolve together in time—that is, in phase. They change gradually from the wave function of the lower state to that of the upper state of the transition (absorption) and back again (stimulated emission) at a rate that increases with the intensity of the laser. In between, the wave functions are a combination of both upper and lower state waves. Thus, when all the wave functions evolve together in step, the observer sees an oscillating absorption and emission known as optical nutation.

The oscillation would persist in time if it were not for collisions. Both elastic and inelastic collisions interrupt the evolution of the wave functions with time thus forcing them out of step with each other and causing a destructive interference effect owing to their now different phases. The magnitude of the optical nutation therefore decays with time, and the nature of the decay carries information about the collisions causing it.

A special optical nutation experiment, called delayed nutation, depends only on inelastic collisions. To obtain information about elastic collisions, researchers need to measure a phenomenon called a photon echo, which depends on both types of collisions. The two experiments together, therefore, are able to separate the inelastic from the elastic collisions and give information on each separately.

In photon echoes, a very short, intense

laser pulse is applied to the sample; a certain short time passes; a second pulse is applied; another short time equal to the time between pulses passes, at which point the sample spontaneously emits a pulse of light in the direction of the previously applied laser pulses—the echo.

Collisions enter the picture during the time between laser pulses. Because of the previously described dephasing effects due to collisions, the strength of the echo becomes progressively smaller the longer the waiting time between pulses. The decay in the intensity of the photon echo that occurs with different time between pulses thus contains information about the collisions involved.

Although pulsed laser light can be used to observe some coherent transient effects, many researchers feel that the experiments have been generally difficult and some effects not even observable. About 5 years ago at IBM, Brewer and Richard Shoemaker (now at the University of Arizona) introduced a technique called Stark switching that solved some of the difficulties for infrared transients. Molecules with a permanent electric dipole moment, when subjected to an electric field, experience a shift in the energies of their quantum states (Stark shift).

Thus, instead of pulsing a laser, researchers can elicit any of the coherent transient effects by using a continuous wave (cw) laser. The proper sequence of voltage pulses, which are easier to control than laser pulses, applied to the sample shifts the energy levels into and out of resonance with the laser. Since the intensity of the laser does not change, the only transient effect present is that due to the coherent effect under study. And because light emitted by particles after a voltage pulse has a different frequency than the laser, a vastly increased sensitivity can be obtained by means of frequency mixing (heterodyning) the laser light and the frequency-shifted light produced in certain transient effects, such as the photon echo.

Not all molecules have permanent electric dipole moments, however. Recently, Brewer and Azriel Genack at IBM reported on a technique called frequency switching, which will make experiments with coherent optical transients much easier and enlarge their range of applicability. The researchers used a tunable dye laser with an electrooptic crystal in the laser cavity. An electric field applied to the crystal determines its index of refraction, which in turn controls the frequency of the laser. With a sequence of low voltage pulses applied to the electrooptic crystal, the laser can be driven into and out of resonance with the atoms or molecules in the sample.

Certain results on methyl fluoride, which has a large electric dipole moment and therefore is well suited to study by the Stark-switching technique, illustrate the usefulness of the coherent transient techniques. Brewer and Joel Levy at IBM in collaboration with Paul Berman of New York University found that elastic collisions of methyl fluoride with itself are due to velocity-changing collisions in which the characteristic velocity jump is only 85 centimeters per second, or about 0.2 percent of the average thermal velocity! They also found the total elastic cross section to be large and comparable to that for inelastic collisions. And Brewer and Grossman, with the Fourier transform technique, were able to measure the velocity dependence of the photon echo decay rate by Stark-switching different velocity groups from the Doppler profile into resonance with their carbon dioxide laser. With this information, the researchers were able to deduce the form of the intermolecular force law (such as dipole-dipole or van der Waals interaction) for each type of collision.—ARTHUR L. ROBINSON