

351 This Week in *Science*

Editorial

353 Uncertainties About Health Effects of Radon

Letters

359 Chloral Hydrate Warning: M. T. SMITH ■ Magnetic Fusion: R. D. HOLT; D. P. HAMILTON ■ International Journal of Health Services: V. NAVARRO ■ Biotechnology, Human Disease, and the FDA: M. MELLON ■ International Congress of Entomology: J. R. ANDERSON, J. T. DOYEN, M. A. HOY, C. KOEHLER, R. L. PIPA, L. A. ANDRES, M. I. HAVERTY, J. B. HOY, N. F. KNOP, P. R. EHRlich, M. GREENSTONE, F. W. PLAPP, JR., Y. SHUPING

News & Comment

364 The Space Station Is Losing Friends ■ Engineers Stymied By Management Chaos
367 Peer Review: Software for Hard Choices ■ Which Patient Did Gallo's Virus Come From?
369 AIDS Vaccine Conference: Is "More" Better?
370 Another Deep Antarctic Ozone Hole
371 *Briefings*: Judd Leaves NIMH ■ Spilled Oil Looks Worse on TV ■ Asian Admissions (Cont.) ■ A Shakeout in R&D?

Research News

372 The Embryo Takes Its Vitamins
374 Superconductor Race Shifts to a New Arena ■ HTS Theory: Where's the Beef?
376 Our Chimp Cousins Get That Much Closer
377 Geysers or Dust Devils on Triton?
378 Overcoming Rejection to Win a Nobel Prize

Perspective

386 Voyager at Triton: J. I. LUNINE

Articles

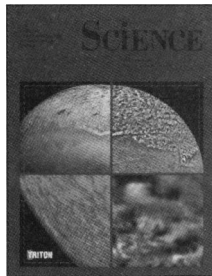
387 The Drug Dilemma: Manipulating the Demand: M. E. JARVIK
392 Nuclear Decay Techniques in Ion Chemistry: F. CACACE
399 Transport and Storage of Vitamin A: R. BLOMHOFF, M. H. GREEN, T. BERG, K. R. NORUM

Research Article

404 Two Domains of Yeast U6 Small Nuclear RNA Required for Both Steps of Nuclear Precursor Messenger RNA Splicing: P. FABRIZIO AND J. ABELSON

■ **SCIENCE (ISSN 0036-8075)** is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1333 H Street, NW, Washington, DC 20005. Second-class postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 1990 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership and subscription (51 issues): \$80. Domestic institutional subscription (51 issues): \$150. Foreign postage extra: Canada \$46, other (surface mail) \$46, air mail via Amsterdam \$85. First class, airmail, school-year, and student rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and 11-digit account number. **Postmaster:** Send change of address to *Science*, P.O. Box 1723, Riverton, NJ 08077. **Single copy sales:** Current issue, \$3.50; back issues, \$5.00; Biotechnology issue, \$6.00 (for postage and handling, add per copy \$0.50 U.S., \$1.00 all foreign); Guide to Biotechnology Products and Instruments, \$20 (for postage and handling add per copy \$1.00 U.S., \$1.50 Canada, \$2.00 other foreign). Bulk rates on request. **Authorization to photocopy** material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act is granted by AAAS to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$1 per copy plus \$0.10 per page is paid directly to CCC, 27 Congress Street, Salem, Massachusetts 01970. The identification code for *Science* is 0036-8075/83 \$1 + .10. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

■ The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objectives are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of human welfare, to advance education in science, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.



COVER Montage of Voyager 2 images showing surface activity on Triton, Neptune's large satellite. Upper left: Triton's south polar region with dark streaks from extinct geysers. Upper right: Enhanced image of the remainder of the polar region. Lower left: Image of "east" plume, which was erupting from Triton's surface at the time of the Voyager 2 encounter, with both the plume (dark blue streak in left of center) and fine particles (probably nitrogen ice crystals) suspended in the atmosphere above the limb shown in deep blue. Lower right: Two different Voyager 2 images of the active "west" plume, projected to a common viewpoint and composited in red and blue. Parallax between the two images causes the plume and its cloud trail to appear as a horizontal red-blue streak. See pages 410 to 443. [Photographs courtesy of National Aeronautics and Space Administration and the U.S. Geological Survey]

Reports

Triton

- 410 Triton's Geyser-Like Plumes: Discovery and Basic Characterization: L. A. SODERBLOM, S. W. KIEFFER, T. L. BECKER, R. H. BROWN, A. F. COOK II, C. J. HANSEN, T. V. JOHNSON, R. L. KIRK, E. M. SHOEMAKER
- 415 Color and Chemistry on Triton: W. R. THOMPSON AND C. SAGAN
- 419 Voyager Disk-Integrated Photometry of Triton: J. HILLIER, P. HELFENSTEIN, A. VERBISCHER, J. VEVERKA, R. H. BROWN, J. GOGUEN, T. V. JOHNSON
- 421 Surface and Airborne Evidence for Plumes and Winds on Triton: C. J. HANSEN, A. S. MCEWEN, A. P. INGERSOLL, R. J. TERRILE
- 424 Subsurface Energy Storage and Transport for Solar-Powered Geysers on Triton: R. L. KIRK, R. H. BROWN, L. A. SODERBLOM
- 429 Temperature and Thermal Emissivity of the Surface of Neptune's Satellite Triton: R. M. NELSON, W. D. SMYTHE, B. D. WALLIS, L. J. HORN, A. L. LANE, M. J. MAYO
- 431 Energy Sources for Triton's Geyser-Like Plumes: R. H. BROWN, R. L. KIRK, T. V. JOHNSON, L. A. SODERBLOM
- 435 Triton's Plumes: The Dust Devil Hypothesis: A. P. INGERSOLL AND K. A. TRYKA
- 437 The Impact Cratering Record on Triton: R. G. STROM, S. K. CROFT, J. M. BOYCE
- 440 Scatterers in Triton's Atmosphere: Implications for the Seasonal Volatile Cycle: J. B. POLLACK, J. M. SCHWARTZ, K. RAGES

AAAS Meetings

- 444 Advance Registration Form ■ Hotel Reservation Instructions ■ The Neurosciences: Challenges for the '90s ■ Discount Airfares ■ Call for Neuroscience Poster Papers

Book Reviews

- 450 Time Reversal, reviewed by A. REDFIELD AND S. SCHWEBER ■ Climate Change and U.S. Water Resources, D. F. LUECKE

Products & Materials

- 453 Faraday Cage Shields Experiments ■ Bioreactor for Monoclonal Antibody Production ■ Biotechnology Patent Information ■ Plate Tectonics Modeling Software ■ Device for One-Handed Capping ■ Mobile Environmental Monitor ■ Literature

Board of Directors

Richard C. Atkinson
*Retiring President,
Chairman*

Donald N. Langenberg
President

Leon M. Lederman
President-elect

Mary Ellen Avery
Francisco J. Ayala
Eugene H. Cota-Robles
Robert A. Frosch
Joseph G. Gavin, Jr.
John H. Gibbons
Beatrix A. Hamburg
Florence P. Haseltine

William T. Golden
Treasurer

Richard S. Nicholson
Executive Officer

Editorial Board

Elizabeth E. Bailey
David Baltimore
William F. Brinkman
E. Margaret Burbidge
Pierre-Gilles de Gennes
Joseph L. Goldstein
Mary L. Good
F. Clark Howell
James D. Idol, Jr.
Leon Knopoff
Oliver E. Nelson
Yasutomi Nishizuka
Helen M. Ranney
David M. Raup
Howard A. Schneiderman
Larry L. Smarr
Robert M. Solow
James D. Watson

Board of Reviewing Editors

John Abelson
Don L. Anderson
Stephen J. Benkovic
Gunter K-J Blobel
Floyd E. Bloom
Henry R. Bourne
James J. Bull
Kathryn Calame
Charles R. Cantor
Raiph J. Cicerone
John M. Coffin
Robert Dorfman
Bruce F. Eldridge
Paul T. Englund
Fredric S. Fay
Harry A. Fozzard

Theodore H. Geballe
Roger I. M. Glass
Stephen P. Goff
Corey S. Goodman
Stephen J. Gould
Eric F. Johnson
Stephen M. Kosslyn
Konrad B. Krauskopf
Charles S. Levings III
Richard Losick
Joseph B. Martin
John C. McGiff
Anthony R. Means
Mortimer Mishkin
Roger A. Nicoll
William H. Orme-Johnson III
Carl O. Pabo
Yeshayau Pocker

Dennis A. Powers
Erkki Ruoslahti
Thomas W. Schoener
Ronald H. Schwartz
Terrence J. Sejnowski
Robert T. N. Tjian
Virginia Trimble
Emil R. Unanue
Geerat J. Vermeij
Bert Vogelstein
Harold Weintraub
Irving L. Weissman
Zena Werb
George M. Whitesides
Owen N. Witte
William B. Wood
Keith Yamamoto

Uncertainties About Health Effects of Radon

The Environmental Protection Agency is preparing to launch a nationwide campaign to increase public concern about dangers arising from exposure to indoor radon. This will represent an intensification of an ongoing program. Homeowners are discovering that potential buyers are insisting on radon inspections before agreeing to purchase a home. Some owners have already incurred costs of \$1000 to \$2000 to decrease radon levels to current EPA recommended action levels (4 pCi/liter). But EPA may promulgate more demanding standards. In late 1988, Congress passed the Indoor Radon Abatement Act setting for EPA the goal of reducing indoor levels to those of outdoor air. On average the cost to homeowners would be on the order of \$10,000 each.

Health physicists have become increasingly critical of what they deem to be EPA overestimates of indoor radon concentrations and of their effects on producing lung cancer. For screening measurements, EPA has recommended locating monitoring devices in basements and making measurements during the winter. In homes, a principal source of radon is from beneath the basement floor. During the winter householders tend to ventilate the home less than in other seasons. The recommended screening procedure yields results as much as four times those obtained in yearlong observation of areas in which residents actually dwell. The screening data have been used by EPA to estimate the number of homes needing remediation and the risk of incurring lung cancer from exposure to indoor radon.

The EPA has indicated that annually as many as 20,000 lung cancers would be due to exposure to radon. EPA Administrator William K. Reilly stated at a press conference that people living in a house with an indoor air level of 4 pCi/liter of radon would incur a risk of lung cancer greater than that created by smoking half a pack of cigarettes a day.

To justify its statements about radon, EPA leans heavily on studies of the incidence of lung cancer in miners. The most recent is a 1988 report issued by the National Research Council (1). The relevant committee made an analysis of data available from four different cohorts of miners. The majority of excess lung cancer deaths of the total occurred among uranium miners of the Colorado Plateau. There, smoking habits were known, and it was possible to show that the risks of lung cancer for smokers were substantially increased by large exposures to radon. Hard data concerning large exposures to miners during the late 1940s and early 1950s are sparse, and the committee had to rely on estimates. Conditions in many mines at that time were cramped and primitive, and there was often no ventilation.

The NRC report included the following statement: "In summary, a number of sources of uncertainty may substantially affect the committee's risk projections; the magnitude of uncertainty associated with each of these sources cannot readily be quantified. Accordingly, the committee acknowledges that the total uncertainty in its risk projections is large" (1, p. 47). In its projections to low exposures the committee made the conventional assumption that risk is a linear function of dose. That is, one can extrapolate from high-dose effects to predict those at low doses. This is an assumption that has never been proved.

Uncertainties in a foundation document (1) on which EPA bases its policies create a great need for an epidemiological approach. Such an effort is fraught with the difficulties of trying to measure a small effect due to radon in the presence of a large effect due to smoking. In addition confounding variables are possible. Information is available concerning possible confounders. The electronic computer makes it feasible to store the relevant data and to subject it to multivariate analysis. Bernard L. Cohen at the University of Pittsburgh has accumulated a data set that provides substantial coverage of about a third of the counties of the United States. He has performed a large-scale analysis of the data and concludes that at low doses found in the average home, radon does not have an adverse effect (2). Were his findings to be confirmed by further studies costing some millions of dollars, the public might be saved not only needless anxiety but many billions of dollars as well.

Instead of efforts directed at all homeowners, EPA should give priority to identifying rare circumstances (including high soil permeability and radium content) where elevated levels of radon prevail and encourage remediation there.—PHILIP H. ABELSON

American Association for the Advancement of Science

Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Publisher: Richard S. Nicholson

Editor: Daniel E. Koshland, Jr.

Deputy Editor: Ellis Rubinstein

Managing Editor: Monica M. Bradford

Deputy Editors: Philip H. Abelson (*Engineering and Applied Sciences*); John I. Brauman (*Physical Sciences*); Thomas R. Cech (*Biological Sciences*)

EDITORIAL STAFF

Senior Editors: Eleanore Butz, Martha Coleman, Barbara Jasny, Katrina L. Kelner, Phillip D. Szuroomi, David F. Voss
Associate Editors: R. Brooks Hanson, Pamela J. Hines, Kelly LaMarco, Linda J. Miller

Letters Editor: Christine Gilbert

Book Reviews: Katherine Livingston, *editor*; Teresa Fryberger

Contributing Editor: Lawrence I. Grossman

Chief Production Editor: Ellen E. Murphy

Editing Department: Lois Schmitt, *head*; Julianne Hunt, Patricia L. Moe, Barbara P. Ordway

Copy Desk: Joi S. Granger, Margaret E. Gray, MaryBeth Shartle, Beverly Shields

Production Director: James Landry

Production Manager: Kathleen C. Fishback

Art Director: Yolanda M. Rook

Assistant Art Director: Julie Cherry

Graphics and Production: Holly Bishop, Catherine S. Siskos

Systems Analyst: William Carter

NEWS STAFF

Managing News Editor: Colin Norman

Correspondent-at-Large: Barbara J. Culliton

Deputy News Editors: John M. Benditt, Jean Marx

News and Comment/Research News: Ann Gibbons, David P. Hamilton, Constance Holden, Richard A. Kerr, Eliot Marshall, Joseph Palca, Robert Pool, Leslie Roberts, M. Mitchell Waldrop

European Correspondent: Jeremy Cherfas

West Coast Correspondent: Marcia Barinaga

Contributing Correspondents: Barry A. Cipra, Robert Crease, Karen Wright

BUSINESS STAFF

Marketing Director: Beth Rosner

Circulation Director: Michael Spinella

Fulfillment Manager: Marlene Zendell

Business Staff Manager: Deborah Rivera-Wienhold

Classified Advertising Supervisor: Amie Charlene King

ADVERTISING REPRESENTATIVES

Director: Earl J. Scherago

Traffic Manager: Donna Rivera

Traffic Manager (Recruitment): Gwen Canter

Advertising Sales Manager: Richard L. Charles

Marketing Manager: Herbert L. Burklund

Employment Sales Manager: Edward C. Keller

Sales: New York, NY 10036: J. Kevin Henebry, 1515 Broadway (212-730-1050); Scotch Plains, NJ 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); Hoffman Estates, IL 60195: Jack Ryan, 525 W. Higgins Rd. (708-885-8675); San Jose, CA 95112: Bob Brindley, 310 S. 16th St. (408-998-4690); Dorset, VT 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581); Damascus, MD 20872: Rick Sommer, 11318 Kings Valley Dr. (301-972-9270); U.K., Europe: Nick Jones, +44(0647)52918; Telex 42513; FAX (0647) 52053.

Information for contributors appears on page XI of the 29 June 1990 issue. Editorial correspondence, including requests for permission to reprint and reprint orders, should be sent to 1333 H Street, NW, Washington, DC 20005. Telephone: 202-326-6500. **Advertising correspondence** should be sent to Tenth Floor, 1515 Broadway, New York, NY 10036. Telephone 212-730-1050 or WU Telex 968082 SCHERAGO, or FAX 212-382-3725. **Subscription/Member Benefits Questions:** 202-326-6417.

1. *Health Risks of Radon and Other Internally Deposited Alpha Emitters, BEIR IV* (National Academy Press, Washington, DC, 1988). 2. B. L. Cohen, "Multi-stratified multiple regression tests of the linear-no threshold theory of radon-induced lung cancer," unpublished paper.