13 October 1978 • Vol. 202 • No. 4364

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SCIENCE

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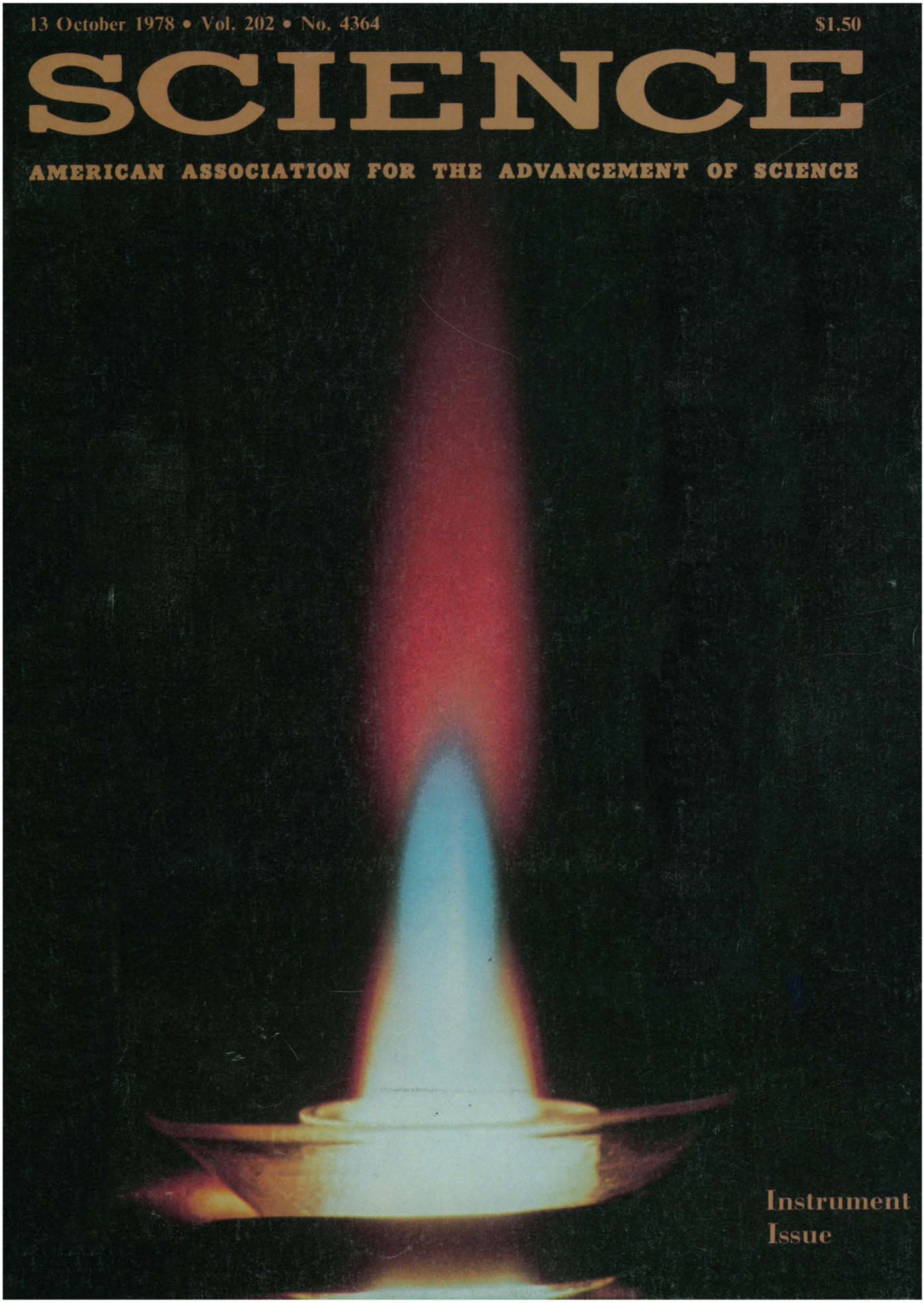
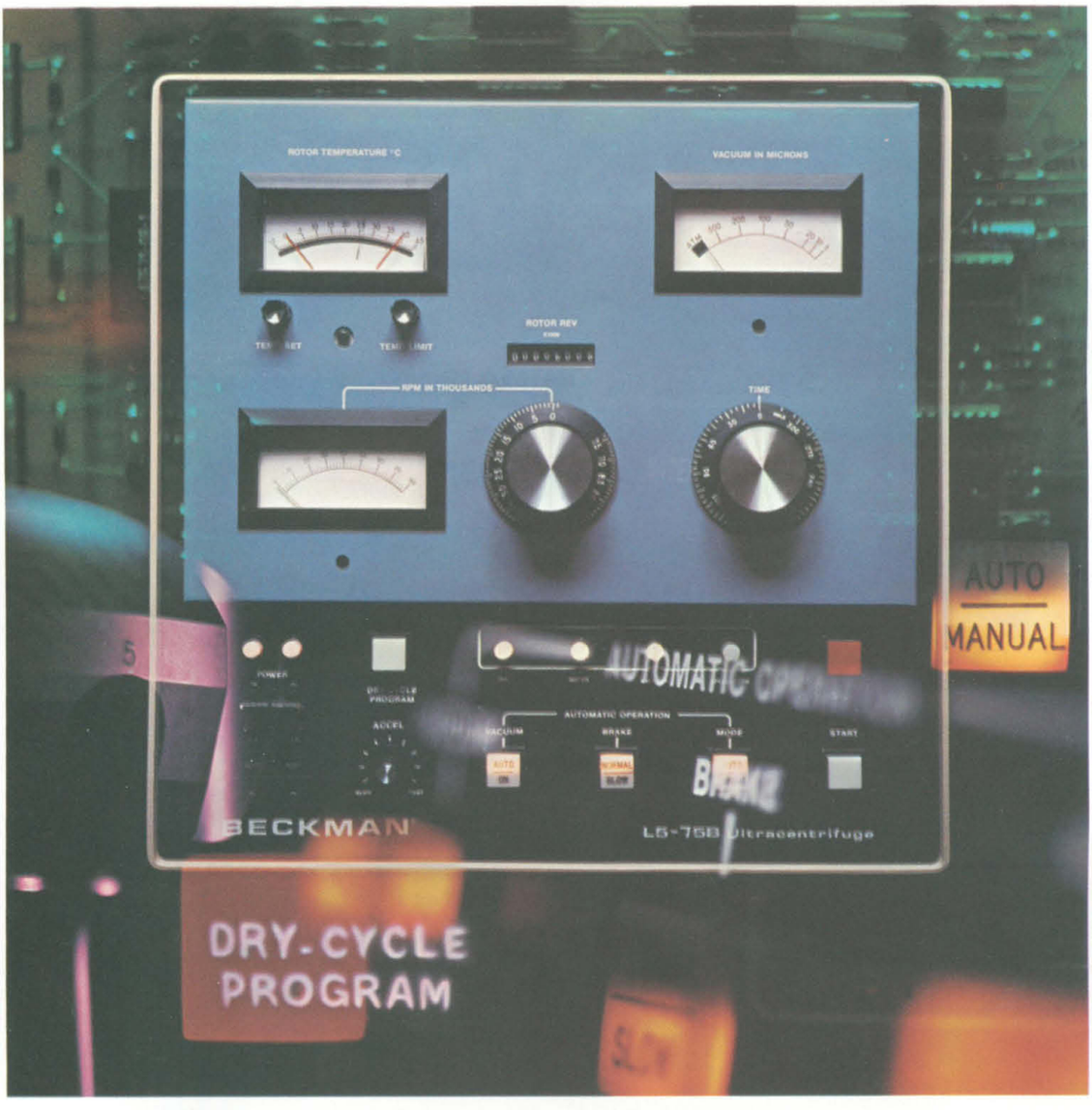


Instrument Issue



New L-5B Ultracentrifuges with Dry Cycle, Automatic/Manual Operation, 0 to 40°C Capability, and 8 Billion Revolution Drive.

The new Beckman Model L-5B ultracentrifuges have improvements you'll readily appreciate. They will save you time in the Automatic mode—yet give you the flexibility of manual operation whenever you wish.

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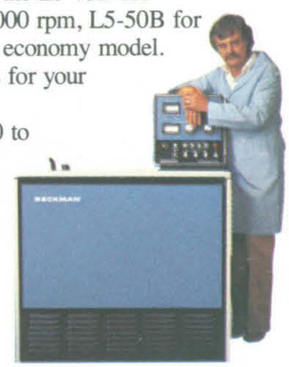

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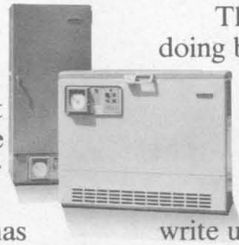

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13 October 1978

Volume 202, No. 4364

SCIENCE

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

Passage of an aerosol of a solution containing the element yttrium through the plasma. Atomization occurs in the white fireball. The blue "diamond" shows the emission of the cloud of yttrium atoms. As air diffuses into the tail flame, yttrium oxide molecules are formed, and their band emission is in the red region of the spectrum. See page 183. [Iowa State University Photo Service]

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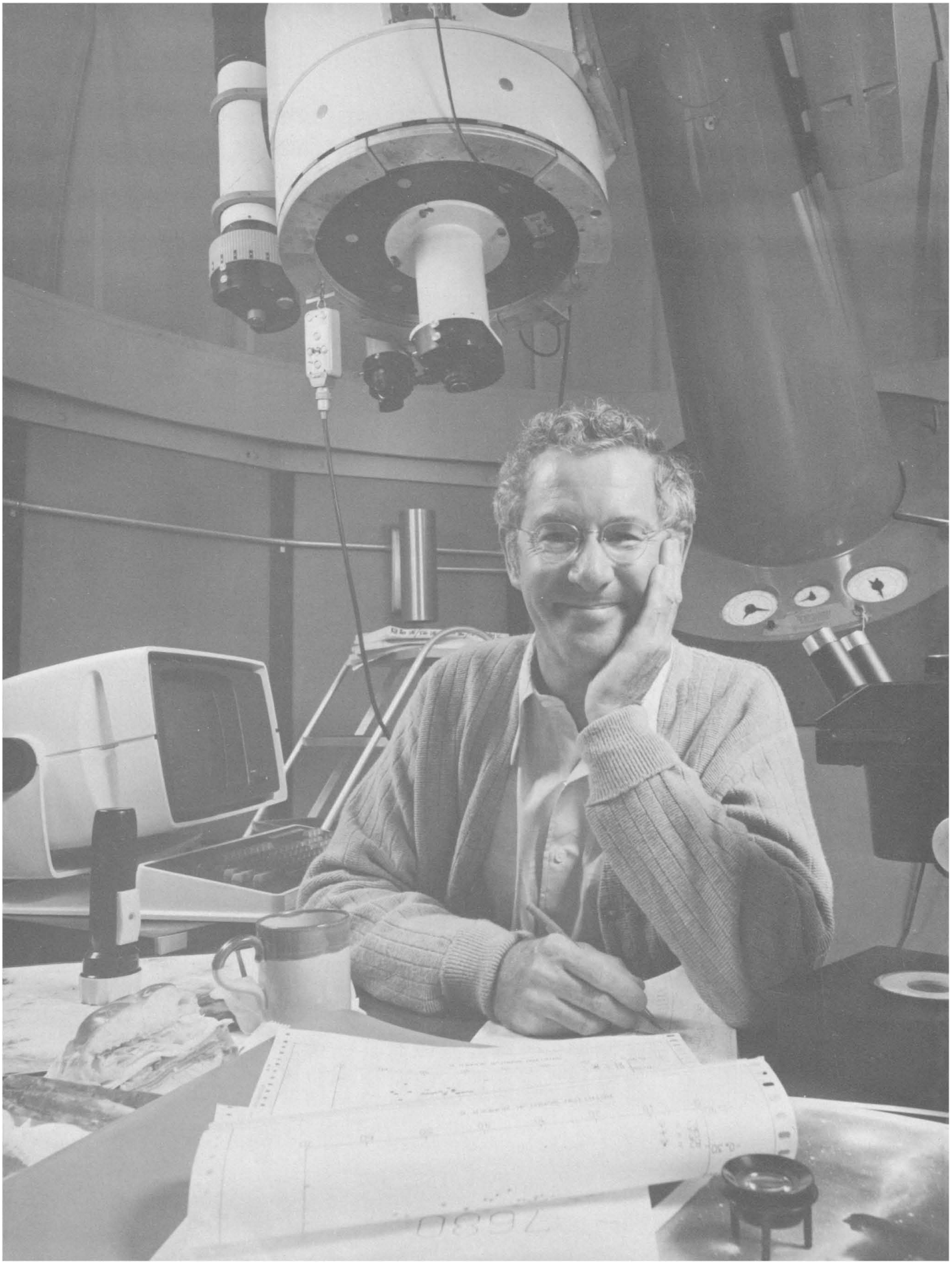

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Each of us—policymaker, physician, technician,and lay person—controls a sizable portion of the entire picture. HEALTH CARE: REGULATION, ECONOMICS, ETHICS, PRACTICE helps define and clarify the many pieces of the health care puzzle.

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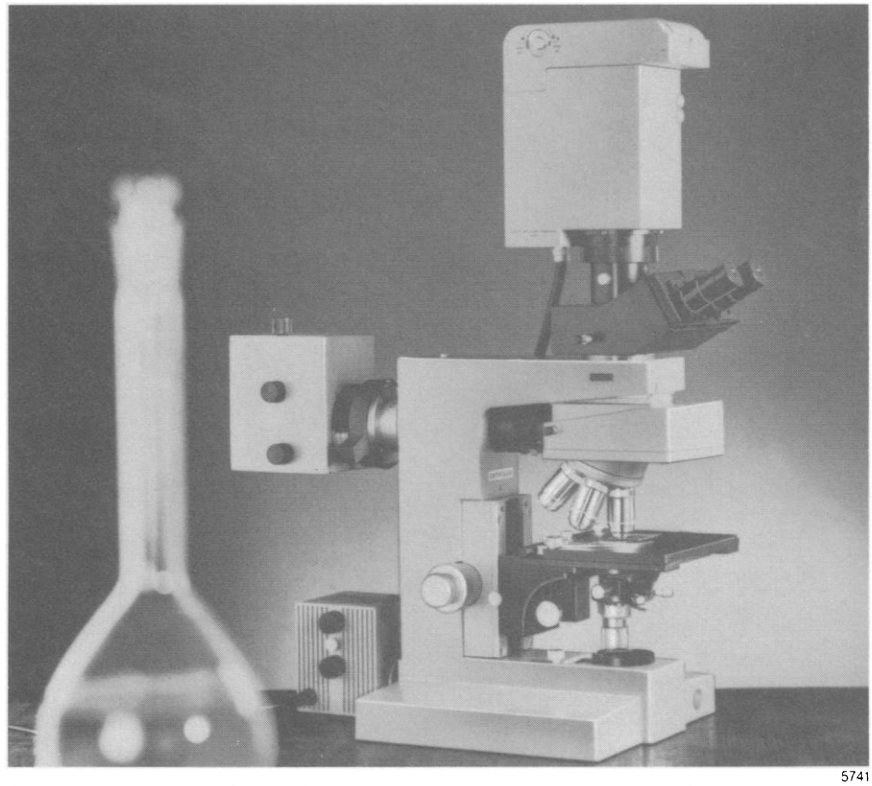
Modular filter system.

Entire filter systems consisting of exciter and barrier filters are now contained in one module. One can quickly be switched to three others or



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interchanged against other application-specific modules, Leitz features eighteen in all.

And the elimination of the darkfield condenser by using incident light fluorescence adds convenience and improves the brightness of the fluorescence image.

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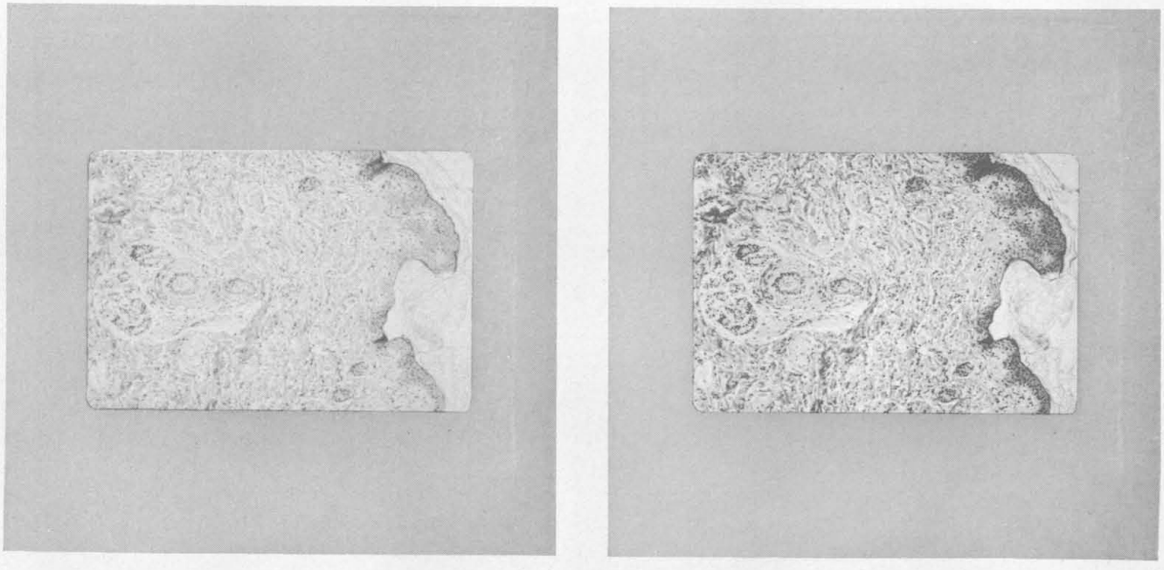

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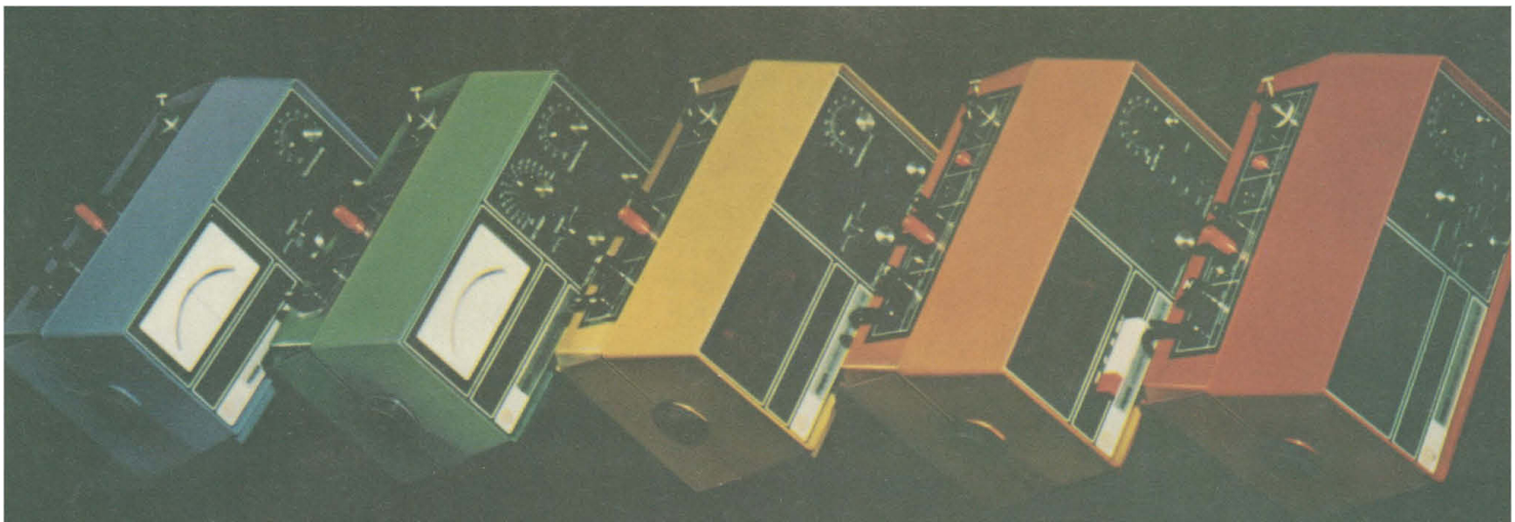

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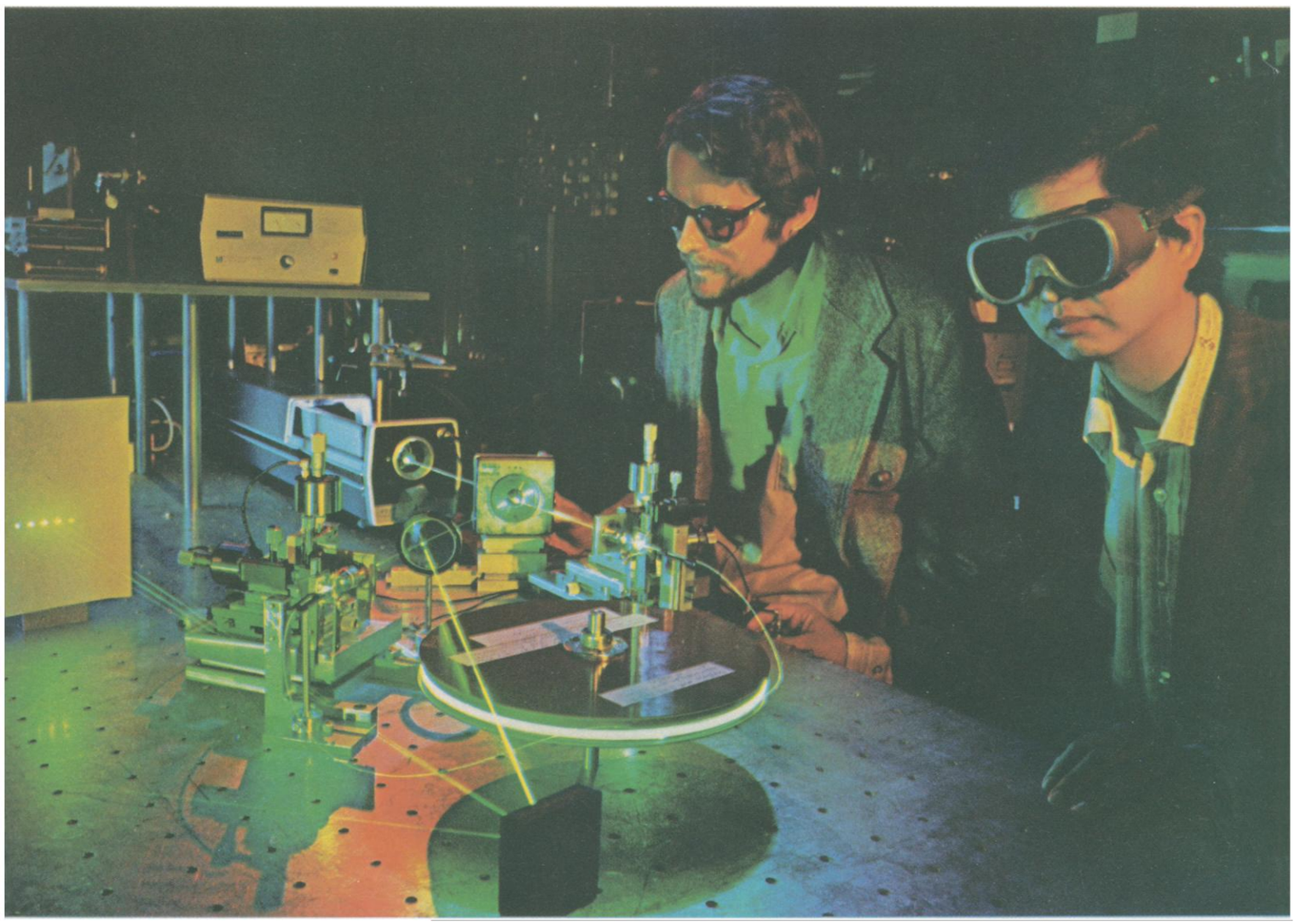

Bell Laboratories
Murray Hill, New Jersey 07974

Bell Labs scientists Roger Stolen and Chinlon Lin work with a fiber Raman laser, one of a new class of light sources that use optical fibers—up to a kilometer long—to produce tunable laser light. At left, the laser's output—which contains multiple Raman-shifted wavelengths—is taken off a beam splitter and dispersed by an external grating to show the broad range of wavelengths that can be tuned.

Bell Labs has developed some of the world's most transparent glass fibers to *carry* light for communications. We've also devised a way to make these highly transparent glass fibers *generate* light. In fact, they are the basis for a new class of tunable light sources called fiber Raman lasers. They're among the latest, and by far the longest, of many lasers invented at Bell Labs, beginning in 1957 with the conception of the laser itself.

Since the new fiber lasers work best at wavelengths at which they are most transparent, we can make them very long. The longest active lasing medium ever built, in fact, was a fiber Raman laser over a kilometer in length. Studying the ways light and glass interact over such distances is part of our research in lightwave communications.

In these new light sources, a glass fiber with high transparency and an extremely thin light-guiding region, or core, is excited by a pump laser. The pump light, interacting with the glass, amplifies light at different wavelengths through a phenomenon known as stimulated Raman scattering. This light is fed back into the fiber by a reflecting mirror. If gain exceeds loss, the repetitively amplified light builds up and "lasing" occurs.

Fiber Raman lasers have conversion efficiencies of about 50%, operate in pulsed and continuous wave modes, and are easily tunable over a broad wavelength range in the visible and near infrared regions of the spectrum.

We've used these lasers to measure the properties of fibers and devices for optical communications; and studies of the lasers themselves have revealed a wealth of information on frequency conversion, optical gain, and other phenomena. Such knowledge could lead to a new class of optoelectronic devices made from fibers, and better fibers for communications.

Looking back

These long lasers come from a long line of Bell Labs firsts:

1957: The basic principles of the laser, conceived by Charles Townes, a Bell Labs consultant, and Bell Labs scientist Arthur Schawlow. (They later received the basic laser patent.)

1960: A laser capable of emitting a continuous beam of coherent light—using helium-neon gas; followed in 1962 by the basic visible light helium-neon laser. (More than 200,000 such lasers are now in use worldwide.) Also, a proposal for a semiconductor laser involving injection across a p-n junction to generate coherent light emitted parallel to the junction.

1961: The continuous wave solid-state laser (neodymium-doped calcium tungstate).

1964: The carbon dioxide laser (highest continuous wave power output system known to date); the neodymium-doped yttrium aluminum garnet laser; the continuously operating argon ion laser; the tunable optical parametric oscillator; and the synchronous mode-locking technique, a basic means for generating short and ultrashort pulses.

1967: The continuous wave helium-cadmium laser (utilizing the Penning ionization effect for high efficiency); such lasers are now used in high-speed graphics, biological and medical applications.

1969: The magnetically tunable spin-flip Raman infrared laser, used in high-resolution spectroscopy, and in pollution detection in both the atmosphere and the stratosphere.

1970: Semiconductor heterostructure lasers capable of continuous operation at room temperature.

1971: The distributed feedback laser, a mirror-free laser structure compatible with integrated optics.

1973: The tunable, continuous wave color-center laser.

1974: Optical pulses less than a trillionth of a second long.

1977: Long-life semiconductor lasers for communications. (Such lasers have performed reliably in the Bell System's lightwave communications installation in Chicago.)

Looking ahead

Today, besides our work with tunable fiber Raman lasers, we're using other lasers to unlock new regions of the spectrum in the near infrared (including tunable light sources for communications), the infrared, and the ultraviolet.

We're also looking to extend the tuning range of the free electron laser into the far infrared region—where no convenient sources of tunable radiation exist.

We're working on integrated optics—combinations of lightwave functions on a single chip.

Lasers are helping us understand ultrafast chemical and biological phenomena, such as the initial events in the process of human vision. By shedding new light on chemical reactions, atmospheric impurities, and microscopic defects in solids, lasers are helping us explore materials and processes useful for tomorrow's communications.

Also under investigation is the use of intense laser irradiation in the fabrication of semiconductor devices. The laser light can be used to heat selective areas of the semiconductor and anneal out defects or produce epitaxial crystalline growth. Laser annealing coupled with ion implantation may provide a unique tool for semiconductor processing.

We've played an important part in the discovery and development of the laser—an invention making dramatic improvements in the way our nation lives, works and communicates.

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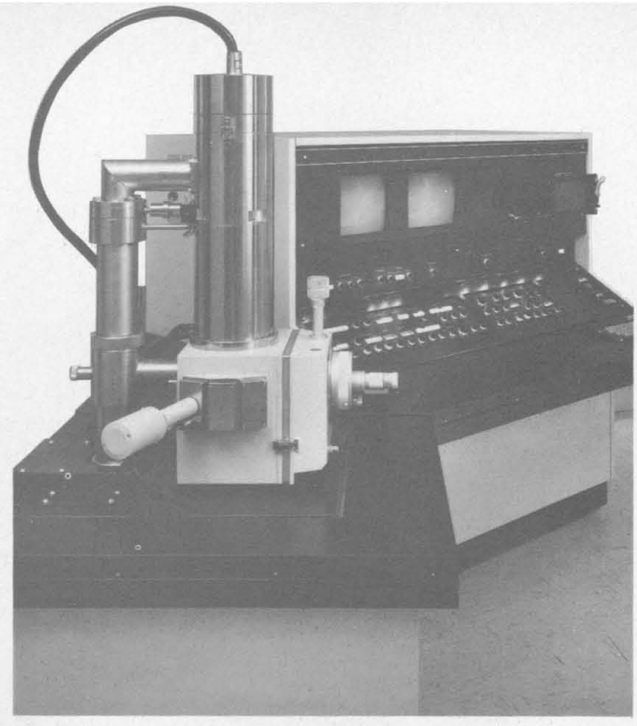

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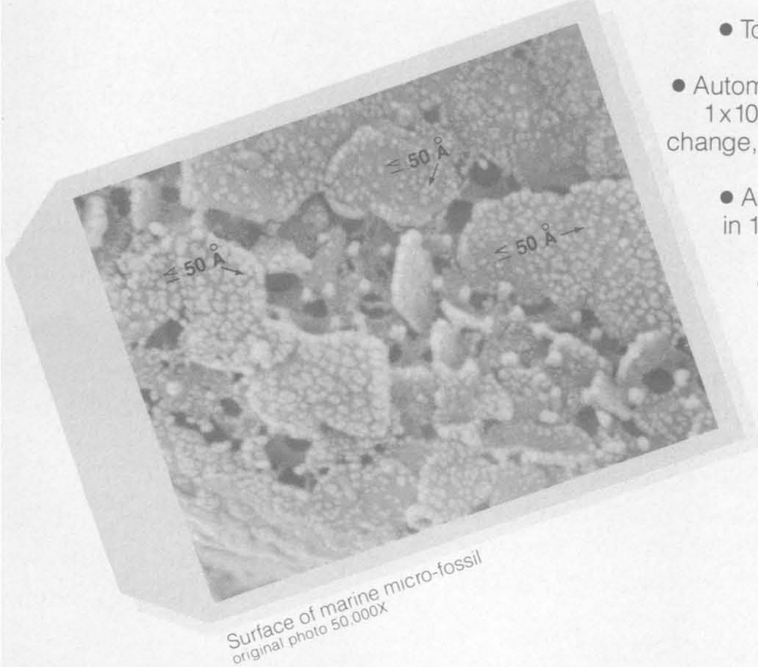

Surface of marine micro-fossil
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See the ISI System-100 at the American Society for Cell Biology November 4-8, 1978. Booths 103-104. San Antonio Convention Center, San Antonio, Texas.

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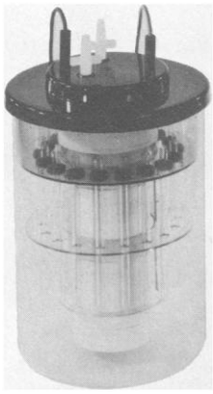
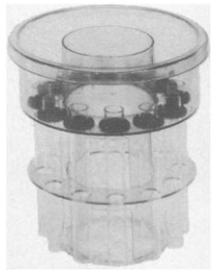
HOEFER SCIENTIFIC INSTRUMENTS





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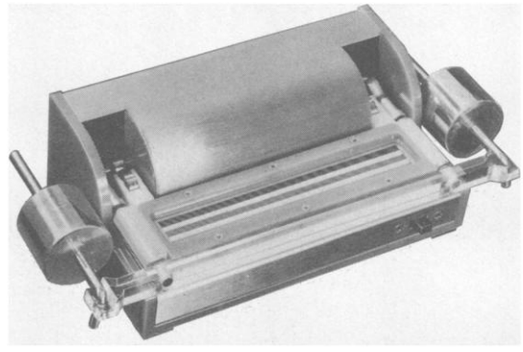

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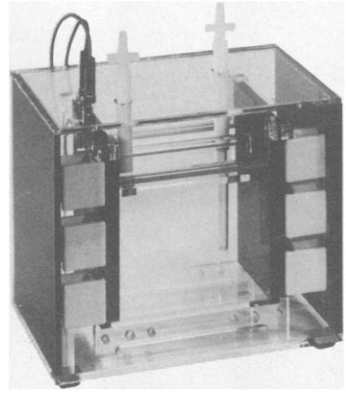
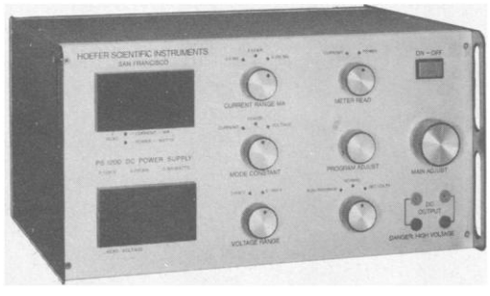
Slice up to 160 one mm segments in one pass—at room temperature. SL 280



Vertical Slab Gel Unit.
10×14 cm slabs. For electrofocusing, 2-D, and preparative work. SE 500



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You can build the Balplan Conference Microscope from your present Balplan or purchase a new Balplan with up to five viewing heads. These are available in 30° and 45° inclined binocular, 30° inclined monocular, and 30° inclined triocular (for photomicrography) units. All viewing heads are interchangeable and rotate a full 360°. If you wish, you may start with a dual-viewing Balplan microscope and later add up to three more viewing heads.

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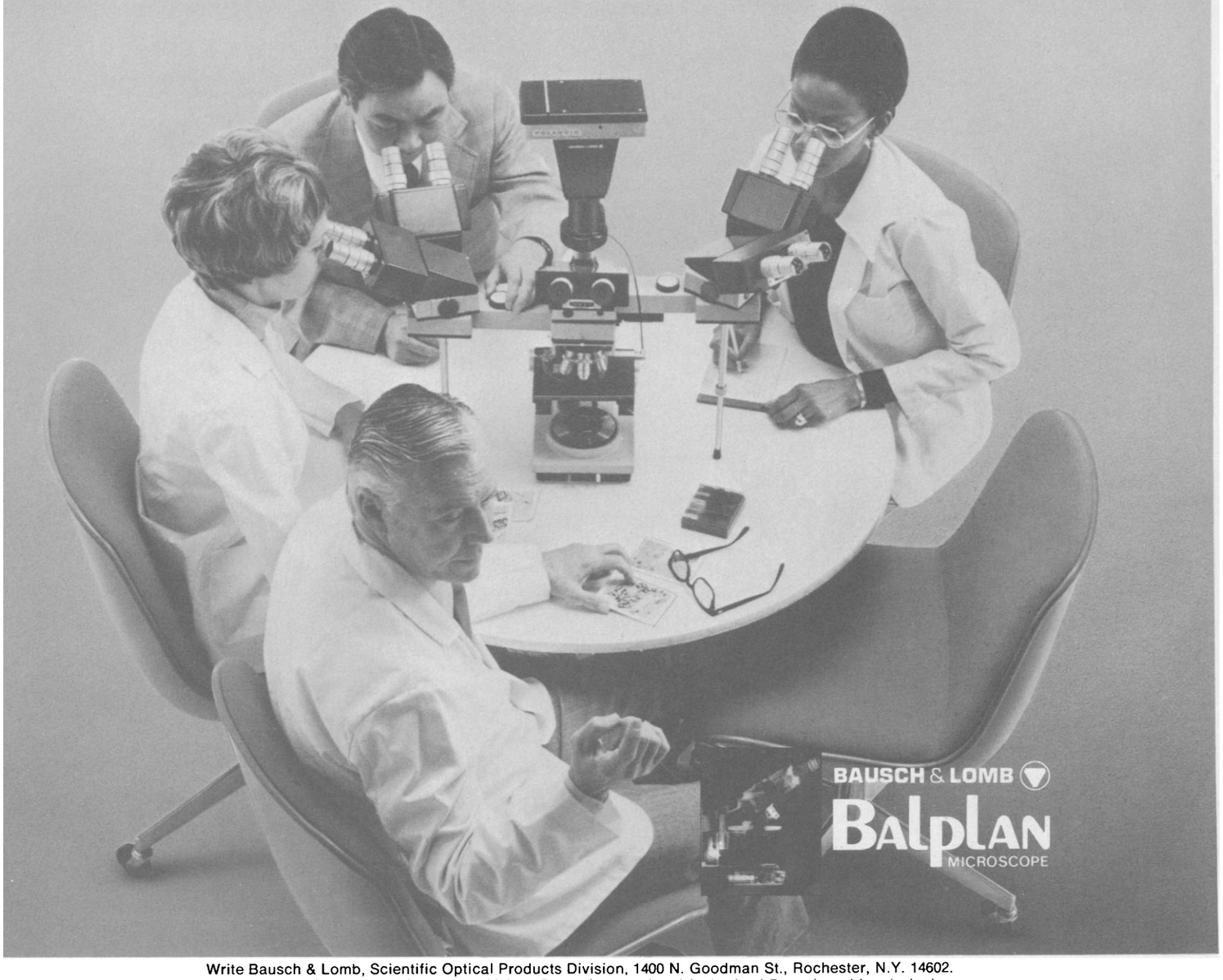

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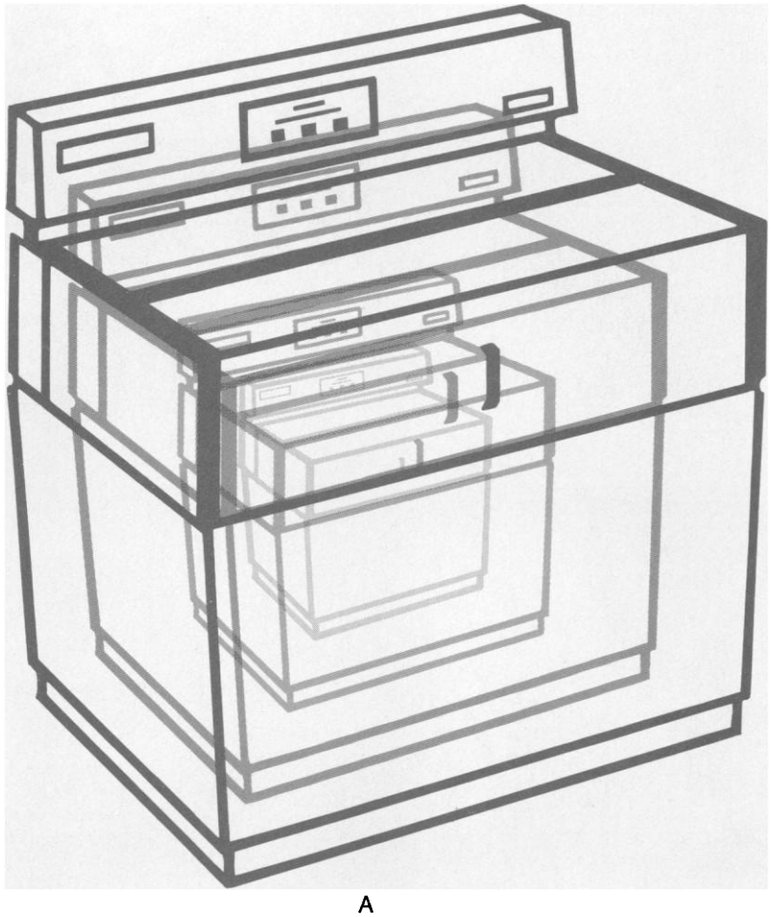

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System A

This is the standard Stay-Clean system now in use in hundreds of facilities all over the country. The cage rack, permanently attached to the unit, can accommodate as many as twelve small cages (11½" by 5¾" by 6") or as many as three large cages (14⅞" by 12⅞" by 6⅝") per shelf. Shelves are easily adjusted without tools and extra shelves are available to accommodate all cage sizes. This system effectively minimizes cage-to-cage contamination.

Note: An identical system is also available with *reverse flow.*

System B

This new system is virtually identical to system A but the cage rack has independent casters and is completely detachable. The shelves are longer than those of system A and will accept as many as fifteen cages (11½" by 5¾" by 6") per shelf. This system is also effective in minimizing cage-to-cage contamination.

Note: An identical system is also available with *reverse flow.*

are five Stay-Clean™ to protect your animals from contamination.

System C

A new Stay-Clean system designed to accommodate any conventional cage rack up to 70" length by 34" width by 80" height. Lexan™ plastic doors enclose the rack and the system is ideal for minimizing *rack-to-rack contamination.*

Why use a Stay-Clean system?

There is ample evidence that microbial airborne contamination plays an important role in the incidence of animal colony infection and that turbulent dirty air is a major mediator of such contamination. Pathogen-free unidirectional air flow over animal cages greatly reduces the concentration of airborne contaminants, be they microbial (bacteria, fungi, molds, spores, etc.) or nonviable particulate matter. Additionally, because the animals are "downstream" of the air source, the airflow effectively prevents re-entry of ambient contaminants.

The air in the Stay-Clean systems is purified by continuous processing through high efficiency particulate air (HEPA) filters which effectively remove virtually all particulate matter of any origin of 0.3 microns or larger and hence provide pathogen-free air.

Accordingly, whenever airborne contamination can jeopardize a colony or a research effort, these systems can aid materially in reducing such contamination and its untold effects. The Stay-Clean systems are particularly useful in reducing colony-threatening cross-contamination.

Important: a particle counter for continuously monitoring air purity is also available.

For more Information

For additional information—or to see a Stay-Clean system in operation near you—write or call Lab Products, Inc., 365 W. Passaic Street, Rochelle Park, New Jersey 07662. (Phone: 201/843-4600)

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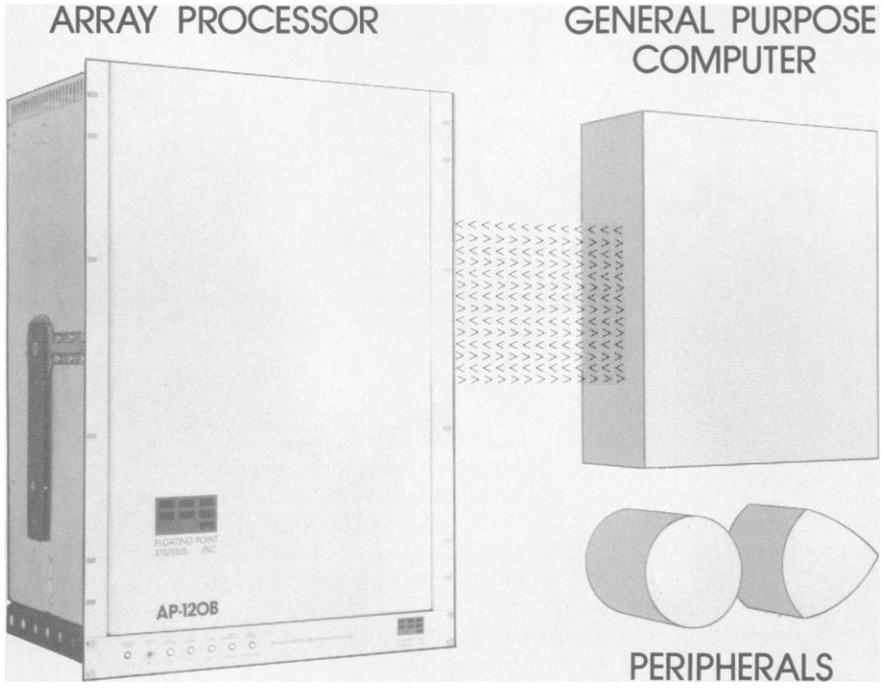
A new advance in scientific computing



A breakthrough in computer architecture, the Array Processor is bringing unparalleled computational power to continually growing numbers of applications in **research, engineering,** and **signal processing**.

The Array Processor is **a computer in its own right,** specifically designed **for extremely efficient processing of large vectors or arrays** of data. Although fully capable of working in an independent system, the Array Processor is typically implemented as a powerful complement to a host computer (which acts primarily as a controller), greatly increasing the computational power of the entire system.

The Array Processor **takes blocks of data and instructions** from the complementary CPU or other device and **performs the computations** called for **at speeds of 100 to 200 times greater than** a stand-alone computer. This means that **a minicomputer** based system can have its computational throughput increased to a degree only available on the largest, and most expensive mainframe computers. It also means that a **large mainframe can have its throughput increased up to 20 fold.** The rationale is simply this: if massive computations are required to effect a simulation or algorithmic model, why not design a programmable processor to handle these tasks efficiently. FPS has pioneered this approach by designing extremely efficient, cost effective Array Processors, interfacing them to all popular computers and providing a package consisting of software development programs, diagnostic programs, and an extensive math library. All documentation and support are provided to bring the systems promptly on line. The significance of this approach becomes evident when one realizes that for **less than $50K** he can have the power of a multi-million dollar CDC 7600 immediately available to implement his scientific analysis programs. Hundreds of FPS Array Processors are in use today.

Time and again the Array Processor has allowed significant research to be accomplished where before budgets did not allow access to the computational power required. This accessability has also produced a catalytic effect allowing new research ideas to come forward for implementation.

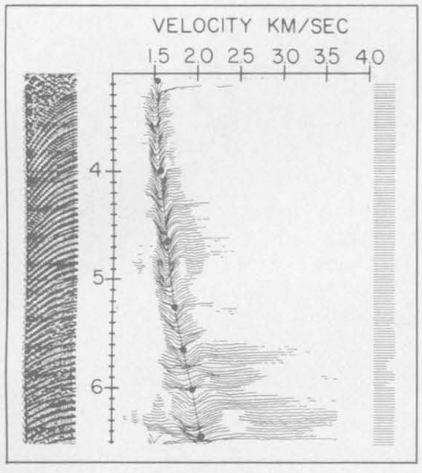
Architecturally, Floating Point Systems' Array Processors consist of fast registers, program memory, data memory, **a pipelined floating-point adder,** and **pipelined floating-point multiplier**—all interconnected by **seven parallel synchronous data buses.** These features are combined with a fast **(167 nanosecond)** instruction cycle. While the conventional computer instruction word can only specify a single operation, such as a **multiply, add, memory fetch, decrement, or test, the FPS Array Processor can do all of these operations in a single 167 nanosecond cycle.** The result is the ability to do the reiterative computations required on large vectors or arrays of data in a very short time.

There is another "unexpected" benefit from this kind of computer architecture. Most algorithms used to implement scientific models and their associated data sets are naturally structured in vector (array) form. While the conventional computers of today require restructuring of the models, the design of the architecture and instruction set of FPS Array Processors is virtually congruent to the mathematical models. Researchers using Array Processors find that they **can readily write new program routines** either in **FORTRAN IV** through their host computer or in **the Array Processor's own assembly language.**

Powerful models can be readily implemented through the extensive FPS Scientific **Math Library (SML) of more than 250 routines** callable through the host FORTRAN. New programs can be added to the SML using the assembly language of the Array Processor.

For example, **Peter Buhl** of the **Lamont Doherty Geological Observatory of Columbia University** applied these techniques to the analysis of **marine seismic reflection data.**

...the Array Processor

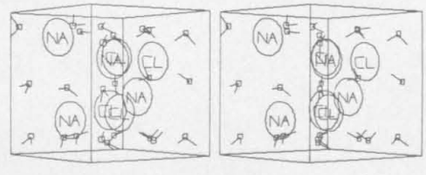


The above data is a plot of the earth's response due to an air gun source at 24 locations along the earth's surface. The vertical scale is propagation time in seconds. Sound velocity in the earth is determined by fitting one-sided hyperbolas to the data. This fitting is done in the Array Processor by multiple cross-correlations of short time windows of the 24 traces. The strength of the correlation as a function of propagation time and assumed velocity is plotted in the center graph as a downward deflection. A line through the deflection troughs defines velocity vs. depth. **The center graph requires 100 million multiply-adds.**

Sound velocity data as a function of depth of the earth provides valuable information about the nature of the strata. A single velocity analysis via a multiple cross-correlation (or semblance) technique required **six hours with conventional computational equipment.** Utilizing an **FPS Array Processor reduced this time to three minutes,** (a 120X throughput improvement) thereby allowing these velocity analyses to be done at closer spacings along the line of profile, **adding an extra dimension to earth cross sections.**

Floating Point Systems' Array Processor also forms part of a system used to process nuclear reactor operating data generated by **reactor safety experiments.** The portion of that system developed by **Sam Sparck, Senior Development Engineer at the Time/Data Division of GenRad, Inc.** is a real-time multi channel **digital filter subsystem.** Input data arrives in buffers of variable length at rates from 50 to 650 buffers/sec. Maximum throughput requirement is 131,000 words/sec. The Array Processor program performs data demultiplexing into separate channel buffers, digital filtering/decimation, bounds checking, and remultiplexing of the decimated data into output buffers. **Decimation ratios of 3:1 to 6,000,000:1** are attained. Certain **selected parameters are tested in real-time** for bounds exceedance, and when exceedance conditions are detected, an audible and visual alarm is generated to alert system operators.

In the area of pure science, a Floating Point Systems' Array Processor is used by researchers at the **University of California, San Diego** to integrate **several hundred coupled differential equations** in the study of the **molecular dynamics of chemical reactions.** A dynamic display system then processes the vector positions of the atoms and shows them in 3D moving images. Chemistry is a field with obvious needs for large increases in computer power. Its fundamental axioms are well known, but the computations involved in applying these axioms are so extended that as yet only relatively simple systems have been studied from first principles.



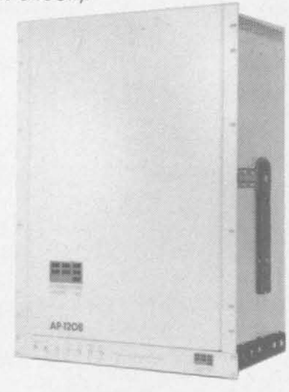
Hard copy output of single time step in the dissolution and solvation of a salt crystallite in water is shown here. You can see this stop-action in striking depth if you fuse the two pictures together into a single stereoscopic image with a slight crossing of your eyes. The experimenters actually have moving 3D pictures literally at their fingertips. The calculations are aimed at a deeper understanding of molecular processes in terms of the motions of the atoms involved.

While the computational limitation of this generation of Array Processors does exist, its potential contribution to technology has yet to be discovered in many areas of scientific analysis. Every day numerically intensive array processing techniques are applied to new areas of research and engineering.

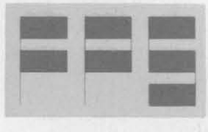
Today **Array Processors can be found in** the calculation, reconstruction, and enhancement of **images** (X-ray, satellite, and seismic)...the **conversion of speech** signals into compressed digital data and the subsequent resynthesis...the composition of images in **radio astronomy**...the statistical analysis of the data affecting **economic models**...the **simulation of mechanical systems,** airframes, and environments... and more.

The Array Processor has literally created a new era in signal processing and scientific computation. An FPS Array Processor interfaced to a **minicomputer** provides the computational power of a megadollar mainframe at a fraction of the cost...combined with a **major mainframe,** it brings the user the computational ability previously available only at tremendous cost.

To learn more about Array Processors...use the coupon below or contact Floating Point Systems directly.



The age of Array Processing is here...and Floating Point Systems is the Array Processor company.



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Featuring a new, better integrated approach, this book presents the fundamental aspects of life at the cellular level in a way designed to best aid student learning. Of particular significance is the inclusion of the geological background for the changes, atmospheric and otherwise, that make eukaryotic existence possible. Emphasis is on the conversion of matter and energy, excitability, contractility, growth and cell division as viewed from the evolutionary perspective of the earth's atmosphere from anaerobic to aerobic. *By Arthur C. Giese, Stanford University. About 750 pp. Illustd. Ready 1979.*
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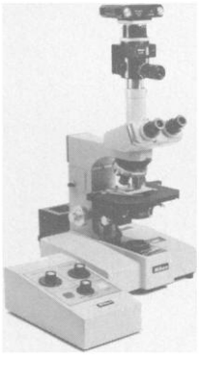

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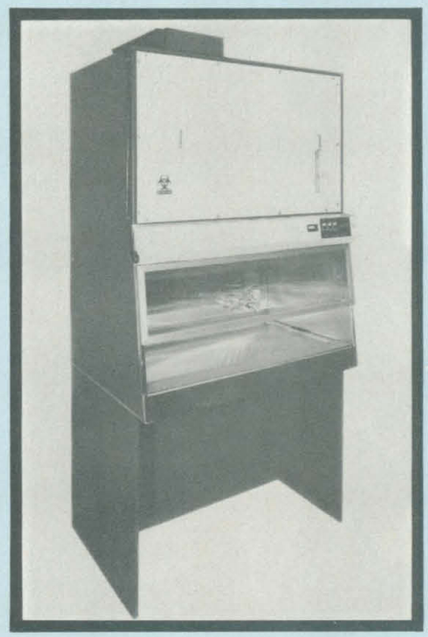

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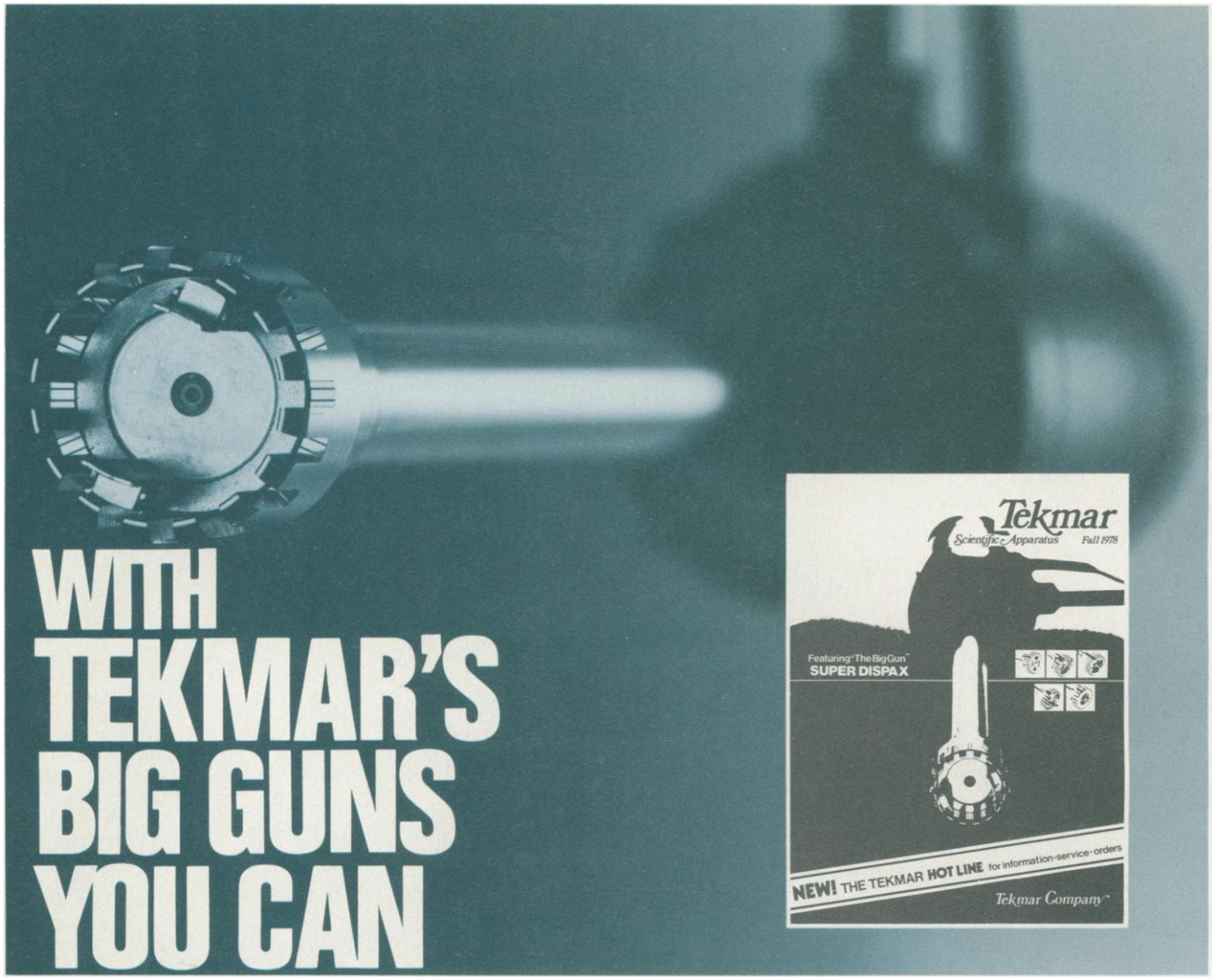

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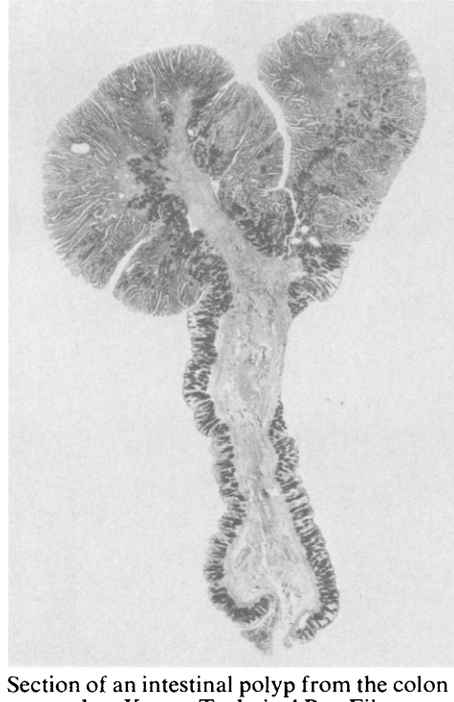

Section of an intestinal polyp from the colon exposed on KODAK Technical Pan Film (ESTAR-AH Base) SO-115. Printed on KODABROME II RC Paper (F-surface) and processed in a KODAK ROYALPRINT Processor, Model 417.

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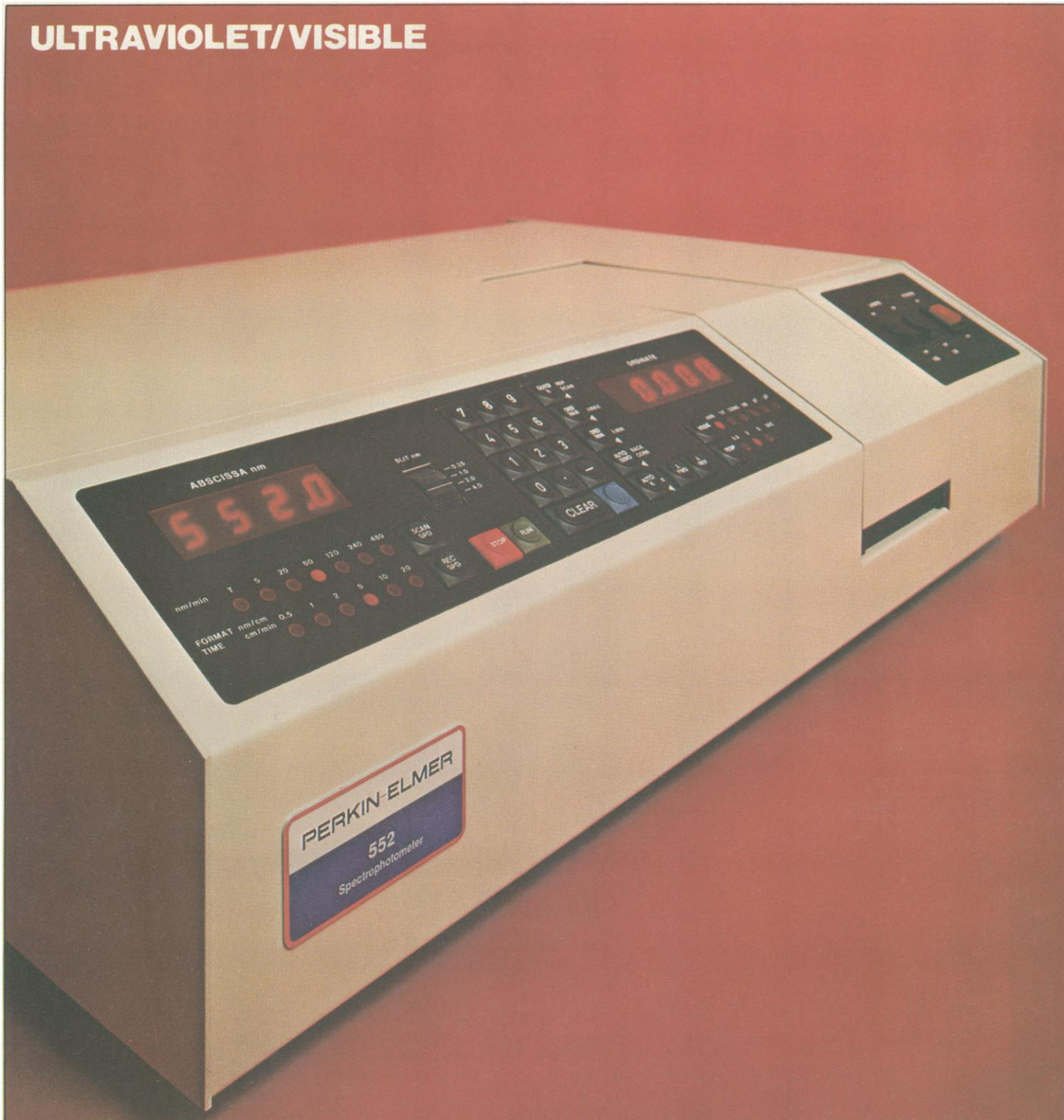

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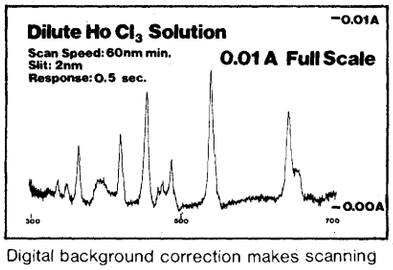
Upon POWER-ON, the Model 552 goes into automatic baseline compensation mode, ensuring baseline flatness of ±0.001A. The optional Keyboard Expander Package can be added to provide enhanced correction capacity and the ability to compensate over preselected wavelength intervals.



Digital background correction makes scanning at very high scale expansion possible.

3. DIGITAL DISPLAY

Both ordinate and wavelength data are clearly displayed on two large digital displays. There is no need to interpolate between indicator lines on meters and mechanical counters. Operating paramaters such as mode, scan speed, format, and response are conveniently displayed by lights. Changing parameters is accomplished by sequentially depressing the appropriate button.

4. MICROCOMPUTER DIRECTED RECORDER

The Model 561 Recorder is controlled by the instrument's microcomputer. Chart drive is via pulses generated within the microcomputer to the stepper motor of the recorder, ensuring precise registration with the monochromator. There is no need to adjust recorder switches to obtain ordinate scaling or suppression: it's all done by the microcomputer.

5. AUTOMATIC 0A/100%T

Simply push the button and the microcomputer sets 0A/100%T. 0%T is automatically set with every chopper cycle.

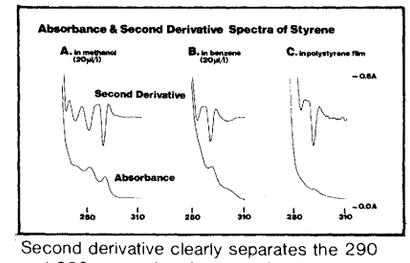
EXPANDABLE KEYBOARD OPERATION

With the Keyboard Expander Package, the power of the microcomputer is increased. Easily installed within the instrument itself, the package provides repetitive scanning, first and second derivative, enhanced background correction capacity, and concentration factor calculation.

With the Keyboard Expander Package, repetitive scanning is made easy. Simply enter the number of scans and the cycle time per scan with the "Rep Scan" key. Now select the upper and lower wavelength limits. With the Model 561 Recorder, the presentation is serial: with the Model 57 XY-Recorder, overlay spectra are obtained.

DERIVATIVE SPECTRA

The Keyboard Expander Package also provides first and second derivative spectral recording. These functions are very useful in determining the absorption maxima of overlapped bands and for the quantitative determinations of trace components.



Second derivative clearly separates the 290 and 280 nm peaks of styrene (in A) from the solvent background in B and C and permits a quantitative measurement on the 290nm peak.

The Keyboard Expander Package allows calculation, display, and entry of a concentration factor for direct readout of results in concentration units of choice.

DEMONSTRATION OR INFORMATION

(Circle Reader Service Number)

206 For Model 552 Data Package

207 For Immediate Demonstration

208 For Bulletin on Derivative Spectroscopy

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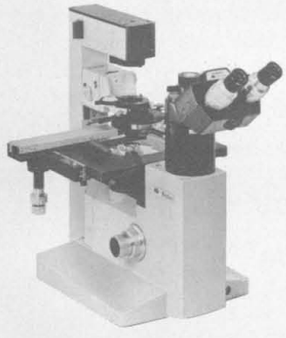

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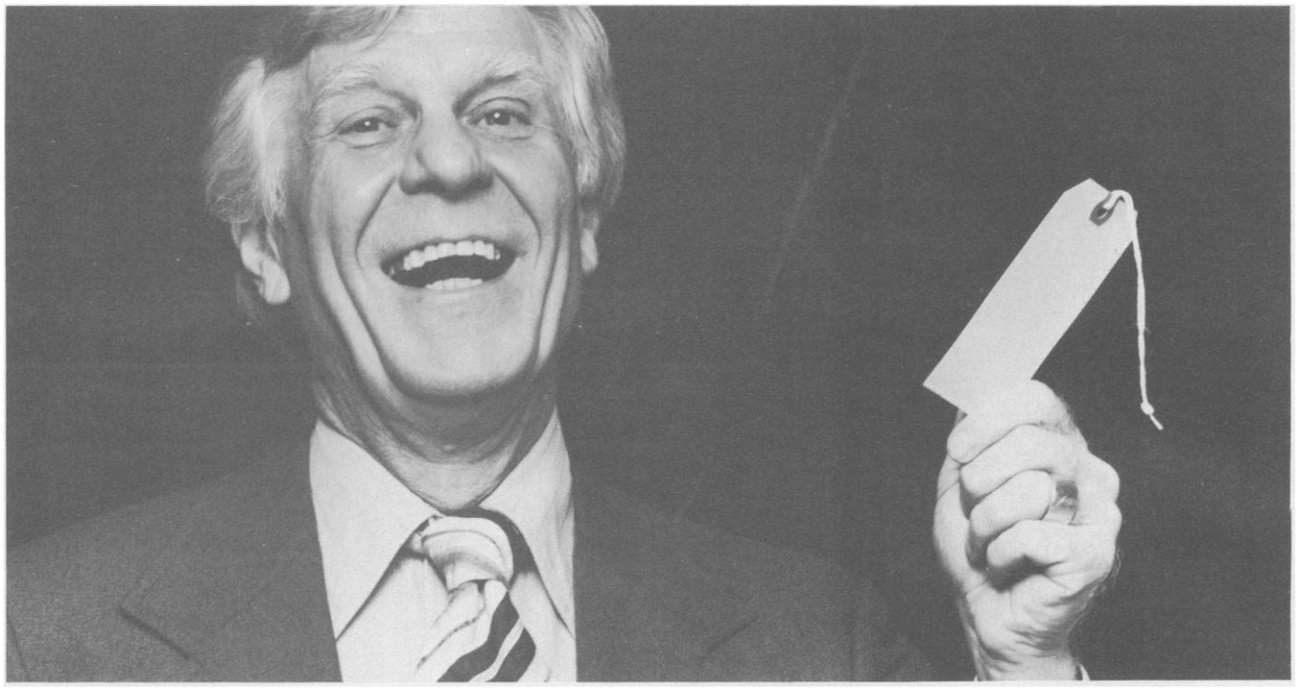

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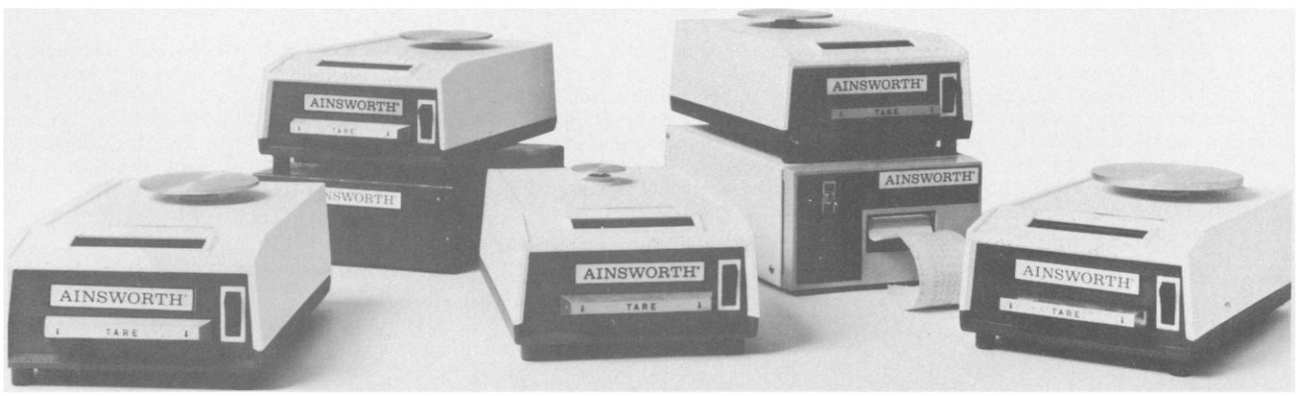

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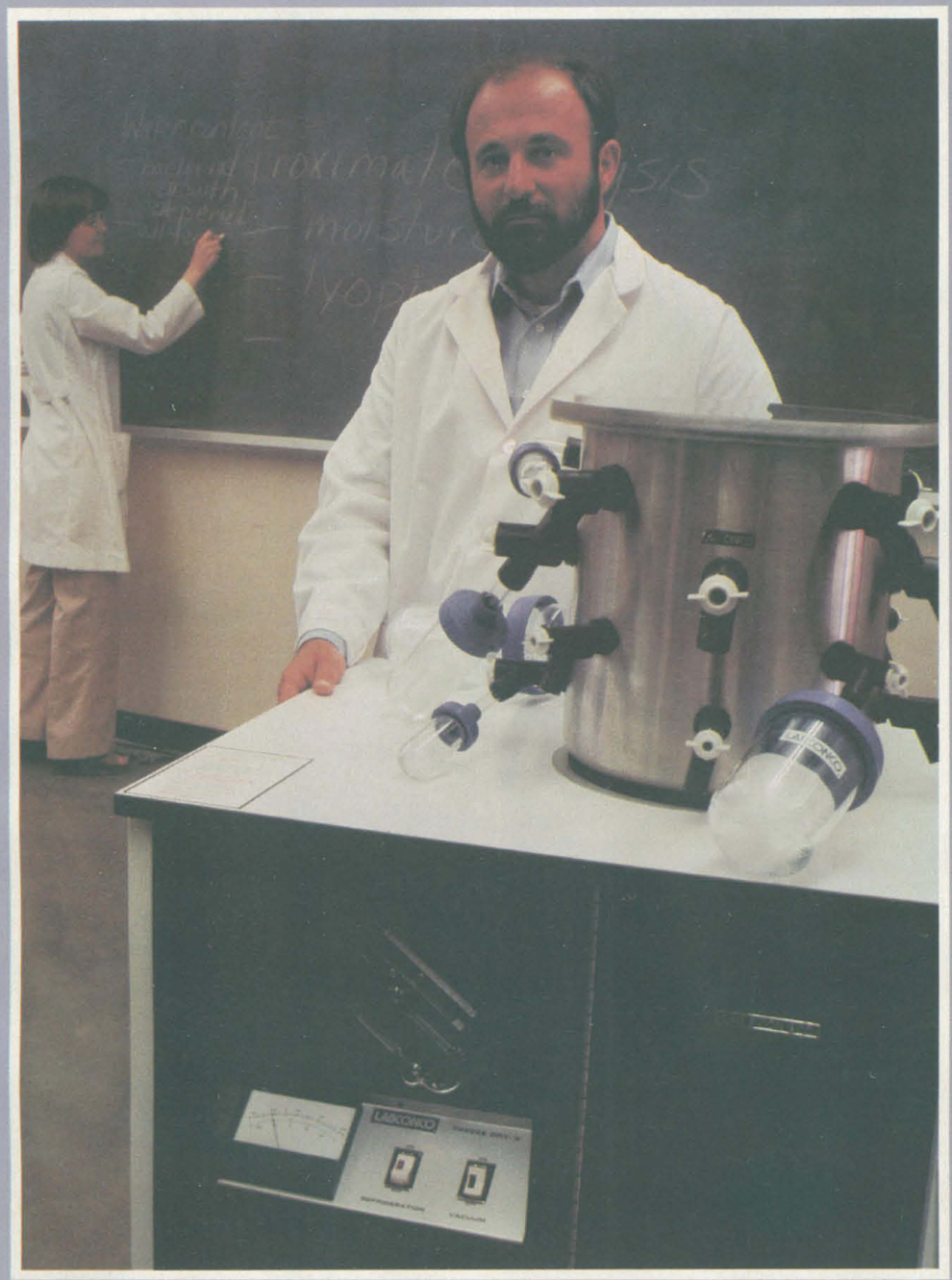

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LABCONCO FREEZE DRY APPARATUS

LETTERS

U.S. Chemists Withdraw from Soviet Symposium

Following are excerpts from a letter informing the Organizing Committee of the Symposium on Macromolecular Chemistry, scheduled to be held in Tashkent from 17 through 21 October, that the individuals there identified have decided to withdraw their participation.

It is with profound regret that we convey the decision, reached by each of us individually, to withdraw from the International Symposium on Macromolecular Chemistry sponsored by IUPAC [the International Union of Pure and Applied Chemistry] and to be held in Tashkent in October. We have come to this painful decision only after thorough assessment of the circumstances currently affecting international scientific cooperation and communication, which it is the purpose of IUPAC to encourage and promote. We ourselves attach the highest importance to this objective. Recent events in the Soviet Union, however, have so gravely hampered its realization as to force us to take this course as a matter of conviction and conscience.

Foremost in our minds at this moment is the spectre of the recent trials and current persecutions of scientists who, according to the evidence available, are guilty of no offense other than expression of their views. . . . We deplore the actions taken against them.

Although we respond compassionately to the plight of the victims of the harsh sentences imposed thus far on those indicted in the current campaign to suppress dissent, our concerns go beyond their fates, tragic as they are. Our broader concern is with the prevailing atmosphere of repression in the Soviet Union and its stifling effect on scientific communication and cooperation.

It is no secret that scientists in the USSR are subject to heavy surveillance. One cannot be unaware of the restrictions on their movements. They are not allowed to communicate with us freely and openly without, evidently, risking their positions, or perhaps hazarding more severe consequences. Visits with scientists in the USSR are constrained, and visits by Soviet scientists abroad are drastically curtailed by the Soviet authorities. Our invitations extended to highly qualified Soviet scientists have repeatedly been interdicted by your authorities. Last minute cancellations by Soviet scientists scheduled to participate in scientific meetings outside the USSR have become a commonplace manifestation of these restrictions. . . .

Under the conditions briefly indicated, international scientific cooperation cannot flourish and indeed cannot be effectively conducted. We reach this conclusion reluctantly and with grave disappointment, for all of us have long subscribed to the view that such cooperation offers great potential for enhancing understanding between peoples of our countries and for the betterment of the world at large. We have not, however, relinquished the hope that current obstructions to genuine scientific cooperation will be removed so that the mutual benefits of such cooperation can be realized. We urge you to prevail upon your government, by every means at your disposal, to alter its repressive policies and practices.

We have repeatedly communicated our views on the violations of the rights of scientists in the USSR to your authorities, including President Aleksandrov of the Soviet Academy of Sciences. Our entreaties have elicited no response. Hence, we are obliged to take more stringent steps.

Please be assured that our high regard for our Soviet colleagues is unblemished by the circumstances that have led us to our own course of action. We are unwavering in our esteem of them and of their contributions to science. We are aware that current impediments to scientific collaboration are not of their doing. We should like to make clear also that our actions are taken independently of our government, and without any influence whatever from governmental officials or authorities. . . .

Professor M. Goodman, Professor H. Morawetz, and Dr. P. W. Morgan, each of whom concurs with the substance of this letter, have previously communicated their decisions in regard to the Tashkent meeting to the Organizing Committee.

In addition, Professor Charles G. Overberger, vice president of the University of Michigan, has canceled commitments for the meeting in Tashkent for related reasons.

HERMAN F. MARK
Polytechnic Institute of New York, Brooklyn 11201
WALTER H. STOCKMAYER
Department of Chemistry, Dartmouth College, Hanover, New Hampshire 03755
NICHOLAS W. TSCHOEGL
Department of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena 91125
PAUL J. FLORY
Department of Chemistry, Stanford University, Stanford, California 94305

Hayflick's Reply

When one is engaged in suing, one cannot always talk. Now I wish to reply to two articles by Nicholas Wade (News and Comment, 9 April 1976, p. 125; 1 Oct. 1976, p. 41). This reply was sent to *Science* in November 1977 and was ultimately submitted by them to eight referees. I was then asked to respond to numerous questions and to document many of the statements that appear below. Wade's articles and his reply that follows these comments were (i) not sent to outside referees, (ii) not documented with references, and (iii) published without an 11-month delay. Specifically, Wade's articles discuss an investigation by James W. Schriver, director of the Division of Management Survey and Review at the National Institutes of Health (NIH), of my management of the human cell strain WI-38 and a subsequent conference held at NIH to discuss the present state of the cells. My previous silence should not be taken for acquiescence, timidity, or guilt: Wade was only doing his job, but in so doing he was led to present as fact many of the wholly unmeritorious allegations with which I was suddenly confronted. These allegations have done damage to my reputation, though fortunately most of my colleagues familiar with the truth have dismissed them. That they are unmeritorious should be quite evident from the fact that, were they true, I could have faced a suit, or criminal charges, or both. In fact it is I who have been obliged to sue.

Naturally I wish to clear my own name. I am equally concerned, however, about the general threat which the treatment I received poses to *all* federally funded scientists. Do my colleagues know that it is possible for government bookkeepers to wander freely through research laboratories, look at records, question personnel in the absence of the principal investigator, report that investigator as a felon, and then have their unsubstantiated word believed by university administrators? Do they know that unrebutted reports by such individuals, making not only moral but scientific and legal judgments, can be circulated gratis to the press and to their colleagues by a process of leakage and invocation of "freedom of information"? Or that when one demands equal time, these individuals will indeed offer to circulate one's reply—at a charge of $11 a copy? And that in consequence one must dignify such conduct with a reply in *Science*?

These circumstances can lead inevitably to the indiscriminate destruction of scientific reputations because no system of safeguards now exists. Most scientists are unaware of the extreme vulnerability of their reputations even to unfounded allegations of wrongdoing. I implore my colleagues to seek procedural safeguards that will prevent nonscientists and the press from unjustly destroying the reputations of innocent people.

Wade's choice of a title for his article about me was designed, in my judgment, to attract readers' attention by casting a dispute in an unnecessarily sensational light. Such ploys are more typical of the sort of yellow journalism that is uncharacteristic of *Science*. The word "Tragedy" used by Wade in his title is more applicable to his reporting than to my situation because he produced an incomplete and inadequately researched article. Wade's characterization of the "Fall" of WI-38 is an unfounded opin-

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VOLUME VI/CHROMATIN, PART C

Edited by HARRIS BUSCH

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Advance Announcement . . .

CYCLITOLS AND PHOSPHOINOSITIDES

Edited by WILLIAM W. WELLS and FRANK EISENBERG, JR.

FROM THE PREFACE: With the passage of nearly a decade since the last conference on cyclitols and phosphoinositides the desire had been growing among many workers in the field to meet again, exchange and evaluate new information gathered since that time, and set new directions for the solution of problems still unsolved. This work then is the product of the latest conference on cyclitols and phosphoinositides held June 26-29, 1977 at Michigan State University, East Lansing, Michigan.

1978, in preparation

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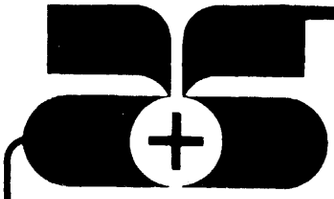

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ion. The usefulness and level of distribution of these cells has continued undiminished in the 2½ years since he inaccurately suggested that they were then to be eclipsed.

In a separate court case, NIH lawyers maintained that original research records are the property of scientists themselves. The U.S. Court of Appeals in Washington, D.C., upheld that position. Nevertheless, Schriver, without my authorization, read, copied, and distributed copies of my laboratory records. Although I have nothing to hide, my colleagues who may resent such an intrusion should know that an NIH investigator who is not a scientist may seize their laboratory records, interpret them as he wishes, and have that interpretation amplified by the press. My colleagues may also be interested to know that, since my suit was filed in 1976, claiming a violation by NIH of the Privacy Act, investigators' documents released by them under Freedom of Information Act inquiries now have the names of individuals and other identifiers deleted. That was not done in my case.

1) Fundamental to Wade's point of view is his apparent assumption, without a shred of fact, that NIH owns the WI-38 cells. There is documentary evidence (*1*, *2*) and several witnesses can testify (*1*) that Leon Jacobs, Associate Director for Collaborative Research at NIH, told representatives of Merck Sharp & Dohme in 1974 that he had consulted with NIH counsel and had concluded that "on the advice of counsel the cells belonged to H[ayflick]" (*2*). Competent, independent legal counsel also shares this opinion. Wade's statement that "there does not seem to be much dispute that the cells were developed on an NIH contract and hence were government property" is an unqualified legal opinion by him. The contract in question has no such provision, as the then NIH Project Officer has clearly stated (*2*) and as Leon Jacobs has confirmed (*1*, *2*). The concepts and procedures used in the contract were not patented but were based on a prior art, discovered by serendipity and published by me several years earlier; hence they are in the public domain. If Wade is right in stating that title to WI-38 was vested in the government, not only are the dozens of establishments who were and still are selling WI-38 for profit selling government-owned property, they are also profiting from several other continuously propagable cell populations that have been developed with public funds. And if the cells were government property, why has NIH chosen to pay for WI-38 cultures since the cells first went on public sale in 1968? Also, in 1971 my NIH project officer widely circulated a memorandum to the effect that a charge would be made to those recipients of WI-38 not using the cells in research on aging. What Wade fails to say is that no charge was ever made for cells distributed under the terms of my contract. That contract stipulated that WI-38 would be distributed gratis to researchers in the field of aging, a provision that was scrupulously adhered to. Finally, it was I who first requested clarification of this entire matter with Ronald Lamont-Havers, then Deputy Director of NIH, in October 1974; the resulting inquiry was made at my request, Lamont-Havers' denials notwithstanding.

2) According to Wade, "it now appears that sufficient [WI-38] stocks [are available] only for the next several years" (9 April 1976, p. 125). Thousands of WI-38 cultures have been sold weekly by several commercial organizations in the 2½ years since Wade made this statement, and there is no reason to believe that this will not continue for many more years. How much credence, then, can be put in the statement attributed to the Bureau of Biologics (BOB) by Wade

in his April 1976 article that "WI-38 stocks will last only a few years at best"? A BOB representative has said that WI-38 is not in short supply and that more than 200 ampules of passage 12 are on hand at the American Type Culture Collection (ATCC) alone (*3*). This was revealed (*4*, p. 20) at the NIH meeting on WI-38 held in September 1976 and attended by Wade before he wrote his second article, but he made no mention of it. The present WI-38 stocks should satisfy the needs of vaccine manufacturers for at least 10 years, a fact that I have steadily maintained. There is no "acute" supply situation, as Wade states. An informal census taken by me indicates that about 2000 frozen ampules of WI-38 at passage levels below 17 are stored in laboratories throughout the world. For example, the Connaught Laboratories in Toronto, Canada, have sufficient ampules to meet all anticipated vaccine production requirements for at least the next 25 years (*5*), Wyeth Laboratories has sufficient WI-38 to meet their needs for at least a decade (*6*), and the Japan Poliomyelitis Institute has 500 ampules of WI-38 on hand (*7*). In view of the availability of WI-38 in so many other places, now, and for an indefinite future period, how much credence can be put in Wade's statement that a contract I negotiated with Merck Sharp & Dohme for their future purchase of WI-38 cells "might have given Merck a near monopoly on a vital world resource"?

3) Wade states that "the contamination [of WI-38] was not reported to NIH or the government vaccine authority." To inform the Division of Biologics Standards (now the BOB) of the contamination in 1968 would have been preposterous, as Wade surely could have reasoned from his description of their negative attitude toward the cells. They were totally disinterested in WI-38 and bitterly fought its use in virus vaccine production for the entire decade 1962–1972. It is therefore with some satisfaction that I note how our ultimate success in persuading them of its usefulness resulted in their active participation in the removal of WI-38 from my laboratory in 1975. The implication by Wade that the contamination of some ampules of WI-38 was kept secret by some conspiracy is absolutely false. Not only were Frank T. Perkins, then Director of the Division of Immunological Products Control in the United Kingdom, and his staff aware of the fact (they themselves first discovered it), but written notification (and subsequent written acknowledgment) was also given by me to the Principal Investigator on the NIH contract under which

WI-38 was first stored and distributed. Perkins headed the only control authority in the world which was then interested in using human diploid cells as a substrate for vaccine production. It was my judgment at that time that the key people interested in the cells were informed. It was not my responsibility to inform NIH, and, indeed, there was no one at NIH who would have been the least bit interested. Neither Perkins nor I chose to make the matter public because to do so could have produced the same kind of unnecessary alarm that Schriver's report and Wade's amplification of it almost created. Telling the new director of the BOB would have been as preposterous as telling the old director; neither cared about our work, and both fought our efforts to have the cells used for vaccine preparation.

4) The contamination of some ampules of WI-38 never has been in any way a threat to vaccines made in cell cultures prepared from sterile ampules. Wade also omits mentioning that a number of ampules of the MRC-5 cell strain, which is also used currently for the production of human virus vaccines, were found to be contaminated (*8*). This revelation was made 7 years after MRC-5 was described and at the September 1976 meeting attended by Wade, but it was inexplicably ignored by him in his October 1976 article. Wade's discussion of the WI-38 contamination makes only brief mention of this being a pioneering effort in 1962, when (i) no laminar flow cabinets existed; (ii) no antibiotics were used in the preparation of several hundred cultures; (iii) hundreds of ampules were hand-sealed by inexperienced workers in my absence; and (iv) no automatic, slow-freezing equipment was used. In spite of these handicaps, the range of contamination is not much different from that found so far in other human diploid cell strains that were produced much later under substantially improved conditions (*8*).

5) Wade says that "the general custom [in vaccine production] is always to start with initially sterile cells. This is the practice followed by the British vaccine authority, for example, with the live polio vaccine made from WI-38 in England. . . ." No vaccine has ever been knowingly prepared in WI-38 or MRC-5 cells derived from a contaminated ampule. If the practice in the United Kingdom is as Wade says, then why is MRC-5 still used for vaccine production? MRC-5, like WI-38, consists of a pool of ampules, some of which have been found to be bacterially contaminated. How then can Wade logically justify his statement that "the credit for the next generation of vaccines will go to MRC-5 instead of to Hayflick and WI-38," or his remark that "J. P. Jacobs [of the MRC] intends to use the MRC-5 cells, rather than take risks with cleaned-up WI-38 cells," when most of the WI-38 ampules used for vaccine production were original ampules opened and tested by Jacobs himself? How reasonable is it for Wade to ask, "Is it possible that vaccine makers have in the past received antibiotic-treated, not sterile and untreated, cultures of WI-38? Jacobs says there is no way to tell." Jacobs is, after all, in the best position to know, because he reconstituted and sterility tested all of the original WI-38 ampules used for vaccine production in the United Kingdom, the United States, and several other countries. In Yugoslavia, the Soviet Union, and France, original ampules were often opened there. Not only has contamination been reported in MRC-5, MRC-9, in the virus seeds used to make vaccines, and in more than 50 percent of primary monkey kidneys currently screened for use in polio vaccine manufacture, but in several human virus vaccines currently in use. Many of these are undoubtedly contaminated with bacteriophage because tests are not designed to detect all known types (*9*). In 1974, I requested that the BOB inspect my laboratory and records for the purpose of determining whether WI-38 distributed by me was being reconstituted under conditions that met requirements for vaccine production, a use not always made known to me by colleagues requesting cultures. The BOB refused my invitation.

There is nothing sinister about decontaminating cell cultures. In fact, decontamination is an accepted procedure for which a sizable scientific literature exists. Even the ATCC, where WI-38 is currently stored, distributes several "cleaned-up" cultures, including a cell line that "has been used extensively in cancer chemotherapy screening tests" (*10*). Virtually all cell cultures in use today (including those used for vaccine production) are "cleaned-up" because they or their progenitors have been grown in filtered and antibiotic-containing media. Almost every pool of bovine serum, trypsin, and synthetic media in which cells are grown is "cleaned-up" by filtration; serum is usually initially contaminated with from 10^5 to 10^8 bacteria per milliliter. Antibiotics are used at some stage in the preparation of almost all human virus vaccines, thus the use of "cleaned-up" cultures containing the cadavers of dead microorganisms is a universally accepted practice—even for the manufacture of human virus vaccine.

There is no need to reiterate this formally to specialists in the field. Nevertheless, all WI-38 used for vaccine production was sterile from the very beginning as determined by standard tests.

6) The contamination issue, is, of course, a diversionary charge. Wade implies that a statement that I made to a U.S. Senate subcommittee was false, which is far more serious. I said that "The human diploid cell strain WI-38 tested in hundreds of laboratories throughout the world has never been found to contain an indigenous contaminating microorganism." That statement is as true today as it was when I made it on 20 April 1972. Indigenous, as used by microbiologists, means that a microorganism is already present in the original cells before removal from the animal and is subsequently carried along with the cells as they are cultured (*11*). My statement was made to distinguish WI-38 from primary monkey kidney cells, in which indigenous microorganisms (viruses) *are* often found. WI-38, like most other widely used cell populations, has often become contaminated after laboratory culture of the original tissue but, as I accurately stated, it "has never been found to contain an indigenous contaminating microorganism."

7) Wade describes my record-keeping habits as "haphazard" or "incomplete," and says that they ". . . might leave something to be desired for the custodian of an important cell line. . . ." What are Wade's qualifications for making this judgment? He has never even seen my laboratory records. There are no specific guidelines for record-keeping that research scientists follow. Probably Pasteur's or Fleming's records "leave something to be desired." Absent any agreement to the contrary, the right to keep research records as one sees fit is as inalienable as is the right to do research itself. Proper peer view is the accepted standard for the evaluation of both. My research records, which always have been made available to site visit teams and project officers, have been accepted without criticism. If scientific data and research laboratory record-keeping are now to come under the scrutiny of government accountants and the press, then their influence on scientific research is more pervasive than most scientists have suspected.

The "important cell line" WI-38 reached its importance "as a valuable national and international resource" (Wade's words) only after 10 years of effort by a few dedicated people, none of whom included BOB personnel. Wade fails to note the irony and expected bias in the opinion offered that my record-keeping was "haphazard," when that judgment was probably expressed to him by the very people who fought the cells and the concepts for more than a decade. If there was concern about record-keeping of such "an important cell line," why did the BOB not ask to see those records before 1974 and refuse to inspect the records in 1974 when they were invited by me to do so?

Wade claims that "It is hard to find anyone who agrees with Hayflick's calculations" in regard to the designation of the population doubling level on the first culture prepared from frozen WI-38 at the eighth population doubling level. He goes on to say that "One cell culture specialist says his argument would be laughed out of court, another describes the reasoning as 'Jesuitical' and 'terribly feeble' " and that a vaccine scientist said that ". . . one would expect by geometric doubling to derive 100 9th passage ampules from 50 of 8th passage. . . ." James E. Shannon (of the ATCC) is quoted as saying that "the numbers specified . . . could not be fulfilled from Hayflick's stocks." Apparently Wade and the individuals he quotes are unaware of published international guidelines which state with notable precision how the ampules required by Merck can be made with ten or fewer ampules (*12*). Despite Wade's restatement of Schriver's unfounded claim, no WI-38 recipient ever received a culture from my laboratory whose stated population doubling level varied from general conventions and those international guidelines.

If Wade wishes to cite authentic misleading labeling of WI-38 population doubling levels, he would do well to look at the practices of the ATCC itself in this regard. Their labeling practices have caused WI-38 distributed by them to be assumed by many recipients over the past 10 years to be six to eight population doublings less than they actually were (*9*).

8) Wade uncritically repeats the view in Schriver's report that ". . . many ampules of the cells [WI-38] cannot be accounted for . . ." by my records, and he goes on to say that "in fact a total of at least 207 remain unaccounted for. This figure includes a discrepancy between the 339 ampules which Hayflick's records show were sent to the Medical Research Council in England and the 271 which the MRC's records show were received." Schriver's view appears to be based not on the state of my records but on his refusal to accept those records. Furthermore, Schriver relied heavily on the records of Pat Jacobs of the MRC laboratories, who, after Schriver's examination of those records, wrote to tell

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me, "As I have said earlier, after our initial check (when I reported that only 131 ampules were received) we found a record book which had fallen behind a filing cabinet which showed that 100 ampules were received in 1962, a figure which we omitted from the first total shown [to Schriver] in our first inventory. Subsequently, as a result of the most thorough search possible, it is true we had to further revise our figures upwards. . . ." The fact is that all ampules of WI-38 can be accounted for.

Wade quotes Perkins as saying that, once the contamination in some pools of ampules was known, "Hayflick's response was that all the contaminated ampules would be destroyed." I did not say that to Perkins, and Wade fails to say that Perkins' laboratory at MRC itself did not destroy *their* allegedly contaminated ampules where, even now about 30 such ampules can be found. If Perkins made the statement Wade attributes to him, why would he not have destroyed his own pool of allegedly contaminated ampules? The fact that he did not is as he, himself, says "because an ampule of cells that had the bacteria killed by antibiotics was perfectly satisfactory for purposes other than vaccine manufacture. Many tests of vaccines are done on human diploid cells and a number of original isolations of viruses are done on these cells. It would have been very wasteful, therefore, to destroy the cells" (*13*).

Before the bacterial contamination was discovered, chlortetracycline was used prophylactically for 6 years to prevent mycoplasma contamination in cultures of WI-38 grown in Perkins' and my laboratories. After the bacterial contamination was discovered, both Perkins and I realized that this antibiotic had killed the bacterial contaminant during the previous 6 years, making its initial presence unknown to us or to hundreds of recipients of WI-38 starter cultures. The presence of bacterial cadavers, presumably present only in the first few subcultivations, apparently had no adverse effect on any measurable parameter during those previous 6 years. It was, therefore, reasonable to conclude that, in future, cultures treated with chlortetracycline could, at least, be safely used for purposes other than vaccine manufacture as Perkins points out (*13*).

Wade refused to wait until my 100-page rebuttal to the NIH report was prepared, although I asked him to do so. He claimed that to wait would result in his being "scooped" by others. I could not then discuss the matter fully with him: my suits were pending and common sense and a misplaced sense of profes-

sional decency prevented me from discussing the matter with the press *before* my rebuttal was sent to NIH. He instead wrote an inaccurate article, rather than wait the short time required for that rebuttal to become available. When my rebuttal did become available, Wade did nothing more than to note its existence in the pages of *Science* (News and Comment, 1 Oct. 1976, p. 41), where he did accurately state that it could be obtained from NIH for $11. It is a pity he did not add that Schriver's original, unrebutted, and seriously inaccurate report was available free from NIH to whomever asked for it.

The facts are simple. I have done no wrong, yet my reputation has been injured and my scientific work interrupted by Wade's amplification of a seriously inaccurate and incomplete report, authored by an individual who selectively excluded information in support of my position, and who, lacking credentials, reached both legal and scientific conclusions. Far more important than what has happened to me is the shadow that has been cast over American science. If my colleagues are content to see this kind of treatment accorded to one of their number, on the grounds that they personally are protected, they are living in a fool's paradise. If my experience does nothing else, it stresses the ease with which authority in science becomes abuse, and we can stop grinning smugly at events in the Soviet Union if we bear it. The *right* people to judge the conduct of scientists are their *peers*. I appeal to *their* opinion, and I appreciate the fact that *Science* has given me the opportunity to make that appeal.

LEONARD HAYFLICK

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References and Notes

1. D. S. Brooks, Merck Sharp & Dohme, Inc., personal communication.
2. J. W. Schriver, "Investigation of activities relating to the storage, distribution, and sale of human diploid cell strains, WI-38 and WI-26. Working papers" (Division of Management Survey and Review, National Institutes of Health, Bethesda, Md., 1976). [These papers reveal an interview with the NIH Project Officer who said, "Since WI-38 cells were developed under a grant the passage 8 cells frozen at the Wistar Institute belonged to the investigator or investigators who developed them. . . . When the NCI contract was awarded to (the) Wistar Institute in 1962, there was no consideration that the WI-38 cells at Wistar were government property. The contract was not awarded to purchase the cell banks but to propagate, characterize and distribute the cells so that the widest possible use could be made of the cells in research. Cells up to the 8th passage at Wistar were not government property—but all cells propagated under the NCI contract became property of [the] government." No charge was ever made for cells distributed under the NCI contract.]
3. J. C. Petricciani, discussion, Joint WHO/IABS Symposium on the Standardization of Cell Substrates for the Production of Virus Vaccines, 13–15 December 1976, Geneva, Switzerland.
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11. *American Heritage Dictionary of the English Language* (American Heritage, New York, 1975), p. 670.
12. *Proceedings, Symposium on the Characterization and Uses of Human Diploid Cell Strains, Permanent Section of Microbiological Standardization, International Association of Microbiological Societies, Opatija, Yugoslavia, 1963* (Institute of Immunology, Zagreb, 1963), appendix 6, p. 732.
13. F. T. Perkins, personal communication, 2 June 1978.

Despite the length of Hayflick's letter, he neglects to share with the reader some quite pertinent facts and implications. For instance, he stood to make about $1 million from sale of what the U.S. government regards as its property. Nor did he ever tell the government's vaccine regulation authority, the Bureau of Biologics, that the WI-38 cells he sold and distributed to foreign vaccine makers came from stocks which he knew to be in part bacterially contaminated. Nor did the Bureau, which with others had invested much time and money in certifying the safety of WI-38, ever discover that a mere handful of original ampules remained until it confiscated the stocks from Hayflick's laboratory in August 1975.

The central issue is Hayflick's stewardship of the WI-38 cells. The facts about this issue remain obscure to this day because Hayflick has all along followed the same tactic, that of talking only about side issues to a drumbeat charge that he is being treated unfairly. The letter above falls squarely into the old pattern. Hayflick refused to cooperate with NIH investigator James W. Schriver, despite being given some 9 months to do so. Only after the NIH report had finally been issued did Hayflick produce a rebuttal, claiming unfair treatment etcetera. The NIH prepared a lengthy counter-rebuttal in which Schriver concluded, in my opinion quite correctly, that there was no reason for him to change a word of his original report.

The Hayflick rebuttal did not address the central issue of his stewardship of the cells. Hayflick passed up another opportunity to explain this matter in February 1976 when he chose to resign from Stanford rather than exercise his right to a hearing before his peers. Hayflick was under the threat of dismissal as a result of an investigation conducted by Stanford independently of the NIH's.

Hayflick was no more forthcoming with *Science* than he was with the NIH. The article of 9 April 1976, nevertheless, includes almost everything that can fairly be said in Hayflick's defense in addition to laying out the case against him. In this regard it is baffling that Hayflick presents the comment about the inadequacy of his record-keeping as an attack when any reader can verify that it was raised as a possible defense of Hayflick against the otherwise devastating conclusions of the Schriver report. There is nothing I wish to change, add to, or subtract from the article as then written, including its title.

The side issues raised by Hayflick are not new, but are mostly the same as he has been presenting since 1975. Somewhat plausible at first hearing, the various contentions turn out to have no or very little merit. On the issue of who owns the cells, the "documentary evidence" referred to is apparently the account of a telephone call in which Hayflick contends that NIH associate director Leon Jacobs said the cells could be sold: Jacobs denies having said any such thing. Whatever the exact inventory of WI-38 cells, the point is that it is far smaller than the Bureau of Biologics had assumed. Hayflick's opinion that he had no responsibility to inform the Bureau of Biologics of the contamination of the WI-38 stocks is not shared by the Bureau of Biologics. As the *Science* article made clear, the point about the contamination is not that it occurred—that is not surprising considering the technology at the time—but that Hayflick never made the fact public. The MRC-5 situation has no relevance to Hayflick's stewardship of WI-38. Hayflick's statement to the Senate committee, despite his explanation, cannot be said to have presented the full facts of the contamination issue. The incident of the missing MRC record book was known to Schriver before he wrote his first report and does not alter his conclusions about the number of ampules unaccounted for.

One new argument in Hayflick's letter is that the allegations against him must be unmeritorious because otherwise, he says, "I could have faced a suit." The logic of the proposition requires no comment, but it so happens that Hayflick does now face suit from the government for recovery of proceeds of the sales of WI-38.

The gravamen of Hayflick's letter is that he has been unfairly treated. I believe that the opposite is the case, and that, in passing up yet another opportunity to address the basic issues, Hayflick's letter is further evidence that the findings of Schriver's initial report are correct.—NICHOLAS WADE

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13 October 1978, Volume 202, Number 4364 **SCIENCE**

Regulating Exposure to Carcinogens

A small but increasing number of academic scientists have become alarmed at the threat of crippling federal regulation of their laboratories. They are concerned about rules in the process of being adopted by the Occupational Safety and Health Administration (OSHA) governing exposures to suspected carcinogens. The rules will be applicable to all industrial laboratories and most colleges and universities. No one quarrels with the desirability of guarding against exposure to chemicals of known toxicity. Controversy arises when substances of limited toxicity are placed on OSHA lists and users are to be subject to regulations designed for very dangerous substances.

In compiling its lists OSHA spurned repeated offers of help from the National Academy of Sciences. Instead it employed a private firm to make a literature survey. In reviewing each chemical, if the firm found two positive results for carcinogenic or neoplastic effects, it looked no further. It stated that negative findings were not taken into account.

At the moment, OSHA asserts that its lists are tentative. However, once a substance is placed in category I, it can be removed only by the Secretary of Labor, who in turn must follow stringent guidelines.

Items are assigned to category I when they produce cancer in humans or in at least two species of test animals. Hematite (iron oxide) was given this classification on questionable evidence. Other substances in the group include benzene, chloroform, carbon tetrachloride, and a host of nonvolatile inorganic salts.

Items are placed in category II if there is suggestive evidence for production of cancer. Ethyl alcohol is one of the items in this category. Cases of liver cancer have been noted among alcoholics. However, the concentration ordinarily present in a laboratory atmosphere is less than that at a cocktail party. A practical regulation for volatile substances such as benzene would be to require that operations with them be conducted in an efficient hood. This would eliminate any hazard.

The proposed OSHA rules for handling substances in categories I and II are set forth in the *Federal Register*, written in gobbledygook apparently by lawyers for lawyers. From a large number of pages the following was extracted by William P. Schaefer of the California Institute of Technology. The employer must monitor each workplace to determine the concentration of the toxic substances at least quarterly. Each employee must be given in writing a report of his or her exposure.

The employer must provide at no cost to the employee, and ensure that employees wear, protective clothing and other equipment. The clothing must be kept clean by the employer, and the employer must ensure that the employee removes all protective clothing at the end of the work shift.

The employer must institute a program of medical surveillance, including individual medical examinations and tests for each employee exposed to any toxic substance, all at no cost to the employee. There must be an initial examination and periodic examinations thereafter.

Records must be kept of all monitoring in the workplace and of all employees who are exposed to any toxic substance. The records must be kept for 40 years, or 20 years after termination, whichever is longer.

One of the galling features of the OSHA regulations is that professional scientists who have only occasional exposure to chemicals such as benzene must comply with rules designed for untrained workers exposed chronically. Were the regulations designed realistically, the several hundred scientists working with dangerous carcinogens would be carefully protected while expensive and useless annoyance would be avoided for perhaps 100,000 others whose most serious laboratory exposure is to ethyl alcohol. If OSHA had its eyes on the main chance, its highest priority would be to ban cigarette smoking in all workplaces. The present OSHA porposals invite ridicule, contempt, and noncompliance.—PHILIP H. ABELSON

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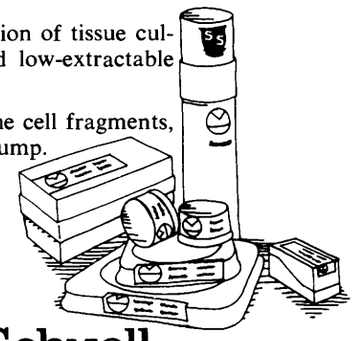

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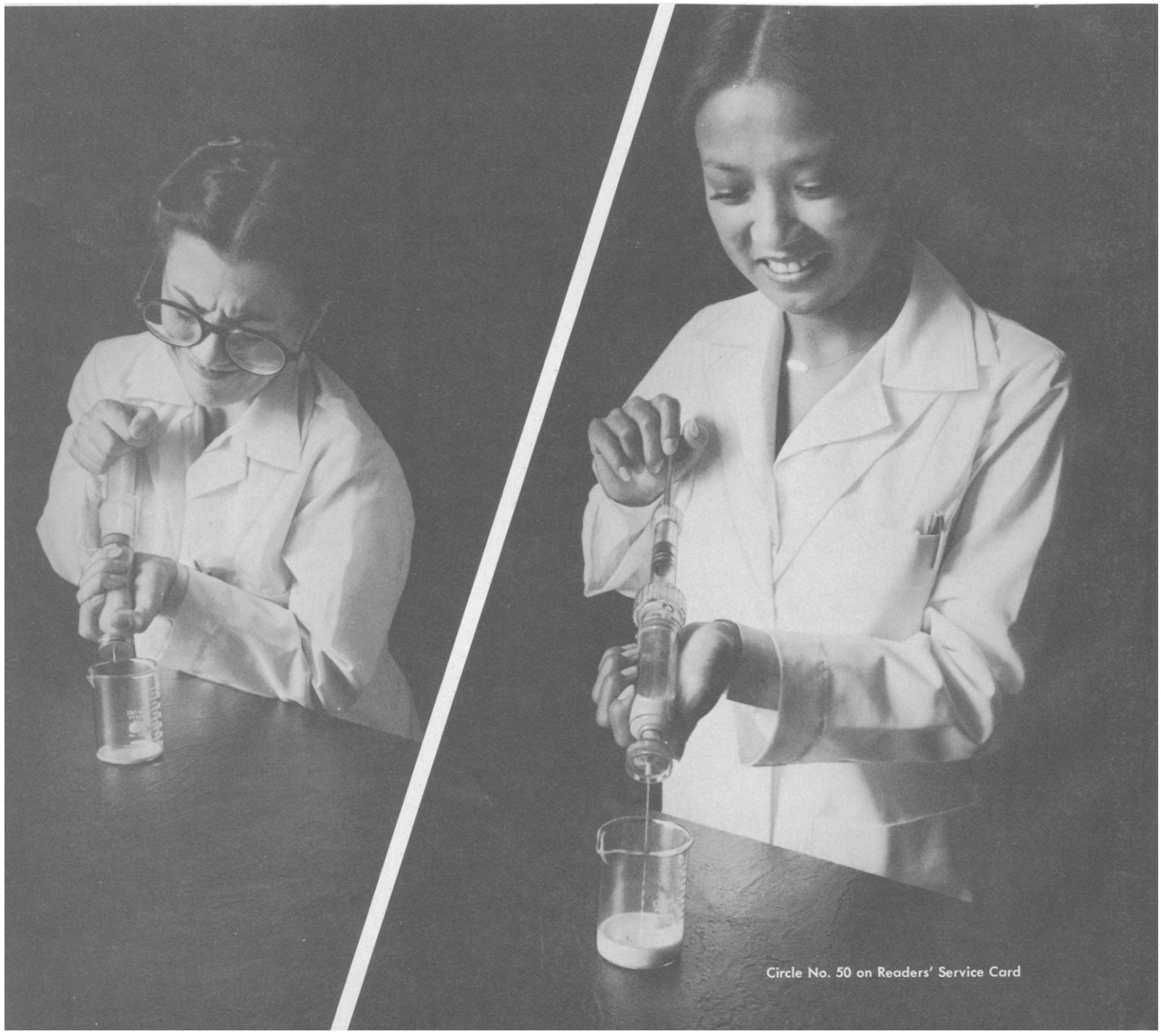

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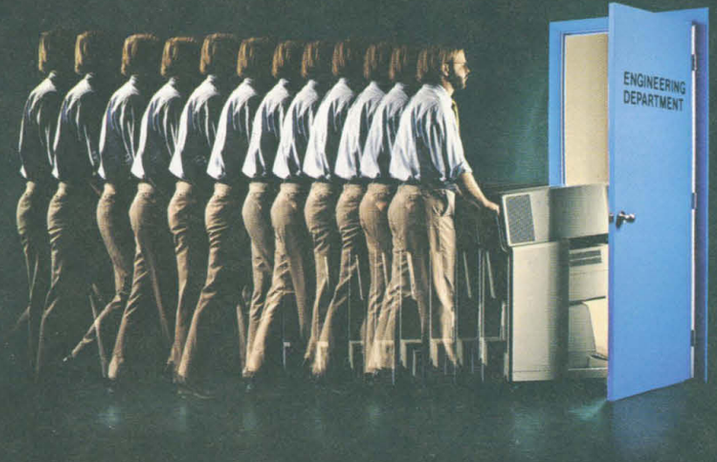
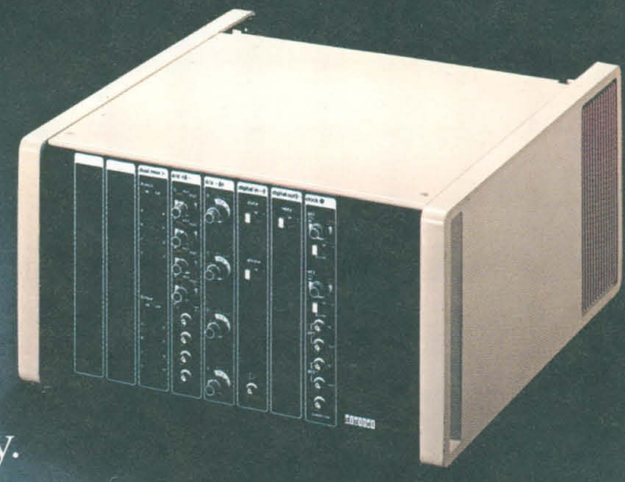
For about the same price you'd pay for a minimal desk-top calculator, you can buy MINC, the easy-to-use, complete computer system. MINC comes with ready-to-run graphic, scientific and laboratory programs. This Digital system has its own graphics terminal, built-in IEEE interface, one million character dual floppies, and three serial-line interfaces—all in a cart that you can wheel from job to job.

Plug MINC in, turn it on, and you can plot charts, solve complex engineering and statistical problems, control instruments and acquire data. It's all BASIC to MINC.



MINC



And, if you want to go beyond BASIC, you can. You can add FORTRAN and other high-level languages. You can add specialized input/output modules.

More system. More functionality. But, not more money.

For more information or a MINC demonstration, contact your local Digital Sales Office or Jack Kay, MINC Product Manager, Laboratory Data Products Group, Digital Equipment Corporation, Marlborough, Massachusetts 01752. Telephone (617) 481-9511, Ext. 6969. European headquarters: 12, av. des Morgines, 1213 Petit-Lancy/Geneva. Tel: 93 33 11. In Canada: Digital Equipment of Canada, Ltd.

digital

What makes MINC run.

MINC is the complete laboratory system that you can have up and running the same day it is delivered. The standard system includes:

- Mobile MINC Cart
- PDP-11 Microcomputer
  - 60,000 characters of solid state memory
  - Integral floating point
  - Line-frequency clock
  - Interface for Video Graphics Terminal, optional line printer and two additional ASCII format serial-line devices (total of 4)
  - IEEE Interface
  - Automatic program load and Diagnostic Module
- Twin, front-loaded Floppy Disk Drives
  - A million characters of random access memory
  - Double-density recording (DMA)
- Video Graphics Terminal with separate keyboard
- MINC Box with slots for eight optional laboratory interface modules including:
  - Analog-to-Digital Converter (16 channels)
  - Analog Multiplexers
  - Analog Preamplifiers
  - Real-time Clocks
  - Digital-to-Analog Converters (4 channels)
  - Digital Outputs (16 lines)
  - Digital Inputs (16 lines)
- ENHANCED BASIC software for computation, graphics and instrument control
- Application software
- Complete Documentation including:
  - "Unpacking and Installing MINC"
  - "Introduction to MINC"
  - "MINC Programming Fundamentals"
  - "MINC Programming Reference"
  - "MINC Graphic Programming"
  - "MINC IEEE Bus Programming"
  - "MINC Lab Module Programming"
  - "Working With MINC Devices"
  - "MINC System Index"

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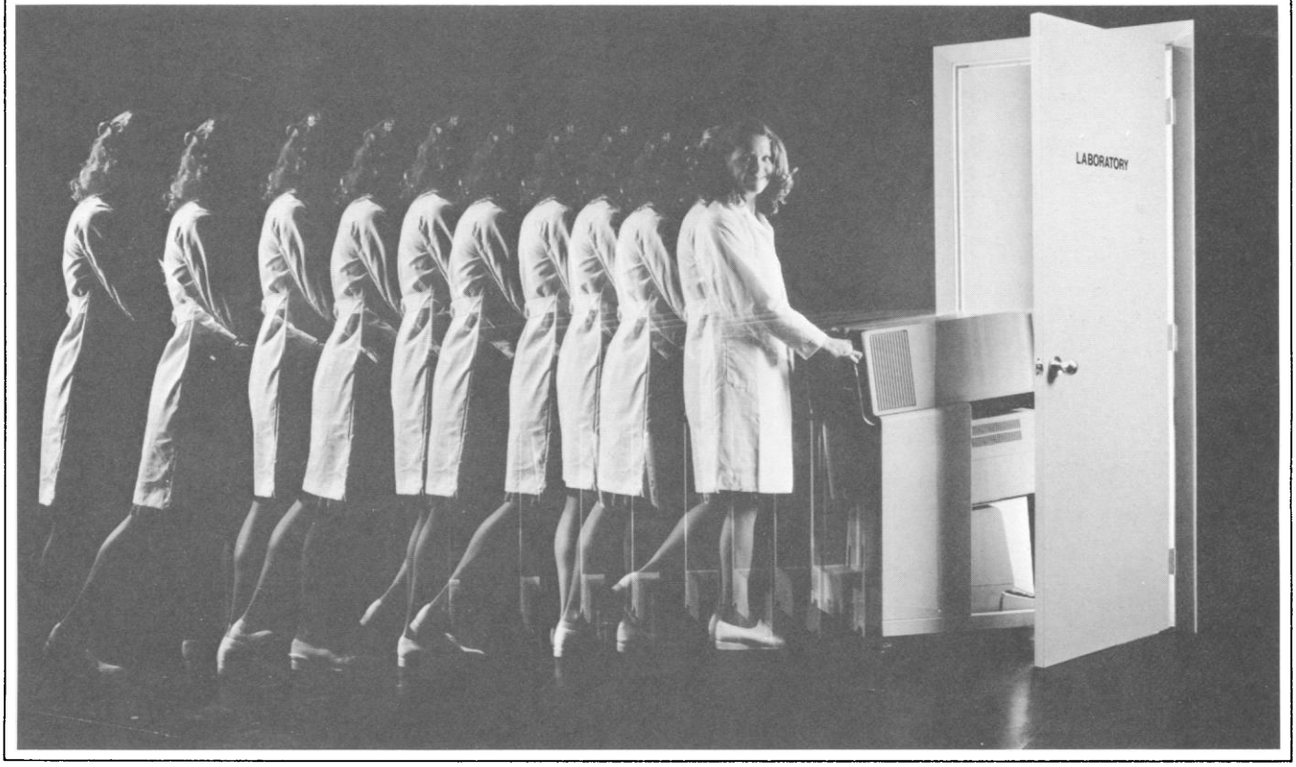

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Annual Meeting

Houston

3–8 January 1979

Tours and Cultural Events

For the Annual Meeting Program, please see the Preliminary Program in the 29 September issue of *Science*, pages 1207–1213. Tours are limited to Meeting Registrants only. Please see map on page 210. This was inadvertently omitted from the 29 September issue.

Tours

1. The Texas Medical Center—Open Heart Surgery: Thursday, 4 January, 8:30 a.m.–noon.

Cardiovascular surgery (depending on scheduling of suitable operations); National Heart and Blood Vessel Research and Demonstration Center, including demonstrations of new diagnostic tests for heart disease, vision and hearing loss; and the prosthesis laboratory.

2. Armand Bayou Nature Center: Thursday, 4 January, 8:30 a.m.–1:30 p.m.

Guided cruise, audiovisual presentation, and nature walk.

3. Houston Ship Channel:

3a. Thursday, 4 January, 1:15 p.m.–4:15 p.m.

3b. Saturday, 6 January, 9:00 a.m.–12:15 p.m.

Cruise/tour of industrial complex with discussion of its construction and development.

4. Astrodome:

4a. Thursday, 4 January, 2:00 p.m.–4:00 p.m.

4b. Sunday, 7 January, 2:00 p.m.–4:00 p.m.

Multimedia presentation; discussion of unique construction and engineering aspects of stadium.

5. Exxon's Baytown Manufacturing Complex: Thursday, 4 January, 1:30 p.m.–4:15 p.m.

Technical orientation; refinery facilities; chemical, rubber, and plastic manufacturing units; research installation; pollution controls.

6. The Texas Medical Center—Cancer Research: Friday, 5 January, 9:30 a.m.–noon.

M. D. Anderson Hospital and Tumor Institute, facilities and various laboratories and research activities.

7. NASA Lyndon Baines Johnson Space Center: Friday, 5 January, noon–6:00 p.m.

Space Museum, training facilities, Mission Control Room, Mission Simulation Areas; discussion of technological, medical, scientific, and engineering experiments.

8. The Texas Medical Center—Nuclear Medicine: Friday, 5 January, 1:30 p.m.–3:30 p.m.

St. Luke's Episcopal Hospital; Computerized Axial Tomographic (CAT) scanners including Delta Whole Body Scanner and other nuclear energy applications in medicine.

9. Museum of Natural Science: Saturday, 6 January, 9:45 a.m.–noon.

Hall of Space Science; Hall of Petroleum Science; Dinosaur Exhibit; Museum of Medical Science, including (TAM) Transparent Anatomical Mannequin; and Burke Baker Planetarium.

10. All-Day Galveston Tour: Sunday, 7 January, 9:00 a.m.–5:30 p.m.

Galveston's sea-wall, yacht harbor; 19th century commercial and residential districts which are historically and architectually significant. (Lunch not included; facilities available.)

11. Museum of Fine Arts: Sunday, 7 January, 9:30 a.m.–noon.

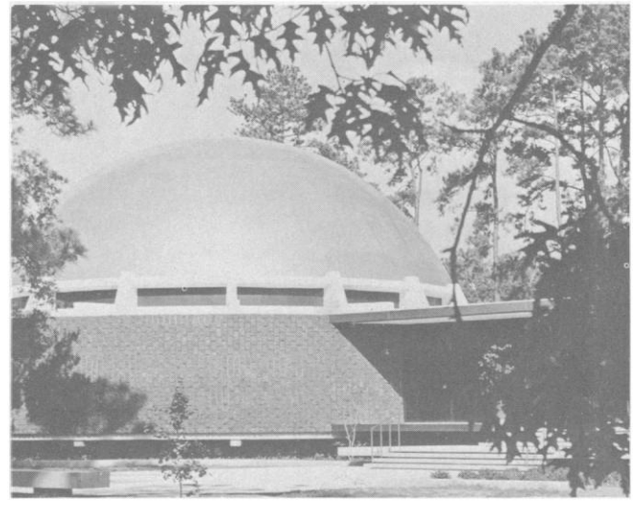
Remington's westerns, European and American masterworks, pre-Columbian, African, and Oceanic artifacts.

12. The Texas Medical Center—Trauma and Family Center: Monday, 8 January, 9:30 a.m.–11:30 a.m.

Hermann Hospital; emergency helicopter transport system, neonatal intensive care units, Birthing Suite.

13. Shell Research Center: Monday, 8 January, 1:00 p.m.–4:30 p.m.

Product and engineering laboratories, including polymer research, and other special applications laboratories.



Burke Baker Planetarium. [Greater Houston Convention and Visitors Council]

In keeping with a long and honored tradition, the forthcoming AAAS Annual Meeting in Houston (3–8 January 1979) will feature an excellent selection of tours. Using the form on this page, please make advance reservations as soon as possible, as space is limited and early commitment must be made to the host organizations. Tickets will be held at the Ticket Desk in the Meeting Registration Area (Grand Ballroom Foyer of the Shamrock Hilton Hotel) and should be picked up at least 24 hours before the tour. A nominal charge will be made to defray transportation costs. Handicapped persons who need assistance for the tours (or for any Meeting function) should consult the staff at the Resource Center for Disabled Persons in the Venetian Room (third floor, Shamrock Hilton). *The times listed for each tour are the actual departure time from the Shamrock Hilton Hotel and the estimated time of return to the hotel, respectively.*

Further information concerning places to see and cultural events in the Houston area during the Meeting can be obtained at the Welcome Center in the Grand Ballroom Foyer.

Annual Meeting
Houston
3–8 January 1979

Reservation Form for Tours

AAAS Meeting registrants who wish to reserve tickets for any of the tours should complete the coupon below and mail it in as soon as possible—space is limited. Tickets should be picked up (and nominal bus fare paid) at the AAAS Ticket Desk in the Meeting Registration Area (Grand Ballroom Foyer, Shamrock Hilton Hotel) during the Annual Meeting, approximately 24 hours in advance of the scheduled tour. Do not send any remittance with this coupon; it is a reservation form only. Please note that tours are limited to Meeting registrants only.

Tour	No. of Tickets
1. Open Heart Surgery [Thur., 4 Jan., 8:30 a.m.–noon]	_____
2. Armand Bayou [Thur., 4 Jan., 8:30 a.m.–1:30 p.m.]	_____
3a. Houston Ship Channel [Thur., 4 Jan., 1:15 p.m.–4:15 p.m.]	_____
3b. Houston Ship Channel [Sat., 6 Jan., 9:00 a.m.–12:15 p.m.]	_____
4a. Astrodome [Thur. 4 Jan., 2:00 p.m.–4:00 p.m.]	_____
4b. Astrodome [Sun., 7 Jan., 2:00 p.m.–4:00 p.m.]	_____
5. Baytown Refinery [Thur., 4 Jan., 1:30 p.m.–4:15 p.m.]	_____
6. Cancer Research [Fri., 5 Jan., 9:30 a.m.–noon]	_____
7. NASA/LBJ Space Ctr. [Fri., 5 Jan., noon–6:00 p.m.]	_____
8. Nuclear Medicine [Fri., 5 Jan., 1:30 p.m.–3:30 p.m.]	_____
9. Museum of Natural Sci. [Sat., 6 Jan., 9:45 a.m.–noon]	_____
10. Galveston [Sun., 7 Jan., 9:00 a.m.–5:30 p.m.]	_____
11. Museum of Fine Arts [Sun., 7 Jan., 9:30 a.m.–noon]	_____
12. Trauma and Family Ctr. [Mon., 8 Jan., 9:30 a.m.–11:30 a.m.]	_____
13. Shell Research Ctr. [Mon., 8 Jan., 1:00 p.m.–4:30 p.m.]	_____

Total Number of Tickets Reserved _____

Name_____

Address_____

City_____ State/Zip_____

Mail to: AAAS Meetings Office
1776 Massachusetts Avenue, NW
Washington, D.C. 20036

1886–87 Jacob Sonnentheil House. [Galveston Historical Foundation]

AAAS Science Film Festival

The AAAS Science Film Festival continues to be a popular feature of the Annual Meeting. The 1979 Festival is a unique collection of educational and entertaining films dealing with science and technology, the social sciences, social issues, and human concerns.

The Festival will run from 10:00 a.m. to 3:00 p.m. Thursday, 4 January, through Sunday, 7 January, in the Cabaret Theatre of the Shamrock Hilton Hotel. Classes accompanied by a teacher are welcome; young people under the age of 10 must be accompanied by an adult. Admission is free.

Further information concerning the Film Festival will be published in the Annual Meeting Program.

Thursday, 4 January

10:00 a.m.	Strategy for Survival: Behavioral Ecology of the Monarch Butterfly
10:29 a.m.	Guale
11:28 a.m.	The Middle Years
11:50 a.m.	Transition Generation: A Third World Problem
12:11 p.m.	Of Time, Tombs and Treasure: The Treasures of Tutankhamen
12:39 p.m.	The Green Machine
1:30 p.m.	The Miracle of Life
1:42 p.m.	Harpsichord Builder
2:10 p.m.	Get It Together
2:30 p.m.	The Family of Japan

Friday, 5 January

10:00 a.m.	Beneath the Frozen World
10:23 a.m.	Out of the Mouths of Babes: The Acquisition of Language
10:51 a.m.	Death of a Gandy Dancer
11:16 a.m.	Water
11:27 a.m.	Greenpeace Voyages to Save the Whales
11:56 a.m.	Now you See Me, Now You Don't
12:16 p.m.	Manimals
12:45 p.m.	100 Watts 120 Volts
12:51 p.m.	Neighbors: Conservation in a Changing Community
1:18 p.m.	Fetal Alcohol Syndrome
1:31 p.m.	Massachusetts Story
2:28 p.m.	The Marginal People

Saturday, 6 January

10:00 a.m.	The Look of America
10:27 a.m.	Marek
11:13 a.m.	Volcano: Birth of a Mountain
11:37 a.m.	The Cry of the Gull
12:04 p.m.	Spaceborne
12:19 p.m.	The Gene Engineers
1:16 p.m.	The Detour
1:30 p.m.	Come Into My Parlour, Said the Spider
1:51 p.m.	Wellsprings
2:58 p.m.	A Waterproof Arboreal Frog

Sunday, 7 January

10:00 a.m.	Galveston: The Gilded Age of the Golden Isle
10:53 a.m.	Donnie
11:13 a.m.	Rhesus Play
11:38 a.m.	Number Our Days
12:07 p.m.	Killer Bees: Fact or Fantasy
12:21 p.m.	Who Are the Debolts, And Where Did They Get 19 Kids?
1:33 p.m.	Firewood: the Other Energy Crisis
1:44 p.m.	Pakistan: Mound of the Dean
2:11 p.m.	Let's Get a Move On
2:35 p.m.	Jackson's Chameleon: Locomotion and Prey Capture
2:48 p.m.	Hardware Wars

Annual Meeting
Houston
3–8 January 1979

MAIL TO:
AAAS—DEPT. R
1515 Massachusetts Ave., NW
Washington, D.C. 20005

ADVANCE REGISTRATION FORM (B)

• *PLEASE READ CAREFULLY* •

- Preconvention Program, badge, and voucher for full Program and Abstracts will be mailed to registrants in early December.
- Full Program and Abstract Volume will be held at *Advance Registrants' Desks* (Shamrock Hilton and Marriott hotels).
- **Registrations received after 15 December will be held at the AAAS Information Booth.**

PART I: Registrant's name and mailing address for receipt of badge(s), preconvention program(s), and *Science* (for new applicants)

(FIRST NAME) (LAST)

(STREET ADDRESS OR P.O. BOX NUMBER)

(CITY) (STATE) (ZIP—U.S.A.)

(COUNTRY) (AREA CODE) (PHONE NUMBER)

(NAME OF INSTITUTION OR COMPANY)

PART III: Additional registrant(s) with same mailing address (use separate form if address differs)

(FIRST NAME) (LAST)

(FIRST NAME) (LAST)

PART II: Check ☑ categories of registration and enclose amount(s) indicated

Meeting Registration Categories	Single	Double (incl. Spouse)
AAAS Member	☐ $25	☐ $38
☐ Student or ☐ Retired Member *(Check one)*	☐ $13	☐ $20
Non-Member	☐ $31	☐ $44

Non-Members applying for membership with registration (check below): Dues of $31 (single) and $43 (double) includes one subscription to *Science* (52 issues per year). Rates are domestic-regular membership. Inquire for Canadian, other foreign, student, and retired persons.

☐ $56 Meeting registr. and single membership

☐ $69 Double registr. and single membership

Name of Member: _____

☐ $81 Dougle registr. and double membership

NOTE: Special one-day attendance registration will be available at Registration Desks.

CONVENTION ADDRESS: _____
(Where you can be reached) (Hotel, Street Address, and/or Phone No.)

Check days attending: Wed ☐ Thu ☐ Fri ☐ Sat ☐ Sun ☐ Mon ☐

☐ **Please check here if you need special services due to handicap. We will contact you prior to the meeting.**

SURVEY OF ATTENDANTS
Annual Meeting, Houston, 3–8 January 1979

Your answers to the following questions will help us in planning future AAAS Annual Meetings. Please complete the following form and either return it with your registration form or send in separately (to the same address) if you wish to respond anonymously (in any case, the two forms will be processed separately).

Principal Professional Interest
11 ☐ Physical, mathematical
12 ☐ Biological, medical
13 ☐ Engineering
14 ☐ Social, behavioral
15 ☐ Science policy
16 ☐ ..... (other)

Principal Professional Activity
21 ☐ Teaching, education
22 ☐ Health practice
23 ☐ Other practice, consulting
24 ☐ Research, development
25 ☐ Administration
26 ☐ ..... (other)

Institutional Affiliation Type
31 ☐ University, 4-year college
32 ☐ Other educational
33 ☐ Industrial, commercial
34 ☐ Other private
35 ☐ Government
36 ☐ ..... (other)

Highest Educational Level
41 ☐ Doctoral Degree
42 ☐ Master's Degree
43 ☐ Other professional
44 ☐ Bachelor's Degree
45 ☐ ..... (other)

Age
51 ☐ Under 26 years
52 ☐ 26 to 35 years
53 ☐ 36 to 45 years
54 ☐ 46 to 55 years
55 ☐ 56 to 65 years
56 ☐ Over 65 years

Number of Past AAAS Meetings Attended
61 ☐ None
62 ☐ One
63 ☐ Two
64 ☐ Three
65 ☐ Four
66 ☐ Five or more

Distance Traveled to Meeting
71 ☐ Under 51 miles
72 ☐ 52 to 150 miles
73 ☐ 151 to 400 miles
74 ☐ 401 to 1000 miles
75 ☐ 1001 to 3000 miles
76 ☐ Over 3000 miles

FOR HOUSING BUREAU USE ONLY

MAIL TO:
AAAS HOUSING BUREAU
1522 Main Street
Houston, Texas 77002

Annual Meeting
Houston
3-8 January 1979

OFFICIAL HOUSING REQUEST FORM

(Reservations received after 13 December cannot be guaranteed)
• *PLEASE READ CAREFULLY* •

- Please *PRINT* or *TYPE* all items to assure accuracy.
- Complete each part below in detail for correct and rapid computer processing.
- Should more than *ONE (1) room* be needed, supplemental room list *MUST* be attached using same format as in Part III.
- *ALL* confirmations will be sent to individual indicated in Part I.

PART I: Complete requested data using abbreviations as necessary.

NAME OF PERSON REQUESTING ROOMS:

(FIRST NAME) (LAST)

(NAME OF COMPANY OR INSTITUTION)

(STREET ADDRESS OR P.O. BOX NUMBER)

(CITY) (STATE) (ZIP - U.S.A.)

(COUNTRY) (AREA CODE) (PHONE NUMBER)

PART II: Select *THREE* hotels or motels of your choice, using *HOTEL CODES* listed below. No request will be processed without *THREE* choices.

First Choice ☐☐☐☐ (HOTEL CODE)

Second Choice ☐☐☐☐ (HOTEL CODE)

Third Choice ☐☐☐☐ (HOTEL CODE)

PART III: **1.** Select type of room desired. **2.** *Print* or *type* names of *all* persons occupying room (last names first). **3.** Enter arrival and departure dates and times.

Check one: **ROOM:** ☐ Single ☐ Double ☐ Twin **SUITE:** ☐ Parlor + 1 Bedroom ☐ Parlor + 2 Bedrooms

Please indicate any special housing needs due to a handicap: _____

Names of all Occupants of Room (Print last name first)

1. _____ 3. _____

2. _____ 4. _____

ARRIVAL DATE: _____ **TIME:** _____ ☐ a.m. ☐ p.m.

DEPARTURE DATE: _____ **TIME:** _____ ☐ a.m. ☐ p.m.

Note: Be sure to list definite arrival and departure date and time. Reservations will be held only until 6 p.m. unless special arrangements are made with hotel. The hotel may request a deposit.

Hotel Room Rates (Add 7% hotel tax)

Hotel	Hotel Code	Single	Double & Twin	Parlor + 1 Bedrm.	Parlor + 2 Bedrms.
Shamrock Hilton (*Headquarters*) [circle preferred rate]	**SH**	$32, $36, $40	$44, $48, $52	$80	$120
Houston Marriott	**MMH**	$30	$38	$100	$135
Astro Village Tower & Lodge	**ASVI**	$30	$36	$100	$135
Holiday Inn—Astro Village	**HIAV**	$28	$34	$75	$100
Tidelands Motor Inn	**TLM**	$26	$33	—	—
Tides II Motor Inn	**TLII**	$28	$35	$60	$100

IMPORTANT: No phone orders will be accepted. Hotel locations are shown on map. Housing Bureau processes reservations in order of date received. Confirmations will come direct from your hotel. DO NOT SEND DEPOSITS WITH RESERVATIONS. If rooms are not available at hotels of your choice, comparable reservations will be made at another cooperating hotel. If rate requested is not available, next available rate will be assigned. Cancellations must be made through the Housing Bureau only; other changes should be made directly with hotel.

For further information see pages 1206–1216, 29 September issue; for Houston map see page 210 in this issue.

aas Annual Meeting Houston

3-8 January 1979

EASTERN and CONTINENTAL Airlines are making it easier than ever for you to attend our Annual Meeting.

Their CONVENTION CENTRAL TRAVEL COORDINATORS are briefed on all details of the meeting and are especially trained to assist you in booking your air accommodations to Houston. But that's not all!!! They can also plan pre or post convention vacations to a variety of exciting places.

If you want to bask in the sun you may choose one or several of the tropical paradises that EASTERN has to offer in Florida, Mexico or the Caribbean.

Or maybe you would prefer a skiing vacation in the Rockies or the dry, sunny air of the Southwest...CONTINENTAL will help you get there.

ACT NOW!!!...the sooner the better...early January is a busy time for travelling...plus, if you make your reservations early you may be eligible for some discounted fares, including the new Super Savers!!!...inquire about EASTERN's Unique Unlimited Mileage Fare, you'll be surprised how far your travel dollars can go!!!

Unlisted toll-free numbers to their Convention Desks are being provided by EASTERN and CONTINENTAL according to geographical location as shown on the map above.

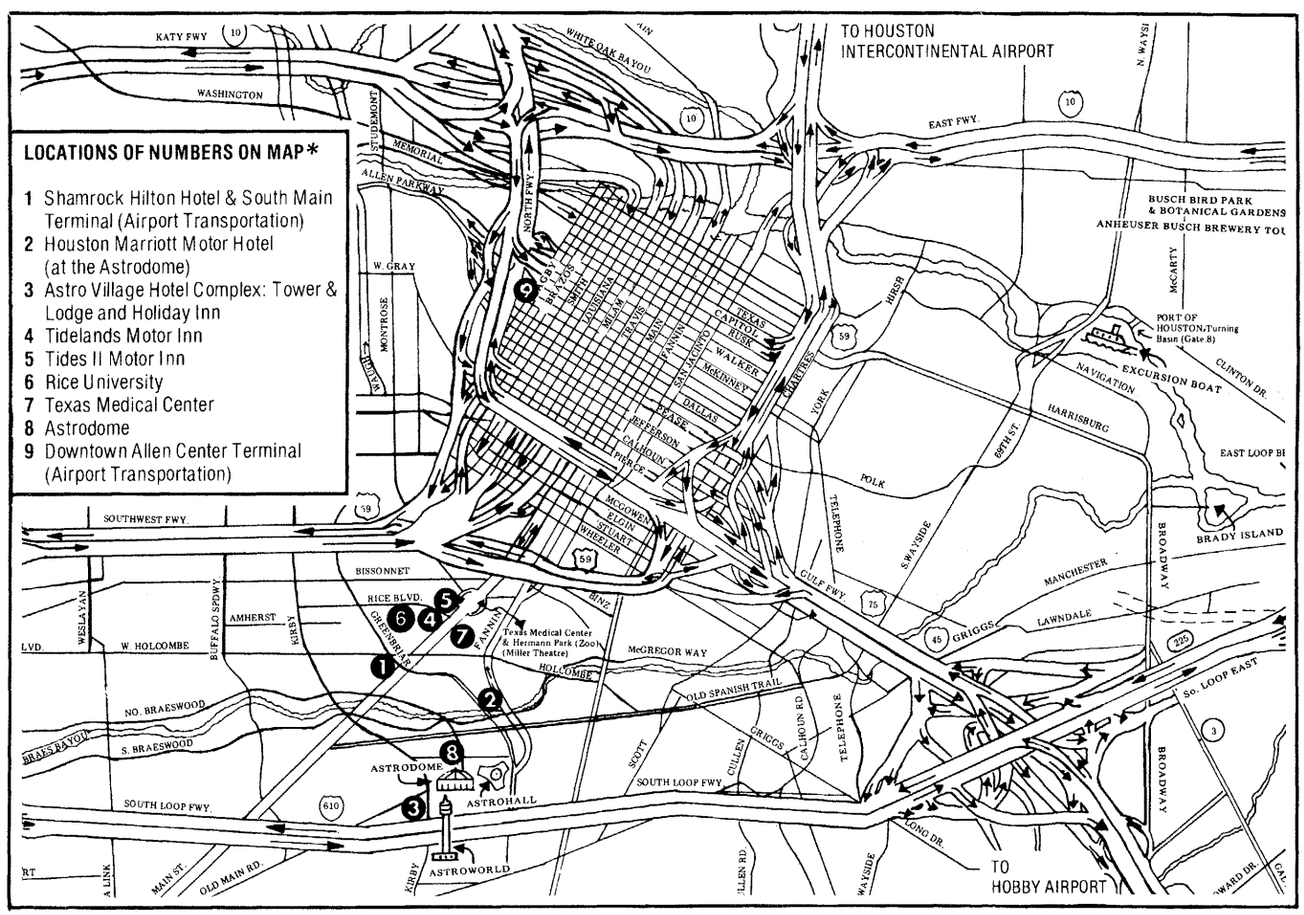
Remember These Numbers...

West of the Mississippi, call 800-525-1130

CONTINENTAL AIRLINES

East of the Mississippi, call 800-327-1295

EASTERN



*Map is not to scale. Approximate distance from Shamrock Hilton (1) to Houston Marriott (2) is ½ mi.; to Astro Village (3), 2 mi.; to Tidelands (4) and Tides II (5), ¼ mi.; to downtown Houston (9), 4 mi.