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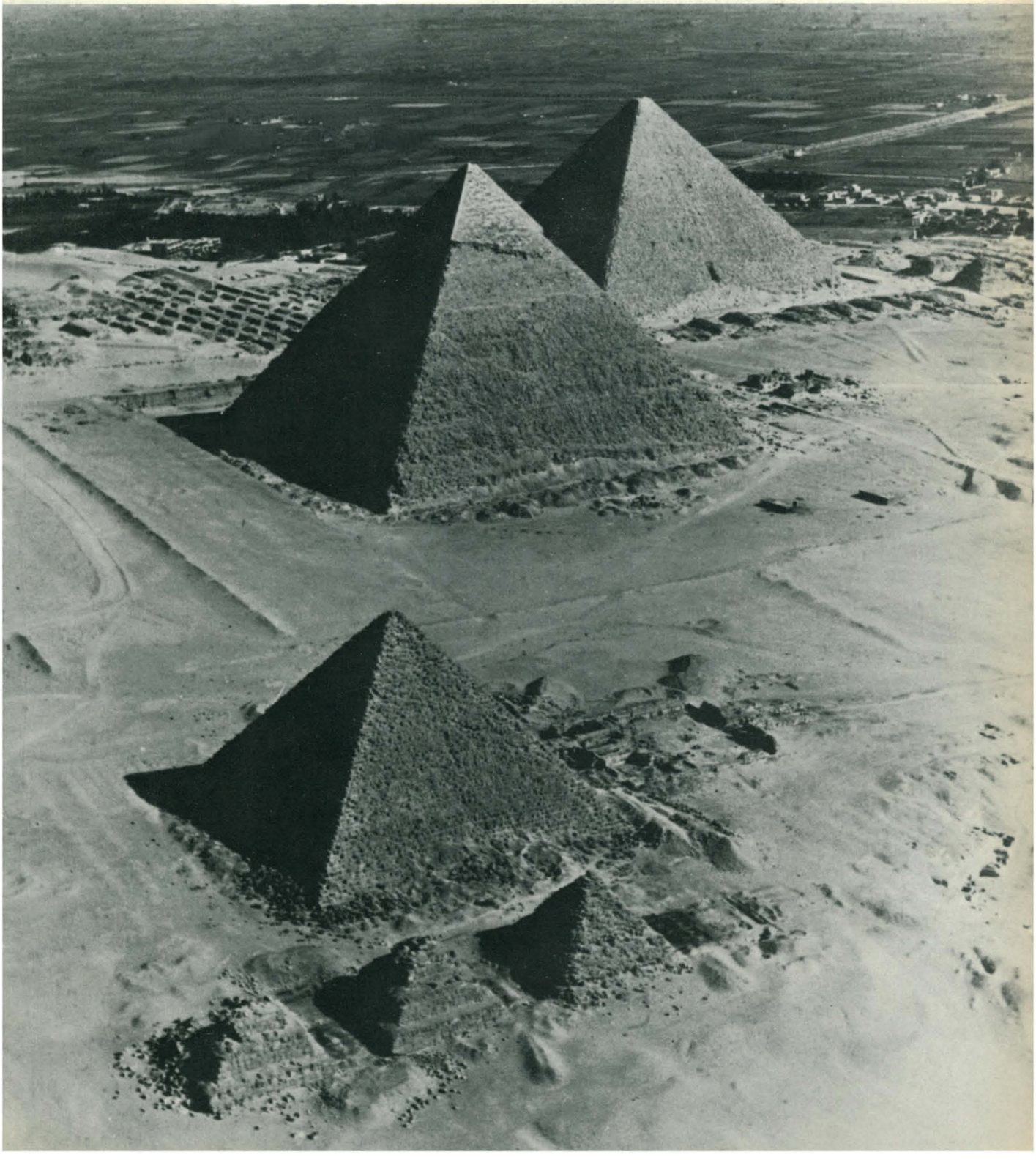

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We want to be useful ...and even interesting

A baking product of possibly cosmic significance

Here we go cuddling up to the astronomers again.

> *Inquiries about availability of strong red sensitivity in the "IIIa" type of emulsion will be welcomed by E. J. Hahn, Scientific Photography Markets, Kodak, Rochester, N.Y. 14650.*

C. E. K. Mees, who started the Kodak Research Laboratories in 1912, was an astronomy buff. Instead of grinding telescope mirrors, he made photographic emulsions for astronomers. Some people refuse to distinguish between work and fun.

Mees numbered his emulsion types from I to V. From I to V, light sensitivity and granularity decreased and inherent contrast increased. Later he appended "a." This indicated a treatment against loss of effect of some of the photons when they are spaced out too much, as at low intensity. Capital letters designated sensitization to certain spectral regions. This nomenclature is now work lingo of the astronomer.

Last year astronomers from seven nations of Europe announced a project to map the sky of the southern hemisphere to "limiting magnitude." They were prepared to regard the capability of Type IIIa-J as "limiting." Why not Ia? Why IIIa?

Because of *detective quantum efficiency* (D.Q.E.). The photographic emulsion, like all detectors, responds to both signal and noise. It responds by grain blackening. From internal causes, some grains blacken that shouldn't; some grains that should, don't. Both cases add further noise. The noise concept comes to photography from radio. D.Q.E., the square of the ratio of output signal/noise to input signal/noise, varies directly with sensitivity and contrast and inversely with granularity. Which is hardly a surprise.

Eight years ago we started preaching to the astronomers to mind their D.Q.E., that there is an optimum choice of parameters of manufacture, exposure, and processing. On all sides of the optimum you got less information per precious hour of telescope time.

Then we presented them with KODAK "Spectroscopic" Plates, Type IIIa-J, the first photographic material designed above all else to maximize D.Q.E. if baked* before exposure. The "J" indicates sensitization only a short way into the blue-green beyond the sensitivity of unaided silver halide. To extend the sensitivity of the IIIa emulsion type beyond a practical photographic limit of 520 nm without losing response to baking has been difficult. Our modestly worded invitation above stems from tests where we almost hit 700 nm with a baked product. Man's window to the universe is opening wider.

*Typically for 18 hours at 55 C, as first worked out by W. C. Miller, Hale Observatories. Later, Miller tells us, he was able to bring the baking time down to 5 hours at 65 C.

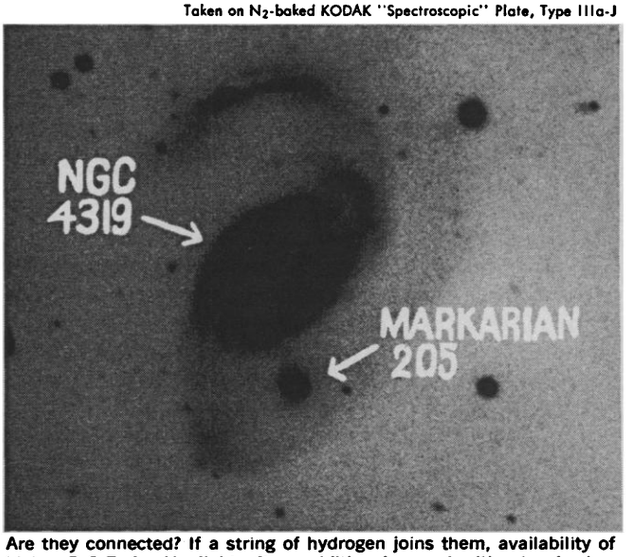
At the moment, though, we bow in the direction of Rosemary Hill. On that hill at Gainesville sits the University of Florida observatory. There close attention was paid to publications from the Kodak Research Laboratories about how moisture and O_2 depress sensitivity to dim light. There, as described in the July '71 issue of *Applied Optics* (*10*:1597), procedure and equipment were devised for *baking and exposing* IIIa-J plates under dry N_2.

Scarcely a month after the paper appeared, astronomers were telling each other of speed gains from 5× to 8× thus achieved at low intensity. This amounted to about the speed of IIa, but with about twice the contrast and half the granularity of IIa. Consequently D.Q.E. reaches 4%. Hitherto no actual photographic emulsion has gone much higher than 0.8%. Theoretical emulsions could go to 3.5% in theory. So our own theorists—conservative people—had theorized.

Let's hear it for Rosemary Hill!

Well beyond buffhood is the incumbent partisan of astronomy's cause at the Kodak Research Laboratories. During a Study Research Leave at Kitt Peak National Observatory he tried to confirm evidence from a Palomar IIIa-J plate that a filament luminous with Hα light connects the galaxy NGC 4319 with the object known as Markarian 205. According to red shifts, these two are receding at 1700 km/sec and 20,250 km/sec respectively. Since no string can be stretching that fast, perhaps red shifts can occur from non-velocity causes. If so, then bang goes the big-bang theory of the expanding universe. Alas, with all the detective quantum efficiency at his command, our man has in vain searched for the string. In *The Astrophysical Journal* for August 15, 1972 (176:L5), a collaborator and he have nothing more startling to report than the possibility that one of the many faint extended objects in that region of the sky—presumably distant galaxies—happens to show up between the relatively nearby NGC 4319 and the apparently more distant Markarian 205.

Taken on N_2-baked KODAK "Spectroscopic" Plate, Type IIIa-J



Are they connected? If a string of hydrogen joins them, availability of higher D.Q.E. for Hα light offers additional opportunities to check a philosophically sensitive point by direct photography.

Kodak

May all enjoy their work

An equal-opportunity employer

2 March 1973

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SCIENCE

SCIENCE is published weekly, except the last week in December, but with an extra issue on the fourth Tuesday in November, by the American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Now combined with **The Scientific Monthly®**. Second-class postage paid at Washington, D.C. Annual subscription $20; foreign postage: Americas $3; overseas $5; air freight to Europe, North Africa, Near East $16; single copies $1 (back issues, $2) except **Guide to Scientific Instruments** which is $4. School year subscription: 9 months, $15; 10 months, $16.75. Provide 4 weeks notice for change of address, giving new and old address and zip codes. Send a recent address label. SCIENCE is indexed in the **Reader's Guide to Periodical Literature.**

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.

COVER

The orientation of the Great Pyramids of Giza has remained unexplained for many decades. General alignment is 4 minutes west of north. This deviation from the north may be explained by continental drift. See page 892. [Courtesy of Museum of Fine Arts, Boston, Massachusetts]

AAAS Audiotapes in 1973

Recordings of symposia held during the AAAS Annual Meeting in Washington, D.C., are available as 5-inch open reels (3¾ i.p.s. for standard machines) or as cassettes. Price: single-session symposium, $15; multi-session: $15 first session, $12 each additional session of same symposium. Each session lasts about three hours.

120-72—Cross Cultural Perspectives on Early Development (One Session).
Cognitive growth of children in rural and town settings in Guatemala. The disadvantages of sensory deprivation may be overcome as an innate and highly plastic capacity for learning develops. *Jerome Kagan, Harvard University.*

121-72—Genetic-Physiological Approaches to Animal Improvement (One Session).
Improving animal performance in the production of food from research in the genetic-physiological aspects of livestock production. *Gordon E. Dickerson, Edward G. Buss, H. H. Hafs, B. N. Day.*

122-72—Facts and Fiction with Regard to Sex Differences (One Session).
Facts and fiction with regard to sex differences from the physiological and sociological point of view, and the psychological basis of sex differences as related to ability in science. *Estelle Ramey, Jacqueline J. Jackson, Barbara Bergmann, Deborah Shapley, and others.*

123-72—Ethical, Legal, and Social Issues of Behavior Control (Sessions I-II).
Preliminary findings of the Research Group on Behavior Control of the Institute of Society, Ethics and the Life Sciences, engaged in long-term study of ethical, legal, and social issues of particular technologies, and their interrelationship and cumulative impact. *Herbert G. Vaughan, Jr., Gerald Klerman, Robert Michels, Harold Edgar, Robert C. Neville, and Perry London.*

124-72—Crime Prevention: Heredity and Environment Revisited (Sessions I-II).
Respective roles of "nature" and "nurture" in shaping human behavior receive a careful reexamination in light of current scientific knowledge, with emphasis on prevention before the criminal act, and the use of research from diverse fields such as genetics, architecture, education, and biochemistry. *Nicholas N. Kittrie, David Rosenthal, Leopold Liss, Samuel Corson and others.*

126-72—Genetic Vulnerability of Crops (One Session).
Study by the National Academy of Sciences on the epidemic of Southern Corn Leaf Blight which created a loss of nearly 15 percent of the corn crop nationwide in 1970, with the suggestion that a much more comprehensive gene pool is needed so that the genetic hazard of vulnerability may be decreased. *James G. Horsfall, Warren H. Gabelman, David H. Timothy, and George F. Sprague.*

128-72—The New Urban Vision (One Session).
A new humanistic architecture seems to be emerging which seeks to design the urban environment with nature, rather than against it, and which makes new, specific and as yet unmet demands on science and technology. *Wolf Von Eckardt,* The Washington *Post.*

129-72—Changing the Weather (Sessions I-II).
What weather management efforts are in the public interest, involving economic, legal, political, and administrative, as well as scientific and technical considerations. What degree of freedom should be used to manage the atmosphere. *Charles L. Hosler, Thomas Malone, Reid Bryson, J. Eugene Haas, and others.*

130-72—Genetics and Human Disease (Sessions I-II).
Topics include: "Cytogenetics," "Immunogenetics," "Sickle Cell Anemia," "Genetic Counseling." *H. Neil Kirkman, Barbara R. Migeon, Robert F. Murray, Edmond A. Murphy and others.*

131-72—Temperate Climate Forestry and the Forest Ecosystem (Sessions I-II).
Environmental problems facing today's forest manager as he seeks to adjust production and regeneration technology to the broad goals of an environmentally sensitive economy. *Theodore C. Byerly, Gene E. Likens, F. Herbert Bormann, William H. Smith, T. C. Nelson, Arnold Bolle, George Staebler, and Donald Dahlston.*

132-72—Sex Role Learning in Childhood and Adolescence (Sessions I-III).
How sex roles come into being in our culture. Traditional sex roles with attention paid to the concept of self as "girl" or "boy" among children and youths in relation to adult sexuality. *John Money, Walter Emmerich, Eleanor Maccoby, Aletha H. Stein, David Lynn, and others.*

133-72—Human Learning Capacity in Neurobiological Perspective (Sessions I-IV).
Four domains in the neurosciences: the architecture of the brain, the study of learning behaviors in other vertebrates, biological basis of language and communicative behavior, and the relationship of brain characteristics to learning environments. *S. Dillon Ripley, Philip C. Ritterbush, Jerome Kagan, Karl H. Pribram, Mark R. Rosenzweig, Peter Klopfer, Richard Chase, Roger Sperry, and others.*

134-72—Must We Limit Economc Growth? (Sessons I-IV).
Questions discussed: Must we limit economic growth in the United States and other developed countries to avoid a world catastrophe of resource exhaustion and environmental pollution? Would such growth preclude a higher standard of living for the underdeveloped world? Are there positive benefits to continued growth? What is the role of energy in controlling growth? *Edward F. Denison, Dennis L. Meadows, S. Fred Singer, Chauncey Starr, Marc Roberts, and others.*

135-72—Genetics, Man, and Society (Sessions I-II).
Current use of genetic knowledge and its implications for the individual and society in the light of the current biologic revolution of fast accumulating knowledge in genetics, taking into account the means and consequences of accumulating this knowledge and the ways to minimize the likelihood of its misuses. *Mack Lipkin, Jr., David C. Duncombe, Michael M. Kaback, James R. Sorenson, Y. Edward Hsia, Muriel F. Humphrey, and others.*

136-72—Communications Revolution (One Session).
Andrew A. Aines, Office of Science Information Services, National Science Foundation.

137-72—Social Applications of Genetic Knowledge (One Session).
Gene manipulation and some of the individual and societal opportunities and problems that will result when this new technology is fully developed. *E. G. Stanley Baker, Robert G. Martin, William J. Mellman, Harold B. Green, and others.*

138-72—New Approaches to Global Weather (One Session).
Response of the international atmospheric research community to the Global Atmospheric Research Program (GARP). Detailed look at two aspects of the program: new observing systems (especially satellites) and predictability. The question is asked: should we control the weather? *Walter Orr Roberts, Philip E. Merilees, Robert W. Stewart, Edward N. Lorenz, and Eugene W. Bierly.*

139-72—Conceptions and Alleviations of Aggression and Violence (Sessions I-II).
Symposium represents the First National Congress of the Organization for the Study of Group Tensions. *John E. Exner, Jr., Jerome Singer, Amitai Etzioni, John Speigel, Irving Salan, Robert Reiff, and others.*

140-72—Man-Environment Relations and Health (Sessions I-IV).
Representatives of major conceptual positions discuss the implication of their systems with health professionals and biological and behavioral scientists, with the focus on the consequences of certain theories of man-environment relations for physical and mental health, and the goal of exploring the possibilities of integrating theoretically conceived relations between man and his environment with the changing practices of health care and maintenance. *Aristide H. Esser, Virginia R. Hannon, Charles Ferster, Edwin Williams, William Ittelson, Dorothea Leighton, Viola Bernard, and others.*

141-72—Understanding Parapsychological Phenomena (One Session).
An attempt to integrate results and theory in four important areas of parapsychological research, with emphasis on aspects of internal state and some of the cognitive processing factors involved, and concluding with a discussion of the general effects of cultural differences and personality patterns. *Robert L. Morris, Charles Honorton, Rex G. Standford, Robert L. Van de Castle, Irvin L. Child, and Walter J. Levy.*

142-72—Educational Achievement and Social Indicators (One Session).
Review, interpretation, and relation to current issues in education of assessments in science, citizenship, and reading, and an analysis of the measurement problems and the relationship between national assessment, social indicators, and educational policy. *Wilbur J. Cohen, Selma J. Mushkin, Dorothy M. Gilford, C. Philip Kearney, J. Stanley Ahmann, and others.*

143-72—Limits to Growth of Technology (One Session).
Technological growth, how it interacts with the other variables, and the necessity of such growth if there are any plausible non-catastrophic scenarios for the future of mankind. *Chauncey Starr, Richard A. Carpenter, Roy P. Jackson, Arthur Kantrowitz, S. Fred Singer, W. Hunter II, and Glen P. Wilson.*

144-72—Prison Research (Sessions I-II).
Review of prison research and proposal of methods, patterns, and programs of research for the future, directed to the prison institution, prison processes, and prison behavior in the United States and Europe (especially Sweden). *John P. Conrad, Norman Bishop, Edwith E. Flynn, Nicholas M. Kittrie, Philip G. Zimbardo, and others.*

145-72—Interdisciplinary Approaches to Community Health with Emphasis on Social Sciences and Mental Health (Sessions I-II).
Various programs and approaches to clinical services, research, graduate students in various disciplines working in community health. Effective use of student manpower in delivery of health services. *Jack A. Wolford, Jan Nolan, Tobias Brocher, Mirta T. Mulhare, and others.*

146-72—. . . and shall we have Science for ever and ever? (One Session).
We face today, as in Alexandrian times disciplinary fragmentation within science, and estrangement of many outsiders from its ideals. Unless the barriers of sympathy and understanding between "scientists" and their fellow-citizens are demolished, and the spirit and integrity of earlier "natural philosophy" are restored, a new Dark Age might well overtake science. *Stephen Toulmin, University of California, Santa Cruz.*

147-72—Humanizing the Earth (One Session).
Using knowledge and reason man can improve on nature. Man-made nature can remain ecologically stable, economically rewarding, and esthetically pleasurable for immense periods of time. Civilizations emerge from a creative symbiosis between man and nature. *Rene Dubos, Rockefeller University.*

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AAAS

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Department MV
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LETTERS

Ecological Sacrifice

As an expression of environmental concern, the printing of the 1972 AAAS annual meeting program on "ecology text paper" clearly puts the AAAS on the side of the environmental good guys. But there is a problem therein which should be pointed out in the interest of scientific accuracy. The problem lies in the ambiguity of the word "recycled." The note on page 2 of the program implies that through economic and esthetic sacrifice used milk cartons and paper plates have been diverted from the stream of solid waste destined for the town dump and have become a useful medium for the publication of the AAAS agenda. This implication is not correct.

If there was an economic sacrifice, it did not relieve the burden of postconsumer waste. Almost all the paper stock used as a raw material for the program paper consisted of industrial scrap generated by a mill manufacturing special food paperboard. This scrap, considered high-grade material, brings over $50 a ton in the secondary market. There was obviously an esthetic sacrifice, because the halftones are not clear.

It's a pity to have accepted lower quality at increased expense; it was not necessary to do this on behalf of the environment. It is possible to purchase recycled paper containing a relatively high percentage of postconsumer waste on which halftones are reproduced with the same clarity as they are on virgin pulp paper. The relatively high cost of the paper used is probably better explained by factors of demand rather than by increased costs of manufacture.

THOMAS H. E. QUIMBY
Resources for the Future,
1755 Massachusetts Avenue, NW,
Washington, D.C. 20036

pH: Another View

The opinions concerning *p*H expressed by Seeman (Letters, 8 Sept. 1972, p. 835) appear to be all to widely shared, even by some editors who permit authors to report "hydrogen ion concentrations" calculated from their *p*H measurements.

An excellent account of the development of the various *p*H scales is to be found in the monograph by Bates (*1*). It is true that when Sørensen first proposed the *p*H scale, it was defined in terms of hydrogen ion concentration. This definition, now long obsolete, continues to be a source of confusion. It came to be realized that the actual measurements of *p*H by various methods involve not the concentration but the activity of the hydrogen ion. Since the absolute activity of the hydrogen ion or any other single ion is not susceptible to measurement, *p*H measurements are actually measurements of the differences of hydrogen ion activity between unknown solutions and standard buffers of assigned *p*H values. It is not legitimate to convert experimentally measured *p*H values into "hydrogen ion concentrations."

The true significance of *p*H is that it is an index of the chemical potential of the proton, not only the proton existing free (or hydrated), but the dissociable proton incorporated in proton-donor molecules. Even when free protons are present in small numbers, those in proton-donor molecules may be in abundance. The hydrogen ion differs fundamentally from a stable ion like the sodium ion in that the average life of a hydrogen ion is short (10^{-6} second or less). There is continual release of protons from donor molecules and recombination into acceptor molecules, with a very large rate of turnover. The stochastic treatment of the concentration and movement of the hydrogen ion is totally different from that of a stable, permanent ion.

The misconception of the significance of *p*H as a measure of the concentration of hydrogen ions is the source of the recurring concern about the numbers of hydrogen ions contained in small subcellular compartments, a concern first expressed in 1934 by Netter (*2*). It was thought that if a compartment were so small as to contain only a few hydrogen ions, the random motion of the hydrogen ions into and out of the compartment would result in fluctuations so great as to render the concept of *p*H meaningless.

Let us consider a spherical compartment of radius 62 angstroms with a volume of 10^{-18} liter. If this compartment contains a 0.1 molar phosphate buffer of *p*H 7, the probability is low that a single hydrogen ion will be found in it at any instant, the statistical number of hydrogen ions being about 0.06. Yet this volume contains about 30,000

each of the proton-donor and proton-acceptor species of phosphate ions. The ratio of these two species, which determines *p*H, will not undergo significant statistical variation, and the concept of *p*H is entirely valid.

Chance (*3*) demonstrated experimentally that "proton noise" was not significant in a single mitochondrion. There is probably no subcellular aqueous compartment recognizable as such, even by electron microscopy, that is so small that the chemical potential of the proton, as expressed by *p*H, would not have a stable value, and for which the concept of *p*H as it applies to large volumes has ceased to have the same validity.

THOMAS C. BUTLER
Department of Pharmacology,
School of Medicine,
University of North Carolina,
Chapel Hill 27514

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1. R. G. Bates, *Determination of pH: Theory and Practice* (Wiley, New York, 1964).
2. H. Netter, *Pfluegers Arch. Gesamie Physiol. Menschen Tiere* **234**, 680 (1934).
3. B. Chance, *Nature* **214**, 399 (1967).

Nuclear Energy and Growth

Alvin M. Weinberg recently cited the Club of Rome report (*1*) in defense of his proposed policy for nuclear energy development (Letters, 1 Dec. 1972, p. 933). "The simple fact is that mankind can avoid the catastrophe predicted by the Club of Rome . . . only if an essentially inexhaustible energy source is developed." I protest the use he has made of our findings. On page 131 of our report we ask rhetorically whether the assumption of infinite energy would alter the outcomes projected by our model. While energy is not explicitly included in our model relationships, the effect of unlimited energy can be partially explored through the assumption of effectively infinite resources. The assumption of infinite resources did not alter our general conclusions.

Of much more relevance to the Weinberg-Edsall exchange is that part of our report in which we describe the implications of a long delay between the generation of persistent pollutants and their appearance in the environment. Wherever the delay is long, vast amounts of pollution may be generated before there is any possibility of effective countermeasures by society.

Thus those countermeasures may come too late to avoid unacceptable pollution damage. We have cited the storage of radioactive wastes as a classic example of this problem.

Edsall points to the unrealistic assumption of social stability underlying a nuclear waste storage program. If Weinberg accepts our results, it is interesting that he does not consider the potential impact of a conceivable rapid decline in population on the stability of the social institutions that must be maintained for the protection of radioactive materials. Unsupported promises of "essentially inexhaustible energy" serve only to forestall the social and economic changes which will inevitably be required to bring demographic and material growth into balance with the finite global environment. Our research addressed issues quite removed from this country's energy policy. However, to the extent that our study provides any basis for a choice among alternative energy strategies, we would agree most emphatically with John Edsall and with Hannes Alfvén, "Fission energy does not represent an acceptable solution to the energy problem. It would place an unendurable burden on the safety and health of future generations" (*2*).

DENNIS L. MEADOWS
Thayer School of Engineering,
Dartmouth College,
Hanover, New Hampshire 03755

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1. D. H. Meadows, D. L. Meadows, J. Randers, W. W Behrens III, *The Limits to Growth* (Potomac Associates–Universe Books, New York, 1972).
2. H. Alfvén, *Bull. At. Sci.* **28** (No. 5), 5 (1972).

I was careful in my letter to point out that an inexhaustible energy source is a necessary—not a sufficient—condition for mankind's ultimate survival. Obviously many other things, including technologies for dealing with pollution and a degree of social stability, will also be required.

Meadows overestimates the difficulty of radioactive waste disposal in bedded salt. Radioactive wastes are now being sequestered in salt in Germany. To those of us who have been working on the matter, every problem that we have been able to think of—including such long-range questions as ultimate glaciations—seems resolvable. This includes the plugging of man-made holes (through which water might seep), although additional work is needed here.

Meadows characterizes my claim that the nuclear breeder provides an essentially inexhaustible energy source as an "unsupported promise." To the extent that any claim for the far future cannot be proved until that future has arrived, Meadows has a point. On the other hand, we do know that the amount of uranium in the granitic rocks is enormous, and that breeder technology, which is fairly well advanced, makes this all but inexhaustible resource available. I would turn Meadows' argument around and ask him, since he does not consider fission an acceptable solution to the energy problem, to propose some other solution that provides inexhaustible energy and is both technologically and economically more than an "unsupported promise."

ALVIN M. WEINBERG
Oak Ridge National Laboratory,
Oak Ridge, Tennessee 37830

Multidimensioned Matrix

On reading "Switchboard versus statistical theories of learning and memory" by E. R. John (8 Sept. 1972, p. 850), I was reminded of a poem I wrote in 1967.

Old Math

I am a multidimensioned matrix
of unrepeated primes
so
my every intersection is
unique and unequatable
what I want for lunch or
whom I want for president
is indistinguishable from
reaching for a cup of tea
or (should be) touching you
any product of unduplicated primes
can be factored in only one way
no indeterminism
no subjectivity
no ambivalence
no evaluation
no opinion
however
intersections containing composites
could be factored ambiguously as
the structure of the number permits
so
sometimes spaces show
between the primes and
(touching you)
products containing composites
from time to time
get hung up and
in consequence
so do I

MEL RECHTMAN
1642 Johnson Road, NE,
Atlanta, Georgia 30306

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SCIENCE

Energy and National Security

It is characteristic of a democratic form of government that major legislation is usually not enacted unless public opinion has crystallized in support of it. When an issue has dramatic appeal, far-reaching legislation is often enacted quickly. When issues are complex and nonemotional, the government moves slowly, if at all. An example of the latter attitude has been the government's treatment of the energy problem. Our national security, financial stability, and standard of living are at stake, but the federal response has not been commensurate with the need. Until recently, most of the talk about energy has been about the problems that will arise in 1985 or 2000. This has the effect of pigeonholing the matter. Who can sustain a high level of excitement about the year 1985?

The latest figures show that we cannot afford the luxury of sleeping for another 12 years. Despite all the publicity about the need to conserve energy, its use continues to expand. The impact of environmental regulations has accelerated the demand for petroleum and its products. Consumption of these resources this year has been exceeding that of last year by about 9 percent, requiring increased dependence on foreign sources at heavy cost in foreign exchange. This winter, about 30 percent of our petroleum will be imported, a sharp rise from the percentage a year ago. Pessimists have been talking of a 50 percent dependence in 1985, but the current rate of change indicates that that figure could be reached in 4 or 5 years unless drastic action is taken.

Along the East Coast of the United States, virtually all fuel for electric power plants is imported. Oil has completely replaced coal. Reserve storage facilities for oil are inadequate. If supplies were stopped for some weeks, we would be in major difficulties. If we were prudent, we would see to it that a 180-day supply was held in reserve. We would also see to it that power plants could be quickly converted to burn coal. In principle, we have enormous reserves of coal. In practice, we are rapidly making these reserves unavailable for use. Coal-firing equipment in power plants is being scrapped; new oil-fired plants have been built that cannot quickly be converted to coal. If our oil supply were cut off, we would be sitting helplessly on much of the world's best coal deposits, unable to use them effectively.

In principle, we can obtain liquid hydrocarbons and methane from coal, and we can treat coal or stack gases to remove sulfur. In practice, the commitment to solving our immediate fuel problems is relatively trivial. What is needed are demonstration plants on the billion-dollar scale. We also need a national program that provides incentives for the individual citizen to be sparing in his use of energy. This probably can be achieved best by making energy more expensive. However, we should not give windfall profits to the oil companies. They have tremendous resources, both financial and technological, but they have not devoted a reasonable fraction of these resources to safeguarding this country from petroleum blackmail.

Indeed, it is questionable whether the rules under which these large companies operate now serve the national interest. This question and others have been addressed lucidly in a recent policy paper prepared for Senator Henry Jackson (D–Wash.).* The Administration is preparing a belated response to the energy problem. It is to be hoped that the recommendations will be more dynamic and comprehensive than indicated by the 1974 budget message.—PHILIP H. ABELSON

* *Toward a Rational Policy for Oil and Gas Imports* (Government Printing Office, Washington, D.C., 1973).