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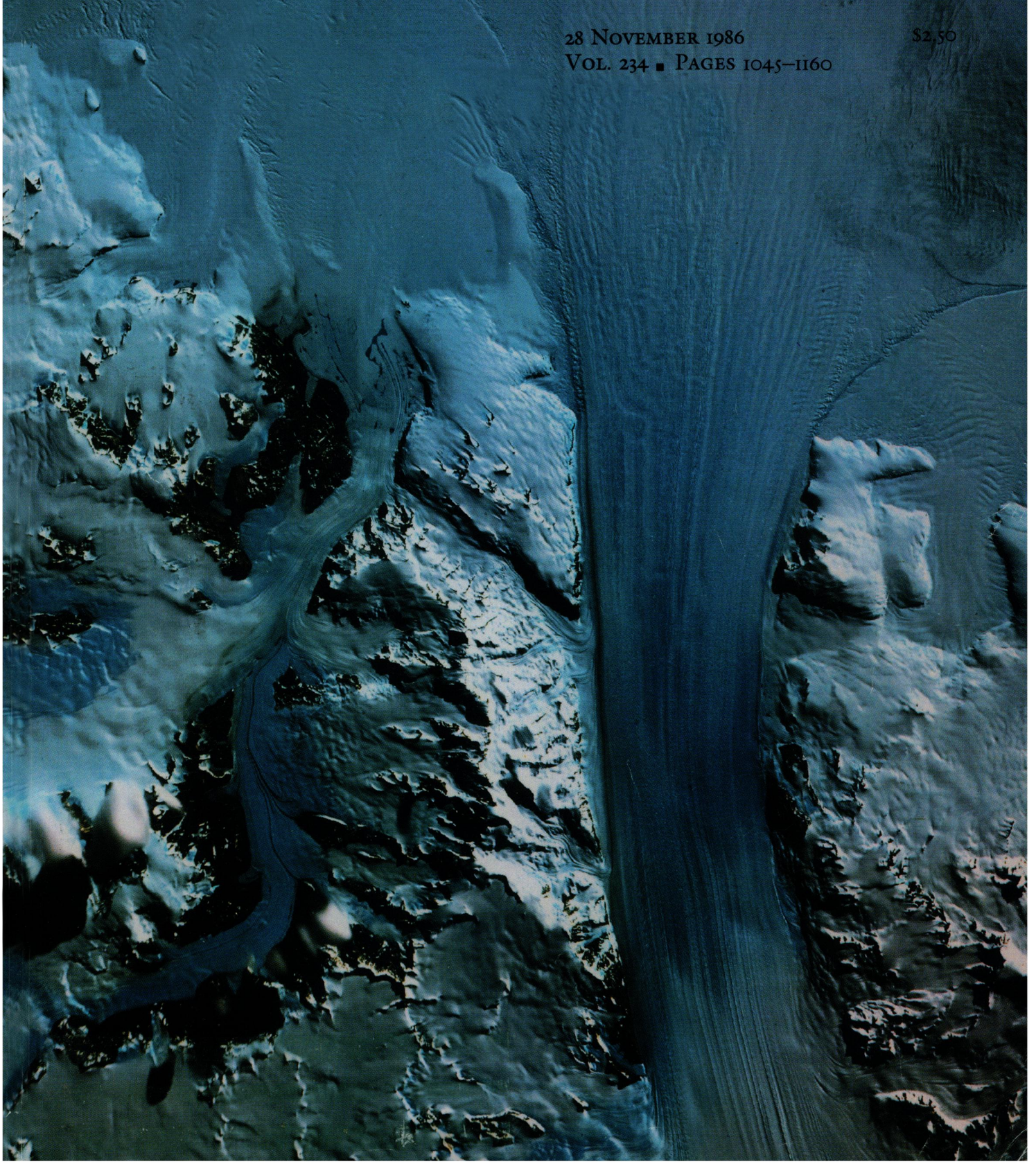

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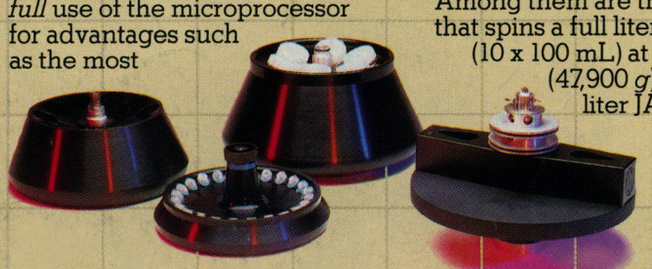

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COVER Landsat image of Byrd Glacier, Antarctica. The glacier (about 25 kilometers wide) flows through the Transantarctic Mountains (left and right) and empties into the Ross Ice Shelf (top). Transverse crevasses, developed where the glacier enters the shelf, remain visible over many years and enable time-lapse measurements of ice velocities. See page 1105. [Landsat-1 multispectral-scanner image 1542-18435, 16 January 1974, path 46, row 119; B. K. Lucchitta and H. M. Ferguson, U.S. Geological Survey, Flagstaff, AZ 86001]

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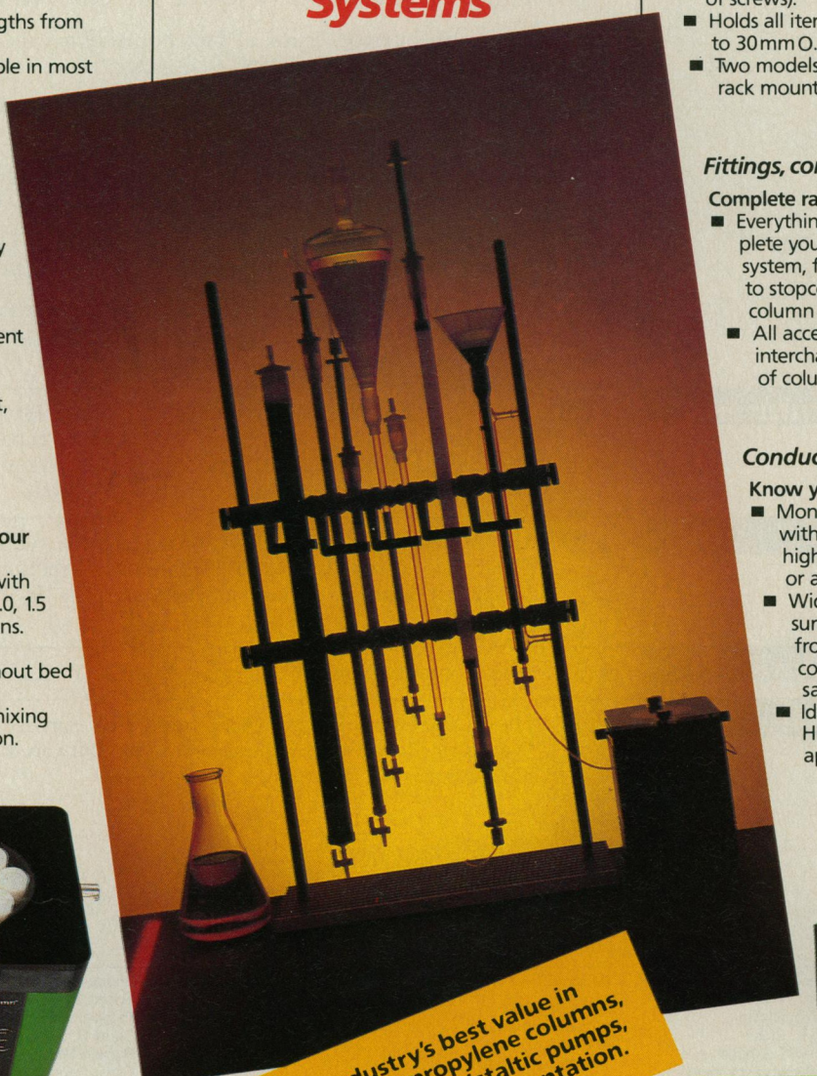

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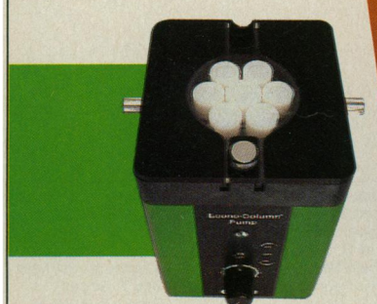

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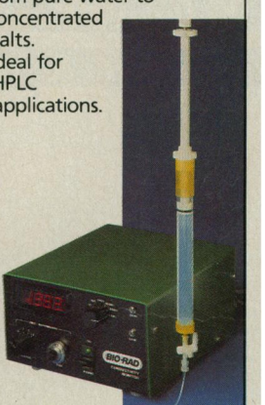

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Volcanoes inactive on Venus

LITTLE or no volcanic activity appears to have occurred on Venus during the past 1 billion years (page 1087). In the planet's highlands, the ancient volcanoes show no electric, geologic, or atmospheric signs of current activity. The Pioneer Venus Orbiter that in 1978 began circling the planet daily detected frequent electrical bursts of 100 hertz in the planet's ionosphere; these signals could have been generated by local interactions between the solar wind and the ionosphere, or they could have resulted from volcanic output that produces lightning. Taylor and Cloutier reviewed the Orbiter electric field data collected between 1978 and 1984. The perturbations in the electric field were found to be distributed randomly over the planet in a pattern resembling that of ionization troughs marking the solar wind interaction with the ionosphere. Only about 16% of the ionospheric noises were within the boundaries of the prominent highlands. (Earlier proposals suggested that such noises would be clustered over highlands if they had a volcanic origin.) This reevaluation of the Orbiter data suggests that, unlike its neighbor Earth, Venus is volcanically dead.

Accuracy of polls

EQUIVALENT surveys, properly designed and conducted at the same time on the same issue and presented in the same context to the same group of people, should yield the same results; they do not always do this (page 1094). Converse and Traugott discuss how error or bias may be introduced into surveys and affect polling accuracy. Sometimes the population polled is not fully enumerated (sampling error): the poor, transient, old, and rural and those in institutions (jails, hospitals, colleges, military establishments) are infrequently polled for "total population" surveys; urban dwellers are collectively poor responders, not opening their doors to strangers or responding to telephone surveys. How a questionnaire is worded can affect what answers will be given; it is possible to bias the questions and obtain answers desired by the poller (advocacy polling). The interviewer's technique, training, and personal attributes can influence respondents' answers as can the expectations or standards of the "house" conducting the poll: for example, interviewers from two polling houses will push to different extents to change "don't know" to definitive answers. These and other polling errors are seldom explained to the public when the results of the poll are announced.

Glacial flow in Antarctica

SATELLITE images of Antarctica (cover) taken by the Landsat spacecraft have provided information on the rate at which outlet glaciers (glaciers bordered by rock) and ice streams (those bordered by ice) from the South Pole's ice sheet are moving as they near the ice shelves and oceans to discharge their ice (page 1105). The velocity figures are important for estimating growth or shrinkage trends for the ice caps and for predicting changes in sea level and climate. Because surface features of glaciers—rifts, depressions, tidal cracks, and crevasses—may remain recognizable for many years, Lucchitta and Ferguson were able to make a 10-year time-lapse study of the fast-moving Byrd Glacier by comparing recent satellite images with older ones. Byrd Glacier has flowed at a rate of 750 to 800 meters per year, confirming earlier and more accurate (but costly and laborious) studies performed from land and aircraft. Landsat images also accurately clocked slower glaciers moving at one fourth that rate. The technology will be useful for inventorying the hundreds of outlet glaciers and ice streams that carry ice to the sea and for evaluating other dynamic features of the polar ice caps that currently retain more than 90% of the earth's fresh water.

Solar irradiance

SOLAR irradiance—the total electromagnetic radiation received by the earth—was regularly recorded between 1980 and 1984 and was found to be decreasing (page 1114). Willson *et al.* describe data obtained with spacecraft (the Solar Maximum Mission and Nimbus-7), sounding rockets, balloons, and ground-based measurements; all confirm a loss of about 0.1% in total solar output. This loss may be coordinated with one of the sun's cycles, the full solar magnetic cycle of 22 years, the 11-year sunspot cycle during which minimum and maximum numbers of sunspots are recorded, or longer magnetic effects. How long the trend will continue and what will be its consequences to the earth's weather remain to be seen.

Bombesin

BOMBESIN is a peptide that stimulates growth and division of mesenchymal and epithelial cells (page 1117). Upon binding to the surface of a sensitive cell, it activates a biochemical pathway that enhances DNA synthesis and the activity of the proto-oncogene c-*myc*. It has now been shown that G proteins, a class of proteins that respond to various neurotransmitters and peptide hormones, play a part in this pathway. Letterio *et al.* found that stimulation of cells by bombesin could be inhibited by pertussis toxin, a potent inhibitor of G-protein activities. A second growth factor, platelet-derived growth factor, which stimulates the same cells as bombesin, retained its activity in the presence of pertussis toxin, suggesting that this factor uses different intracellular signals for producing its effects. Besides being found in normal endocrine cells, bombesin is also associated with some human tumor cells (such as those of small cell carcinomas of the lung), where it may be involved in stimulating characteristic unchecked growth of such tumors.

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The Software Review Section

If we were opening a gas station, we would have gaudy neon signs, searchlights crisscrossing the sky, and large banners announcing this new, incredibly solicitous and superior service. A scholarly journal, however, is constrained to an appropriate type size, a subdued beacon in the Table of Contents, and a muted mention of a new feature in our magazine. Nevertheless, we are enthusiastic about a new section of Software Reviews that we think will provide a service to our readers in an increasingly computerized world.

Since the dawn of civilization man has sought to extend his leverage over nature by the development of useful tools. The abacus, the slide rule, and the pocket calculator are examples of our increasing computational sophistication. In the modern world the computer is changing both life and science in qualitative as well as quantitative ways. We can now search the library from our offices, compare sequences, explore for oil, outline an organic synthesis, and organize our bibliographical references with relatively simple equipment and quite sophisticated programs. Thus it seems appropriate to broaden our Book Reviews to include monthly reviews of software programs that can be useful to scientists by increasing the efficiency of their research.

Software programs are proliferating at an incredible rate, but few individuals have either time or money to initiate comparative studies for the optimal program. Frequently individuals learn of new, more powerful programs only by chance encounter with a fellow scientist long after the program is in extensive use. Moreover, it is of little use to learn of "super" programs that are only compatible with the instrument that does not happen to be in one's own office or laboratory. Our new software reviews have been initiated after consultation with a Software Advisory Panel of experts in a variety of disciplines, who, together with our own staff, developed guidelines for the column.

Our reviews, in general, will compare several different software programs that attack the same problem. We will discuss the scientific problem, its importance, the models on which the software is based, the ability of the program to represent accurately the solution of the problem, and the performance characteristics with various types of equipment. More specifically, the reviews will include comments on the practical application of each program: speed test results, ease of input, quality of output, and problems encountered. All programs analyzed will have been tested by scientists who are using such software to study actual problems. If unexpected difficulties are encountered, the manufacturer will be given the opportunity to explain or resolve the difficulty. Periodically we may include booknote-like entries that will refer to journals that review specific computer software, because in many cases we will not have sufficient space in *Science* to discuss a particular program in complete detail.

We hope to alert scientists in various disciplines to programs about which they may not be aware but which can extend the usefulness of hardware systems that they have already purchased or are contemplating purchasing. Our reviews will also cover time-sharing databases, large multifunctional packages, and, eventually, expert systems.

With any new feature there is the expectation of growing pains and adjustments with experience. We particularly welcome readers' suggestions in regard to programs that they find especially useful. Both good and bad experiences with widely touted programs will be helpful in deciding which programs should be reviewed and what tests should be run. Our plan is to print one section each month and to vary the content and range on the basis of our own evaluations and reader responses.

We are heading into an era in which esoteric abstractions are becoming "natural products." Like natural products, software programs have a self-replicating mechanism. A good review column can provide both needed nutrients and a selection pressure. Let us hope that we can aid the survival of the fittest.—DANIEL E. KOSHLAND, JR.

Letters

Retraction of Data

We write this letter to inform the *Science* readership about information pertinent to a Research Article entitled "Identification of a T helper cell–derived lymphokine that activates resting T lymphocytes" by Claudio Milanese, Neil E. Richardson, and Ellis L. Reinherz which appeared in the 7 March 1986 issue of *Science* (**231**, 1118). In our view, those biological data are not reproducible and are incorrect, and we wish, therefore, to retract the data and the conclusions based on them. To our knowledge, there is no 12-kilodalton lymphokine with the functional attributes described in that publication. A second paper on this lymphokine ("A lymphokine that activates the cytolytic program of both cytotoxic T lymphocyte and natural killer clones" by C. Milanese, R. F. Siliciano, R. E. Schmidt, J. Ritz, N. E. Richardson, and E. L. Reinherz published in the *Journal of Experimental Medicine* [**163**, 1583 (1986)] is similarly being withdrawn. We extend our apologies to the scientific community and trust that certain misinformation presented in that article can be rectified by publication of this retraction letter.

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Ballistic Missile Defense: Cost of Space-Based Laser

Having demonstrated by careful calculations that the "Ballistic Defense System . . . would be unable to maintain its effectiveness at less cost than it would take to proliferate the ballistic missiles necessary to overcome it," George Field and David Spergel (Articles, 21 Mar., p. 1387) conclude that such a system, which is expected to cost hundreds of billions of dollars, will therefore not satisfy President Reagan's own requirement for an "effective strategic defense."

Should the objective of the President's policy be not, as is generally assumed, the maintenance of military balance between the Soviet Union and the United States, but rather the attainment of military superiority over an adversary—whose total economic potential (as measured, say, by its gross national product) is commonly recognized to be inferior to that of the United States—building up strategic defense capabilities costing more than the offensive weapons they will be able to destroy might up to a point still make sense.

As long as the armaments race is confined—as it has been up to now—to the acquisition by each side of the capability to inflict greater and greater damage on the other side, it can be expected to reach an upper limit when both powers, having accumulated enough offensive weapons to be capable of utterly destroying each other, will not dare to use them but, on the other hand, will also have no reason—at least no military reason—to continue the arms race. Since technological advances increase rapidly the "size of the bang" that can be produced for a buck, that limit will be—if it has not yet already been—reached, long before the economically weaker side finds itself unable to continue to transfer its economic resources from civilian to military uses.

An arms race involving the competitive buildup not only of offensive but also of defensive weapons cannot, however, end in a peaceful stalemate of this kind. By allocating more of its remaining economic resources—as long as they are available—to production of either one or the other kind of weapon, each side will always be able to either catch up with or overtake, as the case may be, its adversary. As long as the ratio of the total economic potential, say, the gross national product, of the stronger to that of the weaker power exceeds the "cost-exchange ratio" as defined by Field and Spergel, that is, the cost of producing an additional missile compared with the cost of destroying it, there can be no stalemate ceiling to such an all out arms race.

Starting from a position of approximate military balance, the economically stronger power will in this case be ultimately able to begin to translate its economic superiority into a clear-cut military superiority over the economically weaker power, unless, of course, just before that point has been reached the latter chooses, in desperation, to strike first.

A decision to do so might be said to be irrational, but anyone familiar with past history, not only of the Soviet Union but also of other countries, will concede that the possibility of such a tragic outcome should not be discounted lightly.

A very different picture of the ultimate outcome of the ongoing arms race was presented with the initial announcement of a Strategic Defense Initiative: a picture of both the United States and the Soviet Union basking in the safety of perfect anti-ballistic missile shields. Since the degree of protection provided even by perfect, large complex physical systems cannot possibly be expected to exceed, say 99 or 98%, both sides will be tempted, even forced, to raise the number of nuclear missiles from the thousands that they now possess to tens and even hundreds of thousands. The rosy picture described above is a mirage.

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The article by Field and Spergel on the cost-exchange ratio (CER) of space-based laser defense systems is a welcome precedent in the whole Strategic Defense Initiative (SDI), or "Star Wars," debate because its appearance in an unclassified peer-reviewed journal allows for discussion, criticism, and analysis in the normal scientific mode. The authors focus on a crucial parameter—CER, the cost of destroying a missile divided by the cost of a missile. If one assumes both sides have access to comparable technologies, when the CER is not equal to 1 the system economics tend to destabilize the total number of *offensive* missiles, decreasing them when the CER is less than 1 (good), and increasing them when the CER is greater than 1 (bad). These criteria are based on the argument that replacement of (population-destroying) offensive nuclear missiles by defensive (missile-destroying) deterrents is a desirable path toward international security, while an accelerated offensive arms race is not, and that a transition from an offense- to a defense-dominated world requires a CER of less than 1.

However, we believe the conclusion by Field and Spergel that the CER is "likely to exceed unity for the proposed (space-based laser) system, even if the defense achieves shorter targeting times, while the offense fails to achieve shorter boost-phase durations" is incorrect, as is the authors' contention that they "chose lower limits to costs to the defense and upper limits to costs to the offense." Their clear implication is that even when one attributes the most favorable tech-

nological developments to a laser defense system, its CER is greater than 1.

This is simply not true, as the following example illustrates: Field and Spergel assume an infrared (ir) laser wavelength (λ_{ir}) of approximately 2.7 micrometers (μm) and a mirror with a diameter (D_{ir}) of approximately 10 meters. These values are characteristic of deuterium-fluoride–hydrogen-fluoride (DF-HF) chemical gasdynamic lasers (*1*), but are surely not optimum for space-based laser defense systems. Because beam brightness is proportional to $(\lambda/D)^2$ a shorter wavelength would permit a smaller mirror, lighter weight, and less cost. For example, high-power rare gas-halogen excimer lasers now under development (*2*) operate in the near ultraviolet with a λ of approximately 0.3 μm. For the same beam brightness a mirror diameter of approximately $(\lambda D_{ir})/\lambda_{ir}$, about 1.1 meters, is needed, less than half the 2.4-meter aperture of the Hubble Space Telescope (HST). At constant brightness the number of missiles destroyed per laser platform (n) (table 1 of Field and Spergel) is unaffected. The number of attacking missiles (m) is approximately 1400, and laser platforms ($k = n/m$) are also unaffected. But it follows from equation 17 of Field and Spergel that the cost of destroying a missile, and therefore the CER, is proportional to $D^{1.68}$. Accordingly, CER/CER_{ir} is equal to $(D/D_{ir})^{1.68}$, or about 0.025, where CER_{ir} is the cost-exchange ratio of a DF-HF laser system. Simple scaling then gives the CER's of an excimer space-based laser system, which are directly comparable to those of Field and Spergel (Table 1).

Table 1.

Targeting time t_T (sec)	Duration of boost phase t_B (sec)		
	50	100	200
0.1	0.22	0.13	0.075
1.0	0.40	0.24	0.14
10	1.15	0.68	0.40

This looks more promising than the version in the article and conveys a much more optimistic prospect for space-based laser defense. The authors indicate that "the defense could reduce [CER] by increasing brightness." For the excimer laser brightness goes up by a factor of approximately 100 when the mirror is kept at the nominal 10-meter aperture. However, this imposes more stringent constraints on the mirror surface accuracy and in any event is not a particularly good strategy compared with using smaller mirrors. As is implicit in equation 4 of Field and Spergel, at constant targeting time t_T and boost-phase time t_B, decreasing the dwell time t_D by using a brighter source reaches a point of diminishing returns in terms of missiles destroyed. In other words, the significant potential for decreasing the CER of a space-based laser defense by exploiting short wavelengths is not only obscure in the article by Field and Spergel, but its possible improving effect on performance is not put to optimum use. This does not mean that operational short-wavelength, high-power lasers appropriate for the job at hand actually exist, but that if they could be developed at the efficiency, mass-to-orbit, and power required, the CER of space-based laser defense systems would improve enormously. The limitation here is one of technological development, not an unbeatable law of nature like the diffraction limit.

Another problem with the analysis of Field and Spergel is the cost-estimation approach used, which is both favorable and unfavorable to the defense, in different degrees. It is favorable because it attributes all costs to the optical system and unfavorable because in computing these costs the overpriced HST program is used to extrapolate to large SDI systems, which could incorporate many different types of economies of scale. (In fairness, the authors recognize this

is a problem.) The SDI cost-effectiveness criteria, as put perhaps somewhat more carefully by arms controller Paul Nitze (*3*) than in President Reagan's remarks, is that before it is deployed a strategic defense must be certain to survive attack and be "cost effective *at the margin*" [emphasis ours]. Field and Spergel have modeled the marginal cost aspect by scaling the cost per platform by $k^{-0.23}$ in their equation 16, where k is the number of platforms. However, their baseline cost per unit mass for the 10-meter mirror case is about $\$(3.59 \times 10^9)/(191{,}000$ kilograms), or \$18,800 per kilogram. This is at the very highest end of specific costs for space vehicles, an order of magnitude above operational military aircraft and two orders of magnitude above civilian aircraft with large production runs (*4*). It is some six times higher than current space shuttle transportation costs of \$3000 per kilogram, so it cannot be argued that it is transportation-dominated. If the production costs were cut to \$2000 per kilogram and space transportation costs were cut to \$300 per kilogram (*5*), the theoretical first unit cost would drop by a factor (2300/18800), or about 0.12, and the CER's for the excimer laser system would be as shown in Table 2. At this point, a nonnuclear laser defense begins to look so good that, even when one takes into account the various assumptions listed by Field and Spergel at the end of their article that, if violated, would increase the CER, the reasonable conclusions are that the issue remains open, that technological developments could well create a breakout in which the system would be viable, and that a prima facie case against space-based laser defense is simply not there.

Table 2.

Targeting time t_T (sec)	Duration of boost phase t_B (sec)		
	50	100	200
0.1	0.027	0.016	0.0092
1.0	0.049	0.029	0.017
10	0.14	0.083	0.049

An overriding consideration in assessing strategic defense systems might be pondered by those scientists and engineers who have opted to boycott the SDI program on grounds that it will necessarily destabilize, in an undesirable direction, the strategic arms race: The likely alternative to SDI is not the dismantling of Mutual Assured Destruction, but its institutionalization into the indefinite future. One thing that has been learned from 40 years of bilateral arms control negotiations by U.S. and Soviet administrations is that strategic offensive weapons, once acquired, are almost impossible to get rid of. This is partly because they are an extremely cost-effective technology in the threat-counterthreat dynamics of the arms race (*6*). While we have grown up with the system, it is potentially devastating to the planet (*7*). It is still not certain that an SDI system can be found that will "work" in the sense of providing a credible first-strike shield for populations on both sides behind which they can reduce and eventually eliminate offensive strategic weapons, but there is a real possibility of success and a real danger in giving up too soon.

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REFERENCES AND NOTES

1. R. W. F. Gross and D. J. Spenser, in *Handbook of Chemical Lasers*, R. W. F. Gross and J. F. Bott, Eds. (Wiley, New York, 1976), pp. 619–666; W. R. Warren, in *Gas Flow and Chemical Lasers*, J. F. Wendt, Ed. (Hemisphere, New York, 1979), pp. 151–167.
2. C. A. Brau, in *Excimer Lasers*, C. K. Rhodes, Ed. (Springer-Verlag, New York, 1979), pp. 87–133. True continuous wave operation of excimer lasers is difficult to obtain because instabilities in the ionized gas limit individual pulses to about 1 microsecond [R. S. Taylor and K. E. Leopold, *Appl. Phys. Lett.* **47**, 81 (1985)]. However, high-repetition rate excimer lasers with gas recycling can be employed [C.

P. Christensen, in *High Power Lasers and Applications*, K. L. Kompa and H. Walther, Eds. (Springer-Verlag, New York, 1978), pp. 45–48]. Given a "burst mode" onboard power supply to pump the excimer states there is no apparent reason why 25 megawatts mean output power levels of more than 100 seconds, comparable to those of DF-HF chemical lasers at 2.7 μm assumed by Field and Spergel, could not be obtained at a λ of approximately 0.3 μm in space-based systems. If the power supply were a high-power density fuel cell, the system would in effect be a short-wavelength chemical laser with an intermediate electrical conversion step.

3. *Time*, 11 March 1985, p. 17.
4. F. R. Eldridge, *Wind Machines* (Van Nostrand Reinhold, New York, 1980), p. 144.
5. L. Bekey and J. E. Naugle, *Just Over the Horizon in Space Astronautics and Aeronautics* (National Aeronautics and Space Administration, Washington, DC, 1980). This technical assessment projected substantial cost reductions for post–space shuttle launch vehicle technologies on the basis of energy requirements: "The Shuttle will not do better than $1000 to transport one kilogram to orbit, compared to only $5 to fly one kilogram in an airliner from Los Angeles to New York, although the energy requirements are the same." These authors expected that fully reusable vehicles and other transportation systems would reduce the costs of space transportation "by at least two orders of magnitude." More recently, aerospace planes with airbreathing propulsion systems based on supersonic combustion technology have been seriously proposed for flying directly into orbit with reusable components at far below present launch vehicle costs. A hypersonic transport airliner version, dubbed the Orient Express, has received preliminary development funding by the present Administration.
6. L. F. Richardson, *Arms and Security* (Homewood, Pittsburgh, PA, 1919/1960). Richardson's arms race models are expressed as coupled rate equations for stocks of military goods accumulating in a given nation and that of its rival. The stock flow interaction is such that if the perceived difference is too large or too small, a nation alters its decisions accordingly. For plausible values of parameters a runaway arms race is usually inevitable given an atmosphere of mutual distrust (modeled as perceived tension indices), which is limited ultimately by budgetary constraints from the nonmilitary sector of the economies. Contemporary applications of Richardson modeling to the U.S./Soviet strategic arms situation are discussed by M. D. Ward [*Am. Pol. Sci. Rev.* **78**, 297 (1984); *Confl. Manage. Peace Sci.* 7, 1 (1984)].
7. J. Schell, *The Fate of the Earth* (Knopf, New York, 1982).

Response: Hoffert and Miller state that infrared lasers are not optimum, that ultraviolet lasers will result in the reduced cost-exchange ratios (CER's) in their table 1, and that further reductions in costs will be possible (their table 2), so that "a nonnuclear laser defense begins to look so good . . . that a *prima facie* case against [it] is simply not there."

Infrared lasers indeed may not be optimum. We stated in our article (p. 1389) that shorter wavelength lasers have the potential to decrease the CER. Our analysis was restricted to infrared lasers; as some readers may not have understood this, we regret that the word "infrared" was not included in the title.

We agree that shorter wavelength (0.3 micrometer) lasers in space could result in lower costs. Hoffert and Miller propose a high power, rare gas–halogen excimer laser for this application. Noting that suitable such lasers do not now exist, they suggest that lasers of the "efficiency, mass-to-orbit, and power required" can be developed. This seems doubtful (*1, 2*). Gerold Yonas (*1*), until recently Chief Scientist of the Strategic Defense Initiative Organization, has stated that the "efficiency [of excimer lasers] is so low and generating apparatus is so bulky (even though the optics could be a reasonable size) it is unlikely that they and their fuel supply could be lifted into space in cost effective ways."

Hoffert and Miller scale the cost of infrared laser optics down by a factor of 40 because of the smaller mirror size. However, one cannot simply carry this factor directly over to the CER, because with such a low cost for the optical system alone, other components of a laser platform, which we neglected in order to be conservative in our article, including the generator of the laser beam, the power supply, and systems for pointing, acquisition, and tracking, would probably dominate the cost, particularly in view of Yonas' comments. The CER's in table 1 of Hoffert and Miller are therefore unreliable pending a more detailed analysis of a space-based excimer laser system.

Hoffert and Miller dispute our method of cost analysis. We calculated costs from a model that is based on well-documented space systems (*3*). According to this model, the Hubble Space Telescope (HST) is not "overpriced" as stated by Hoffert and Miller, as it actually cost 20% less than the model predicts. (We took this into account by renormalizing the model to the actual cost of the HST.) Complex space systems are very expensive, and there is no evidence for the supposition of Hoffert and Miller that production costs can be reduced to $2000 per kilogram; so their table 2 has little value.

We remind the reader of the many conservative assumptions listed at the end of our article, the violation of any of which could significantly increase the CER of a space-based laser system. We are not persuaded by Hoffert and Miller that such systems "look so good."

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REFERENCES

1. G. Yonas, *Phys. Today* **38**, 24 (June 1985).
2. *Report to the Congress on the Strategic Defense Initiative* (Department of Defense, Washington, DC, 1985); Office of Technology Assessment, U.S. Congress, *Ballistic Missile Defense Technologies* (OTA-ISC-254, Government Printing Office, Washington, DC, September 1985).
3. W. L. Pritchard, *Acta Astron.* 7, 373 (1980).

ICSU General Assembly

With reference to David Dickson's briefing on the International Council of Scientific Unions (ICSU) (News & Comment, 3 Oct., p. 19), the venue of the 1988 meeting of ICSU's General Assembly was not decided in Berne. Invitations were received from the Science Council of Japan and the China Association for Science and Technology, but the Assembly did not go beyond welcoming the proposal that it should next meet in East Asia. The final decision as to the venue of the 22nd General Assembly, whether it will be Beijing or Tokyo, will be made by the ICSU Executive Board in January 1987.

JULIA MARTON-LEFÈVRE
International Council of
Scientific Unions,
51, Boulevard de Montmorency,
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Spanking and Rationality

Daniel E. Koshland, Jr., in his editorial on "Spanking, reason, and the environment" (24 Oct., p. 409) says "The reality is that we live in a world that becomes more densely populated each year and that population depends on chemicals for its food and standard of living." Then he suggests research free of headlines, law cases, and politicizing.

But is it not perfectly obvious (and rational) that the basic problem lies in population growth and the basic solution lies in population control? If it is not, then perhaps Koshland should have been spanked when he first believed the world was rational.

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Erratum: In the article "Molecular biology of the H-2 histocompatibility complex" by Richard A. Flavell *et al.* (25 July, p. 437), reference 44 should have been omitted.

Erratum: In the News & Comment article "The Chesapeake Bay's difficult comeback" by Marjorie Sun (15 Aug., p. 715), the size of the Bay was reported incorrectly to be 64,000 square miles. It is the Bay's watershed that spans 64,000 square miles. The Bay itself covers more than 2,500 square miles of surface area, according to Environmental Protection Agency figures.

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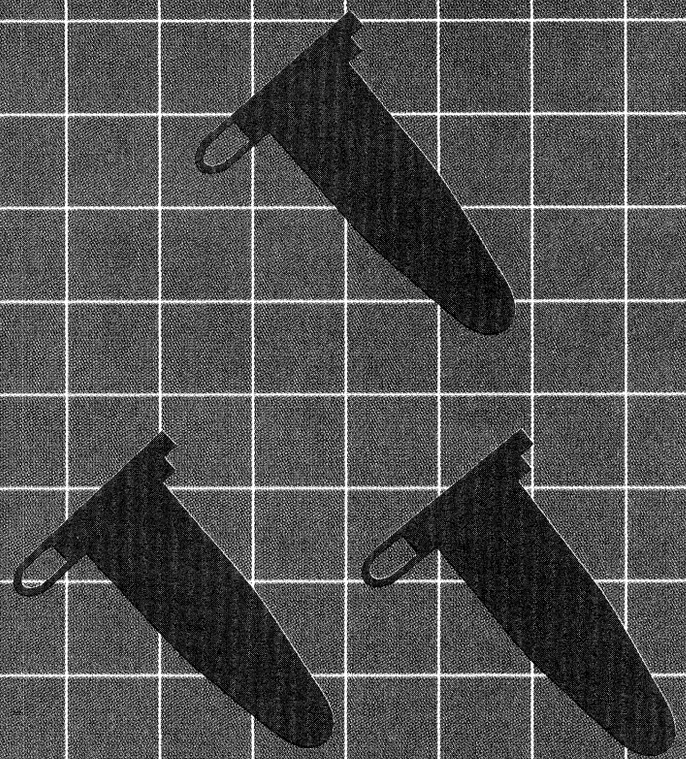

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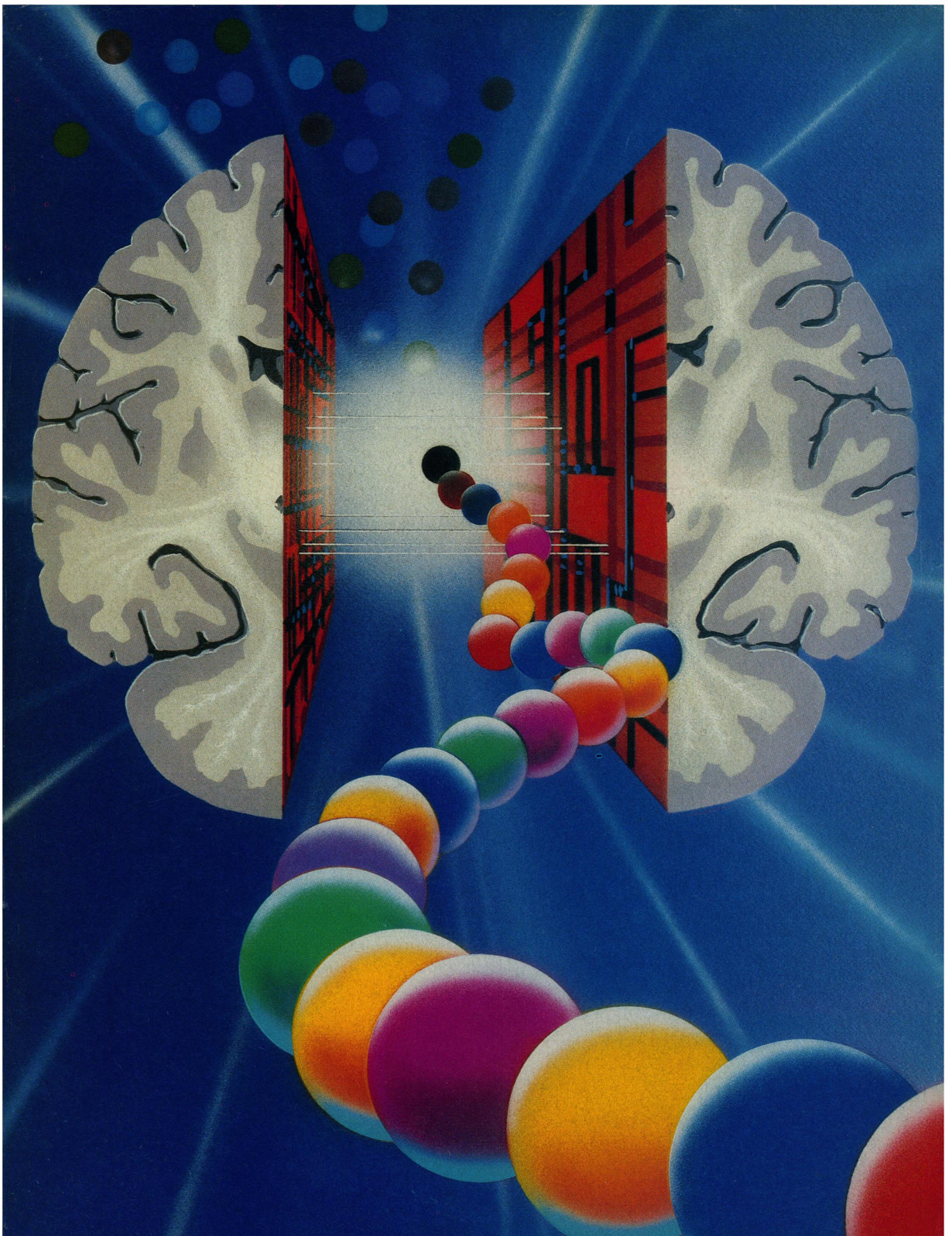

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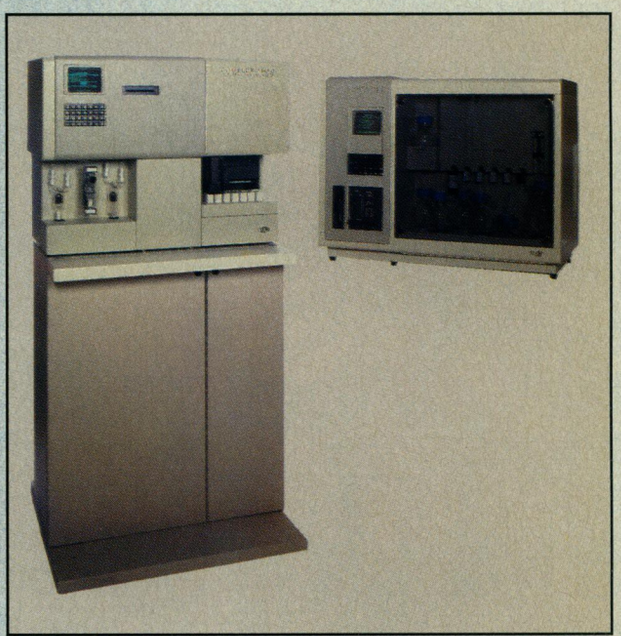

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