SCIENCE 26 September 1969
Vol. 165, No. 3900
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Index Issue

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If there's one area we are especially proud of in the years since we introduced the commercial electron microscope, it's the reputation we've earned for building dependable instrument systems. A typical example is the new Model 101. The Siemens "101" is a total system concept. Each component is engineered to provide consistent performance —plate after plate, year after year—whether you produce 10 plates, or 10,000 plates a year.

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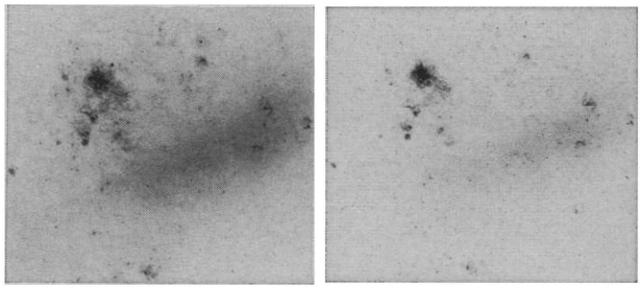
Kodak

Does this help any?

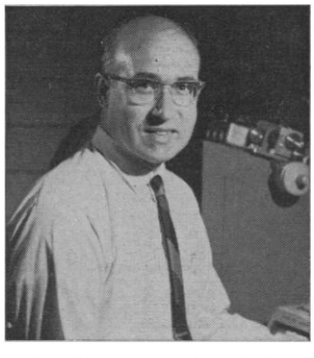


This past February, Bart J. Bok (University of Arizona) compared the new KODAK Special Plate 098-01 (left) with the long-established KODAK Spectroscopic Plate, Type 103a-E on the Curtis-Schmidt Telescope (University of Michigan) at Cerro Tololo, Chile. Looking for 60 minutes at the 30 Doradus Nebula in the Large Magellanic Cloud, our new emulsion not only shows the Axis of the Large Cloud far better but also catches an $H\alpha$ nebulosity hardly shown by the other. An improvement in $H\alpha$ visualization is to an astronomer what a better harvesting machine is to a potato farmer.

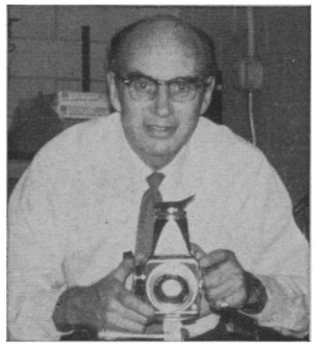
Astrologers have been among the most influential of men. When the other savants turned on them and proclaimed them fakers, the surviving honest students of the stars fell far in influence. Through a long and patient recovery, they have won high respect from those of us with a more selfish life style.

It is hard to explain convincingly why we keep scraping the art of photographic emulsion-making to earn the approbation (and not a great deal more) of a group of customers, far from rich but very smart, all of whom could fit comfortably into a single lecture room of moderate size. The Working Group on Photographic Materials of the American Astronomical Society did exactly that this past summer. This was the occasion for the first issue of the periodical *AAS Photo-Bulletin*, which we are having printed for them under their own editor, with one of our own star-struck technical advertising men helping from his own home on his own time. We have lived in this servile awe of astronomers for at least 50 years, and it hasn't impeded our progress noticeably.

Man's most photosensitive scheme



Paul Gilman, as photographed by Bob Phillips



Bob Phillips, as photographed by Paul Gilman

Bob Phillips is the better photographer, but Paul Gilman does more for photography. This is as it should be, for Mr. Phillips is a senior man in our Photo Illustrations Division, while Dr. Gilman is a Research Associate of the Kodak Research Laboratories who specializes in those organic molecules that absorb photons and pass a resultant something to silver halide crystals. More specifically, he studies how the transfer is accomplished. Without that phenomenon and improvements effected over the years, photography would never have amounted to much, and astronomers might still be scrapping with astrologers, if for no better reason than to rest their eyeballs.

To tell *all* that Gilman and the others in his specialty do for photography would be not unlike buying a large fleet of expensive limousines and lining them up with doors open and motors running beside a sign reading, "Take a few. They're free."

On the other hand, no respectable scientist latching onto any fundamental information about man's most photosensitive device—which is what these dye molecules and their associated AgX crystals are—is willing to keep it a secret any longer than required to make sure he speaks the truth.

Lately, William West of our Laboratories and Gilman have devoted the open portion of their work to fluorescence and phosphorescence as indicators of possible mechanisms in the dye-to-AgX transfer. Much involved are the phenomena of supersensitization (which gave a mighty boost to our fortunes and to the art of photography and the motion picture when we popped it on the world in the early '30s) and of J-aggregation (a very special two-dimensional ordering of the dye molecules named in honor of the late E. E. Jelley of our Laboratories and subsequently found to have broad implications elsewhere, as in the detection of biological macromolecules).

Under the title "Recent Observations on Spectral Sensitization and Supersensitization," a current summing-up of this securely fundamental work appears in the September-October '69 issue of Photographic Science and Engineering. *To dig out of it thoughts applicable beyond photography (or not beyond photography, for that matter) may prove no mean task. Reprint available from Senior Advertising Associate, Eastman Kodak Company, Rochester, N.Y. 14650.*

Where the lanterns hang

The noncovalent festooning of big molecules by little ones possessing special radiative properties can do more than detect the big ones. The fluorescence can shed light on the hidden details of their construction, as you can read in a splendid tutorial paper in *Accounts of Chemical Research:1*, 65 (March, 1968). We offer the compounds designated therein as 1,8-ANS, 2,6-TNS, and DNS* (as well as others of similar purpose, along with a cordial invitation to cast a vote with Eastman Kodak Company, Eastman Organic Chemicals, Rochester, N.Y. 14650, for our adding still others).

These compounds exhibit very little fluorescence in polar media until they attach themselves to hydrophobic sites on proteins, such as the heme crevice in hemoglobin. In many proteins, hydrophobic groups are enfolded too deep within to be reached until some denaturation has occurred, which the fluorescence then signals. Beyond this, the authors look forward to the use of fluorescent probes in detecting more interesting conformation changes that are reversible.

From Tennessee, meanwhile, where we conduct basic research on less intricate macromolecules—nonbiological ones—, we hope soon to contribute some interesting findings of our own on what polarization and anisotropy of emission from a fluorescent probe show about orientation in the amorphous regions of fibers.

*1,8-ANS = EASTMAN P10296
2,6-TNS = EASTMAN 10613
DNS chloride = EASTMAN 9090

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26 September 1969
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SCIENCE

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COVER

A 7.6-centimeter square of the lunar surface photographed with a special close-up camera carried on the Apollo 11 flight. The picture shows a region inside a small crater in which some objects glitter, apparently due to having a glazed surface. See page 1345. [National Aeronautics and Space Administration]

How to put today's instrumentation to work for you.

New electronic probe can magnify, then analyze tiny specks with X-rays.

The Philips 4500 Electron Probe Microanalyzer offers the analytical chemist simultaneous optimization for operation as an electron probe microanalyzer and a scanning electron microscope.

The new microprobe system contains computer-adaptable spectrometry scanning, specimen stage drives and sample current metering. Up to four two-crystal x-ray spectrometers, combined with a dual lens electron optical system, permit qualitative and quantitative analysis of submicron to three inch samples from Boron up in the atomic table.

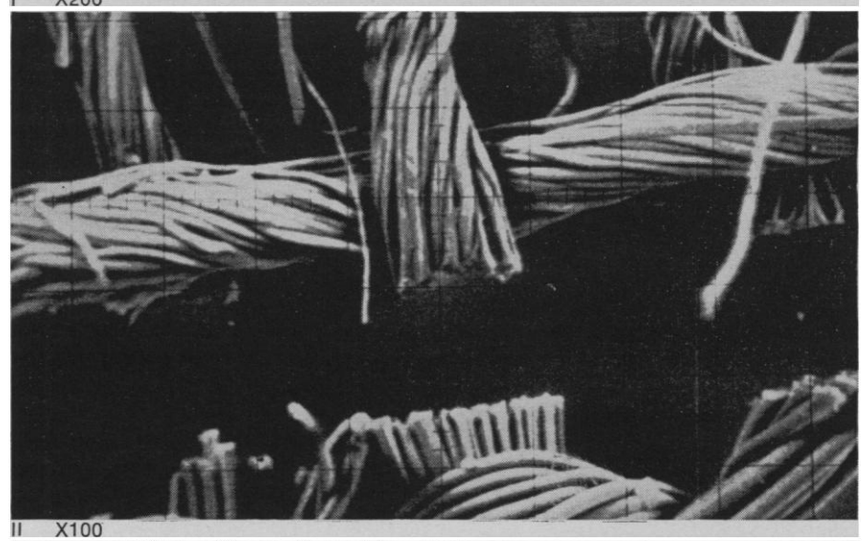
Typical applications are illustrated by the micrographs on the right. I is a scanning electron micrograph (back scatter electrons) of a typical integrated circuit. Instrument capability includes study of sample structure and morphology combined with the ability to analyze contamination spots which might cause circuit malfunction.

II is a scanning electron micrograph (back scatter electrons) of a cut edge of cloth. Applications in textile industries include not only study of fiber morphology but also studies involving analysis of contaminating layers, coatings, etc. Multiple spectrometers permit simultaneous analysis for up to 4 elements. High take-off angle permits examination of relatively rough surfaces.

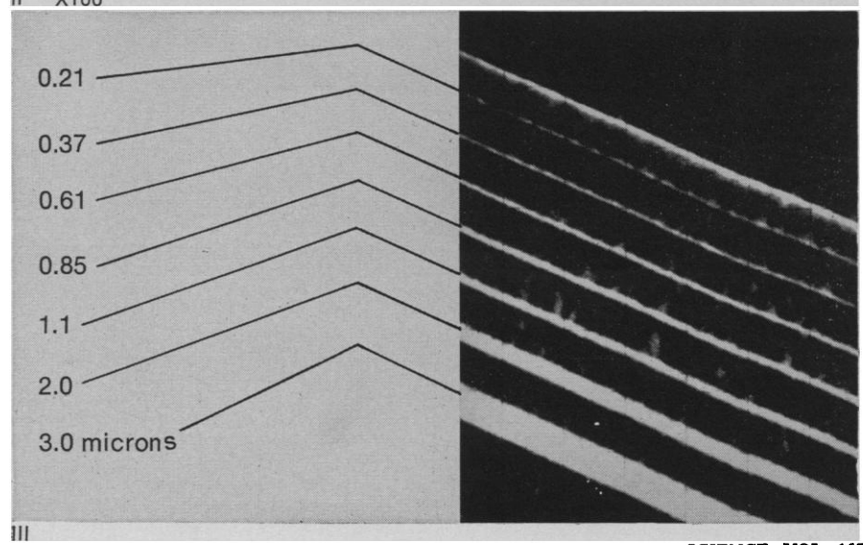
III. Back scattered electron images of copper-gold sandwiches demonstrate special resolution and minimum electron spot size in the electron probe mode of operation. The smallest copper layer visible is .21 micrometers. Optimization of the instrument for scanning electron microscope resolution to 500 A generally requires only the selection of limiting apertures and adjustment of lens current.

For full details, circle #1.

I X200



II X100



III

PHILIPS
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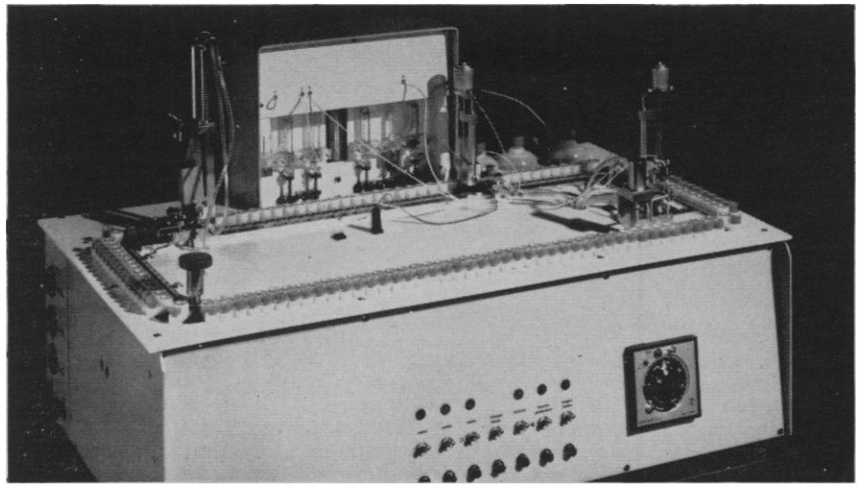
INSTRUMENTS

Analyze 120 samples an hour



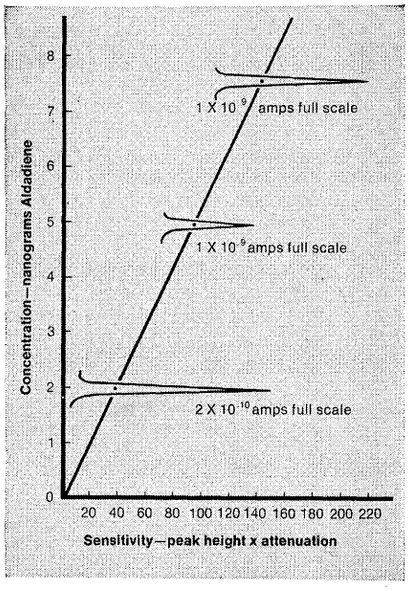
The new AC 60 Automatic Chemistry Systems are an outstanding choice for the busy routine laboratory and are the lowest cost systems available.

They are fully automated; so simple to operate that unskilled staff can be trained rapidly because both programming and interchanging of analysis schemes is simple and foolproof.

Typical methods include: Protein, Glucose, Urea, Inorganic Phosphorus, Haemogloben, Magnesium, SGOT, SGPT, Cholesterol, Ammonia Nitrogen, etc.

Circle #2.

Automated analysis of Aldadiene steroid using high temperature EC Ni 63 detector and auto solid sample injection.



The new Series 104/106 Gas Chromatograph offers you the following:

- modular design
- multiple detectors
  high sensitivity
  high specificity
  high temperature EC Ni 63 capability
- high column performance
- automatic solid sample injection
- computer compatible

Circle #4.

New computer-controlled X-ray spectrometer offers greater accuracy and speed.

The new PW1220C Sequential X-Ray Spectrometer permits computer analysis from one reference standard sample, in one example, of more than 200 different steel alloys, measuring 24 different elements ranging from trace quantities up to major concentrations. The computer calculates the concentrations using just one reference standard sample for all alloy types.

The PW 1220C can be supplied complete with required hardware and software necessary to meet the needs for specific applications in industries such as cement, glass, steel, and for processes involving sintering and production of lubricating oils. Extremely complicated analysis associated with inter-element effects, involving complex equations, can be solved without the danger of human error or increase in manpower.

Programs are available for 4K and 8K systems. The program best suited for you depends on your analytical problem.

For full details, circle #3.

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Pollution that assaults the lungs, the digestive tract, the ear ... and how effective instruments can lead to abatement

The Lungs

Until very recently, Molecular Rotational Resonance (MRR) Spectroscopy often seemed like a brilliant scientific breakthrough destined to remain an ivory tower curiosity for lack of a practical application in the real world of quantitative analysis.

In its pristine form, MRR allowed the scientist to look into molecular structure by measuring changes in the absorption of microwave energy which result from transitions between rotational energy levels in a polar molecule. Because differences exist in the composition or geometry of individual molecular species, there is a characteristic MRR spectrum for each molecule. Absorption peaks are unique for each molecule and MRR readily differentiates between them, even in a complex mixture, because of its inherent specificity. In the usual case, measuring the frequency of a single absorption line completely identifies the molecule.

MRR has recently been shown to be a practical quantitative tool too. In a paper published in the *Journal of Chemical Physics* (46, 3698, 1967) the response of the HP 8400B MRR Spectrometer was shown to be linear with concentration from the lowest detectable limit to 100%. More recent work with common air pollutants (SO_2, NO_2, hydrocarbons) has demonstrated that MRR gives a quantitative response for each gas, even in the complex mixtures that are commonly associated with air pollution samples. The actual sensitivity limit for SO_2 has been determined at 3.5 nanograms without using concentration techniques (... this corresponds to a concentration of 11.6 ppb in a one liter sample). To further enhance its usefulness in the quantitative analysis of air pollutants, most MRR experiments are carried out at low pressures—typically 10-15 μ Hg—a condition that greatly reduces the rate at which the pollutants react with each other.

Precisely where the MRR Spectrometer fits into the pattern of analytical chemistry is still being studied. Based on the work reported above, it certainly should be considered for air pollution analysis, especially for calibrating on-site air pollution monitors. Results of experimental work in air pollution and other significant analyses with the MRR Spectrometer are published regularly in *Molecules and Microwaves*, a copy of which awaits your request.

The Digestive Tract

In the days before Rachel Carson's *Silent Spring*, the only popular connection between pesticides and the human digestive tract was benign: one was reassured that large parts of the world would be hungry, even suffer famine, except for the beneficial effect of pesticides on agricultural production. Nowadays, it's more common to hear warnings from respected scientific sources that pesticides constitute a real and present danger to life on this planet because they are ingested as residues in the food we eat and the liquids we drink.

These are not mutually contradictory arguments so much as they are accurate descriptions of both sides of the split personality of pesticides. The only conceivable solution to this very human dilemma is better control of the use of pesticides, and more careful analysis of pesticide residues in foodstuffs.

Enter the gas chromatograph (GC). While the men engaged in pesticide detection are many and far-flung, instrumentation for this sensitive work falls almost solely on the GC. On this basis, Hewlett-Packard has directed much research effort towards perfecting both instrumentation and technique. Although pesticide detection is still most often recorded in the nanogram range, an HP GC—more than four years ago—separated a laboratory pesticide sample at the picogram level. Most of this chemical detective work is being performed on the HP Model 402 High-Efficiency GC—an instrument perfected especially for this and other biochemical research. HP's pesticide analysts prefer to use this instrument equipped with an electron capture type of detector. The latter employs a radioactive tritium source to produce electrons whose capture by the pesticide molecules is a direct measure of their presence. Recently, HP chemist-designers have perfected a new electron capture detector that employs a radioactive Ni^{63} source that is more stable at higher temperatures thereby holding out a promise of more searching pesticide detection than the older tritium type can accomplish.

Sometimes the inherent difficulty of pesticide analysis is resolved by improvements in technique rather than hardware. HP chemists have developed special techniques for the analysis of pesticide residues in many foodstuffs, and sample extraction techniques for the analysis of bovine and human milk.

If you'd care to pursue this subject in more depth, write for Applications Lab Report 1003, yours on request.

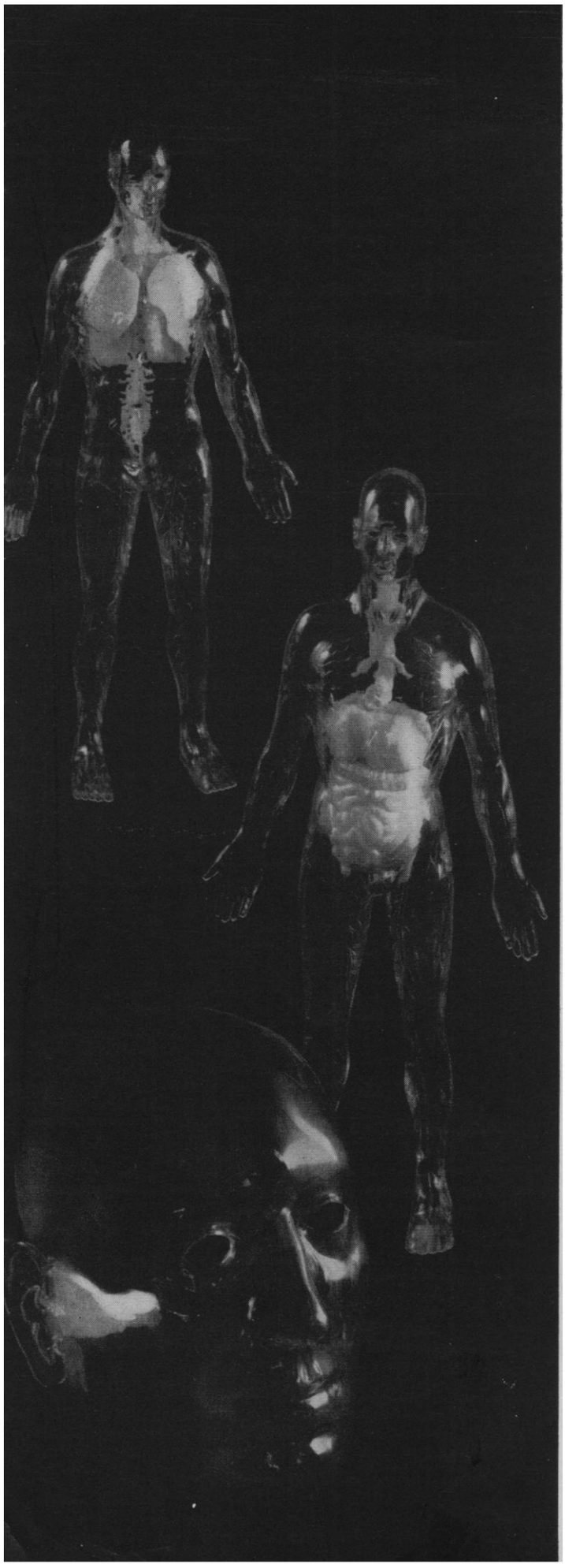
The Ear

Well played by a fine orchestra, Brahms can only be described as beautiful. But reproduced too loud on a cheap phonograph, it's noise. An increasingly widespread and serious form of pollution, noise can make us uncomfortable; prolonged loud noise damages hearing; very loud noises can cause pain, psychosis and even death.

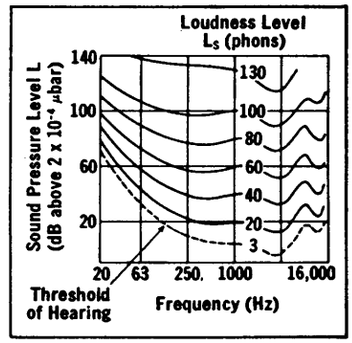
Obviously the time has come to control this form of 20th century environmental pollution. When HP scientists turned their talents to noise measurement, they ran into a very unusual problem. Objectively sound is simply a matter of rapidly changing air pressure, easy to measure with traditional sound level meters. But noise is really not an objective phenomenon: what the ear hears is a subjective sensation of loudness involving complicated physiological and psychological mechanisms.

For an instrument to measure sound as the ear hears it, it must imitate the unique properties of the ear. Take loudness level which is traditionally measured in *phons*. Although the logarithmic phon scale covers the large dynamic range of the ear—120 dB—it does not fit a subjective loudness scale. The trouble is that a noise that sounds twice as loud as another does not measure double the number of phons. So a subjective measure of loudness was developed by international agreement in which the unit is a *sone* and whose scale corresponds closely to the subjective sensation of loudness. For example, the comparison between a jet takeoff and a quiet conversation is 3:1 in phons (120 vs. 40) ... and a much more realistic 60:1 in sones (256 vs. 4).

Neither is the frequency response of the human ear a straightforward thing: the ear responds differently to sounds of different



frequencies and loudness levels. Although there is a small variation from person to person, normal ears agree within a few dB with the plot reproduced here (ISO Recommendation 226).



An even more significant peculiarity of the ear is its response to the pitch and bandwidth of a noise. Broadband sounds, like those of jet aircraft, seem much louder than narrow-band noise of the same sound pressure level. Thus accurate loudness measurements can be made only by taking into account the spectral distribution of the sound and relating it to empirically determined critical bandwidths. This phenomenon has given rise to the *Bark* scale: the audio range comprises 24 Bark, each of which equals the ear's critical bandwidth at a given center frequency.

Probably the most significant difference between objective and subjective measure of loudness occurs when two sounds are presented to the ear simultaneously. If the two sounds are widely separated in frequency, their partial loudnesses simply add to form the total loudness. But if they are not separated by a critical bandwidth, one sound masks the other: the closer together, the greater the influence. The noise analyst expresses this characteristic quantitatively in terms of *loudness density*, in sones/Bark.

The HP 8051A Loudness Analyzer is, in effect, a calibrated electronic ear that takes all of these subjective reactions of the human ear into consideration in measuring loudness based on ISO Recommendation 532 (Zwicker's Method). It listens to sound through a calibrated microphone or tape recorder, automatically produces a continuous spectral analysis and displays it as a plot of loudness density vs. subjective pitch. The instrument also computes and displays the total loudness of the sound, that is the integral of the Zwicker diagram.

The instrument is a great help in noise abatement studies because it shows how noise reduction techniques can be applied most effectively. Its spectral analysis points the finger at the most obvious sound-producing component, suggests what kind of sound-absorbing material may be needed, offers quick *before* and *after* comparisons of noise abatement programs.

A much more complex and versatile instrument for audio spectrum analysis, the recently announced HP 80501A Audio Data Processor combines the equivalent of a Loudness Analyzer with a powerful HP 2115A Digital Computer. The 80501A measures loudness with Kryter, Stevens, TALARM, SAE or dB weightings depending on the choice of standard computer programs. Results are available immediately: for example, the 80501A yields a complete analysis of aircraft noise while the plane is still overhead.

Our new 116-page Acoustics Handbook does justice to this rather complex subject. For your copy, write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

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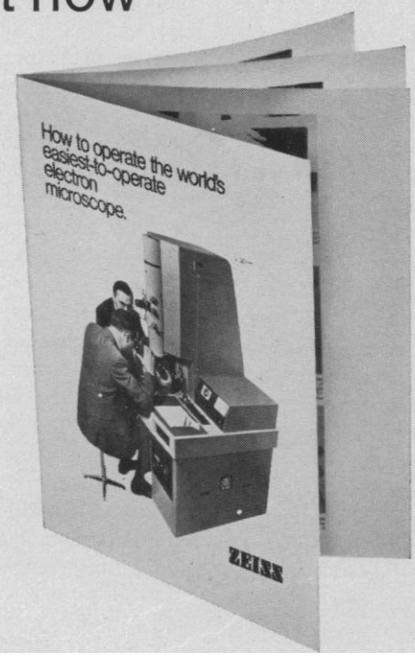

The new ZEISS EM-9S is the electron microscope for researchers and teachers interested in electron microscopic studies, not electron microscopes. It is the easiest-to-operate, most foolproof instrument on the market. To show you, or your students, just how easy it is, we've put together a little booklet that illustrates every step of the operation. It shows such features as:

(1) The *fully* automatic camera system—just moving one lever closes the shutter, moves the screen out of the beam path, reads the electron density *directly* (a spot reading, not an integration), opens the shutter for the correct length of time, closes the shutter, superimposes the exposure number photographically on the film, and changes the negative. A red warning light shines directly into the binocular to indicate when the film magazine is empty.

(2) The foolproof airlock—it lets you change specimens in less than 10 seconds, with one hand, sitting down, and in darkness.

(3) The standard-equipment, multiple (21 holes) thin-metal film aperture—specially made for all EM-9 models, it assures care-free use over prolonged periods of time.

When you've been sitting in the dark for hours, fighting specimens whose preparation has followed Murphy's Law, you'll appreciate these and the other features of the EM-9S that enable you to concentrate entirely on the screen, not on the machinery.

Combine all this with 7Å point-to-point resolution, a magnification range from 0 to 60,000x, small size and low price, and you have an instrument that is really in a class by itself.

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26 September 1969, Volume 165, Number 3900

SCIENCE

Political Action in Behalf of Science

Last year, when the Johnson Administration placed a ceiling on federal expenditures, support of scientific research was cut more sharply than most other items in the federal budget. In general, scientists cooperated without grumbling in what they hoped was a one-time emergency. Recent events indicate that this hope has been denied and that a combination of cuts and inflation will bring a 2-year reduction in academic research of about 20 percent. Responsibility for this reduction rests both on the Congress and on the Executive and has a bipartisan basis. The Nixon Administration's effort to increase the budget of the National Science Foundation has been thwarted thus far by the Democratic-controlled House Appropriations Committee. In turn, in allocating a $3.5 billion expenditure cut, which amounts to a little over 3 percent of the discretionary budget, the Executive branch discriminated against medical research. At first, support was slashed by more than 20 percent, a situation which obtained for more than a month. Later, when the matter was made public in front-page newspaper stories, the drop was rescinded and replaced by a 5- to 10-percent cut.

News of the deep cut was first brought into the open this month at a session of the American Chemical Society in New York. The audience was dismayed. Later, one observer commented, "We are witnessing a mindless dismantling of the American scientific enterprise." To prevent further destruction scientists must engage in broadly based, long-term, thoughtful political action.

Major decisions with respect to government support of science are made by politicians. They, in turn, are responsive to public opinion, to material in the mass media (especially the press), to the intervention of influential citizens, and to their own experience and observations. Scientists have been fairly active in informing the public about constructive aspects of their work. Scientists have neglected the important opportunities inherent in direct contacts with politicians.

Politicians operate with the pressing knowledge that they can be effective only if they can be elected. In consequence, they are especially sensitive to the opinions and demands of those of their constituents who have, or can employ, substantial political influence. For example, a politician pays attention to the words of the president of a major educational institution in his district, and to its distinguished alumni. In general, the politician gives personal attention to letters from such influential persons and makes himself available for conversations. Accordingly, scientists should make special efforts to communicate with politicians through top men associated in any way with their institutions.

Another mechanism for influencing politicians is illustrated by action taken in one district in the Midwest. Two colleges jointly invited their congressman to spend a day with them. On that occasion scientists at the colleges described their research and how it was interacting with the education of undergraduates. They showed him equipment provided by the National Science Foundation and told him of other support they had received from that source. The congressman was impressed with what he saw and heard, and stated that he had not realized the extent and importance of such federal support.

Scientists can stop the mindless dismantling of American science. They have the wit and energy to develop the political clout necessary to do the job, and they should get about that business.—PHILIP H. ABELSON

AUDIOTAPES OF AAAS ANNUAL MEETING SYMPOSIA AND PANEL DISCUSSIONS

Dallas, Texas, 26–31 December 1968

Through a cooperative arrangement between AAAS and Science Service, tape recordings of 15 symposia and panel discussions, presented at the Annual Meeting of the AAAS, are now being released at cost for general distribution. The objective of this undertaking is to make the proceedings of these meetings rapidly available to a wide public.

In a number of sessions, some information was presented on slides. Authors should be contacted directly for copies. Because of a serious epidemic of influenza at the time of the Dallas meeting, a few of the contributions were not given by the originally announced authors.

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Acknowledgment is made to Ampex Corp. for assistance in recording and distribution and to WAMU, American University, for aid in editing.

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