

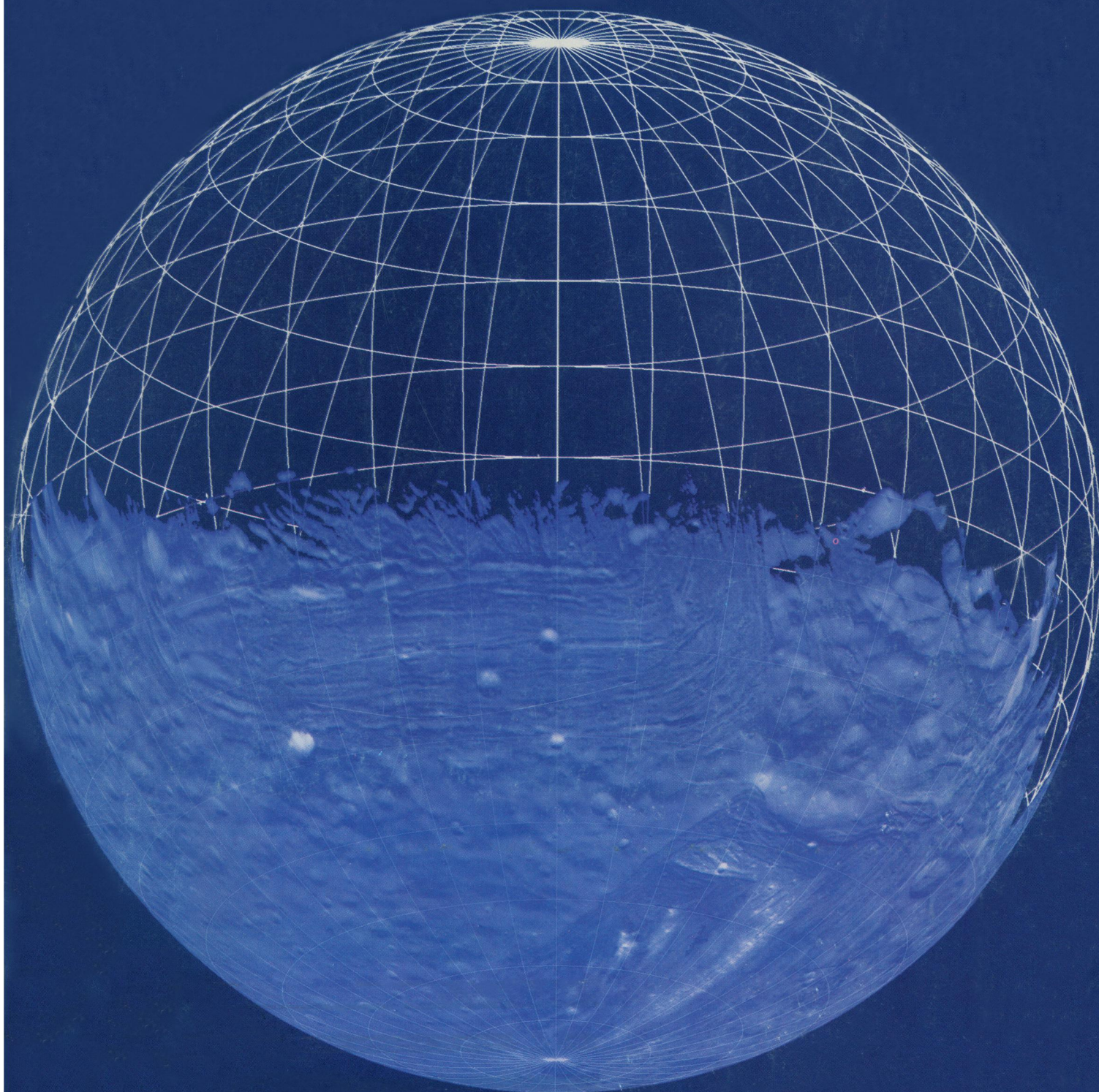
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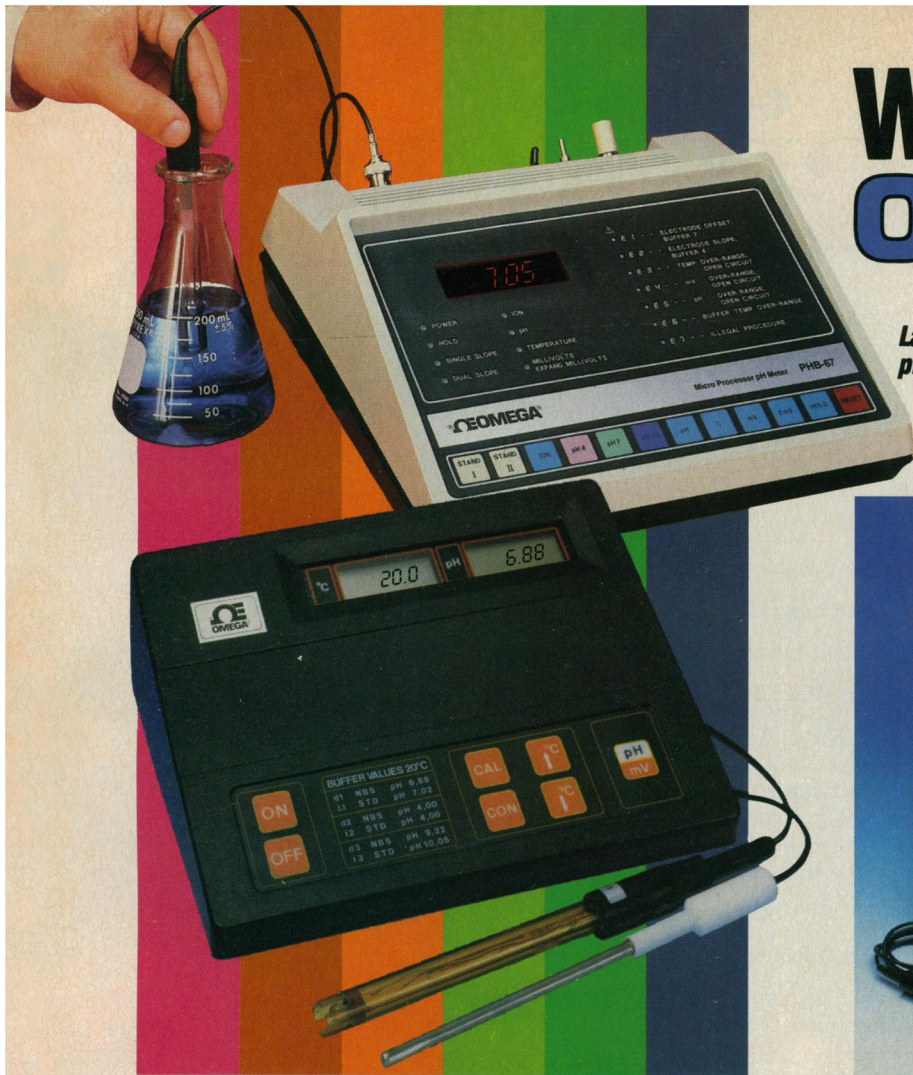
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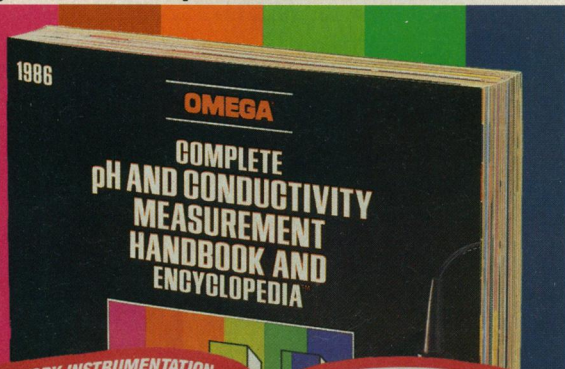
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7 This Week in *Science*

Editorial

- 9 Changing Times: G. A. STROBEL

Letters

- 10 Acid Deposition in the Western United States: G. M. HIDY; L. NEWMAN and C. M. BENKOVITZ; M. OPPENHEIMER, C. B. EPSTEIN, R. E. YUHNKE ■
Evolution of Color Vision: H. KALMUS

News & Comment

- 15 Congress Weighs Closing Vandenberg
16 U.K. Astronomers Split on Observatory's Fate
18 Yellow Rain Evidence Slowly Whittled Away
19 The UCLA-Occidental-Gorbachev Connection
21 *Briefing*: NASA Terminates Centaur Development ■ House Appropriations Committee Kind to Physics ■ Florida Physician to Be Assistant Secretary for Health ■ Drug Export Bill Torpedoed by Amendment ■ Data Problems Halt Work at Two Nuclear Waste Repository Sites

Research News

- 23 Anthropologist Argues That Language Cannot Be Read in Stones
24 *Briefing*: DNA Sequencing Goes Automatic
25 A Chemical Route to Advanced Ceramics
27 *Briefing*: Planetary Rings May Not Be Forever ■ Progress Toward a Schistosomiasis Vaccine

Articles

- 29 Comax: An Expert System for Cotton Crop Management: H. LEMMON

Research Articles

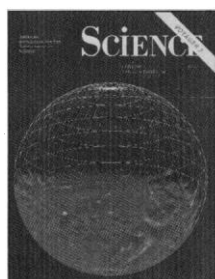
- 34 Photosynthesis-Associated Gene Families: Differences in Response to Tissue-Specific and Environmental Factors: J. SIMPSON, M. VAN MONTAGU, L. HERRERA-ESTRELLA

Reports

Voyager 2 Mission to Uranus

- 39 The Voyager 2 Encounter with the Uranian System: E. C. STONE and E. D. MINER
43 Voyager 2 in the Uranian System: Imaging Science Results: B. A. SMITH, L. A. SODERBLOM, R. BEEBE, D. BLISS, J. M. BOYCE, A. BRAHIC, G. A. BRIGGS, R. H. BROWN, S. A. COLLINS, A. F. COOK II *et al.*
65 Photometry from Voyager 2: Initial Results from the Uranian Atmosphere, Satellites, and Rings: A. L. LANE, C. W. HORD, R. A. WEST, L. W. ESPOSITO, K. E. SIMMONS, R. M. NELSON, B. D. WALLIS, B. J. BURATTI *et al.*

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COVER Miranda, Uranus' innermost major satellite. This view was assembled from nine images returned during Voyager 2's close pass in January 1986. The images were acquired from widely different viewing stations due to the closeness of pass and high velocity of the spacecraft. In this view of the 490-kilometer satellite, the equator and terminator are almost coincident because the sun shines nearly on the south pole. Miranda's trailing hemisphere is in the center of the view as the satellite moves directly away from us in its orbit. See page 39. [Members of Planetary Cartography Group of the U.S. Geological Survey, Flagstaff, AZ, assembled this computer mosaic and rotated it to this perspective]

- 70 Infrared Observations of the Uranian System: R. HANEL, B. CONRATH, F. M. FLASAR, V. KUNDE, W. MAGUIRE, J. PEARL, J. PIRRAGLIA, R. SAMUELSON, D. CRUIKSHANK, D. GAUTIER, P. GIERASCH, L. HORN *et al.*
- 74 Ultraviolet Spectrometer Observations of Uranus: A. L. BROADFOOT, F. HERBERT, J. B. HOLBERG, D. M. HUNTEN, S. KUMAR, B. R. SANDEL, D. E. SHEMANSKY, G. R. SMITH, R. V. YELLE, D. F. STROBEL *et al.*
- 79 Voyager 2 Radio Science Observations of the Uranian System: Atmosphere, Rings, and Satellites: G. L. TYLER, D. N. SWEETNAM, J. D. ANDERSON, J. K. CAMPBELL, V. R. ESHLEMAN, D. P. HINSON, G. S. LEVY, G. F. LINDAL *et al.*
- 85 Magnetic Fields at Uranus: N. F. NESS, M. H. ACUÑA, K. W. BEHANNON, L. F. BURLAGA, J. E. P. CONNERNEY, R. P. LEPPING, F. M. NEUBAUER
- 89 Plasma Observations Near Uranus: Initial Results from Voyager 2: H. S. BRIDGE, J. W. BELCHER, B. COPPI, A. J. LAZARUS, R. L. MCNUTT, JR., S. OLBERT, J. D. RICHARDSON, M. R. SANDS, R. S. SELESNICK, J. D. SULLIVAN *et al.*
- 93 Energetic Charged Particles in the Uranian Magnetosphere: E. C. STONE, J. F. COOPER, A. C. CUMMINGS, F. B. McDONALD, J. H. TRAINOR, N. LAL, R. MCGUIRE, D. L. CHENETTE
- 97 The Magnetosphere of Uranus: Hot Plasma and Radiation Environment: S. M. KRIMIGIS, T. P. ARMSTRONG, W. I. AXFORD, A. F. CHENG, G. GLOECKLER, D. C. HAMILTON, E. P. KEATH, L. J. LANZEROTTI *et al.*
- 102 Voyager 2 Radio Observations of Uranus: J. W. WARWICK, D. R. EVANS, J. H. ROMIG, C. B. SAWYER, M. D. DESCH, M. L. KAISER, J. K. ALEXANDER, T. D. CARR, D. H. STAELIN, S. GULKIS, R. L. POYNTER, M. AUBIER *et al.*
- 106 First Plasma Wave Observations at Uranus: D. A. GURNETT, W. S. KURTH, F. L. SCARF, R. L. POYNTER

AAAS News

- 110 Association Awards Presented at Annual Meeting in Philadelphia ■ Chalk Leaves AAAS, Frankel to Head CSFR Staff: J. WRATHER ■ Chaos at AAAS ■ AAAS Special Event at the "New" New York Hall of Science

Book Reviews

- 113 Early History of Cosmic Ray Studies, *reviewed by* L. M. BROWN ■ Perspectives in Particles and Fields, C. REBBI ■ Evolutionary Biology of Primitive Fishes, W. E. BEMIS ■ Some Other Books of Interest ■ Reprints of Books Previously Reviewed ■ Books Received

Products & Materials

- 117 Secondary Ion Mass Spectrometry ■ Fourier Transform Infrared Spectrometer ■ Flatbed Recorders ■ Coagulation Analyzer ■ Energy Dispersive X-ray Fluorescence Analysis ■ Inserts for Shaking and Vortexing 96-Well Plates

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This volume contains 24 articles published in *Science* between 1982–84, ranging from the solar system to the pulsars at the very edge of the observable universe. Research techniques and instruments described cover such diverse topics as proton decay, the Very Large Array, and the planned Space Station as a platform for future experiments.

Each article is self-contained, yet as a whole, the volume reveals a broad, coherent, and contemporary picture of our astronomical universe. Selected for their depth of coverage and breadth of topics by Morton S. Roberts, past Director of the National Radio Astronomy Observatory, these articles are of interest to the entire scientific community.

Contents

I. SOLAR SYSTEM

- Sun's Influence on Earth's Atmosphere and Interplanetary Space, *J.V. Evans*
Solar Flares, Proton Showers, and Space Shuttle, *D.M. Rust*
Cosmic-Ray Record in Solar System Matter, *R.C. Reedy, J.R. Arnold, D. Lal*
Ultraviolet Spectroscopy and Composition of Cometary Ice, *P.D. Feldman*

II. STRUCTURE AND CONTENT OF THE GALAXY

- New Milky Way, *L. Blitz, M. Fich, S. Kulkarni*
Most Luminous Stars, *R.M. Humphreys and K. Davidson*
Chromospheres, Transition Regions, and Coronas, *E. Böhm-Vitense*
Interstellar Matter and Chemical Evolution, *M. Peimbert, A. Serrano, S. Torres-Peimbert*
Formation of Stellar Systems from Interstellar Molecular Clouds, *R.D. Gehrz, D.C. Black, P.M. Solomon*
Binary Stars, *B. Paczyński*

- Dynamics of Globular Clusters, *L. Spitzer, Jr.*
Magnetic Activity of Sunlike Stars, *A.H. Vaughan*
Stars, Their Evolution and Stability, *S. Chandrasekhar*

III. GALAXIES AND COSMOLOGY

- Most Distant Known Galaxies, *R.G. Kron*
Galactic Evolution...*K.M. Strom and S.E. Strom*
Rotation of Spiral Galaxies, *V.C. Rubin*
Quasars and Gravitational Lenses, *E.L. Turner*
Windows on a New Cosmology, *G. Lake*
Origin of Galaxies and Clusters...*P.J.E. Peebles*
Jets in Extragalactic Radio Sources, *D.S. DeYoung*
Quest for Origin of Elements, *W.A. Fowler*
Dark Night-Sky Riddle...*E.R. Harrison*

IV. INSTRUMENTATION

- Radio Astronomy with Very Large Array, *R.M. Hjellming and R.C. Bignell*
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This Week in SCIENCE

Voyager's voyage

THIS week's special issue documents another stunning tour de force for the Voyager 2 spacecraft that in January had its close encounter with Uranus (pages 39–109). Voyager left Earth to visit the outer planets on 20 August 1977, carrying an array of scientific equipment. (Each report in this issue describes results obtained with one instrument.) Flybys of Jupiter in 1979, Saturn in 1981, and Uranus in 1986 have provided information about each of these planetary systems as well as about the evolution of the whole solar system. Comparisons have been made among the outer planets and between them and the terrestrial planets. This mission has been remarkable: after 9 years in space and after traveling 3 billion kilometers from Earth, all the Voyager instruments are functioning well, little or no recalibration has been needed, and resolution is excellent. Voyager 2 is now headed away from Uranus toward Neptune for a flyby in 1989. It will eventually pass through the orbit of Pluto (but not close to the planet) and then will continue out beyond the solar system, transmitting data back to Earth until the solar batteries that power the instruments stop working.

Magnetosphere of Uranus

STUDIES of magnetospheres—the regions in which planetary magnetic fields govern local physical processes—are key objectives of planetary exploration. Uranus was found by Voyager 2 to have an unusual magnetic field tilted 60° from the planet's axis of rotation (as though something hit Uranus early in its evolution and knocked it out of alignment). Uranus' major rings and moons orbit within the magnetosphere. Like Earth, Uranus also has a rotating magnetotail, swept back to the nightside of the planet by the solar wind. The field, with its unusual and exotic geometry, may be generated by a dynamo deep within the planet.

Rings of Uranus

NINE rings—called 6 (closest), 5, 4, α , β , η , γ , δ , and ϵ —were detected around Uranus in 1977. The Voyager 2 mission identified two more, one between the planet and ring 6 and the other between δ and ϵ . In addition, about 100 new ring-like features were detected interspersed within the main rings. Blocked light from stars that passed behind the rings was used to study ring properties and arrangement. The rings are dark and large and consist of collections of well-separated particles. Micrometer-sized dust particles indicate a young age, perhaps 6 million years, for some rings; the planet itself is more than 4 billion years old. Formation of rings may occur when large bodies (such as satellites) fragment; the particles may then be gravitationally confined into rings by “shepherding” satellites (see Research News, p. 27).

Satellites of Uranus

URANUS has 15 moons in orbits beyond the rings—Miranda (cover), Ariel, Umbriel, Titania, Oberon, and ten new ones identified by Voyager 2. All are dark and lack atmospheres. One orbits inside the ϵ ring; the other nine orbit between the rings and Miranda. The two that straddle ϵ may apply torques to the ring particles to keep them from spreading and dispersing. Voyager images show that the Uranian moons are extensively cratered and faulted; their patchwork landscapes suggest that they were disrupted (perhaps when the alignment of the planet was disturbed) and then reassembled haphazardly.

Farming by computer

THE best yield of cotton comes to the farmer who knows exactly when to fertilize and irrigate and when to harvest the crop, which is hidden inside the boll (page 29). Planting and harvesting, the latter involving defoliants and boll openers, have largely

been automated in this country; Lemmon describes a system in which decision-making has also been automated. The cotton management expert (Comax) system, a computer program that works at the level of a human expert, advises the farmer on crop management. It works in conjunction with a computer model (Gossym) in which the growth of the plant is simulated. With data collected by sensors at the farm on soil, water, and weather conditions, Comax and Gossym compute what irrigation, fertilization, and other treatments should be used to optimize the growth of the crop; the exact time of crop maturation can also be projected. In the first application of the system to a working 6000-acre farm, the economic yield was improved by \$60 per acre. Such an increase may make even the most traditional farmer cotton to the idea of having a computer as an expert consultant.

Gene activation in photosynthesis

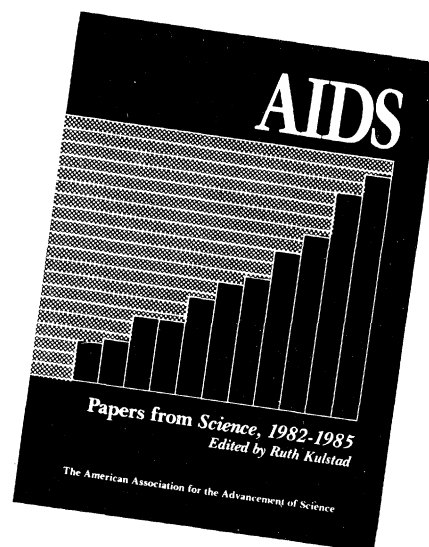
ACTIVATION of plant genes associated with photosynthesis requires light, developed plastids, and undefined tissue-specific factors (page 34). Simpson *et al.* assessed how such factors turn on genes associated with photosynthesis by using genetic chimeras; each chimera was constructed from two genes, one that encodes the detectable enzyme neomycin phosphotransferase II [NPT(II)] and a second (genes named *rbcs* and *LHCP* were used) involved in regulating photosynthesis. NPT(II) was only produced upon activation of the promoters of *rbcs* or *LHCP*, and expression was highest in cells of mesophyll tissue. For each chimera, organ-specific expression was demonstrated through evaluation of gene activation in leaves, stems, sepals, roots, petals, stigmas, anthers, and seeds; the pattern of tissue specificity differed for the two chimeras. Furthermore, each chimera interacted with different photoreceptors, indicating additional complexities in the regulation of the photosynthetic process.

Announcing a new book from AAAS

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Some of the most frequently cited papers on acquired immune deficiency syndrome (AIDS) that appeared in *Science* between August 1982 and September 1985 are included in this volume. Arranged chronologically, these 108 research papers and *Science* news reports show how far AIDS research has come and provide an indication of the directions in which it might go.

This fully indexed collection is useful not only for the experimental data and conclusions, but also as an excellent source of references to AIDS work in other major journals worldwide. An overview of research in AIDS to date is provided in the introduction by Dr. Myron Essex, chairman of the Department of Cancer Biology, Harvard University School of Public Health.

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Changing Times

At a time of financial stress brought about by a declining agricultural economy, reduced world prices for oil and gas, reduced demand for coal, and increased imports from abroad, the taxable incomes from many farm and energy-producing states would seem inadequate to keep pace with pre-1985 expenditures for science and related activities. The states most dramatically affected are those in the deep South, the northern plains and Rocky Mountains, and a few in the northeastern and central portions of the United States. On top of the economic plight, many of these states have not been very competitive in acquiring research funds from federal sources. One study showed, for instance, that the top ten states received 66 percent of federal research funds, whereas the bottom ten received 1.5 percent.

Some may argue that only a few states should be funded to carry the entire burden of this nation's research effort. On the other hand, it seems that a more broadly based scientific enterprise might provide some of the answers needed to cope with troubled economic times. Such activity could help encourage new businesses or help old ones find novel products.

To some extent, steps to cope with this problem are already being taken by the National Science Foundation. In 1980 an experimental program to stimulate competitive research (EPSCoR) was established. At that time, Arkansas, Maine, Montana, South Carolina, and West Virginia were selected from seven competitors to receive funding at a level of \$500,000 to \$600,000 per year each for 5 years with comparable local matching funds.

These modest sums of federal money had large catalytic effects. The advice of U.S. senators and representatives was sought, and presidents of the state universities participated as did members of the university faculties. Influential people from industry and in the legislatures had roles on advisory committees active in each state. Additional local funds were pledged. Out of much consultation, many research proposals emerged. These were evaluated by a large number of expert reviewers situated in other states. In addition, outsiders made project site visits. The best proposals were identified and supported.

The result of having EPSCoR in Montana, South Carolina, Arkansas, and other states has been a notable increase in the success of independent proposals submitted to NSF, the National Institutes of Health, and other agencies. Just as important has been the maintenance of research committees that have played critical roles in helping with the development of state science and technology alliances. These alliances have funded university-industry-related research. Project peer review at a national and international level has resided with the state EPSCoR programs.

Realizing the benefits of EPSCoR, in 1985 Congress supported NSF in expanding the program to 11 more states and Puerto Rico. In spite of difficult economic times, the states, realizing the value of the EPSCoR program, have allocated matching commitments that exceed NSF dollars two- to sixfold. Few other federally sponsored research programs can say as much. In addition, in many states, the working relationship established between industry, government, and the university is a novel event—one that is needed and one that should be encouraged.

However, some additional things would help. The people in the poorer states need the assistance of scientists in other states to (i) help with peer review of projects, (ii) participate as research collaborators, and (iii) visit the states and establish rapport with scientists in them. As a nation we sometimes seem more willing to help foreign governments with their science than those comparable enterprises in our own third world states.

For the benefit of the nation, NSF should continue its involvement with EPSCoR, and Congress should encourage the development of comparable EPSCoR programs in agriculture, commerce, energy, environment, and defense. Federal agencies and organizations including the National Academy of Sciences need to be encouraged to have participants from a broader number of states on their panels, committees, and boards.

Times are definitely changing, and the way in which science is funded, administered, and utilized needs to be closely examined especially as it relates to many of the states and territories of this nation.—GARY A. STROBEL, R. G. Gray Professor and Director, MONTS, Montana State University, Bozeman, MT 59717