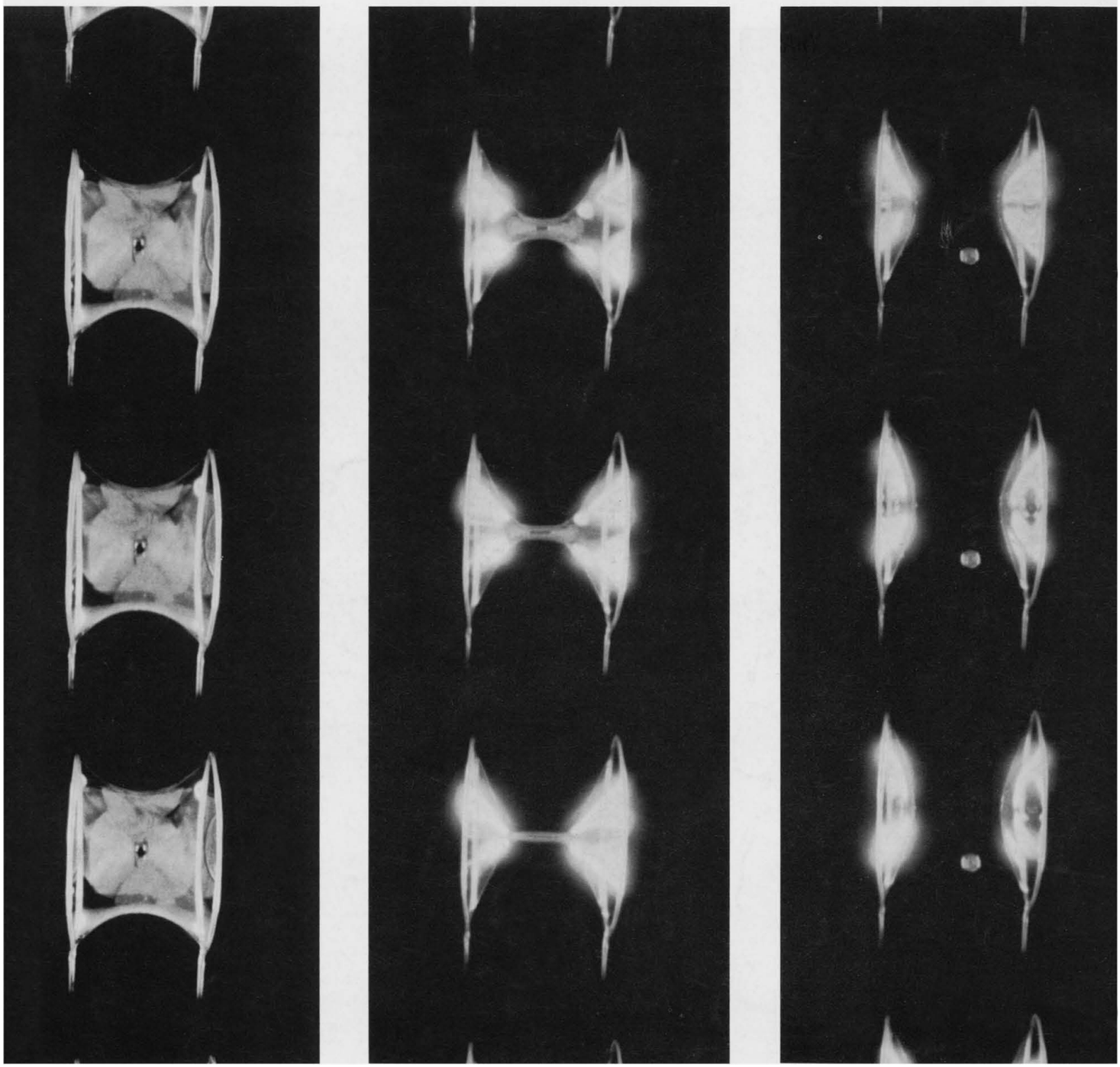
SCIENCE

23 March 1962

Vol. 135, No. 3508

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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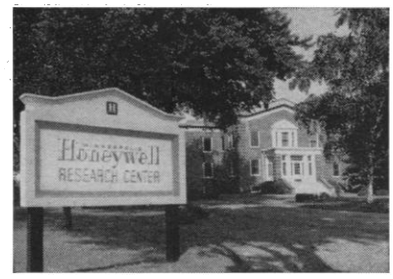


Infrared Spectroscopic Studies of Molten Salts

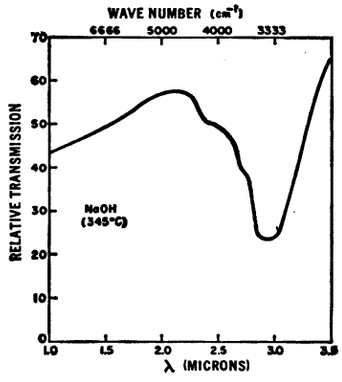
Of the three states of matter, solid, liquid and gaseous, the least is known about the liquid state. This is especially true in the field of molten salts. When a substance becomes molten, properties change drastically and certain change of state phenomena are unpredictable. New examination techniques are providing usable measurements and new insights in this field.

Solid and gaseous systems have been thoroughly studied and much classical data is available. Much less is known about the molten state and virtually nothing has been done in this field except for recent government-sponsored work on liquid coolants for nuclear reactors.

There is a large number of inorganic salts and their properties in a water solution are well documented. There is little knowledge, however, of their characteristics in the molten state. It is interesting to note that when used as a solvent each family of salts would represent a field of study as large as our presently defined field of inorganic chemistry.

Curious chemists have puzzled over molten salts for years. Why don't salts in the liquid state behave as a dense gas? Why does the liquid state depart from the usual law of like dissolving like? What principles of solution phenomena account for eutectics and ternaries? Why do almost identical crystal forms, such as sodium chloride and sodium hydroxide, have such widely separated melting points?

Until recently techniques did not permit laboratory experiments to answer these questions largely because salts at high temperatures become tremendously corrosive and no usable containers had been devised that would permit spectroscopic examination of salts in the molten state. Honeywell research scientists have recently developed a new apparatus in which a thin film of material under test is held in the interstices of a platinum gauze. The gauze is connected to an electrical circuit and heated to maintain the material in the liquid state at the desired temperature. The material itself, with no compensation for container material needed, can be examined above, below or at the melting point. Honeywell scientists, with this new technique, have been the first to apply infrared spectroscopy to liquid state measurements. Resulting data were somewhat surprising, but a check method using a highly polished gold container which reflects infrared after passage through the molten salt affirms the accuracy.



First Absorption Spectra of Molten (345°c) NAOH

This platinum screen technique permits the studying of infrared frequencies associated with the stretching and rocking motions of molten-salt molecules. It also allows a direct measurement of the changes in frequencies of a system as it goes through the melting point. It is a qualitative tool for determining what species of material are present, what changes or reactions occur and why certain mixtures melt at the temperatures they do.

It is known that the X-ray diffraction patterns for sodium chloride and sodium hydroxide are quite similar, bonding energies are fairly close, yet the melting points are 500°C apart. Our data indicate that this is because melting does not involve a complete dissociation of the crystal structure into single molecules or ions. Rather it seems that a quasilattice structure results wherein some dissociation occurs, but cybotactic groups retain structure and are dispersed in the dissociation medium. Sodium hydroxide retains a structure upon melting and thus melts at a lower temperature than sodium chloride which dissociates to a much higher degree upon melting.

Infrared absorption spectra taken below, at and above the melting point reveal another interesting phenomena. Sodium hydroxide in the solid state is not hydrogen bonded. Upon melting it forms hydrogen-bonds which then break as it is heated further. This is evidenced by shifts in the absorption bands. As a result of a series of such spectroscopic examinations, preliminary explanations of phenomena not previously understood are emerging.

With additional knowledge being uncovered by Honeywell's and other laboratories, molten salts will most certainly be put to important uses. Several interesting things already present themselves. A storage battery could be charged in the liquid state, cooled to the inactive solid state and upon remelting would supply power instantaneously. A switch or other device would be open and inactive in the solid state but would become closed when melting was induced by a heat source. Electrical power could be generated by a combination of fused salts used as thermocouples. More importantly, scientific curiosity alone compels us to explore this vast new field of chemistry.

If you are engaged in scientific work involving molten salts and would like to know more of Honeywell's research in this field, you are invited to correspond with Dr. D. A. Olsen and Mr. L. J. Hallgren, Honeywell Research Center, Hopkins, Minnesota. If you wish a current paper on Honeywell's techniques in molten salt spectroscopy, write Honeywell Research, Minneapolis 8, Minnesota.

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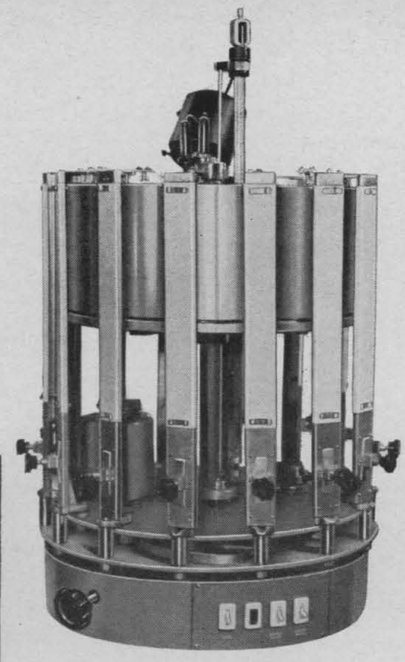

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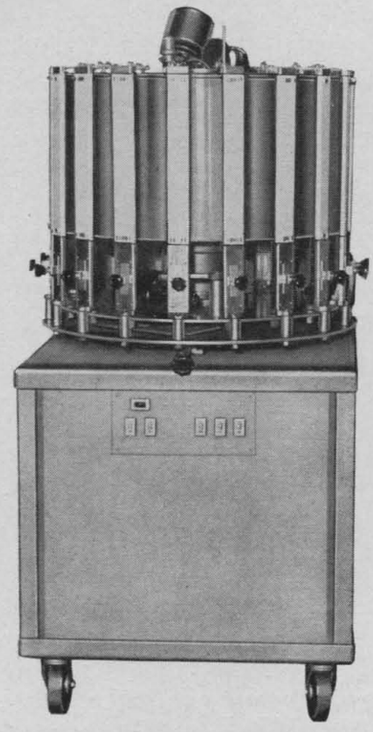

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SCIENCE

Cover

Expanding soap film catenoid. (Left) The catenoid expands as the wire rings are separated. (Middle) The surface film ruptures. (Right) After rupture, vibrating film remains attached to each ring, and a residual droplet breaks away. Film speed, 2000 frames per second. [From a science fair project by Barbara Jean R. Jones, Governor Livingston Regional High School, Berkeley Heights, N.J.]

23 March 1962, Volume 135, Number 3508 **SCIENCE**

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Shelters: Pro and Kahn

The argument against a bomb-shelter program, based not on its ineffectiveness but on the possibility, against all odds, that it may eventually prove too effective, has been stated with considerable precision by Freeman Dyson, of the Institute for Advanced Study, in the March issue of the *Bulletin of the Atomic Scientists*. The article assumes that this country and the Soviet Union could each dig its people and its resources into the ground so effectively that a new kind of race would result between bombs and shelters: that is, deep shelters would mean bigger bombs which, in turn, would mean deeper shelters and so on. Once this assumption is made, the argument is based on estimates of three quantities of fission energy.

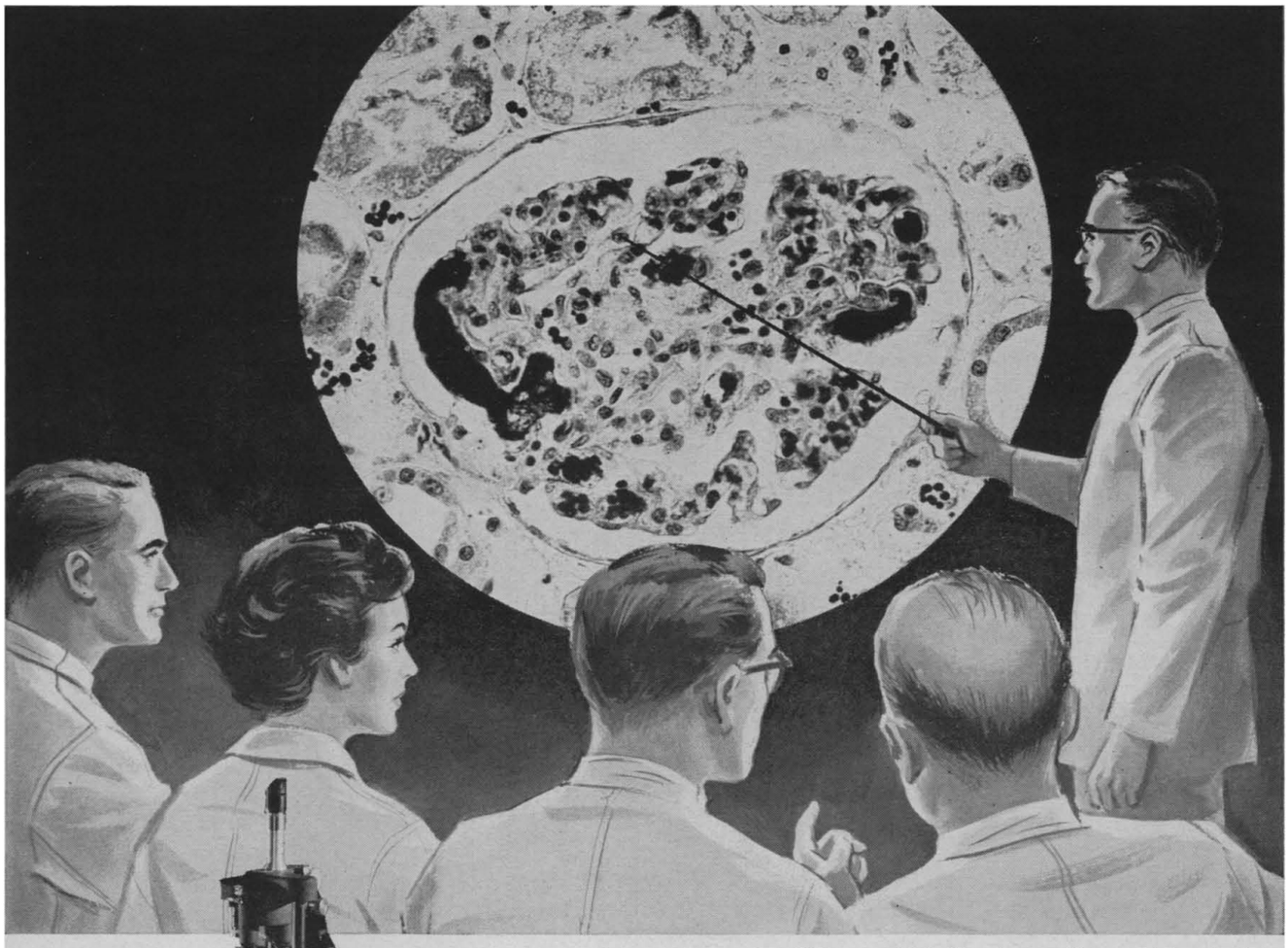
The first quantity is called a "Beach"—the term, which originated at an arms-control conference, refers to Nevil Shute's well-known novel. It is the quantity of fission energy which, if used in atmospheric explosions, would give through global fallout a lethal dose of radiation to half the earth's population. The second quantity Dyson calls a "Kahn." It is the quantity of fission energy which if used on ground targets in either country could kill by local fallout just about everyone in that country. And the third quantity Dyson calls a "Stockpile." It is the quantity of fission energy that will be available during the next decade for release during a war.

On the basis of his calculations, Dyson finds that a Kahn is much smaller than a Beach. This means that a major war without shelters might destroy the United States and the Soviet Union, but permit the rest of the human race to survive, for only a Kahn would be exploded. The owners of the bombs would all be dead before they could explode more. Dyson also finds that a Stockpile is slightly bigger than a Beach. This means that a major war with shelters that are effective in Dyson's sense might result in the death of mankind, for each side would be able to bombard the other until a Stockpile, the set of all bombs, had been exploded.

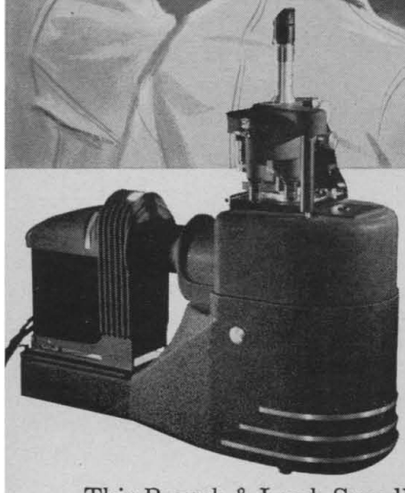
Such is the argument in outline. The argument is very precise, but its very precision suggests the introduction of still another quantity, or rather a new unit of measurement, the "Dyson." This is a measure of the speculation you must introduce into an argument in order to go from the premise to the conclusion. Some arguments require more Dysons than others. We set arbitrarily at 100 Dysons the amount of speculation in an argument so hypothetical that, like the man in the O. Henry story who meets the same fate no matter which path he takes at a crossroads, you can arrive at the same consequence, starting in the opposite direction and taking steps no more hypothetical than those first used.

Dyson's argument, as he is careful to make clear, is built on certain assumptions. After all, different levels of effectiveness in shelters differ astronomically in cost, and the Administration probably will continue to be governed by its statement that a race between bombs and shelters is unsound because it costs more to dig a deeper hole than it does to build a bigger bomb. The point of the article seems to be that the extreme unlikelihood of such a race must be matched against the absolutely terrible consequence that might result if the race took place. Yet, it seems to us, although we have not yet done our calculations, that the argument is so high on the Dyson scale that a choice here is by no means excluded.

It is possible to accept the argument as an argument against deep shelters, but not find it compelling as an argument against fallout shelters. And so the question remains open whether fallout shelters, although ineffective as Dyson uses the term, might not still be worthwhile.—J.T.



Kidney, 300X (Rochester General Hospital)



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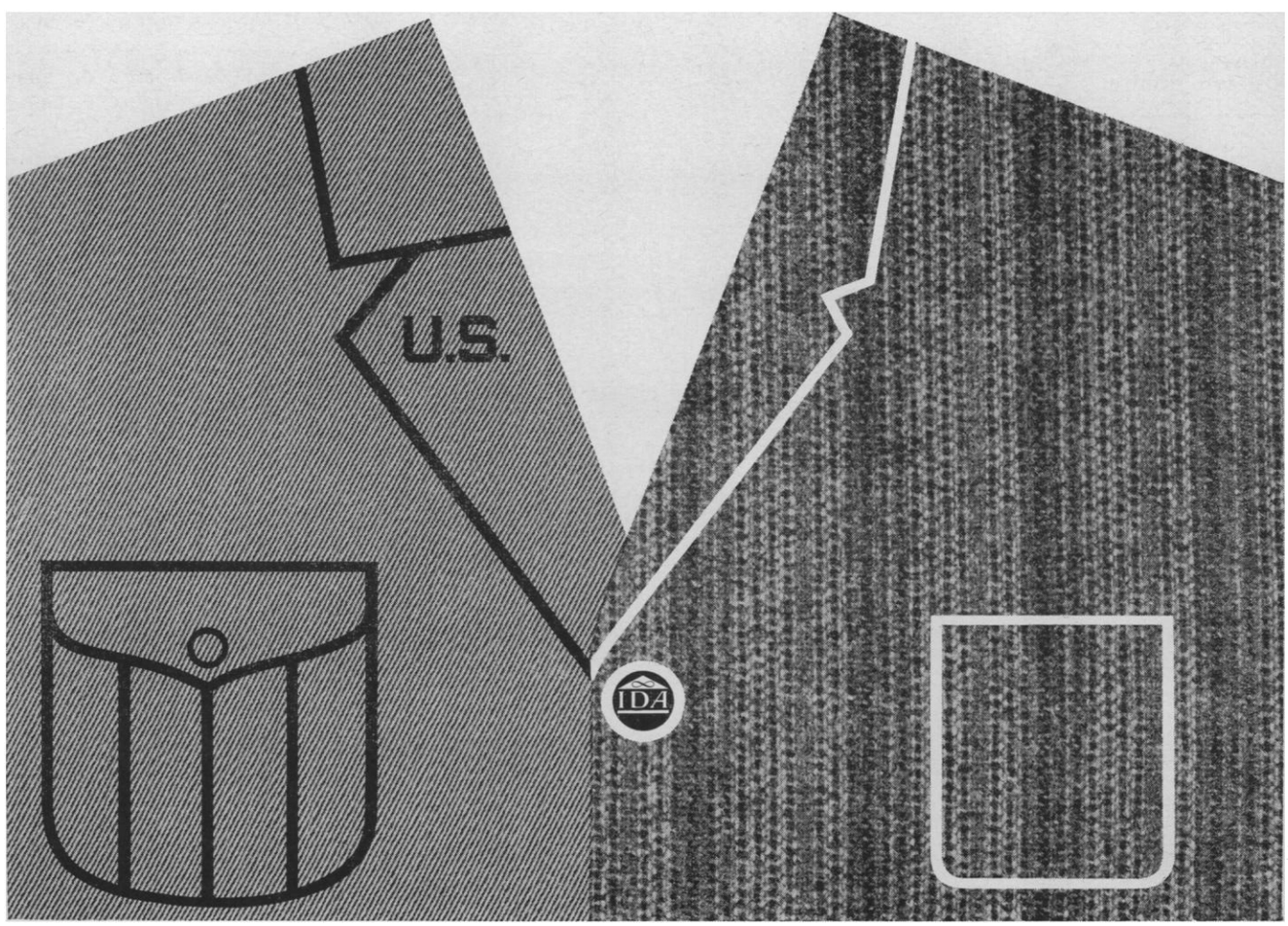

Letters

Deferring to a Minority

Your news note on the U.N. "population explosion" debate [*Science* **135**, 29 (5 Jan. 1962)] has, if I read it correctly, some disturbing implications that may have escaped many readers.

The implication is clear that the government of the United States is deferring, on a matter of transcendent international importance, to political pressure by a religious minority. You would also seem to suggest that while the U.S. government is sufficiently concerned with the welfare of the United Nations to avoid "arousing further antipathy to that troubled organization," it is convinced that the minority group would not sufficiently share such concern to refrain from action that would generate antipathy.

The exercise of the veto power by this particular church is not new to anyone familiar with the human population problem. It is significant, however, that this should be recognized in the pages of *Science*.

This is a matter where time is of the essence, since, with even the full support of the United Nations and the U.S. government, progress in reducing population growth is sure to be slow, initially at least. Meanwhile 100 million babies a year are born, many of them foreordained to die miserable and painful deaths. Those who live will often live at the expense of those born earlier.

WILLIAM VOGT

140 Riverside Drive, New York

Allowance for Overhead

The editorial entitled "Costly cash" [*Science* **134**, 2009 (1961)] does not give a completely accurate picture with respect to overhead charges on government-supported research contracts and grants. While it is true that National Science Foundation grants give only 20 percent, this 20 percent is applicable to all charges, including apparatus, supplies, and so on. The larger overhead allowances in grants from other agencies are usually applied only to direct salary charges. Thus, the National Science Foundation's 20 percent might be equivalent to Office of Naval Research overhead allowances of 40 percent. Furthermore, some agencies stipulate that there must be

a university contribution to the total research cost of a project, the amount varying from perhaps 5 to 50 percent. There is also the consideration that, at the termination of the contract or grant, the title to capital equipment rests either with the government or with the university. Thus, it would seem that we have to look beyond the percentage figure in order to obtain a realistic evaluation of overhead allowances.

LEONARD MULDAWER
Temple University,
Philadelphia, Pennsylvania

I have read with considerable interest the editorial entitled "Costly cash." For your information, during 1960–61, Western Reserve University, while spending $5.018 million in federal and private funds for project research, incurred an obligation for unreimbursed indirect costs of $665,000. I should like to point out that while grants, particularly those from the U.S. Public Health Service, do not provide for anything like sufficient overhead, many nonfederal sources are even less generous. Thus it seems to me that we must not level such charges against the federal government alone.

On the basis of a formula worked out by the government audit agency we have determined that 26.2 percent of the total costs is an allowable charge for indirect costs on research projects. While we have not, to date, turned down any grant because of inadequate allowance for overhead, there is little doubt in my mind that this possibility will become increasingly less remote in the years ahead.

WILLIAM M. HESTON
Western Reserve University,
Cleveland, Ohio

The Rise of Sap

In the article "Cohesive lift of sap in the rattan vine" [*Science* **134**, 1835 (1961)], Scholander, Hemmingsen, and Garvey state that the rise of sap in tall trees has been puzzling "for more than a century" and that the cohesion theory of Dixon and Joly (1894) and Askenasy (1895) is generally accepted.

This very problem was considered by the reverend Stephen Hales (1677–1761) in the early years of the 18th century. Hales, known as the first man to have measured arterial blood pressure [*Haemostatics* (1733)], was inter-

ested in the quantitative approach to various problems of animal and plant physiology. As far as I know, he associated the rise of sap in tall trees with the pulling force generated by evaporation from the leaves. Does not Hales's principle underlie Dixon and Joly's as well as Askenasy's theory?

Almost a quarter of a millennium has passed since Hales attacked the problem which, as Scholander says, still challenges "the experimental ingenuity of future workers." It is worth while to remember that, according to Hales, our thoughts should carry us "a little farther than the plain evidence of experiments will warrant . . . otherwise we should make but very slow advances in future discoveries." Is it experimental ingenuity or ingenuity in conceptualization which now is needed most?

SIGISMUND PELLER
164 East 81 Street, New York

Objectivity and Responsibility

I enjoyed and appreciated the editorial "The other fellows' ball park" [*Science* **134**, 1163 (20 Oct. 1961)]. This touches one facet of a broader problem. I observe regretfully that certain elements of the scientific community are so absorbed in presenting the unprejudiced, objective viewpoint that they often do great damage to the democratic cause, usually by careless implication and omission. This is usually attributable to their being far better informed about the weaknesses of our own system than they are about the weaknesses of the competitive system.

Of late, *Science* has been particularly negligent about accepting responsibility for presenting a complete picture. For instance, in "Soviet defections: Conclusions of broad discontent unwarranted" ("Science and the news," 20 Oct.), the last paragraph is expressed exactly as I would expect it to be stated in a Russian newspaper, and no doubt Russian newspapers will quote this material verbatim.

Science and scientists cannot divest themselves of their national responsibility to consider the net effect of their expressions, particularly at this time when our own citizens and people the world over are keenly aware of the role of science in the present and future.

WILLIAM E. N. DOTY
1507 Holbrook, Ponca City, Oklahoma

Meetings

Microbiology in Latin America

The second Latin-American and the first Costa Rican national congresses of microbiology were jointly held from 10 to 17 December 1961, in San José, Costa Rica. The meeting was attended by about 300 participants from 16 nations, including 50 from England, Canada, and the United States.

Listed in the scientific program were more than 150 titles, encompassing the following fields: general, medical, and veterinary bacteriology; immunology; helminthology; mycology; protozoology; virology; phytopathology; and agricultural and industrial microbiology. The greatest interest was expressed in medical microbiology. Abstracts of papers were published in a "General program and résumé"; many of the individual papers will appear in scientific journals.

Special symposia or panel sessions focused on leishmaniasis, intestinal parasitosis, microbial physiology and

biochemistry, and the teaching of microbiology and parasitology. In other sessions, new and important scientific films available for educational purposes were shown. Simultaneous Spanish-English translation made language no barrier to effective communication in the special sessions.

Registrants were afforded opportunity to inspect the entirely new and remarkably designed buildings comprising the University of Costa Rica. The status of microbiology in the host nation was indicated by its position as a separate college and by an impressively functional and well-equipped building in University City. A day was devoted to a trip through beautiful mountainous countryside to the Inter-American Institute of Agricultural Science.

Among the commercial and scientific exhibits at the congress, that of *Revista Latinamericana de Microbiologia*, an international journal of the Latin-American Association, elicited special interest. The journal provides lucid abstracts in translation of the articles, which are usually in Spanish. Important for coverage of microbiology in a great geographical area *Revista* is available at $6 (U.S.) per year through the editor, J. M. Gutiérrez Vásquez, Escuela Nacional de Ciencias Biológicas, Instituto Politecnico Nacional, Mexico, D.F.

A fine social program included daily luncheons, staging of traditional music and dance, an orchestral symphony, and a grand ball in the Latin-American manner, at which congress participants were honored by the presence of the President of the Republic, Señor Mario Echandi Jimenez.

The congress was ably managed by an organizing committee of the Costa Rica Association, of which the secretary-general was John L. de Abate, at the time of the meetings. Officers of the Latin-American Association were Geraldo Varela, president; Renato Soto Pacheco, vice president; Luis Palencia Franco, secretary; and Enriqueta Pizarro Suarez, treasurer. Their counterparts in the Costa Rica Association were, respectively, Renato Soto Pacheco, Roger Bolanos, Fernando Montero-Gei, and Guillermo Monge Amador.

Newly elected officers of the Latin-American Association are A. Pomales Lebron, president; Jose Oliver Gonzales, secretary; and Irving Fox, treasurer.

The American Society for Microbiology was officially represented by Philipp Gerhardt, secretary, and R. W. Sarber, executive-secretary, who were warmly received and included among the guests of honor. Their travel was sponsored by the National Science Foundation and Difco Laboratories, Inc.

The Latin-American congresses are convened at 3-year intervals. The first was held in Mexico City in 1958. The third is scheduled for 1964 in a place yet to be named. It holds promise of being as stimulating and rewarding as the congress just concluded.

PHILIPP GERHARDT
Department of Bacteriology, University of Michigan, Ann Arbor

Forthcoming Events

April

1–3. International College of Surgeons, Las Vegas, Nev. (Secretary, ICS, 1516 Lake Shore Dr., Chicago 10, Ill.)

1–4. American Radium Soc., annual, New York, N.Y. (C. G. Stetson, Dept. of Radiology, Englewood Hospital, Englewood, N.J.)

1–6. American Soc. of Abdominal Surgeons, clinical congr., Chicago, Ill. (B. F.

Alfano, ASAS, 663 Main St., Melrose 76, Mass.)

2–5. American College of Obstetricians and Gynecologists, Chicago, Ill. (Chief of Information, Dept. of the Army, Washington 25)

2–5. Instrument Soc. of America, instrument-automation conf. and exhibit, Pittsburgh, Pa. (W. H. Kushnick, ISA, 313 Sixth Ave., Pittsburgh 22)

2–13. Photogrammetry Week, Munich, Germany. (H. Bischoff, Zeiss–Aerotopograph G.M.P.H., Ismaniger Str. 57, Munich 27)

3–5. Organic, Inorganic, and Physical Chemistry, symp., annual, Chemical Soc., Sheffield, England. (General Secretary, Burlington House, London, W.1, England)

3–5. Plasma Sheath, symp., Boston, Mass. (C. Ellis, Air Force Electronics Research Directorate (CRRD), L. G. Hanscom Field, Mass.)

3–6. Society of Automotive Engineers, natl. aeronautic, production forum and engineering display, New York, N.Y. (R. W. Crory, SAE, 485 Lexington Ave., New York 17)

3–7. Inter-American Nuclear Energy Commission, Mexico City, Mexico. (IANEC, Pan American Union, Washington 6)

4–6. Institute on Rehabilitation of the Mentally Ill, New York, N.Y. (B. J. Black, Altro Health and Rehabilitation Services, Inc., New York)

4–6. Physics of Graphite-Moderated Reactors, symp., Bournemouth, England. (Inst. of Physics and the Physical Soc., 47 Belgrave Sq., London, S.W.1, England)

4–6. Short Run Production Techniques, intern. seminar, American Soc. of Tool and Manufacturing Engineers, Mexico City, Mexico. (Conf. Director, ASTME, 10700 Puritan Ave., Detroit 38, Mich.)

5–7. Pacific Sociological Assoc., annual, Sacramento, Calif. (R. Nisbet, Univ. of California, Riverside)

6–8. American Soc. of Internal Medicine, annual, Philadelphia, Pa. (S. O. Krasnoff, ASIM, 3410 Geary Blvd., San Francisco 18, Calif.)

6–8. Association of Clinical Scientists, Chicago, Ill. (R. P. MacFate, 323 Northwood Rd., Riverside, Ill.)

6–8. Biological Photographic Assoc., midwestern sectional, Des Moines, Iowa. (BPA, 551 W. Grant Place, Chicago 14, Ill.)

7. New Jersey Acad. of Science, annual, West Long Branch. (H. L. Silverman, NJAS, 361 Highland Ave., Newark 4, N.J.)

7. New Mexico Acad. of Science, Socorro. (K. G. Melgaard, P.O. Box 546, Mesilla Park, N.M.)

7. Paleontological Research Institution, Ithaca, N.Y. (R. Harris, PRI, 109 Dearborn Pl., Ithaca)

7–9. Impact of Physical Metallurgy on Technology, symp., San Carlos de Bariloche, Argentina. (J. A. Sabato, National Atomic Energy Commission, Avda. Libertador General San Martin 8250, Buenos Aires, Argentina)

9–10. Chemical and Petroleum Instrumentation Symp., natl., Instrument Soc. of America, Wilmington, Del. (C. W. Sanders, E. I. du Pont de Nemours & Co., Louviers Bldg., Newark, Del.)

(See 16 March issue for comprehensive list)