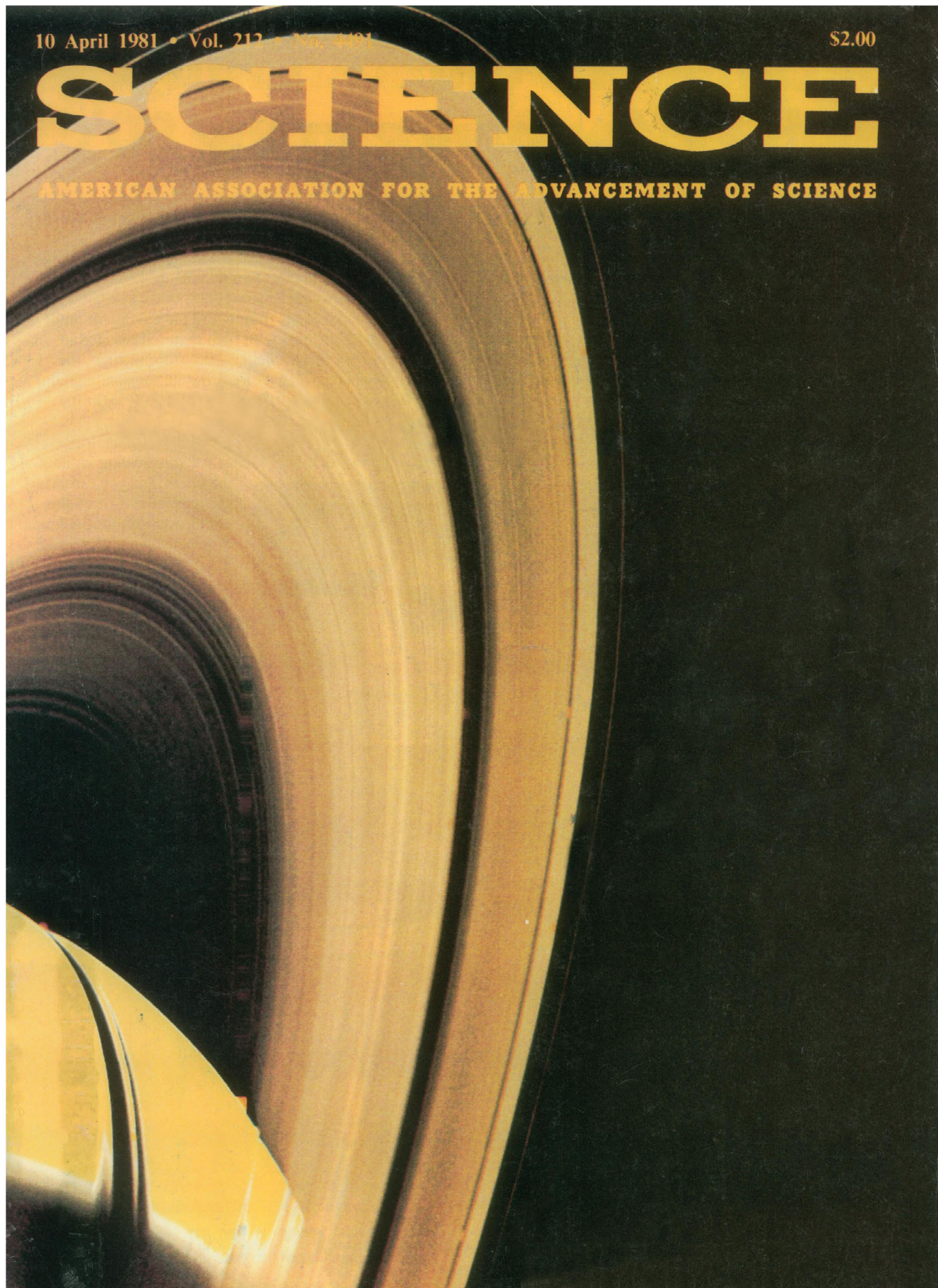


10 April 1981 • Vol. 212 • No. 4491

\$2.00

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Beckman L8 Ultracentrifuges—High Performance in the 80's

From every aspect of performance, the L8 ultracentrifuges are unsurpassed. Whether you choose the 80,000-rpm Model L8-80, or the 70,000 or 55,000-rpm models, you get the most advanced drive system, programming capability, over 40 rotors to choose from, and a host of built-in features which assure you top performance in the years ahead.

The drive system is Ultra-8™—a frequency-controlled induction motor that drives the rotor directly from *inside* the vacuum system. We warrant the complete drive for 16 billion revolutions.

Programmability comes from microprocessor control using the Memory-Pac™ module. You insert a Memory-Pac in the L8 control panel, and seconds later it is programmed with whatever rotor speed, temperature, etc., you wish. You're assured of error-free duplicate runs with no time spent in set-ups.

L8 features include a Dry Cycle to remove

moisture from the chamber, an ω^2t Integrator for accurately reproducing runs in sucrose gradients, and internal diagnostic systems for simple servicing.

For high performance rotors, no one comes close to Beckman. There are two 80,000-rpm rotors: the 80 Ti fixed angle which generates 602,000 g at 80,000-rpm—highest force of any rotor—and the VTi-80 for rapid density gradient runs with such materials as steroid receptors. For the Model L8-70 ultracentrifuge, the 70,000-rpm Type 70.1 Ti rotor has an outstanding combination of volume (163 mL) and force (450,000 g) for such separations as plasmid DNA.

Add a superb line of tubes and adapters, topped by the unique Quick-Seal™ tubes for sure sealing without

tube caps, and you can easily see why investigators the world over choose Beckman ultracentrifuges. For more information, write Beckman Instruments, Inc., Spinco Division, 1117 California Ave., Palo Alto, CA 94304.



BECKMAN

Circle No. 94 on Readers' Service Card

A NEW SCHWARZ/MANN CATALOG TO SIGNAL OUR 5th DECADE OF SERVICE TO RESEARCH IN THE LIFE SCIENCES

For the past 40 years, life scientists throughout the world have used Schwarz/Mann biochemicals to further their research efforts. And, as the needs of the research community change, Schwarz/Mann has kept pace by providing the required new products.

1940's

- Glutathione
- Nucleic acid derivatives

1950's

- ^{14}C Labeled nucleic acid derivatives
- Optically standardized amino acids

1960's

- Labeled nucleic acid derivatives with higher activities and additional isotopes
- Antimetabolites for cancer research
- CPK precision-scale molecular models

1970's

- Peptide synthesis products and equipment
- Labeled and non-labeled products for *in vitro* clinical assays

And new for the 1980's

- ^{32}P Ribonucleotides
- ^{32}P Deoxyribonucleotides
- 8-Azido- ^{32}P labeled Photoaffinity Probes

We'll send you detailed new product information throughout this decade if you order our first catalog of the 1980's:



Schwarz/Mann, Inc.

Division of Mediscience, Inc.,
2 Ram Ridge Road,
Spring Valley, NY 10977

914-356-4544 800-431-2800

Circle No. 97 on Readers' Service Card



For a copy of the new Schwarz/Mann catalog, fill out and mail coupon to:

Schwarz/Mann Inc.
Division of Mediscience, Inc.
2 Ram Ridge Road
Spring Valley, NY 10977

Name _____

Institution _____

Address _____

City/State/Zip _____

Phone () _____

SCIENCE

LETTERS	Mathematical Ability: Is Sex a Factor?: <i>C. Tomizuka and S. Tobias; E. K. Stage and R. Karplus; S. Chipman; E. Egelman et al.; D. J. Moran; E. H. Luchins and A. S. Luchins; A. Kelly; C. P. Benbow and J. C. Stanley</i>	114
EDITORIAL	Voyager Mission to Saturn	125
ARTICLES	The Bridge of Language: <i>N. Frye</i>	127
	Iron Ore: From Depletion to Abundance: <i>P. J. Kakela</i>	132
NEWS AND COMMENT	Fraud and the Structure of Science	137
	MX Lobotomized by Air Force, Critic Says	138
	Interferon: No Magic Bullet Against Cancer	141
	Califano Tells Tales of the Top Post at HEW	142
	<i>Briefing:</i> DOE Blocks Mailing of "Antinuclear" Publication; House Science Panel Throws Down Gauntlet; More About Cloned Mice; Levy to Leave NHLBI; Heroin No Better than Morphine as Analgesic	144
RESEARCH NEWS	The 1981 Pittsburgh Conference: A Special Instrument Report Myriad Ways to Measure Small Particles	146
	<i>Instrument Highlights:</i> Rough Going for Lasers at the Pittsburgh Conference; How Many Solvents Is the Limit for HPLC?; Concentrations Measured by Delayed Lasing; Persistence Pays Off in the Form of a New Product; IR Spectrophotometer Wed to a Microscope; IBM Now Making Analytical Instruments	148
	New Ways to Measure SO ₂ Remotely	152
	At \$100 per Hour, Service Is a Big Concern	153

BOARD OF DIRECTORS

FREDERICK MOSTELLER
Retiring President, Chairman

D. ALLAN BROMLEY
President

E. MARGARET BURBIDGE
President-Elect

ELOISE E. CLARK
EDWARD E. DAVID, JR.

NANCIE L. GONZALEZ
DAVID A. HAMBURG

CHAIRMEN AND SECRETARIES OF AAAS SECTIONS

MATHEMATICS (A)
Ralph P. Boas
Ronald Graham

PHYSICS (B)
Maurice Goldhaber
Rolf M. Sinclair

CHEMISTRY (C)
Robert W. Parry
William L. Jolly

ASTRONOMY (D)
Owen Gingerich
Donat G. Wentzel

PSYCHOLOGY (J)
George A. Miller
Meredith P. Crawford

SOCIAL, ECONOMIC, AND POLITICAL SCIENCES (K)
James G. March
Gillian Lindt

HISTORY AND PHILOSOPHY OF SCIENCE (L)
Harry Woolf
Diana L. Hall

ENGINEERING (M)
Michael Michaelis
Donald E. Marlowe

EDUCATION (Q)
Ann C. Howe
Roger G. Olstad

DENTISTRY (R)
Maynard K. Hine
Harold M. Fulmer

PHARMACEUTICAL SCIENCES (S)
Anthony P. Simonelli
Robert A. Wiley

INFORMATION, COMPUTING, AND COMMUNICATION (T)
George W. Tresselt
Madeline M. Henderson

DIVISIONS

ALASKA DIVISION

John Bligh
President

T. Neil Davis
Executive Secretary

PACIFIC DIVISION

Beatrice M. Sweeney
President

Alan E. Leviton
Executive Director

SOUTHWESTERN AND ROCKY MOUNTAIN DIVISION

Sam Shushan
President

M. Michelle B.
Executive Officer

SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Second-class postage (publication No. 484460) paid at Washington, D.C., and at an additional entry. Now combined with *The Science Monthly*. Copyright © 1981 by the American Association for the Advancement of Science. Domestic individual membership and subscription (51 issues): \$43. Domestic institutional subscription (51 issues): \$80. Foreign postage extra: Canada \$24, other (surface mail) \$27, air-surface via Amsterdam \$55. First class, airmail, school-year, and student rates on request. Single copies \$2 (\$2.50 by mail); back issues \$3 (\$3.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BOOK REVIEWS	Cosmologie Physique, reviewed by J. E. Gunn; Evolution in Age-Structured Populations, R. E. Michod; Olfaction in Mammals, D. G. Kleiman; Behavior of Marine Animals, N. P. Ashmole; Books Received	154
REPORTS	Voyager 1 Encounter with the Saturnian System: E. C. Stone and E. D. Miner	159
	Encounter with Saturn: Voyager 1 Imaging Science Results B. A. Smith et al.	163
	Orbits of the Small Satellites of Saturn: S. P. Synnott et al.	191
	Infrared Observations of the Saturnian System from Voyager 1: R. Hanel et al.	192
	Radio Science Investigations of the Saturn System with Voyager 1: Preliminary Results: G. L. Tyler et al.	201
	Extreme Ultraviolet Observations from Voyager 1 Encounter with Saturn: A. L. Broadfoot et al.	206
	Magnetic Field Studies by Voyager 1: Preliminary Results at Saturn: N. F. Ness et al.	211
	Plasma Observations Near Saturn: Initial Results from Voyager 1: H. S. Bridge et al.	217
	Low-Energy Charged Particles in Saturn's Magnetosphere: Results from Voyager 1: S. M. Krimigis et al.	225
	Energetic Charged Particles in Saturn's Magnetosphere: Voyager 1 Results: R. E. Vogt et al.	231
	Plasma Waves Near Saturn: Initial Results from Voyager 1: D. A. Gurnett, W. S. Kurth, F. L. Scarf	235
	Planetary Radio Astronomy Observations from Voyager 1 Near Saturn: J. S. Warwick et al.	239
PRODUCTS AND MATERIALS	Centrifuge; Marker Proteins; Miniature Specimen Light; Rheometer; Cholesterol Analyzer; Polynucleotide Synthesizer; Dissecting Boards; Ventilated Cage Rack; Literature	244

J. HARRISON ER E. MASSEY	RUSSELL W. PETERSON HARRIET ZUCKERMAN	WILLIAM T. GOLDEN Treasurer	WILLIAM D. CAREY Executive Officer
PHYSICS AND GEOGRAPHY (E) Simon Mas Dutro, Jr.	BIOLOGICAL SCIENCES (G) John A. Moore Walter Chavin	ANTHROPOLOGY (H) Alan R. Beals Priscilla Reining	
PHYSICAL SCIENCES (N) D. Bogdonoff Lowenstein	AGRICULTURE (O) Martin A. Massengale Coyt T. Wilson	INDUSTRIAL SCIENCE (P) John Diebold Robert L. Stern	
PHYSICS (U) E. Fienberg ser	ATMOSPHERIC AND HYDROSPHERIC SCIENCES (W) Julius London Glenn R. Hilst	GENERAL (X) Herman Pollack S. Fred Singer	

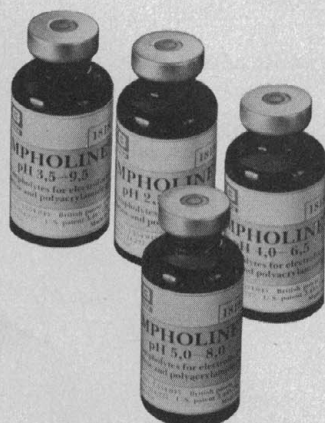
COVER

Computer-enhanced photo of Saturn (taken 13 November 1980 by Voyager 1) shows Saturn's rings and their shadows against the lighted crescent of the planet. The photo was taken from a distance of 1,570,000 kilometers beyond the planet. The bright, overexposed limb of Saturn is visible through the rings. Radial spokes in the B ring, which appeared dark in pictures taken when Voyager 1 was approaching Saturn, can be seen here as bright markings, suggesting that the spoke particles are a few microns in diameter. The thin F ring displays brightness variations that are caused by nonuniform distribution of material in that ring. See page

LKB ANNOUNCES MORE.

MORE CONVENIENCE

New pre-blended Ampholine® carrier ampholytes for electrofocusing are available in three narrow and one wide pH range. Now there's no need to spend time mixing to achieve these specific ranges. Just select the pre-blended Ampholine you need (pH 2.5 to 4.5, 4.0 to 6.5, 5.0 to 8.0 and 3.5 to 9.5). They're designed to give the same linear, virtually drift-free pH gradient achieved using standard Ampholine with LKB Agarose-EF or acrylamide gels.

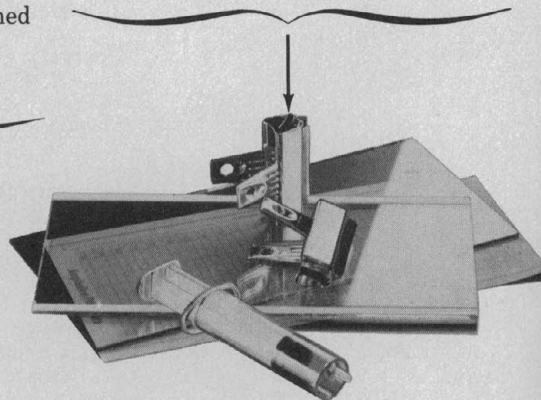


MORE POWER

The new Model 2197 Power Supply for electrofocusing and electrophoresis offers top-of-the-line features at a very affordable price. The Model 2197 delivers up to 2500V for high-resolution electrofocusing and its 250mA output makes it useful for other electrophoretic techniques. Choose constant power/constant voltage/constant current/time control modes to suit your application. Automatic crossover between running modes compensates for varying gel conditions. Built-in timer with alarm and automatic shutoff allows for time control. With accurate control of four parameters, you can achieve maximum resolution and reproducibility in all your electrofocusing and electrophoresis experiments. Bright LED display lets you monitor performance easily and the Model 2197 is designed to comply with all relevant safety standards.

MORE ECONOMY

LKB's new capillary gel casting system easily produces gels only one quarter the thickness of standard ones. You save substantially on reagent use and you'll be able to employ higher voltage for decreased run times because the new thinner gels dissipate heat more efficiently. The capillary gel casting kit works with agarose and acrylamide gels. Combine it with the new pre-blended Ampholine and the 2500 volt power supply to significantly reduce your run times while cutting costs. Ask your local LKB representative for more information on these new products and the complete line of LKB instruments and consumables. Depend on the leader in electrofocusing to give you more.



LKB

Head office:
LKB Produkter AB
Box 305
S-161 26 Bromma, Sweden
Tel. 08/98 00 40, telex 10492

Main US sales office:
LKB Instruments, Inc.
12221 Parklawn Drive
Rockville, Md 20852
Tel. 301-881 2510
telex 230 89 682

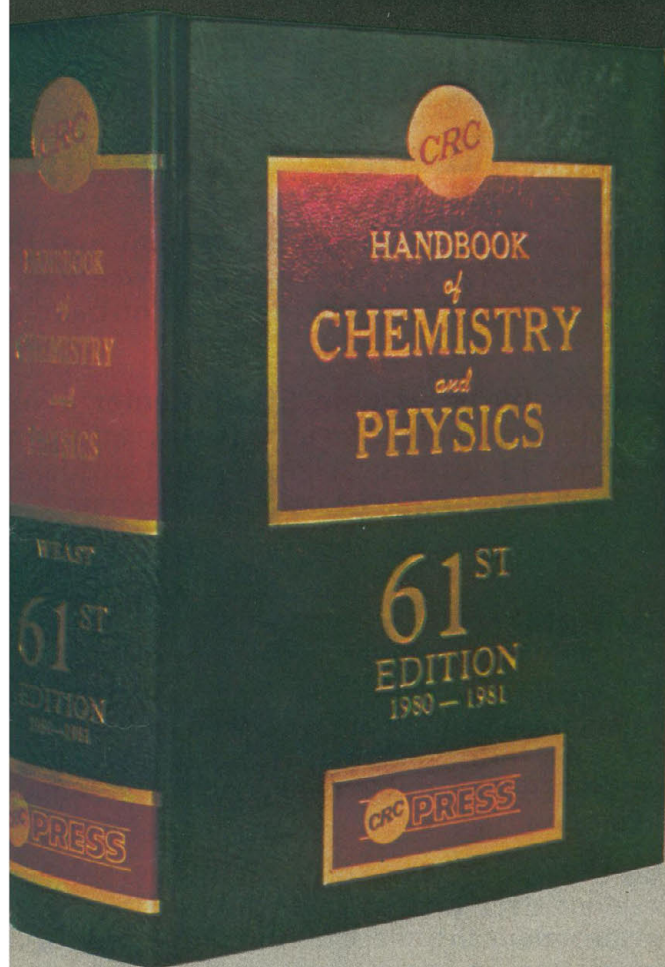
Other sales offices in:
Athens (for the Middle East),
Copenhagen, Ghent,
The Hague, Hong Kong,
London, Munich, Paris,
Rome, Turku, Vienna

Circle No. 5 on Readers' Service Card

SAVE 58%

The 61st Edition at the price of the 51st ...

NOW ONLY \$24.95



For a limited time, you can have today's 61st edition of the most frequently used data reference in the world for only \$24.95. This low price reflects a roll-back in time to our 1970 price on the 51st edition.

Newly added features on the 61st edition include: Nomenclature of Some Monomers and Polymers; Critical Temperatures and Critical Pressures of the Elements; SI Derived Units with Special Names; and Mean Free Path of the Gases, and the Table of Physical Constants of Organic Compounds has been increased from 13,500 to 15,000 compounds.

Order Form

Rush me the 61st Edition of the CRC Handbook of Chemistry and Physics for only \$24.95* (regularly \$59.95).

To qualify for this special offer, each order must:

- specify catalog number 461KLD
- be prepaid direct to CRC Press
- be postmarked by May 31, 1981

Enclosed is my check/money order for \$

Name.....

Co./Inst.....

Address.....

City..... State..... Zip.....

* Outside U.S., \$28.95 per copy. Payable in U.S. currency or draft on a U.S. bank. Florida residents add 4% sales tax.

5736



CRC PRESS, INC.



An Academic Review: Safety Assessment of Artificial Sweeteners

MAY 12 & 13, 1981 • WASHINGTON, D.C. • HOLIDAY INN – CAPITOL

The symposium will address the basic medical sciences involved in safety assessment and the practical aspects of risk assessment as regards saccharin, cyclamates and other artificial sweeteners. It is particularly timely in light of the June 30th expiration of the Congressional moratorium on banning saccharin.

To generate the indepth understanding the subject area merits, the International Study Center, a New York based non-profit organization of leading university scientists and physicians, is sponsoring the conference. The symposium will feature a panel of some 15 leading scientists and academic physicians who will air matters concerning the safety and risk assessment of artificial sweeteners . . . an academic review of these compounds.

SYMPOSIUM CO-CHAIRMEN

Benjamin L. Van Duuren, Sc.D. Professor of Environmental Medicine at New York University School of Medicine and Associate Director of the Institute of Environmental Medicine at the NYU Medical Center. An internationally known expert on chemical carcinogenesis and one of the originators of research on promoters and co-carcinogens. Dr. Van Duuren has published more than 300 scientific papers and is a frequent presenter at major scientific symposia in this country and Europe.

Bernard M. Wagner, M.D. Professor of Pathology at Columbia University College of Physicians and Surgeons and Director of Laboratories at Overlook Hospital. President-elect of the International Academy of Pathologists and Chairman of the Committee on Pathology of the American College of Toxicology. Dr. Wagner has published over 100 scientific papers and is an active participant in international medical symposia.

SYMPOSIUM DETAILS

The symposium will be held on Tuesday and Wednesday, May 12 and 13 at the Holiday Inn – Capitol, located across from the Smithsonian. Ticket prices are \$500 each and include meeting materials and lunch on both days. Early registration is strongly advised.

A limited number of scholarship tickets are available for university faculty; government rates for federal and state officials. Hotel room reservations can be made by calling the Holiday Inn Capitol direct; toll free phone number is 800-424-9130.

For more information and copies of the symposium agenda and list of panelists, call or write the Study Center.

International Study Center for Environmental Health Sciences
503 Grasslands Road, Valhalla, New York 10595

Quick Quiz:

Are you involved in any of the following applications that need AFFORDABLE high-speed computation?

- ☐ STRUCTURAL ANALYSIS
- ☐ FLUID DYNAMICS
- ☐ ELECTRONIC CIRCUIT DESIGN
- ☐ SIGNAL PROCESSING
- ☐ IMAGE PROCESSING
- ☐ REAL-TIME SIMULATION
- ☐ RESERVOIR SIMULATION
- ☐ LOAD-FLOW ANALYSIS
- ☐ LINEAR PROGRAMMING
- ☐ HIGH-SPEED DATA REDUCTION

CONGRATULATIONS! If you checked any of these applications, you have just won a FREE ticket for the National Computer Conference, May 4-7, Island Booth 621 McCormick Place, Chicago, Illinois.

Here's an opportunity to see demonstrations of powerful array processor computer systems and how they may relate to your applications.

If you call and tell us your application interests, we'll send you free, a ticket to the National Computer Conference.

Floating Point Systems is recognized as the world's leading manufacturer of Array Processors, offering:

- ✓ Up to 200X increase in throughput for minicomputer systems.
- ✓ Unequalled cost/performance for super mini systems.
- ✓ Exceptional economy when off-loading from mainframes.

**Call for your FREE TICKET
(800) 547-1445, Ex. 4999**



**FLOATING POINT
SYSTEMS, INC.**

... World's Leader in Array Processors

P.O. Box 23489, Portland, OR. 97223
For information circle R S #143
For contact by FPS
Circle RS #144

A special issue of Science on one of today's most important and exciting research areas

Recombinant DNA

Edited by
John Abelson and
Eleanore Butz

Contents

Editorial

Recombinant DNA Revisited: *M. Singer*

Articles

A Revolution in Biology: *J. Abelson*

DNA Sequence Data Analysis

Steps Toward Computer Analysis of Nucleotide Sequences: *T. R. Gingeras and R. J. Roberts*

Structure of Genes That Do Not Rearrange

Structure and in vitro Transcription of Human Globin Genes: *N. J. Proudfoot, M. H. M. Shander, J. L. Manly, M. L. Gelfer, T. Maniatis*

Mouse Globin System: A Functional and Evolutionary Analysis: *P. Leder, J. N. Hansen, D. Konkel, A. Leder, Y. Nishioka, C. Talkington*

At Least Three Human Type α Interferons: Structure of $\alpha 2$: *M. Streuli, S. Nagata, C. Weissman*

Structure of the Genes that Rearrange in Development

Mapping of Heavy Chain Genes for Mouse Immunoglobulins *M* and *D*: *C. -P. Liu, P. W. Tucker, J. F. Mushinski, F. R. Blattner*

Mouse Immunoglobulin D: Messenger RNA and Genomic DNA Sequences: *P. W. Tucker, C. -P. Liu, J. F. Mushinski, F. R. Blattner*

DNA Sequences Mediating Class Switching in α -Immunoglobulins: *M. M. Davis, S. K. Kim, L. E. Hood*

Immunoglobulin Gene Rearrangement in Immature B Cells: *R. Maki, J. Kearney, C. Paige, S. Tonegawa*

Genes Whose Mission Is to Jump

Phase Variation: Evolution of a Controlling Element: *M. Simon, J. Zieg, M. Silverman, G. Mandel, R. Doolittle*

The Origins of Gene Instability in Yeast: *G. S. Roeder, P. J. Farabaugh, D. T. Chaleff, G. R. Fink*

Recombination of Dispersed Repeated DNA Sequences in Yeast: *S. Scherer and R. W. Davis*

Tumor DNA Structure in Plant Cells Transformed by *A. Tumefaciens*: *P. Zambryski, M. Holsters, K. Kruger, A. Depicker, J. Schell, M. Van Montagu, H. M. Goodman*

Engineered Mutagenesis

Isolation of Mutants of an Animal Virus in Bacteria: *K. W. C. Peden, J. M. Pipas, S. Pearson-White, D. Nathans*

Directed Deletion of a Yeast Transfer RNA Intervening Sequence: *R. B. Wallace, P. F. Johnson, S. Tanaka, M. Schöld, K. Itakura, J. Abelson*

Chemical DNA Synthesis and Recombinant DNA Studies: *K. Itakura and A. D. Riggs*

Expression of Cloned Genes in New Environment Promoters Sequences of Eukaryotic Protein-Coding Genes: *J. Corden, B. Wasyluk, A. Buchwalder, P. Sassone-Corsi, C. Keding, P. Chambon*

Altering Genotype and Phenotype by DNA-Mediated Gene Transfer: *A. Pellicer, D. Robins, B. Wold, R. Sweet, J. Jackson, I. Lowy, J. M. Roberts, G. K. Sim, S. Silverstein, R. Axel*

Expression of a Bacterial Gene in Mammalian Cells: *R. C. Mulligan and P. Berg*

A Technique for Expressing Eukaryotic Genes in Bacteria: *L. Guarante, T. M. Roberts, M. Ptashne*

Effect of Interferon- $\alpha 1$ from *E. coli* on Some Cell Functions: *M. G. Masucci, R. Szigeti, E. Klein, G. Klein, J. Gruet, L. Montagnier, H. Taira, A. Hall, S. Nagata, C. Weissman*

Also includes a Glossary of Terms

Send me _____ copies of the Science Special Issue on Recombinant DNA at \$1.50 each plus .50¢ postage and handling.

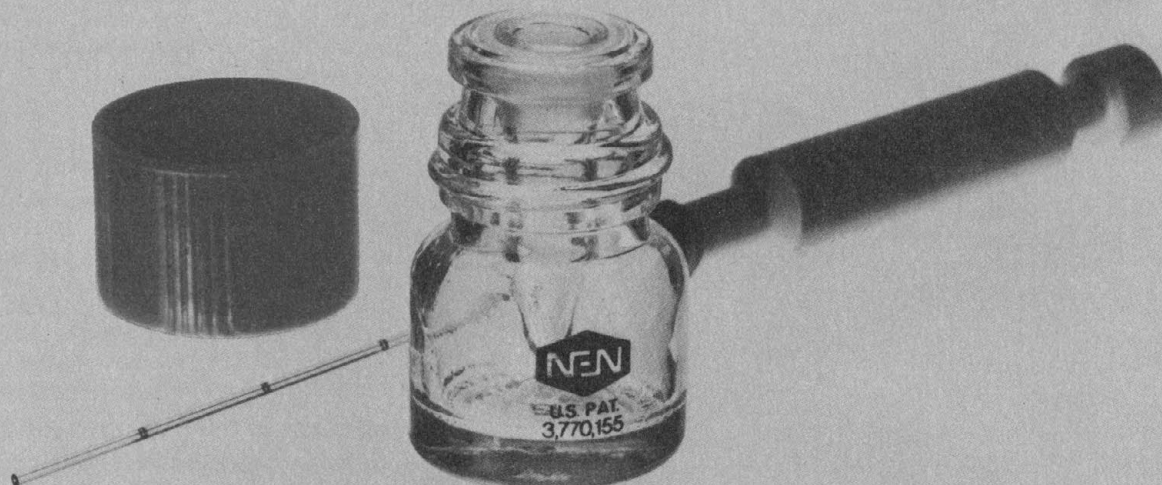
Name _____

Address _____

City, State, Zip _____

Orders under \$10 must be prepaid. Send order to AAAS, Dept. DNA, 1515 Massachusetts Ave., NW, Washington, DC 20005. Allow 6-8 weeks for delivery.

^{32}P nucleotides you simply open and use



Our $>600\text{Ci}/\text{mmol}$ dNTPs, $[\alpha - ^{32}\text{P}]$ - are now also available concentrated to $\sim 10\text{mCi}/\text{ml}$ in an aqueous solution, ready to pipet directly into your reaction mixture. No need to remove or concentrate the packaging solution. No unnecessary handling.

What's more, we've extended their radiochemical stability significantly with 10mM Tricine, a buffer known to be compatible in research systems. Biological testing by nick translation verifies their biological activity and assures you of reliable performance.

NEG-012A dATP, $[\alpha - ^{32}\text{P}]$ - NEG-014A dGTP, $[\alpha - ^{32}\text{P}]$ -
NEG-013A dCTP, $[\alpha - ^{32}\text{P}]$ - NEG-005A dTTP, $[\alpha - ^{32}\text{P}]$ -
 $>600\text{Ci}/\text{mmol}$, $\sim 10\text{mCi}/\text{ml}$, in 10mM aqueous Tricine
buffer solution (pH 7.6), Combi-V-Vial

Produced weekly and shipped daily. Send for complete ordering information on these and our standard concentration dNTPs, $[\alpha - ^{32}\text{P}]$ - .

Not for use in humans or clinical diagnosis



New England Nuclear

549 Albany Street, Boston, Massachusetts 02118

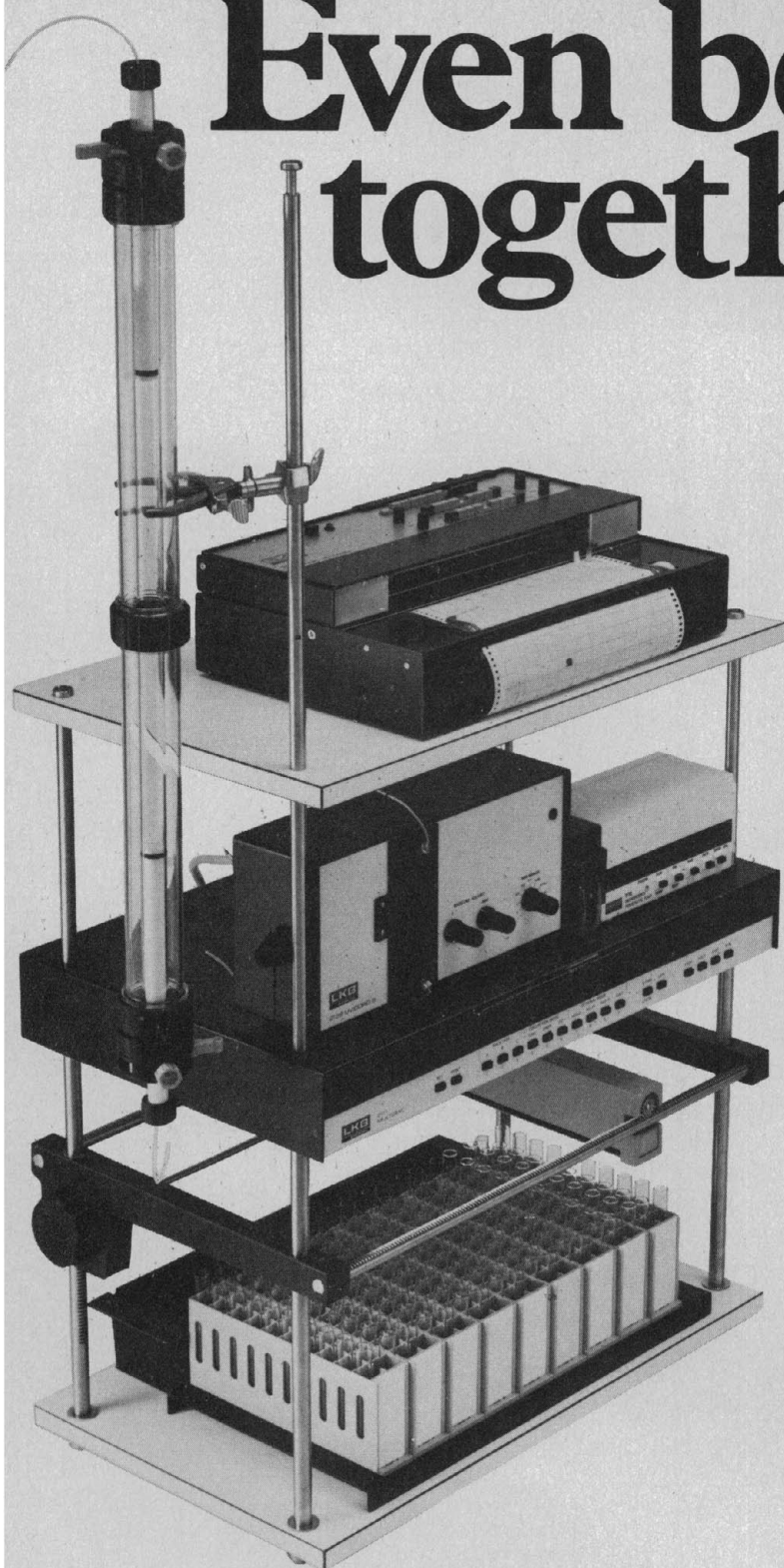
Call toll free: 800-225-1572

(In Massachusetts and International: 617-482-9595)

NEN Chemicals GmbH: D-6072 Dreieich, W. Germany, Postfach 401240, Tel. (06103) 85034, Telex 4-17993 NEN D
NEN Canada: 2453 46th Avenue, Lachine, Que. H8T 3C9, Tel. 514-636-4971, Telex 05-821808

Circle No. 172 on Readers' Service Card

Even better together.



Individually, LKB chromatography instruments provide outstanding reliability and consistently accurate results.

But together, they form total, integrated systems that are unequalled in their ease of use and dependability. The LKB 2111 MultiRac® Fraction Collector is the core of just such a system.

LKB excellence in design

The LKB 2111-MultiRac® system combines the ultra-reliable 2111 Fraction Collector with the new MicroPerpex® peristaltic pump, 2210 dual channel recorder and high sensitivity 2138 Uvicord®S UV monitor in one compact package. This entire system takes up less than 2 square feet of bench or cold room space. Yet, every instrument is easy to reach and adjust.

Integrated ease of operation

With the programmable 2111 MultiRac controlling the run, you're assured of accurate, no waste, no problem collections. And with precise pump control of fraction volumes,

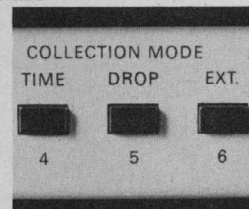
automatic flow stop function during tube changes and continuous display of flow rate on the MicroPerpex pump, the system needs minimal interaction time with laboratory personnel.



Versatile and reliable

This new LKB collector draws on years of design experience and incorporates the most advanced circuitry. Because the MultiRac precisely shifts the drop head, it can accommodate a large variety of collection vessels.

The sophisticated microprocessor controller of the collector lets you select time, drop or precise volume modes, diverts void volumes to waste and can be programmed to save tubes by collecting valleys in large volumes, peaks in small.



See it all together

Ask your LKB representative for more information on LKB complete chromatography systems. See how they work even better together.

LKB

LKB Instruments, Inc.
12221 Parklawn Drive
Rockville, Md 20852
Tel. 301-881 2510
telex 230 89 682

Circle No. 195 on Readers' Service Card

NOW...TOP-LOADERS BECOME ANALYTICALS.



SARTORIUS COMBINES 0.1 mg READABILITY WITH COMPACT SIZE AND CONVENIENCE.

- Fully Electronic • Digital Readout • Instant Taring
- No Weight Dialing • Portable

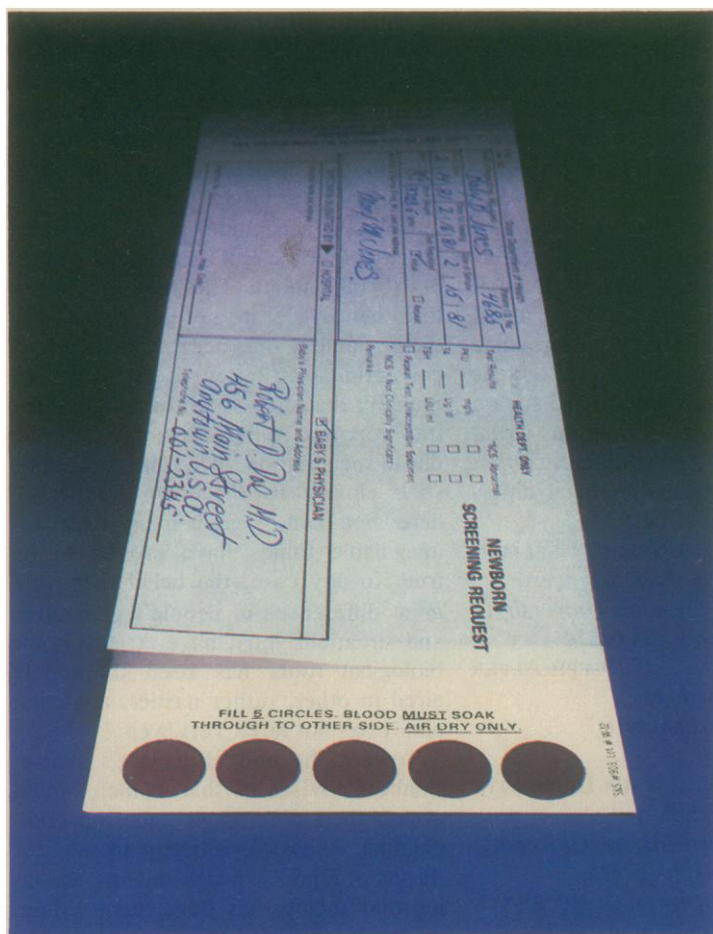
These microprocessor-equipped Sartorius Electronic Balances are as compact as top-loaders, yet as accurate as analyticals.

Model 1602MP (left) weighs 160g to 0.1mg; Model 1207MP (right) weighs 80g to 0.1mg. Operation is completely automatic; there are no weights to 'dial in' and no suspended 'swinging' pan. Far smaller and lighter than comparable analytical balances, these models may easily be moved to any weighing location as needed.

Sartorius... those remarkable yellow balances. For literature, write: Sartorius Division, Brinkmann Instruments, Inc., Subsidiary of Sybron Corp., Cantiague Road, Westbury, NY 11590, or call 516/334-7500.

For information circle No. 110 on Readers' Service Card
For a demonstration circle No. 111 on Readers' Service Card

sartorius



A SAMPLE OF OUR PAPERWORK- S&S #903

S&S #903™ specimen collection paper is quickly becoming the most widely accepted medium for the collection and transport of nearly all body fluid samples. This versatile paper is used in screening tests for PKU, neonatal T₄ and TSH, sickle cell anemia, maple syrup urine disease, hypothyroidism, Duchenne muscular dystrophy, and other metabolic disorders.

Name your requirement. S&S #903 paper can be custom-cut and printed to your specifications, just as it's prepared for public health facilities, private laboratories, and diagnostic kit manufacturers, nationwide. As with all S&S products, it's designed and made to meet your unique needs.

Schleicher & Schuell has the experience, capabilities, and resources to draw on a large line of standard products for special requirements or to convert an innovative concept into a functioning reality. After all, that's *exactly* what S&S has been doing for 400 years!

In separation technology, Schleicher & Schuell is the natural choice for the original instrument, kit or equipment manufacturer. Send for our complete new catalog, "Innovative Products for Separation Science."

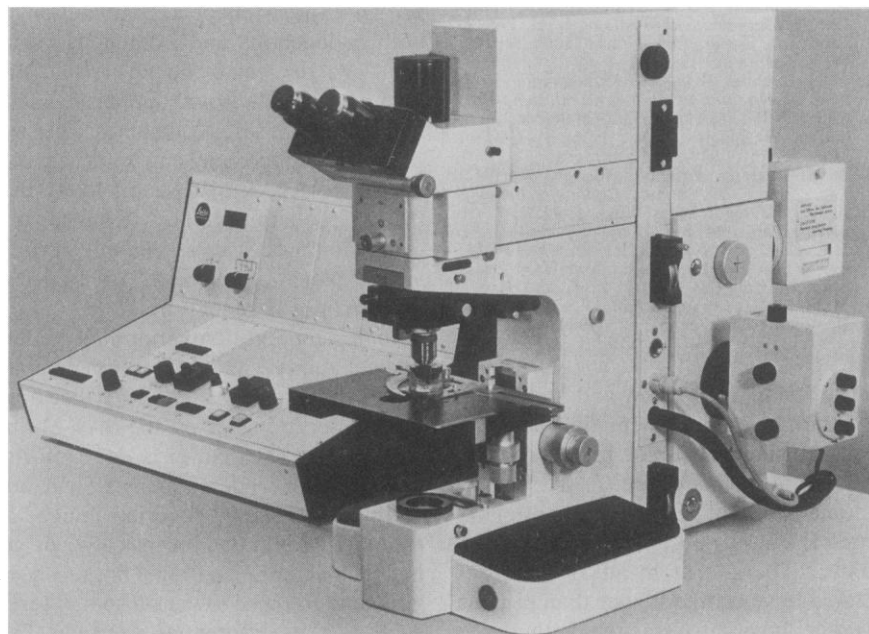
Circle No. 135 on Readers' Service Card

Schleicher & Schuell
Innovators in Separation Science

Schleicher & Schuell, Inc., 543 Washington Street, Keene, N.H. 03431. Phone: (603) 352-3810
Schleicher & Schüll GmbH, D-3354 Dassel Kr. Einbeck, West Germany • Schleicher & Schüll AG, CH-8714 Feldbach ZH, Switzerland

"Visit us at FASEB Booth # H33 and H35"

Leitz MPV-3 Microscope Photometer. Unlimited modularity for unlimited versatility.



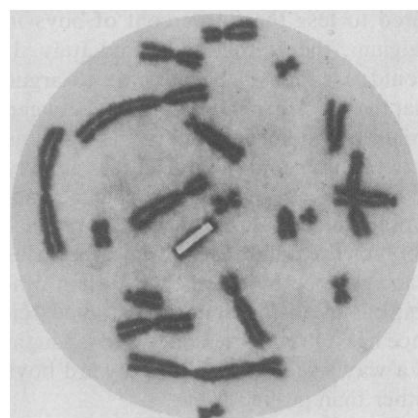
Leitz has been building Microscope Photometers for over half a century. This expertise, combined with our practical experience in user applications, has brought us to the third generation of Modular Photometer Systems, the MPV-3. Now the art of light measurement in the microscope image is so refined that photometric analysis on as small as $\frac{1}{2}$ μm -size structures can be performed routinely.

The MPV-3 incorporates many new innovations and system components. And it is built around the Leitz Orthoplan® Research Microscope. **Unlimited modularity**

There are rapidly interchangeable photometer heads that accommodate both emission spectral and X-Y mirror scanning. Of course, all static measurements such as absorption, autoradiography and fluorescence analysis are within the range of the basic

MPV-3 abilities.

The MPV-3 lets you mask image details with a variable or fixed diaphragm projected in the observation tube. A motorized prism rotates to align masks and specimen structures. Everything seen can be photographed. The problem of fluorescence fading is eliminated by pulsed shutters.



A built-in peakreader analyzes the fluorescence pulses. An optional (digitally controlled)

illumination monochromator, plus various range and speed scanning stages, and a large selection of illuminators and optics, round out the program.

The control console allows automatic measurement sequences and accepts add-on modules for electronic shutter control, CCTV, data printer, and monochromator and scanning stage controls. Interfaces, digital and analog outputs on the MPV-3 connect to data processing equipment.

Unlimited applications

The range of biomedical applications extends from integral absorption measurement on quantitatively stained cells to extinction pattern analysis of scanned structures. From automated silver grain counting in autoradiography to fast spectral analysis of fading fluorescence or histogramming of intensities of fluorescent detail.

Send in the coupon, we'll tell you more.



**Leitz
means precision.
Worldwide.**

E. Leitz® Inc.
Rockleigh, N.J. 07647

S 410

Please tell me more about
the Leitz MPV-3 photometer.

NAME _____

INSTITUTION _____

ADDRESS _____

CITY _____

STATE _____

ZIP _____

Amoco is using America's greatest resource to increase oil and natural gas production today.

The creativity and ingenuity that made America the world's most productive innovator is at work at Amoco. Using the latest technology in almost every physical science, Amoco researchers are working on the energy America will need in the year 2000.

In our Naperville, Illinois laboratories, microbiologists are finding ways to use energy stored in simple plant life. Solid state physicists are investigating the

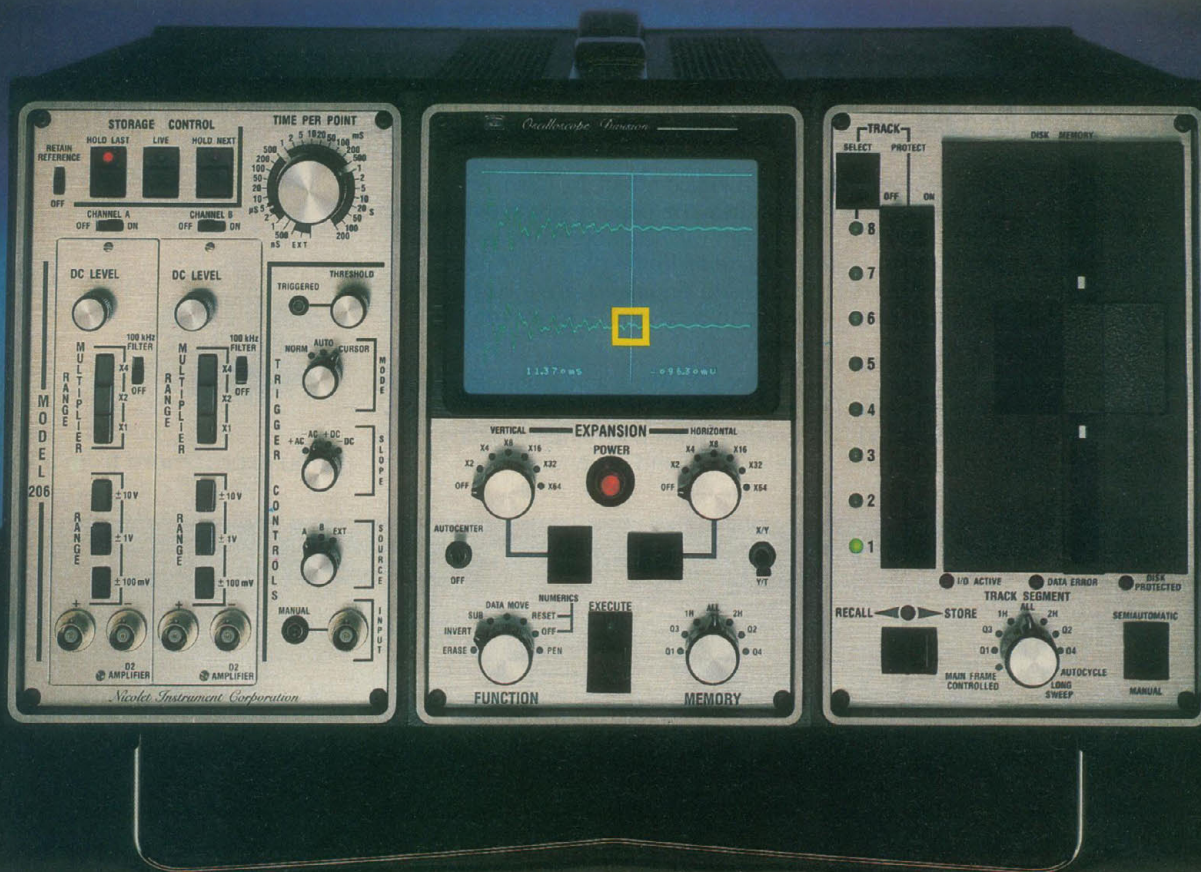
photovoltaic effect. In Tulsa, Amoco scientists are exploring ways to extract oil from the most complex geological formations in the country. And in Colorado, engineers are investigating ways to recover the oil locked in shale.

Amoco scientists and technologists are dedicated to the search for the energy needed to keep America growing in the year 2000 and beyond.



You expect more from a leader.

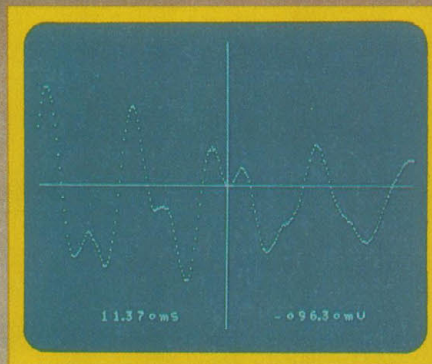




*See things
you've never seen before.*

Nicolet digital oscilloscopes offer you resolution, precision, dynamic range and transient capture capabilities unobtainable on analog oscilloscopes. *They are simple to operate and yet extremely versatile.*

Signals can be viewed live, continuously compared to a reference waveform or stored for detailed examination. Continuous, normal and pre-trigger operation are offered as standard and in all modes cursor-interactive time and voltage coordinates can be displayed concurrently with the signal. Stored waveforms can be displayed or plotted in XY or YT format, transferred to internal disk memory for permanent storage or output to other



Expansion of selected area in above photo, for detailed analysis.



computing devices via industry standard interfaces.

In addition to offering you the performance you would expect from the industry leader, Nicolet digital oscilloscopes are extremely well proven with thousands in effective use throughout the world.

Find out how Nicolet can help you solve problems and see things you've never seen before.

For more information, simply circle the reader service card or call 608/271-3333. Or write: Nicolet Instrument Corporation, 5225 Verona Road, Madison, Wisconsin 53711.



**NICOLET
INSTRUMENT
CORPORATION**
OSCILLOSCOPE DIVISION
Sales and Service Offices Worldwide

Circle No. 114 on Readers' Service Card

Digital
Nicolet Oscilloscopes

THE LEADING EDGE

#1 in a series of reports on new technology from Xerox

About a year ago, Xerox introduced the Ethernet network—a pioneering new development that makes it possible to link different office machines into a single network that's reliable, flexible and easily expandable.

The following are some notes explaining the technological underpinnings of this development. They are contributed by Xerox research scientist David Boggs.

The Ethernet system was designed to meet several rather ambitious objectives.

First, it had to allow many users within a given organization to access the same data. Next, it had to allow the organization the economies that come from resource sharing; that is, if several people could share the same information processing equipment, it would cut down on the amount and expense of hardware needed. In addition, the resulting network had to be flexible; users had to be able to change components easily so the network could grow smoothly as new capability was needed. Finally, it had to have maximum reliability—a system based on the notion of shared information would look pretty silly if users couldn't get at the information because the network was broken.

Collision Detection

The Ethernet network uses a coaxial cable to connect various pieces of information equipment. Information travels over the cable in packets which are sent from one machine to another.

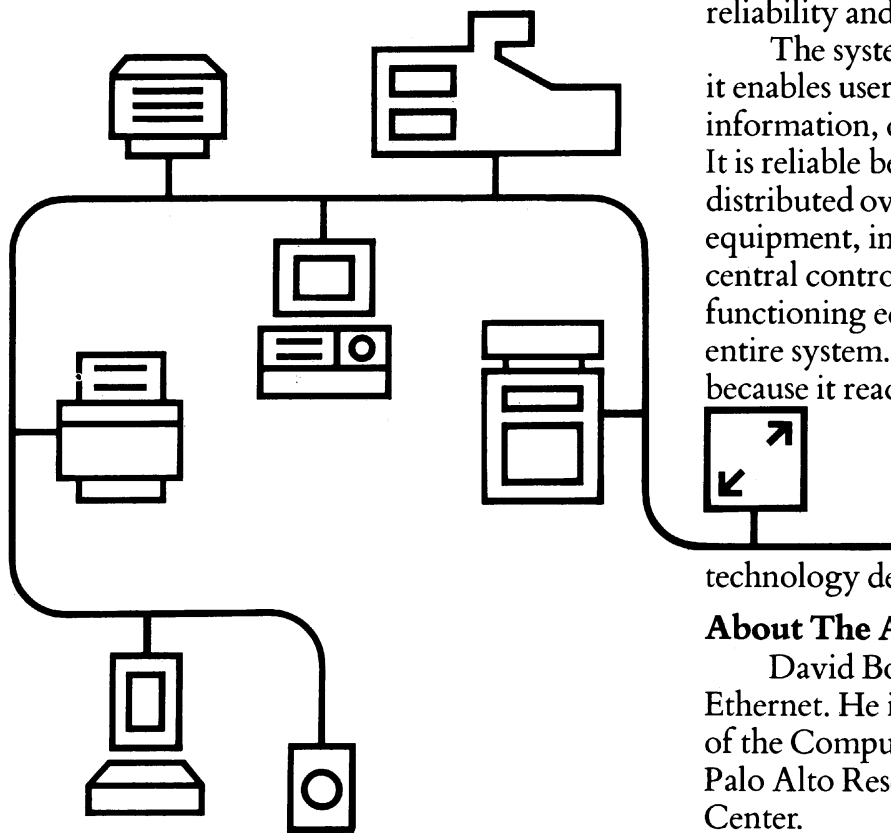
A key problem in any system of this type is how to control access to the cable: what are the rules determining when a piece of equipment can talk? Ethernet's method resembles the unwritten rules used by people at a party to decide who gets to tell the next story.

While someone is speaking, everyone else waits. When the current speaker stops, those who want to say something pause, and then launch into their speeches. If they *collide* with each other (hear someone else talking, too), they all stop and wait to start up again. Eventually one pauses the shortest time and starts talking so soon that everyone else hears him and waits.

When a piece of equipment wants to use the Ethernet cable, it listens first to hear if any other station is talking. When it hears silence on the cable, the station starts talking, but it also listens. If it hears other stations sending too, it stops, as do the other stations. Then it waits a

random amount of time, on the order of microseconds, and tries again. The more times a station collides, the longer, on the average, it waits before trying again.

In the technical literature, this technique is called carrier-sense multiple-access with collision detection. It is a modification of a method developed by researchers at the University of Hawaii and further refined by my colleague Dr. Robert Metcalfe. As long as the interval during which stations elbow each other for control of the cable is short relative to the interval during which the winner uses the cable, it is very efficient. Just as important, it requires no central



control—there is no distinguished station to break or become overloaded.

The System

With the foregoing problems solved, Ethernet was ready for introduction. It consists of a few relatively simple components:

Ether. This is the cable referred to earlier. Since it consists of just copper and plastic, its reliability is high and its cost is low.

Transceivers. These are small boxes that insert and extract bits of information as they pass by on the cable.

Controllers. These are large scale integrated circuit chips which enable all sorts of equipment, from communicating typewriters to mainframe computers, regardless of the manufacturer, to connect to the Ethernet.

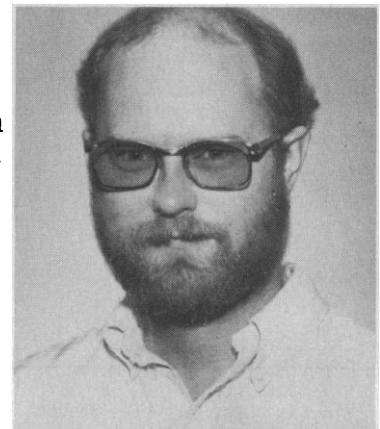
The resulting system is not only fast (transmitting millions of bits of information per second), it's essentially modular in design. It's largely because of this modularity that Ethernet succeeds in meeting its objectives of economy, reliability and expandability.

The system is economical simply because it enables users to share both equipment and information, cutting down on hardware costs. It is reliable because control of the system is distributed over many pieces of communicating equipment, instead of being vested in a single central controller where a single piece of malfunctioning equipment can immobilize an entire system. And Ethernet is expandable because it readily accepts new pieces of information processing equipment. This enables an organization to plug in new machines gradually, as its needs dictate, or as technology develops new and better ones.

About The Author

David Boggs is one of the inventors of Ethernet. He is a member of the research staff of the Computer Science Laboratory at Xerox's Palo Alto Research Center.

He holds a Bachelor's degree in Electrical Engineering from Princeton University and a Master's degree from Stanford University, where he is currently pursuing a Ph.D.



XEROX

XEROX® and Ethernet are trademarks of XEROX CORPORATION.

EM-109: the specimen saver.

New design keeps high performance (3.44Å) with 3 unique systems.

1. Unique camera system, totally outside the vacuum—the **TFP** Trans-Fiberoptic-Photographic System. Changing film is like reloading your own camera.

2. Unique automatic focusing system for maximum specimen protection—the **MDF** Micro-Dose-Focusing System. Focusing has never been so easy, so automatic, so specimen-saving.

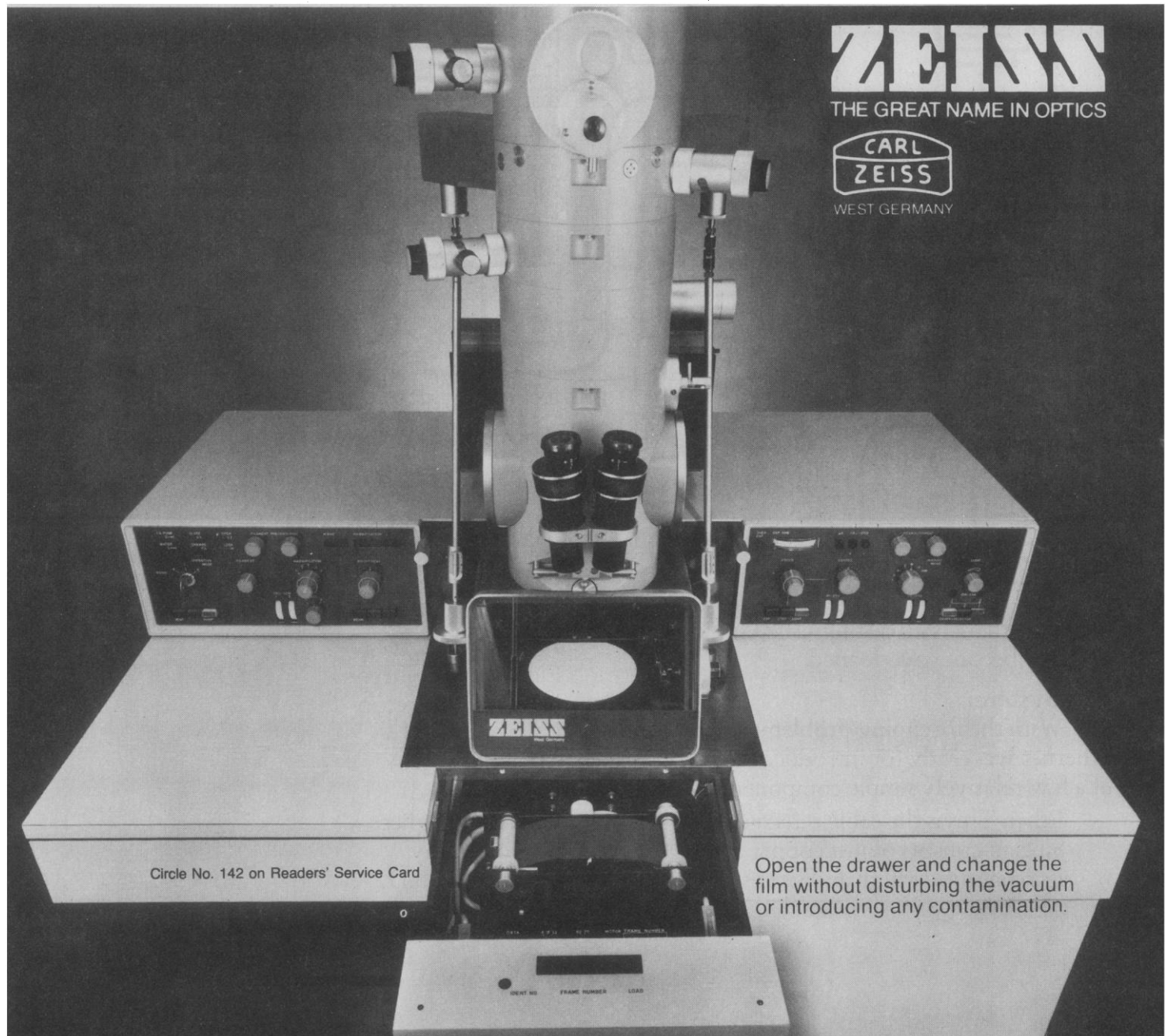
3. Unique vacuum system for ultra-clean specimen conditions—the **IGP** Ion-Getter Pumping System. The EM-109 is always ready for use, instantly.

TFP, MDF, IGP—a lot of letters, but they spell "Specimen Saver," the new EM-109 Electron Microscope from Zeiss.

Call or write today for the detailed catalog that explains these unique systems in full.

Nationwide Service

Carl Zeiss, Inc., 444 5th Avenue, New York, N.Y. 10018 (212) 730-4400. Branches: Atlanta, Boston, Chicago, Houston, Los Angeles, San Francisco, Washington, D.C. in Canada: 45 Valleybrook Drive, Don Mills, Ontario, M3B 2S6. Or call (416) 449-4660.



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.

Editorial Board

1981: PETER BELL, BRYCE CRAWFORD, JR., E. PETER GEIDUSCHEK, EMIL W. HAURY, SALLY GREGORY KOHLSTEDT, MANCUR OLSON, PETER H. RAVEN, WILLIAM P. SLICHTER, FREDERIC G. WORDEN

1982: WILLIAM ESTES, CLEMENT L. MARKERT, JOHN R. PIERCE, BRYANT W. ROSSITER, VERA C. RUBIN, MAXINE F. SINGER, PAUL E. WAGGONER, ALEXANDER ZUCKER

Publisher

WILLIAM D. CAREY

Editor

PHILIP H. ABELSON

Editorial Staff

Managing Editor

ROBERT V. ORMES

Assistant Managing Editor

JOHN E. RINGLE

News Editor: BARBARA J. CULLITON

News and Comment: WILLIAM J. BROAD, LUTHER J. CARTER, CONSTANCE HOLDEN, ELIOT MARSHALL, COLIN NORMAN, R. JEFFREY SMITH, MARJORIE SUN, NICHOLAS WADE, JOHN WALSH

Research News: RICHARD A. KERR, GINA BARI KOLATA, ROGER LEWIN, JEAN L. MARX, THOMAS H. MAUGH II, ARTHUR L. ROBINSON, M. MITCHELL WALDROP

Administrative Assistant, News: SCHERRAINE MACK;
Editorial Assistants, News: FANNIE GROOM, CASSANDRA WATTS

Senior Editors: ELEANORE BUTZ, MARY DORFMAN, RUTH KULSTAD

Associate Editors: SYLVIA EBERHART, CAITILIN GORDON, LOIS SCHMITT

Assistant Editors: MARTHA COLLINS, STEPHEN KEPPEL, EDITH MEYERS

Book Reviews: KATHERINE LIVINGSTON, *Editor:* LINDA HEISERMAN, JANET KEGG

Letters: CHRISTINE GILBERT

Copy Editor: ISABELLA BOULDIN

Production: NANCY HARTNAGEL, JOHN BAKER; ROSE LOWERY; HOLLY BISHOP, ELEANOR WARNER; MARY MCDANIEL, JEAN ROCKWOOD, LEAH RYAN, SHARON RYAN

Covers, Reprints, and Permissions: GRAYCE FINGER, *Editor:* GERALDINE CRUMP, CORRINE HARRIS

Guide to Scientific Instruments: RICHARD G. SOMMER
Assistants to the Editors: SUSAN ELLIOTT, DIANE HOLLAND

Membership Recruitment: GWENDOLYN HUDDLE

Member and Subscription Records: ANN RAGLAND
EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321. Cable: Advancesci, Washington. For "Information for Contributors," write to the editorial office or see page xi, *Science*, 27 March 1981.

BUSINESS CORRESPONDENCE: Area Code 202. Membership and Subscriptions: 467-4417.

Advertising Representatives

Director: EARL J. SCHERAGO

Production Manager: GINA REILLY

Advertising Sales Manager: RICHARD L. CHARLES

Marketing Manager: HERBERT L. BURKLUND

Sales: NEW YORK, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); SCOTCH PLAINS, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); CHICAGO, ILL. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-337-4973); BEVERLY HILLS, CALIF. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); DORSET, VT. 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581).

ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York, N.Y. 10036. Phone: 212-730-1050.

Voyager Mission to Saturn

Voyager 1 made its closest approach to Saturn on 12 November 1980. On that day, the mission control center at Jet Propulsion Laboratory was the focus of intense worldwide attention. Interest in the Voyager mission to Saturn approached that accorded the first manned lunar landing. This issue contains the first set of scientific reports from the flyby of the planet, its many satellites, and its rings.

The Saturn system is a frigid mysterious world nearly 1.6 billion kilometers (1 billion miles) from Earth. Per unit area, it receives about 1 percent as much sunlight as does Earth. Spacecraft visiting it must be prepared to withstand extreme cold, to operate semi-autonomously, and to convey messages to and receive messages from Earth.

Saturn has a mass 95 times that of Earth. It has an atmosphere that consists mainly of hydrogen, with helium (approximately 11 percent) the next most abundant component. Methane, ammonia, ethane, ethylene, acetylene, and phosphine have also been detected. The temperature decreases from 150 K in the upper atmosphere to a minimum of about 85 K at a pressure of 100 millibars and then increases to about 160 K at 1.4 bars. The planet is obscured by clouds, which move at velocities that are a function of latitude. Eastward wind speeds near the equator as high as 480 meters per second (1100 miles per hour) were observed.

One of the major objectives of the Voyager mission was to gather information about Saturn's satellites. There are 15 of them, including three that were discovered during the flyby. Titan, the largest of the group, is the second largest satellite in the solar system (Jupiter's Ganymede is first) and the only one known to possess a substantial atmosphere. Although it is covered with clouds and haze, Voyager experimenters were able to determine its diameter (5140 kilometers). Using this datum and the mass, they calculated Titan's density to be 1.9, which corresponds to a 50:50 mix of rock and water ice. The atmospheric pressure at the surface of Titan is 1.6 bars and the temperature approximately 93 K. Nitrogen is the main constituent of the atmosphere, with methane next in abundance. At the conditions on the surface of Titan, gaseous, liquid, or solid methane might be present. The other satellites were not obscured by clouds. They were covered with water ice and in some cases are composed mainly of water ice. A striking feature of Mimas is a crater roughly 130 kilometers in diameter. Craters were also observed on most of the other satellites.

Saturn's rings were found to have a far more complex structure than predicted. They consist mainly of water ice. Voyager 1 results indicate that the A and C rings contain particles with effective diameters of 10 and 2 meters, respectively. The Cassini division, a classical ring element separating the A and B rings, itself contains five broad rings with substructure. The F ring has an unusual morphology, with two components that appear kinked and braided.

The foregoing paragraphs mention only a fraction of the information now available about the Saturn system. Moreover, only part of the experimental data has been analyzed thus far. When analysis is complete, a very substantial body of facts will be added. For centuries scientists have attempted to answer three major questions about the solar system: How did it originate? How did it evolve? and How does it operate today? The information gathered with manned and unmanned spacecraft greatly limits the range of permissible speculation. A theory that covers the origin and evolution of the solar system will illuminate processes that have occurred on Earth. Data about atmospheric motions on Earth, Mars, Jupiter, and Saturn will be used to test models of global circulation.

The Voyager 1 mission to Saturn has been another great success in a long series of U.S. exploits in space. The engineers, scientists, and technicians involved in the era of space exploration can take pride in their work. They have participated in one of humanity's greatest achievements.

—PHILLIP H. ABELSON

ANOTHER TECHNOLOGICAL ADVANCE FROM SHARP.

MURPHY'S LAW DEFIED.

"If anything can go wrong, it will" and usually does, especially when you're entering an equation into a calculator.

Until now, you may have been using the error-prone procedure of encoding and decoding the steps of an assembly code. The Sharp 5100 Scientific Calculator eliminates this needless procedure. It's the first programmable calculator that allows you to enter directly, using algebraic, logarithmic, exponential and other functions in their familiar form.

That's Murphy's Law defied.

The 5100 is also the first hand-held to give you a complete display of the equation: you see 24 characters at a time in a dot-matrix display that rolls right or left to accommodate one or more formulas of up to 80 steps. So that while other programmable calculators display only one *program step* at a time, the 5100 displays the actual equation in its entirety, and in the way you're accustomed to seeing it.

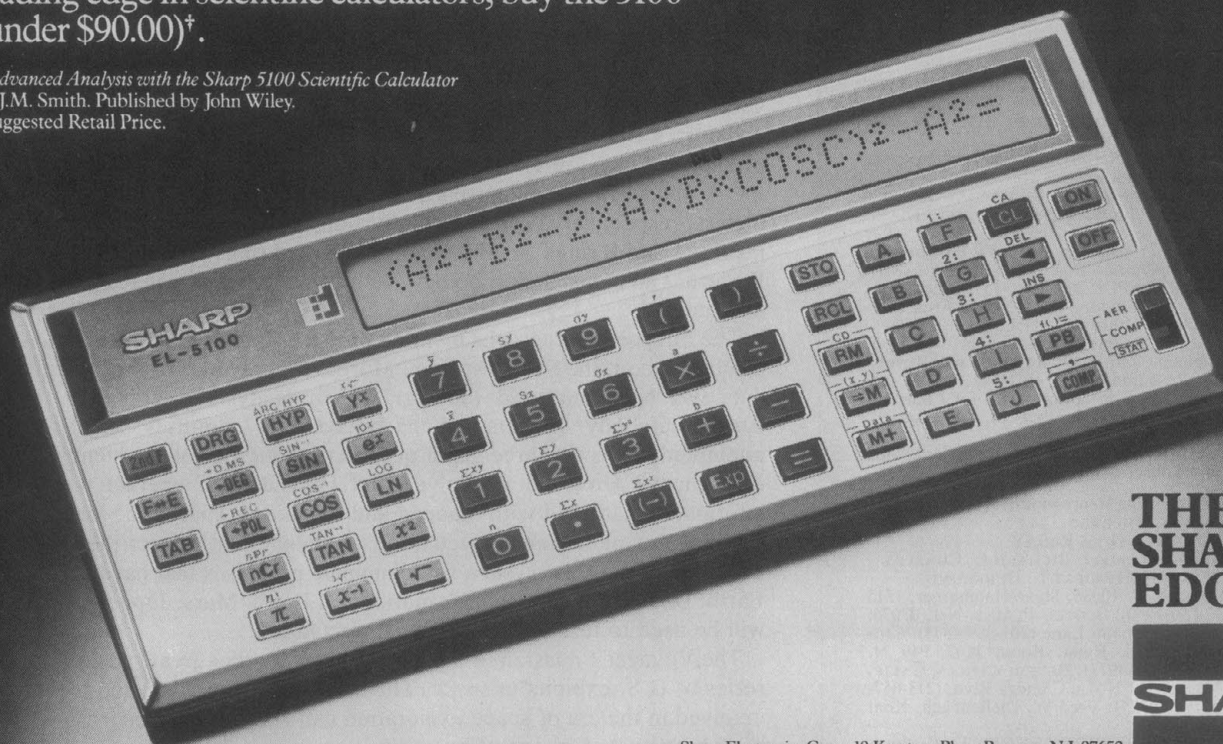
If, anywhere along the line, you've entered an incorrect character (Murphy's Law at work), the display makes it easy for you to spot. You can then move the 5100's computer-like cursor to any part of the display to correct it.

In addition to the fast solution of frequently used formulas, the 5100 is extremely convenient for deriving difference tables, performing data analysis, numerical integration, simulations of linear systems, statistical and probability calculations, and many other procedures. It has so many uses, it would take a book to fully describe them, and someone has even written one.*

Sharp offers you a complete line of highly advanced scientifics, and if you want the leading edge in scientific calculators, buy the 5100 (under \$90.00)*.

*Advanced Analysis with the Sharp 5100 Scientific Calculator
by J.M. Smith. Published by John Wiley.

*Suggested Retail Price.



**THE
SHARP
EDGE**



Sharp Electronics Corp., 10 Keystone Place, Paramus, N.J. 07652

Circle No. 151 on Readers' Service Card