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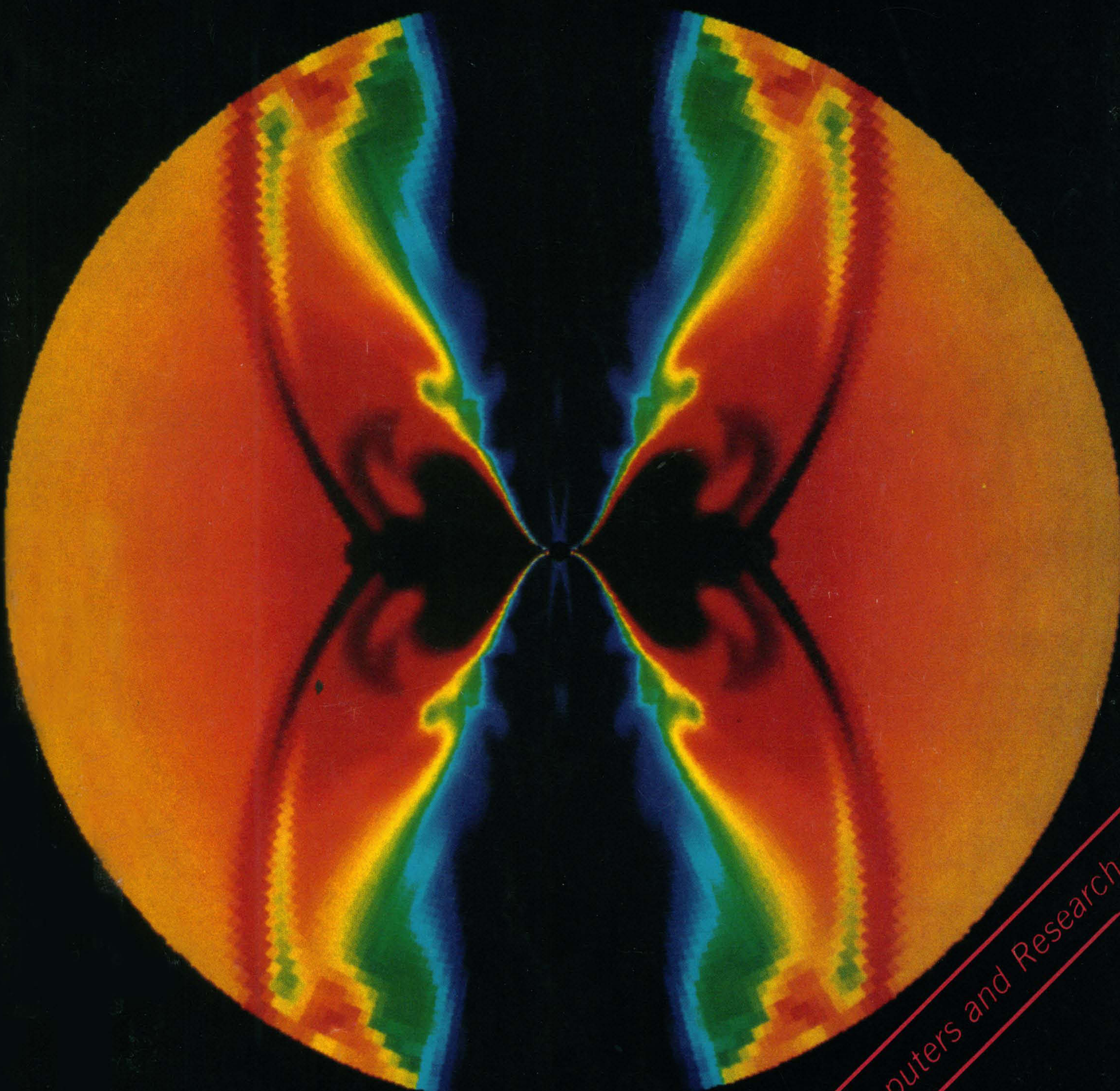

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COVER

The color image represents a cross section of a spiraling gas flow near a black hole. The colors represent the gas density in every zone on the computational grid; density decreases in spectral order from red to blue. The underlying grid can be seen as the small squares at the outer edges of the image. The red stripes that "pinch in" at the equator (horizontal plane) are shock waves. The heart-shaped region is a fat disk orbiting the black hole. See page 403. [Computation by John Hawley and Larry L. Smarr, Department of Astronomy, University of Illinois. Calculations were performed on the Cray-1 supercomputer, Max-Planck Institut für Physik und Astrophysik, Garching, Federal Republic of Germany]

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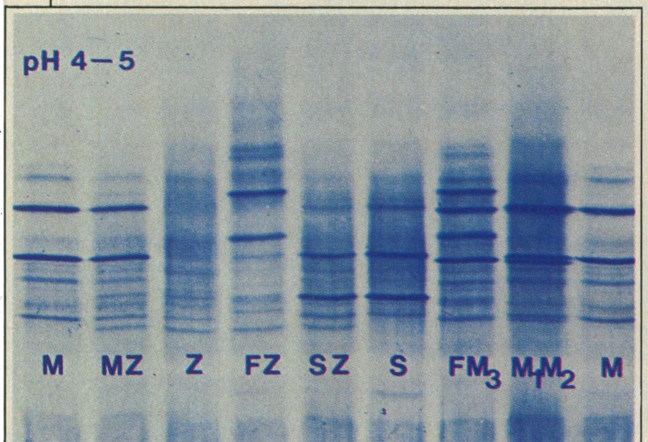
Eight phenotypes of α_1-antitrypsin are clearly identified using one of the convenient LKB Ampholine PAGplates ▼



ULTRATHIN GELS FOR MAXIMUM ECONOMY
Anticipating the need for less expensive electrofocusing gels, LKB developed the new UltroMould: a simple device designed to cast bubble-free gels as thin as 0.1mm in less than 30 seconds. Based on a patented sliding plate method, UltroMould is easy to use, producing perfectly accurate and uniform gels and ensuring a high standard of reproducibility. Adding UltroMould to the LKB Horizontal Electrophoresis System means that significantly less gel solution and smaller sample volumes are required, resulting in far more economical electrofocusing.

LKB UltroMould casts bubble-free ultrathin gels in only 30 seconds, making gel casting quicker, easier and more certain ▶

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This is one in a series of advertisements describing the unrivalled versatility of the LKB Horizontal Electrophoresis System. For further information about analytical electrofocusing, and the many other applications of the system, send today for our brochure.

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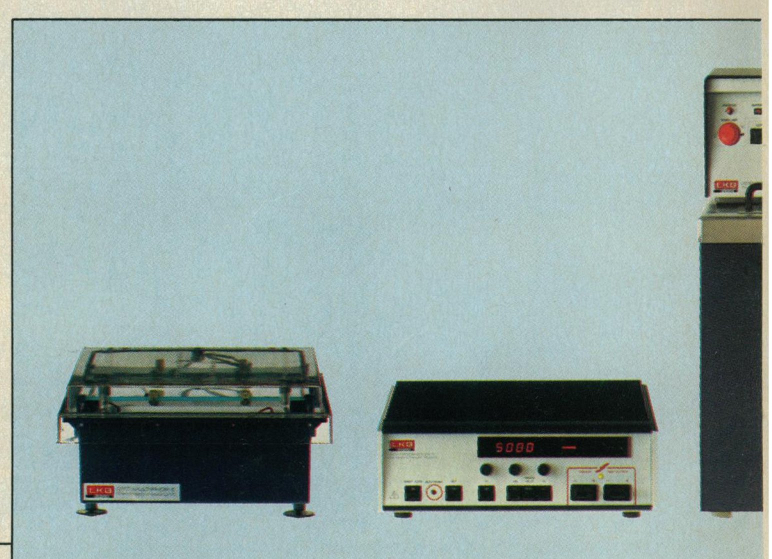

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analytical electrofocusing

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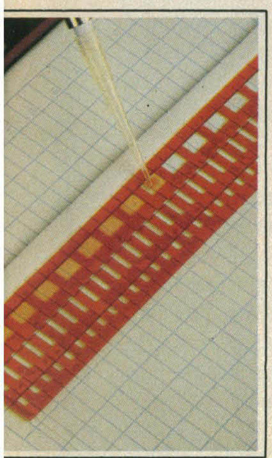
Another of the many options available to the user of the LKB Horizontal Electrophoresis System is the application of Agarose electrofocusing gels. LKB supplies extremely pure agaroses, carefully developed for electrofocusing, and the original capillary casting method simplifies the task of producing 0.5 mm gels on GelBond Film backing sheets. Agarose is non-toxic and easy to handle and the entire analysis procedure, including casting and running, is very rapid.

Separating the GelBond Film from the glass plate gives a 0.5 mm agarose gel, firmly attached to its support and ready to use ▶



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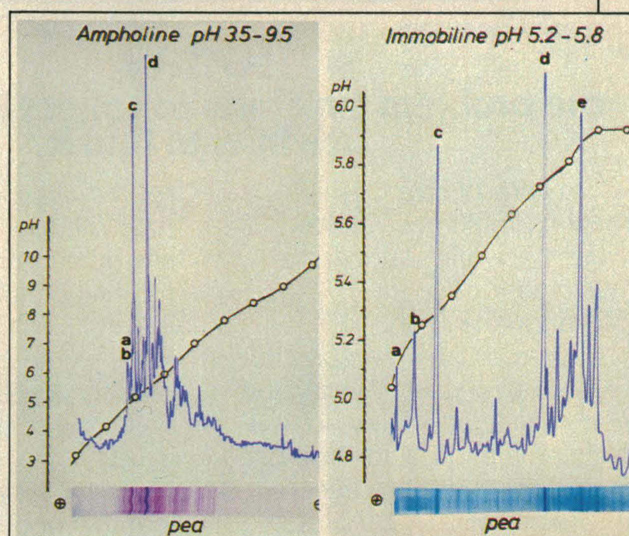
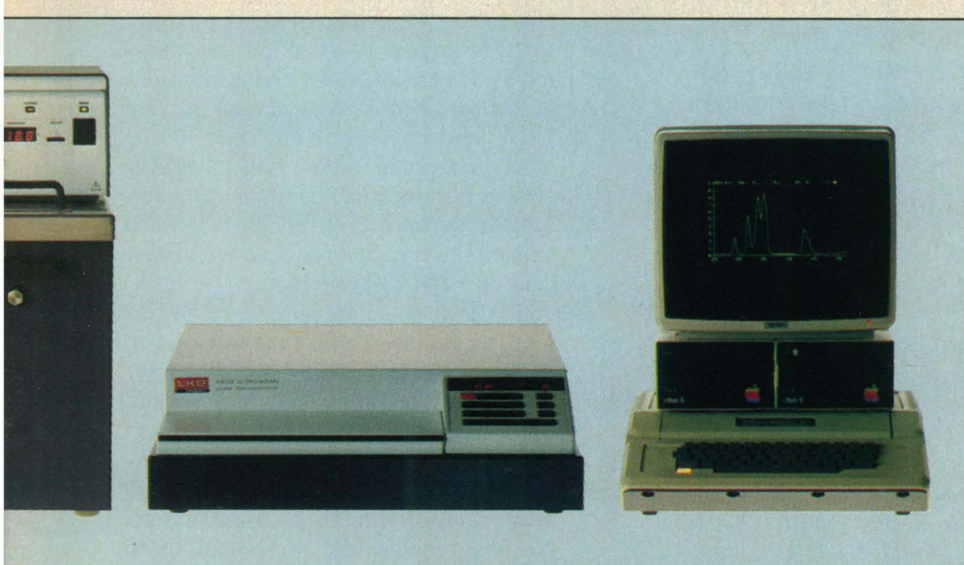
Comparison of traditional electrofocusing and LKB Immobiline System (courtesy of Dr A Görg et al, Technische Universität, München) ▶





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Sulfur Dioxide Emissions

M. Oppenheimer *et al.* (Letters, 8 Mar. p. 1154) take issue with Philip H. Abelson's conclusions (Editorial, 14 Dec., p. 1263) that action to reduce pollution in the United States would be premature, and they characterize Abelson's position as "both unconvincing and puzzling." The writers contend that "surface water acidification cannot be avoided if sulfur dioxide emissions are not reduced by one-half or more." However, Abelson's position seems entirely reasonable in light of the weight of the evidence now available and the conflicting interpretations expressed by participants in the emissions reduction issue.

The 1983 report of a National Academy of Sciences (NAS) committee (*1*), noted that decreasing sulfur dioxide emissions may not significantly affect the acidity of precipitation. In Environmental Protection Agency (EPA) Region 1 (New England), SO_2 emissions fell by 38 percent from 1965 to 1978, with no significant long-term trend in the acidity of precipitation at Hubbard Brook, New Hampshire. Similarly, in EPA Region 2 (New York and New Jersey), SO_2 emissions fell by 40 percent over the same period, again with no significant long-term trend in acidity (*2*).

Others (*3*) have analyzed the precipitation chemistry data for three sites from the mid-1950's and the mid-1970's. In Virginia, acidity increased by 74 percent, while SO_4^{2-} fell by 3 percent. In Pennsylvania, acidity increased by 216 percent, while SO_4^{2-} fell by 23 percent. In Illinois, acidity increased by 27,000 percent, while SO_4^{2-} increased by 22 percent.

The relation between SO_2 emissions and sulfate deposition is also equivocal. In EPA Region 1, while SO_2 emissions fell by 38 percent, sulfate concentrations at Hubbard Brook, New Hampshire, fell by 33 percent (*1*). In New York, a drop of 40 percent in sulfate concentrations (*1*) was accompanied by an annual average drop of 2 percent in sulfate (*4*), which amounts to a reduction of about 25 percent over the 13-year span.

In a letter about the apparent inconsistency in opinions about the linearity of the SO_2-sulfate relation, the executive director of the National Acid Precipitation Assessment Program has reported (*5*) the explanation agreed upon by the NAS committee and the National Laboratory Consortium (NLC). Emission-deposition relationships were said to be "nearly [linear] (i.e., proportionately

1:1) when *averaged* over at least a year and *averaged* spatially over a large half-continent sized area." He also commented that "this is a valid hypothesis based on current information which will be tested as new research yields better information. However, both parties [NAS and NLC] agreed that for smaller spatial scales and shorter time scales, the relationship may not be directly proportional. . . . In other words, linearity may apply to average deposition and yet not hold true for each receptor site of concern."

The sites of concern are largely forested mountain areas, specifically the trees, lakes, and streams in forested watersheds. The evidence increasingly points to the decaying organic layer of forest litter as the primary source of acidity (*6*).

Concern about the acidification phenomenon is appropriate, but if benefits for sensitive ecosystems are to be achieved, the mechanisms that operate must be clarified and quantified. The hard data now available do not support the hypothesis that major reductions of emissions will benefit the ecosystems of major concern. As successive research findings emerge, Abelson's position becomes ever more convincing and appropriate.

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Larchmont, New York 10538

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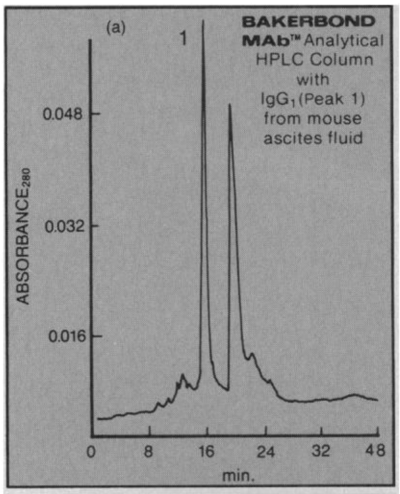
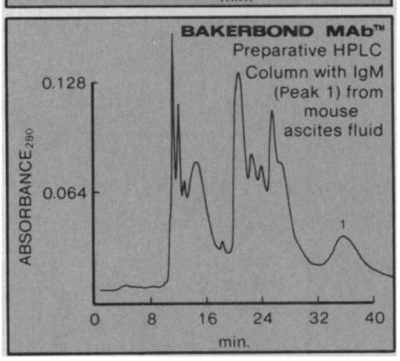
2. N.E. Peters, R. A. Schroeder, D. E. Troutman, *Temporal Trends in the Acidity of Precipitation and Surface Waters of New York* (U.S. Geological Survey Water-Supply Paper 2188, Government Printing Office, Washington, D.C., 1982).
3. *The Acidic Deposition Phenomenon and its Effects: Critical Assessment Review Papers*, vol. 1, *Atmospheric Sciences* (Environmental Protection Agency, Washington, D.C., 1984); G. J. Stensland and R. G. Semonin, *Bull. Am. Meteorol. Soc.* **63**, 1277 (1982).
4. *Acid Rain: Sources and Effects in Connecticut. Report of the Acid Rain Task Force* (Bulletin 809, Connecticut Agricultural Experiment Station, New Haven, 1983).
5. C. Bernabo, letter to the Committee on Energy and Commerce, U.S. House of Representatives, 22 February 1984.
6. *Acid Rain and Transported Air Pollutants—Implications for Public Policy* (Office of Technology Assessment, Washington, D.C., 1984); *The Integrated Lake-Watershed Acidification Study*, vol. 4, *Summary of Major Results* (Electric Power Research Institute, Palo Alto, Calif., 1984).

High-Technology Agriculture

I liked Jean Mayer's editorial "Preventing famine" (15 Feb., p. 708). He makes everything sound so simple. American and Canadian experts, like the White Knight in Alice in Wonderland,





will now gallop off in all directions and plow up the continent of Africa with huge American tractors, scattering artificial fertilizers and pesticides as they go along. But what happens in those areas where it simply does not rain? And will African rulers allow all this intervention? People with substantial experience in high-technology agriculture are to be found in large numbers in Africa and they should be consulted. There is also a great deal of knowledge about possible increased food production in Africa. I have no doubt that American agriculture is efficient in the short run. But how good is it on a sustained-yield basis? What about the decline of irrigation farming based on the Ogallala aquifer in the United States and the increasing soil erosion all over the world, especially in Africa? How much will American-style agriculture cost in Africa, and who will pay for it? Already many Canadian and American farmers are going bankrupt because of low food prices. African rulers, with some noteworthy exceptions, have appeared to be more interested in cash crops than in food production.

Many years ago Kwame Nkrumah tried collective farming in Ghana, complete with large tractors. The effort was a disaster. There have also been attempts at collective farming in Ethiopia and Mozambique. These countries are now asking for food aid. The Soviet Union, the mother and father of collective farming, last year imported 50 million metric tons of grain. So we must conclude that there are different varieties of "high-technology" agriculture. Some work, while others are a flop.

The population of Africa was about 140 million in 1930 and is about 540 million now. Population growth is resolutely outstripping food supplies. Can we change total cultures in Africa? How will we (the West) be given this power?

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Infrastructure

In his editorial of 1 March (p. 991), Erich Bloch reports guidelines for fiscal year 1986 budget development at the National Science Foundation. Specific reference is made to science and engineering infrastructure as one of the three major priorities. Renewed concern at the NSF for the people who will advance science and engineering is laudable and already visible. Recent review of the NSF's support for undergraduate institutions during fiscal year 1984 by a review group representing a broad spectrum of institutions and associations found that the first year of the NSF's effort to encourage and support research at these colleges and universities had proceeded quite well. Working with funding targets and through the dedicated efforts of its staff, the NSF awarded 141 grants in its Research in Undergraduate Institutions Program, 75 of which were to first-time awardees. Although the success ratio for funded proposals was less than the NSF average, review priorities were at least comparable. As a consequence of NSF encouragement a new, previously neglected, group of qualified research scientists has been brought into the mainstream. Their efforts, and the undergraduate students whom they inspire, offer renewed optimism for this nation's ability to retain research preeminence in science and engineering.

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Nitropyrenes

A minor error mars the otherwise very informative account by Eliot Marshall of the Asilomar Conference convened by the Health Effects Institute (News and Comment, 15 Feb., p. 729). In that article, 2-nitropyrene is identified as a "highly potent" carcinogen that is present in diesel exhaust and was "recently" removed from xerographic toners. Actually, 2-nitropyrene is probably not an anthropogenic chemical and thus was not present in toners. Reference should have been made to 1,6- and 1,8-dinitropyrene, which are indeed carcinogens and were removed from xerographic toners 5 years ago (H. S. Rosenkranz *et al.*, Reports, 29 Aug. 1980, p. 1039). Subsequently these dinitropyrenes, as well as 1-nitropyrene and other nitrated polycyclic aromatic hydrocarbons, have been found to be ubiquitous products of incomplete combustion processes and have been detected not only in diesel exhaust but also, for example, in fly ash, the emissions of kerosene home heaters, and grilled chicken yakitori.

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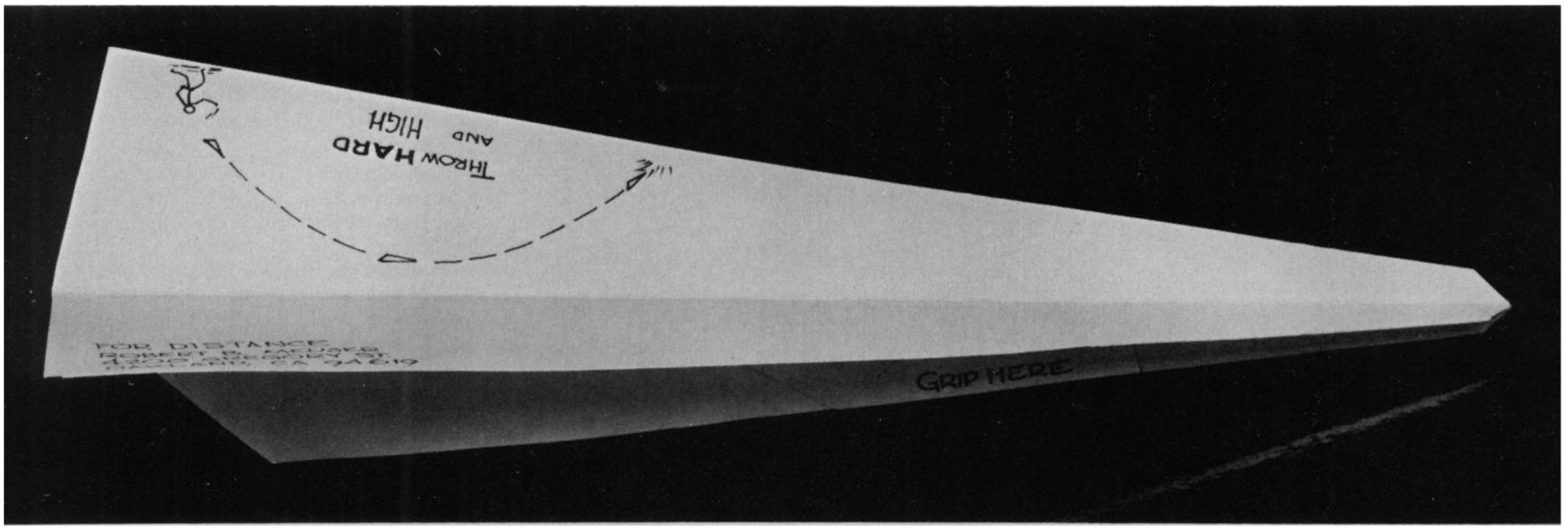
Department of Environmental Health Sciences, Case Western Reserve University, Cleveland, Ohio 44106

IT'S ONLY A PAPER PLANE...



But it flew 58 feet, two inches, winning in the nonprofessional category of *Scientific American*'s paper airplane contest in 1967. A lot has changed since then. Real planes have traded heavy, metal parts for pieces made of layered and fibrous composite materials. And, we assume, the paper plane buffs of the world have been tinkering too, folding along different lines and perhaps learning a few tricks from the nonpaper engineers. So *Science 85* magazine, Seattle's Museum of Flight and the Smithsonian Institution's National Air and Space Museum announce The Second Great International Paper Airplane Contest of the Century.

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Time Aloft
Distance
Aerobatics
Aesthetic Design (all these planes must fly at least 15 feet or three seconds)

THE CATEGORIES:
- Professional—teachers and graduate students in aeronautics and related fields as well as engineers, designers, and others employed in the aerospace industry
- Nonprofessional—everyone else
- Junior—entrants under 14 years old, eligible for time and distance events only (parent-child teams must enter under the professional or nonprofessional categories)

THE JUDGES:
A high-flying panel will test your design in the wide open spaces of a Boeing aircraft hangar in Seattle.
—Michael Collins, aerospace consultant and former Apollo astronaut
—Dennis Flanagan, editor emeritus of *Scientific American*
—Ilan Kroo, NASA aerodynamics designer
—Yasuaki Ninomiya, designer of Whitewings toy airplanes
—Sheila Widnall, MIT aerodynamics engineer

THE AWARDS:
THE BERNOULLI MEDALLION for paper flight goes to first-, second-, and third-place winners in each event. First-place winners will be flown, all expenses paid, to Seattle to receive their awards and fly their planes during a special ceremony at the Seattle Kingdome in June. Some of the winning designs will be published in the September issue of *Science 85*.

THE RULES:
All entries must be made only of paper. Glue and cellophane tape may be used only for bonding purposes, not to add weight. Paper lamination and paper reinforcement *is* allowed.

Your entry is your airplane, properly folded, with your name, address, phone number, and any special throwing instructions written clearly on the plane. Also write which event you would like to enter (only one event per plane) and whether you are in the Professional, Nonprofessional, or Junior group. Planes missing any of the required information will be disqualified.

Entries should be sent to: International Paper Airplane Contest, Museum of Flight, 9404 E. Marginal Way South, Seattle, Washington 98108.

Entries must be received by May 1, 1985. All entries become the property of *Science 85*, the Museum of Flight and the National Air and Space Museum. By submitting their designs, entrants agree to allow *Science 85*, the Museum of Flight and the National Air and Space Museum to publish them and use them in subsequent promotional material. Employes and relatives of employes of *Science 85*, the Museum of Flight, the National Air and Space Museum, and AG Industries/Whitewings are not eligible.

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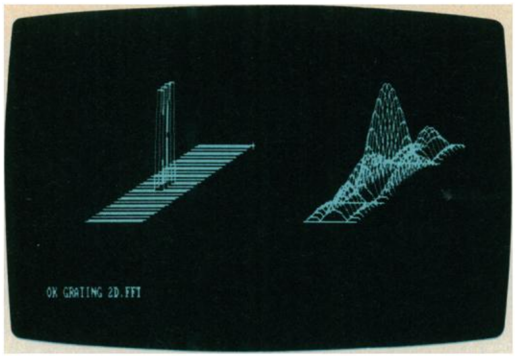

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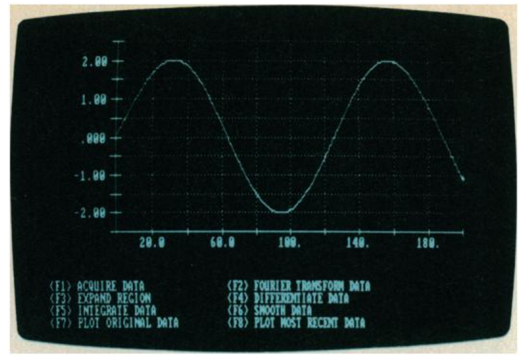

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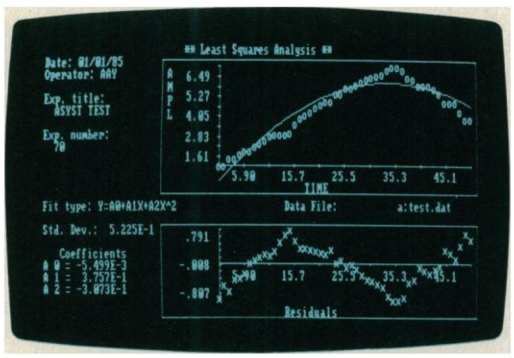

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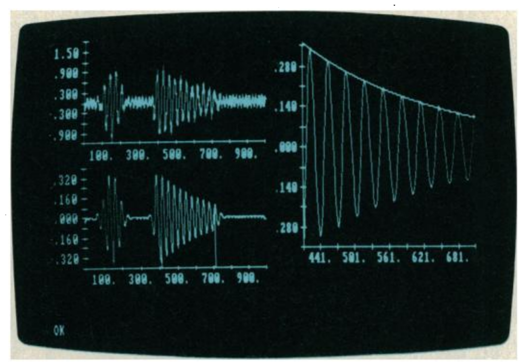

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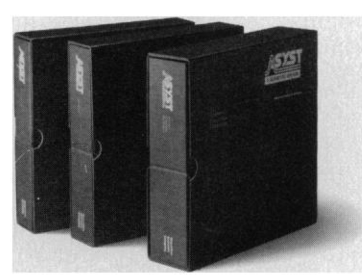

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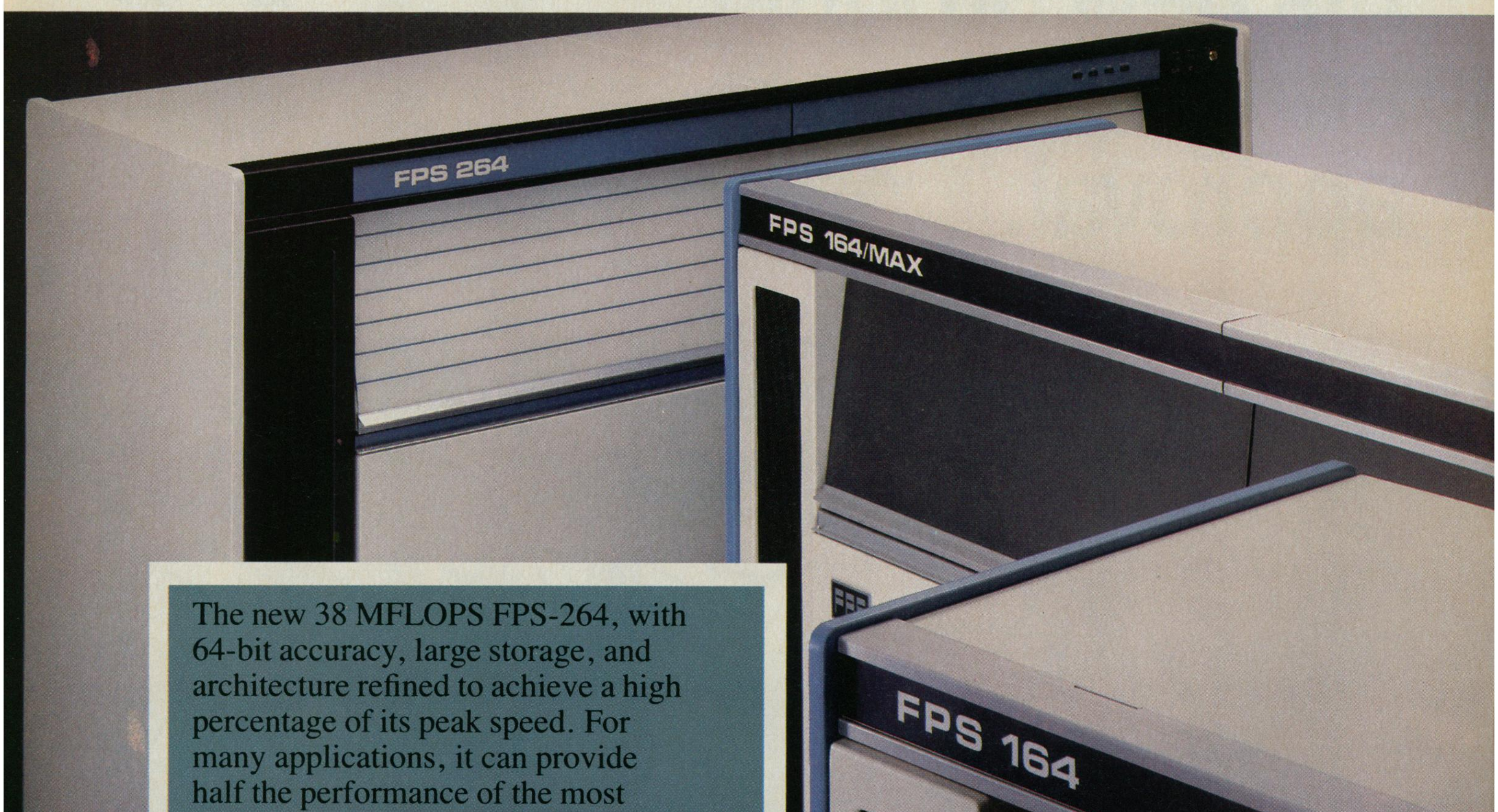

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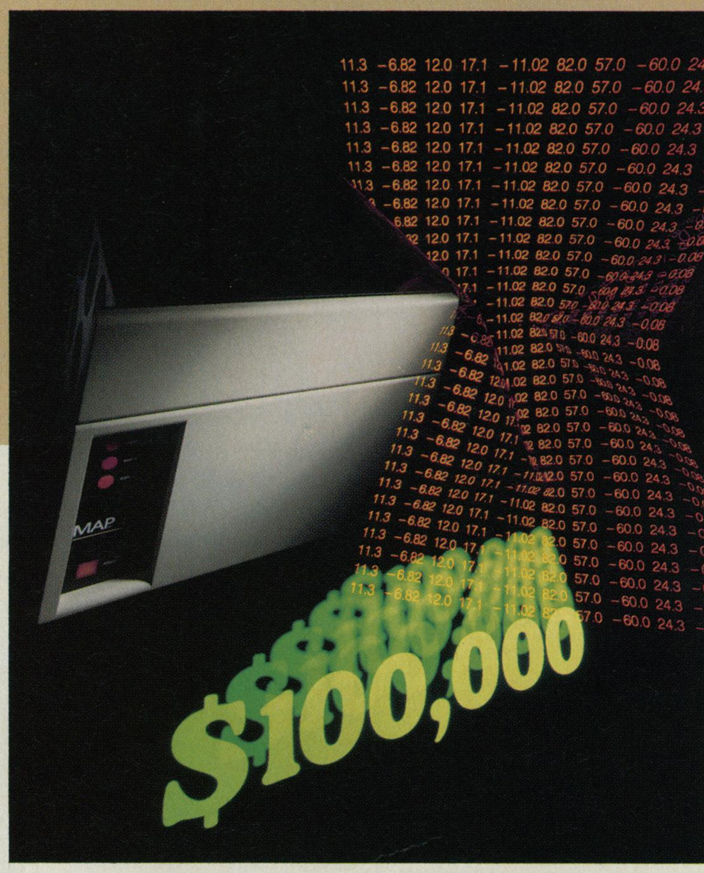

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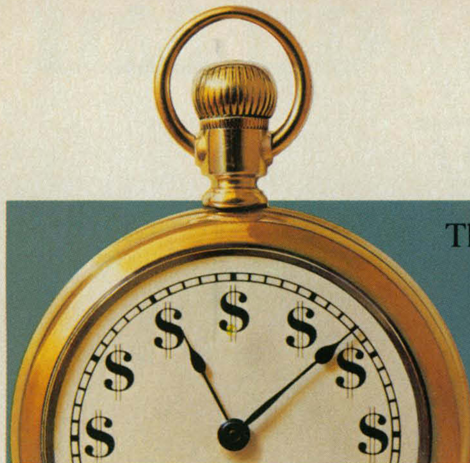

The FPS optimizing FORTRAN-77 Compiler lets you easily adapt code to FPS' pipelined architecture in a form that is nearly as efficient as hand-coded assembly language. With extensions for asynchronous I/O and for enhancing compatibility with other compilers, it is one of most comprehensive tools of its kind.

likely to find that the advantage of immediate, local access is well worth the sacrifice of standing in line for the "fastest" machines.

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Family Specifications

	FPS-264	FPS-164/MAX	FPS-164
Peak speed, MFLOPS	38	33-341	11
Dynamic range	2.8 x 10^{-309} to 9.0 x 10^{+307}	2.8 x 10^{-309} to 9.0 x 10^{+307}	2.8 x 10^{-309} to 9.0 x 10^{+307}
Logic format	64 bits	64 bits	64 bits
Main memory capacity	4.5 MWords	15 MWords	7.25 MWords
Maximum disk storage capacity	16 Gbytes	3 Gbytes	3 Gbytes
Precision	15 decimal digits	15 decimal digits	15 decimal digits
Vector registers	4 x 2K	124 x 2K (max.)	4 x 2K
Scalar registers	64	184 (max.)	64
Host interfaces	IBM, DEC	IBM, DEC, Sperry, Apollo	
Program Development Software	FORTRAN Compiler, Overlay Linker, Assembler, Object Librarian, Interactive Debugger.		

Family Performance Measures

	FPS-264	FPS-164/MAX		FPS-164
		15 accelerators	1 accelerator	
Peak MFLOPS	38	341	33	11
Peak MOPS	190	1705	165	55
Peak MIPS (Multi-instruction partcels)	19	5.5	5.5	5.5
Typical MFLOPS, LINPACK Benchmark	9.9	20.0	6.0	2.6
Whetstones (64-bit)	20,100	5800	5800	5800
1000x1000 matrix multiply, seconds	53	10	66	189
$K/MFLOPS (system price/peak speed)	$16.8K	$2.5K	$12.3K	$27.1K

4. The FPS family is expandable. Proven dependable. Well-supported. In other words, a safe, farsighted investment. You can upgrade your existing FPS computer, or evolve from one level of performance to another, with minimal disruption. And you can bank on a record of reliability that begins with exhaustive manufacturing testing and extends to our 21 field office service facilities worldwide.

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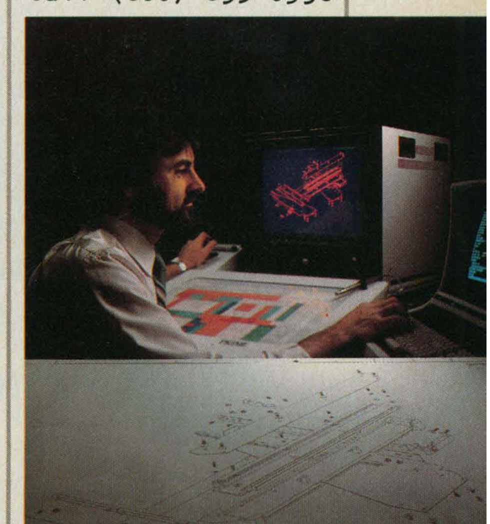

THE PROVEN POWER IN ACCESSIBLE HIGH-SPEED COMPUTATION.

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26 April 1985, Volume 228, Number 4698

SCIENCE

The Computer Issue

I learned the other day that wind tunnels are essentially obsolete for testing airplane designs. Modern understanding of aerodynamics and the ability to alter multiple variables of wind, size, airflow, and so on by computer mean that structural designs can be more efficiently examined by computer than by old-fashioned experiments. My immediate reaction was to travel by train. Although I have bowed to the onward march of modern science and continue to use airplanes, this development indicates the enormous, sometimes unknown, change in all of our lives occasioned by the computer. In this issue some ways in which computers are being used are described by authors recruited for *Science* by Philip H. Abelson.

The development from calculating machine to computer involved many scientists and engineers among whom Alan Turing and John von Neumann are usually mentioned. It is instructive to realize that since von Neumann's studies in the 1940's, computers have increased in speed by a factor of 1 billion and have become cheaper per computation by a factor of 10 million. Larry Smarr describes a problem in which there are 25,600 variables at each step and a single experiment makes use of at least 10,000 steps. The solution involves 1.25 billion numbers. Problems of this complexity could not even be planned, let alone solved, just a few years ago. This increase in complexity has, moreover, altered the thinking of scientists. Old-fashioned types, like me, have a feeling that the true answer to a scientific problem lies in an analytical equation; numerical calculations are only approximations to the real answer. Modern computer experts are frequently dealing with problems with so many variables that the true visualization requires a numerical solution; the analytical equation is only an approximation.

These articles also reveal a second change in our lives. The handheld pocket calculator now lies on laboratory benchtops, so cheap that theft is no longer considered a serious problem, and personal computers are being given to college students at the beginning of their college careers. What will happen to students, as M. Mitchell Waldrop asks, if the ease of push-button access to information eliminates the normal interactions occasioned by meeting at the library or attending classes? What will happen to the character of a student who has never had to wait in line for a book?

Entire sciences are being changed, as described in the article by E. J. Corey *et al.* on the use of computers to design organic syntheses. Will the computer really replace the cerebellums of the great organic chemists with their incredible storehouses of individual reactions? Similar revolutions may be in store for the humanities, agriculture, and economics, in which the ability to examine many variables and to have access to large amounts of data will change problem-solving.

Communication between scientists and the education of students will also be affected. Knowledge of electronic databases will be as important as keeping up with the latest journals. *Science*, for example, will soon add software reviews to the book reviews. Teaching may be enhanced by machines and allow students to progress at their own pace.

Although the enormous power of computers brings joy to many, this power can have a destructive element as well. The elimination of routine jobs by computerization will have a fundamental effect on society. It is not enough to say to individuals who are displaced that a new productivity will allow you to be supported all your lives. Humane understanding and a generous effort must motivate those who will benefit from these wonderful machines to help those who are displaced by them. The promise of computers may best be realized in approaching solutions to that most complex multivariate problem, the establishment of a fully productive and satisfying society.

For the good of society, we may have to enact laws to protect some endangered species. Already computers are being used to design musical scores. When they start writing editorials, they will have gone too far.

—DANIEL E. KOSHLAND, JR.

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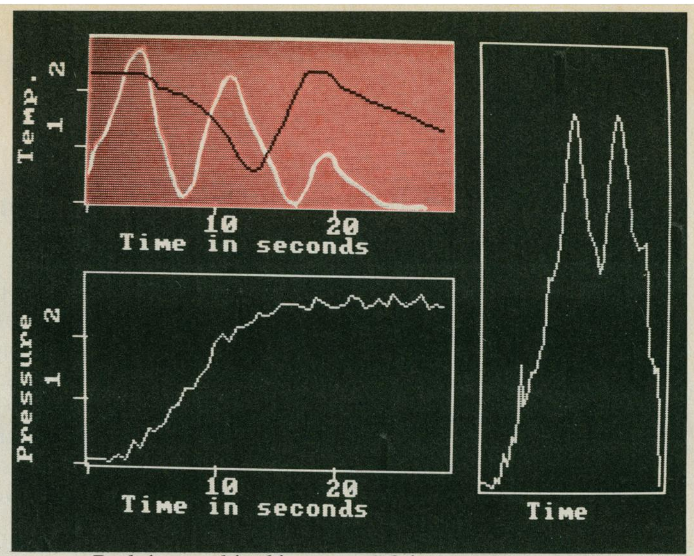

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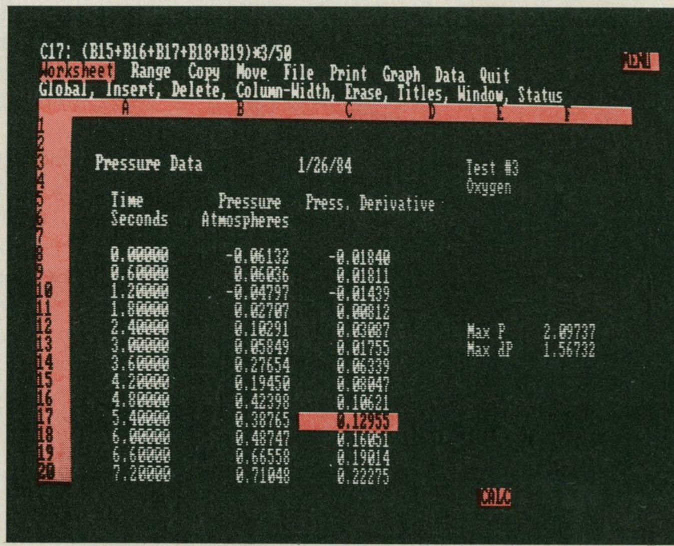

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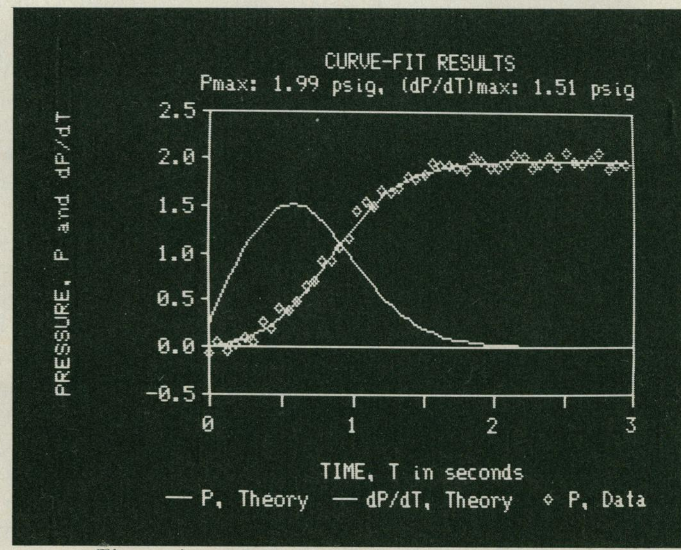

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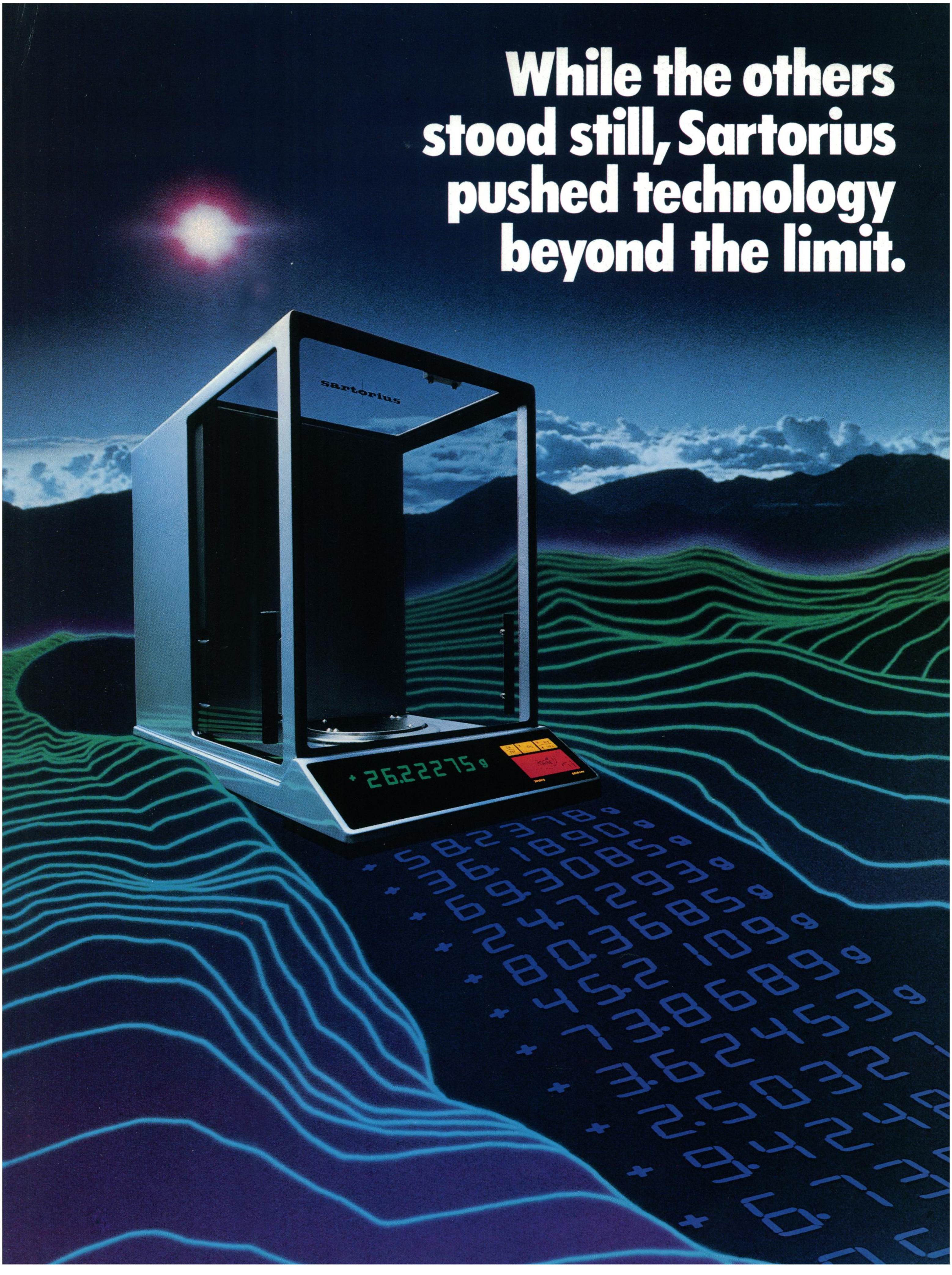
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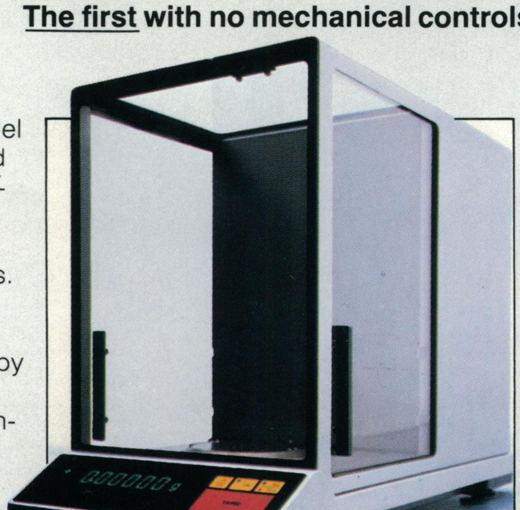
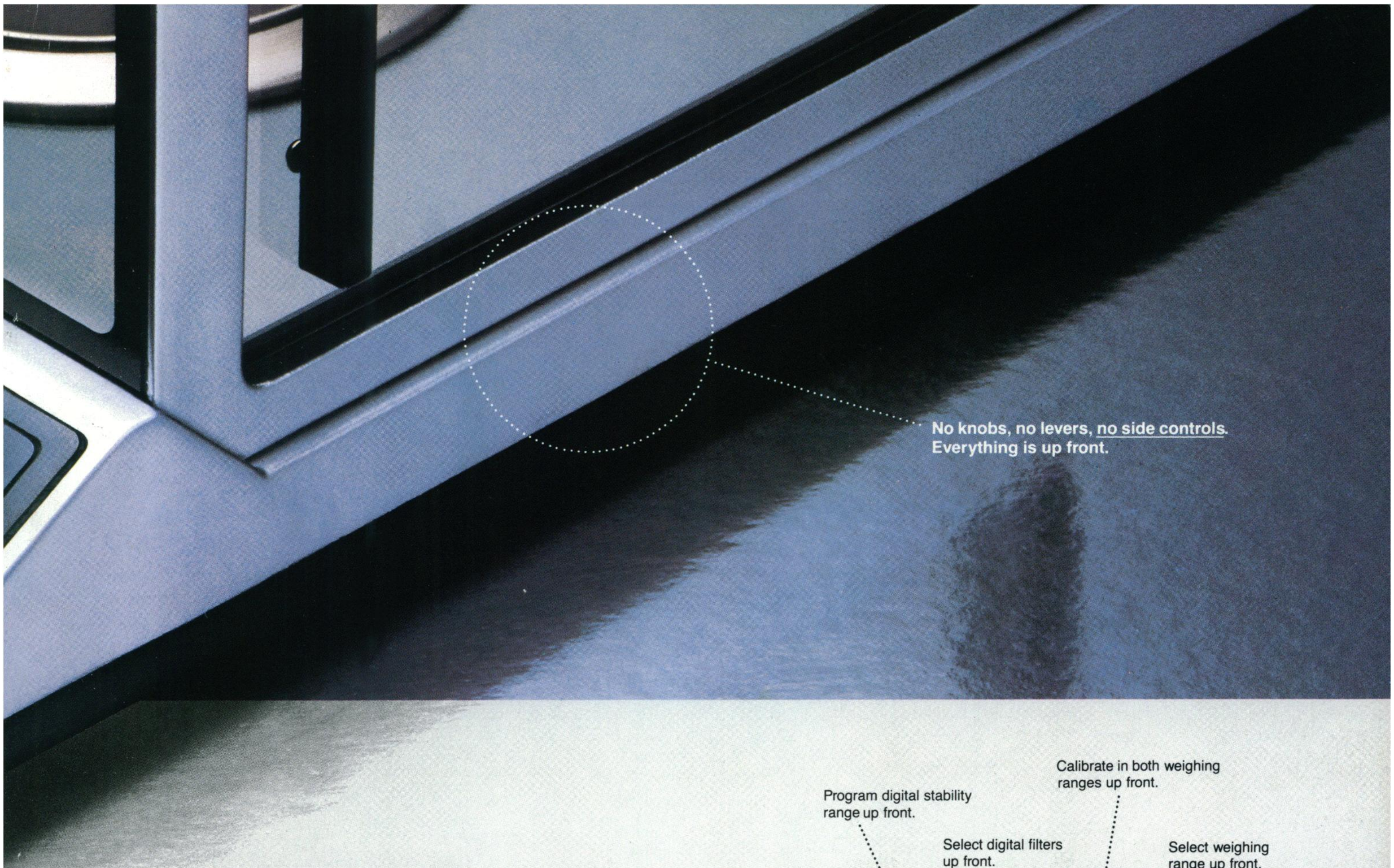


Sartorius introduces the new Model 1712—a balance that's way ahead of all the rest. It combines state-of-the-art electronics with a trim, streamlined design to create a whole new generation of balances. With the 1712, complicated procedures and clumsy mechanical controls are ancient history. Now, by a mere finger touch, Sartorius brings you to the forefront of weighing technology.

The simplest weighs possible.

All functions of the 1712 are controlled by a touch-sensitive panel on the front of the balance. To weigh, just press TARE, load the sample and, in seconds, your result appears clearly on the bright ⅞-inch readout. Calibration, programming, and weighing range selection are just as easy.

To celebrate our 25th anniversary of manufacturing electronic balances, the Sartorius 1712 Silver Edition will be available for a limited time only.



Analytical weighing range, with 0.1 mg readability.

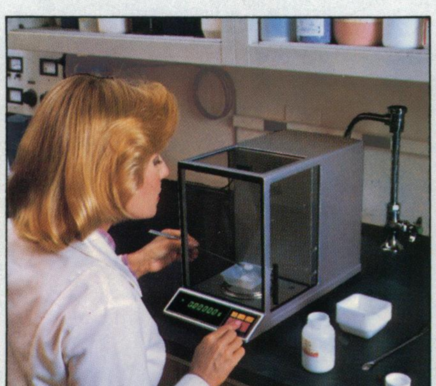
Semi-micro weighing range, with 0.01 mg readability.

Really two balances in one.

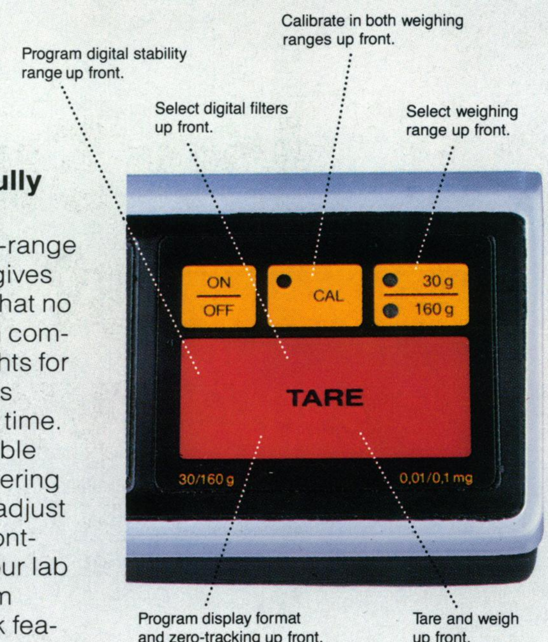
The 1712 can handle more of your weighs because it has two distinct weighing ranges: an analytical range to 160 g and a semi-micro range to 30 g. But it's really two balances in one, because you calibrate it and adjust its operating parameters—digital filter settings, stability ranges, display format, and zero-tracking—separately and independently for each weighing range. You can also expand the 1712's extensive capabilities by adding optional (RS232C) data outputs.

All weighs precise with fully automatic calibration.

Because of its exclusive dual-range calibration system, the 1712 gives you accuracy and precision that no other multirange balance can compete with. Two separate weights for two separate weighing ranges assure accurate results every time. The 1712 also guarantees stable readings by filtering out interfering disturbances, and it lets you adjust operating parameters with front-panel programming to suit your lab environment. And if a problem arises, the unique AutoCheck feature of Model 1712 will locate it and tell you where it is.

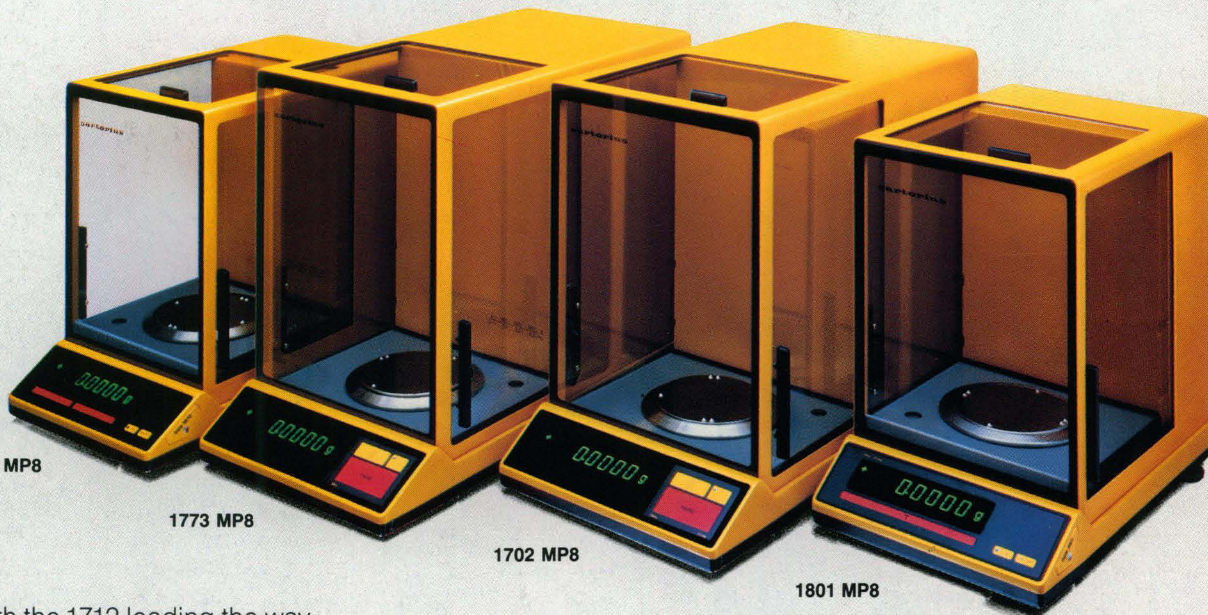


Ergonomically designed for comfort and convenience.



The first fully automatic, analytical balance. Total control from the front panel. And two completely independent balances in one. But there's even more to the 1712. A larger weighing chamber and lower platform for greater user comfort and convenience. An aerodynamically designed pan that resists mild air currents and is big enough to accommodate almost any vessel. Let Sartorius show you the weigh of the future. Call for a demonstration today.

More weighs to win you over.



1872 MP8

1773 MP8

1702 MP8

1801 MP8

With the 1712 leading the way, Sartorius also offers you the 1702, with classic 200 g weighing range, and the 1773, featuring analytical weighing to 300 g. Both are fully automatic and include the same convenient features as the 1712. For more routine operations and educational applications, consider Model 1801 or 1872.

These balances are economical and compact but never short on performance. And all Sartorius 1700 and 1800 series analytical balances give you the confidence and ease of use that comes only from complete up-front control and the most advanced weighing technology in the world.

Technical Data	1702 MP8	1712 MP8	1773 MP8	1801 MP8	1872 MP8
Weighing range	0-200 g	0-30/160 g	0-100/200/300 g	0-110 g	0-60/100/160 g
Readability	0.1 mg	0.01/0.1 mg	0.1/0.2/0.5 mg	0.1 mg	0.1/0.2/0.5 mg
Reproducibility (SD)	≤+0.1 mg	≤±0.02/0.1 mg	≤±0.1/0.1/0.25 mg	≤±0.1 mg	≤±0.1/0.1/0.25 mg
Linearity	≤±0.2 mg	≤±0.03/0.2 mg	≤±0.2/0.2/0.5 mg	≤±0.2 mg	≤±0.2/0.2/0.5 mg
Taring range (by subtraction)	0-200 g	0-30/160 g	0-300 g	0-110 g	0-160 g
Stabilization time	~3 sec	~5/3 sec	~3 sec	~3 sec	~3 sec
Housing (w x d x h)	211x408x313 mm	211x408x313 mm	211x408x313 mm	186x315x270 mm	186x315x270 mm
Weighing chamber (w x d x h)	188x155x253 mm	188x155x253 mm	188x155x253 mm	168x154x207 mm	168x154x207 mm
Pan size/pan clearance	90 mm/246 mm	90 mm/246 mm	90 mm/246 mm	90 mm/200 mm	90 mm/200 mm
Weight (net/gross)	13 kg/15 kg	13 kg/15 kg	13 kg/15 kg	12 kg/14 kg	12 kg/14 kg

Operating conditions (all balances): 110-240 V adjustable, 50/60 Hz; operating temperature: 10°–40°C.
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