21st CENTURY
SCIENCE & TECHNOLOGY

SUMMER 1995

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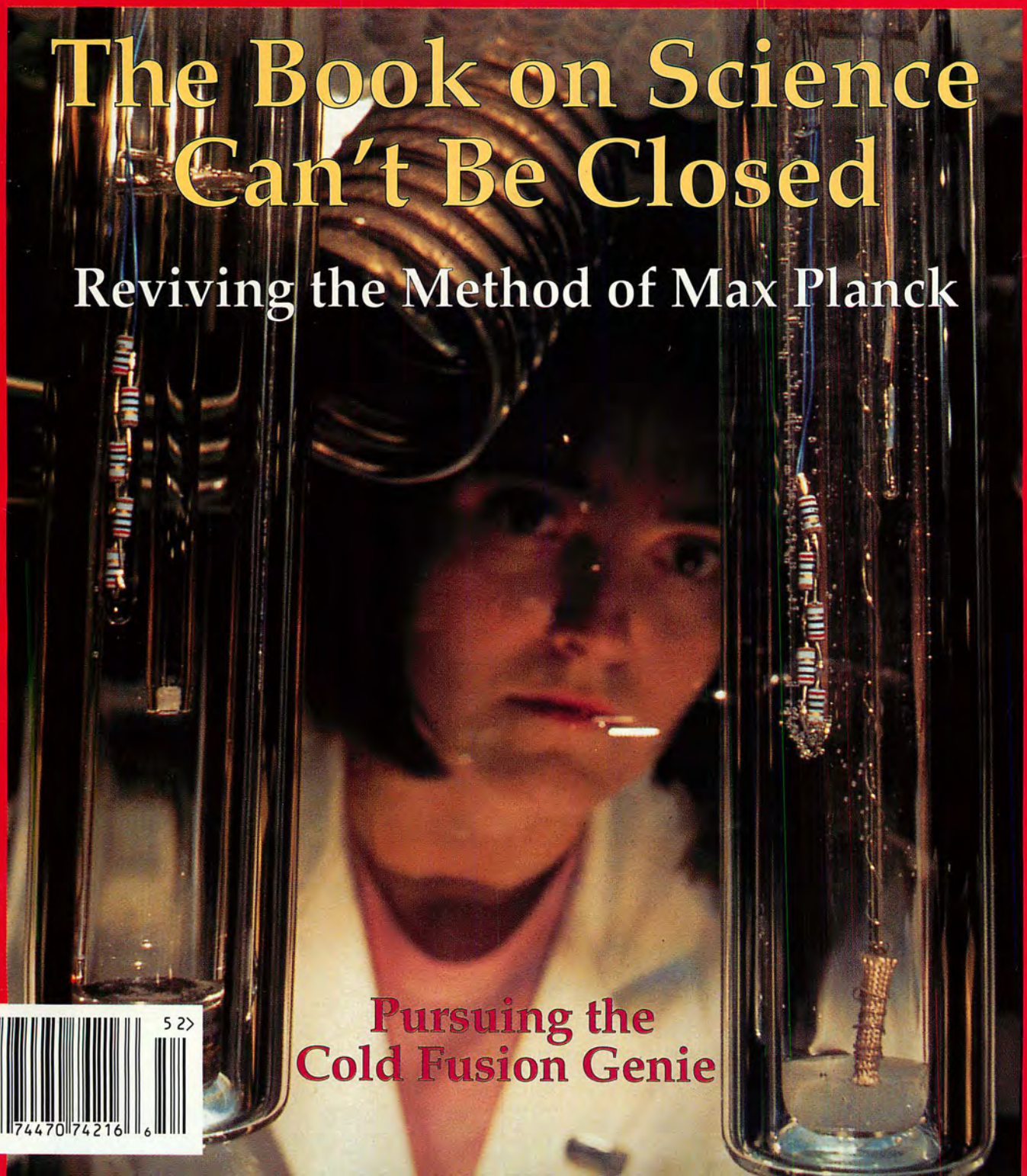
A WARNING ON 'WISE USE' P. 8

The Book on Science Can't Be Closed

Reviving the Method of Max Planck



Pursuing the Cold Fusion Genie

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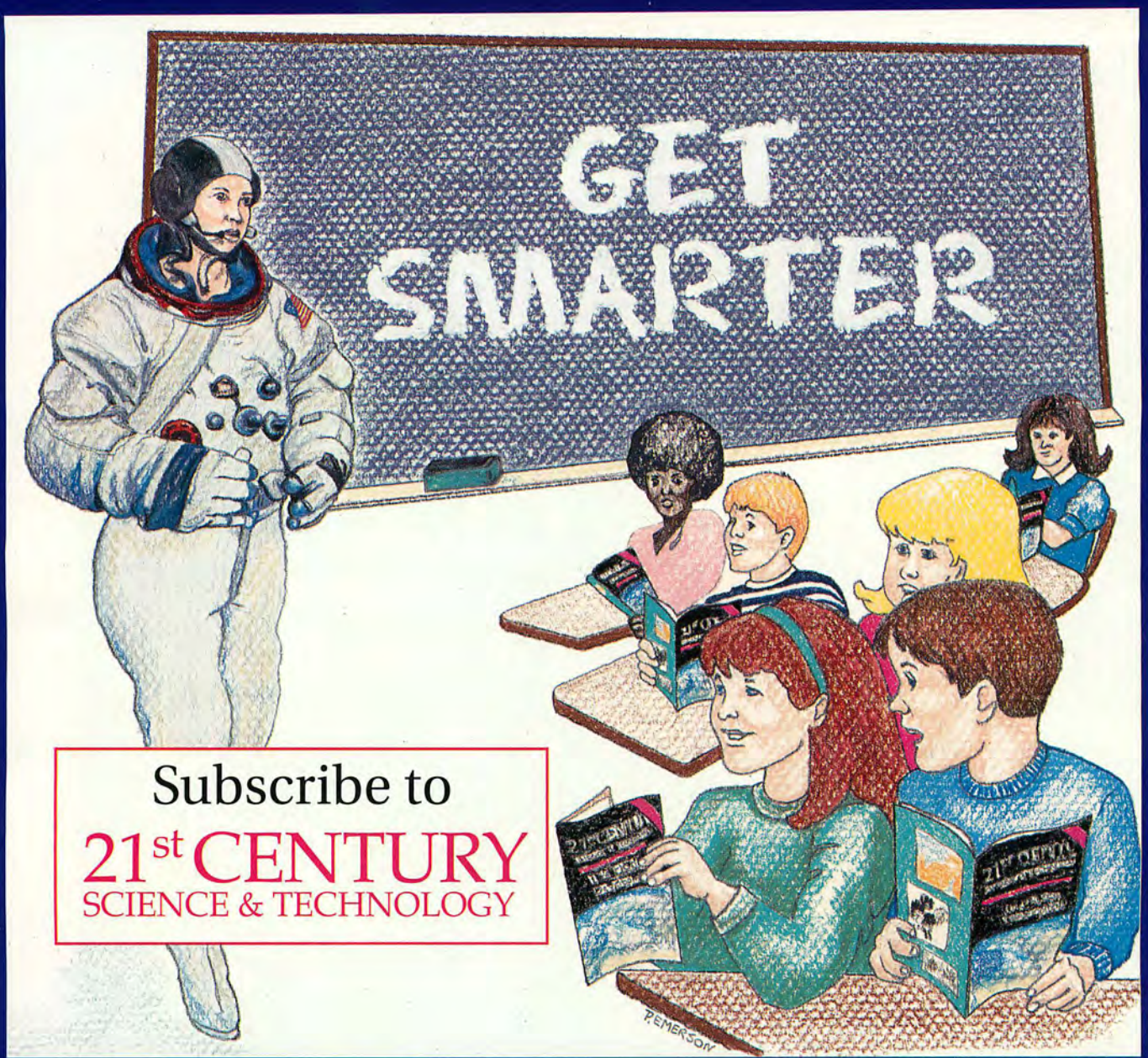

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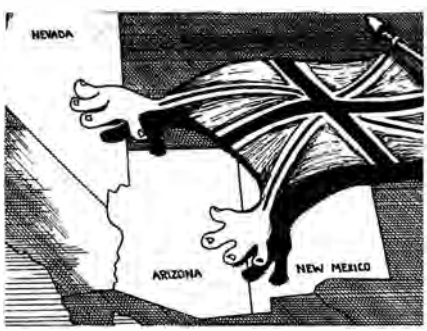
21st CENTURY SCIENCE & TECHNOLOGY

Vol. 8, No. 2 Summer 1995

Features

News



Radical environmentalists and 'wise use' activists are directed by the same anti-American forces, with the aim of breaking up the United States. See Special Report, p. 8.

Departments

On the cover: Cold fusion electrolytic cell at the Minoru Institute of Advanced Research (IMRA) in southern France in the laboratory of Fleischmann and Pons, 1993. Photo by Philippe Plailly/Science Photo Library; cover design by Rosemary Moak.

21st Century Science & Technology (ISSN 0895-6820) is published 4 times a year in 1995, every third month, by 21st Century Science Associates, 60 Sycolin Road, Suite 203, Leesburg, Va. 22075. Tel. (703) 777-7473.

Address all correspondence to **21st Century**, P.O. Box 16285, Washington, D.C. 20041.

Second-class postage is paid at Leesburg, Va. and additional mailing offices.

Dedicated to providing accurate and comprehensive information on advanced technologies and science policy, **21st Century** is committed to restoring American scientific and technological leadership. **21st Century** covers the frontiers of science, focusing on the self-developing qualities of the physical universe in such areas as plasma physics—the basis for fusion power—as well as biology and microphysics, and including groundbreaking studies of the historical development of science and technology. Opinions expressed in articles are not necessarily those of 21st Century Science Associates or the scientific advisory board.

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POSTMASTER: Send address changes to 21st Century, P.O. Box 16285, Washington, D.C. 20041-0285.

Printed in the USA ISSN 0895-6820

EDITORIAL

Pursuing the Genie Of Cold Fusion

The book on science can't be closed!

A true discovery, as opposed to a technical elaboration of an accepted principle, must by its nature overturn some, if not all, of the cherished axiomatic assumptions accepted as true. In the 20th century, we have seen repeated attempts to destroy the truly great discovery by Max Planck of the quantization of all physical processes—a discovery that completely shattered the plausibility of Newtonian physics.

Most notable has been the effort to impose Niels Bohr's Copenhagen interpretation of quantum physics upon the field. True, quantum field theory has replaced Bohr's quantum mechanics, just as the field theory of Lagrange and Laplace rescued Newtonian physics from what would otherwise have been well-deserved oblivion, but by doing so they have submerged genuine science in a more or less effective technology of science.

It is the moment of discontinuity, which characterizes the actual creative process of discovery, that *is* science. Such a process may occur as a sudden burst of insight or it may be protracted over years; it may be the act of only one man or woman or of a group of scientists in a kind of dialogue. It may occur as an act of recognition—the observation of something new that has emerged serendipitously—or it may come as the result of a conscious search for a more fundamental understanding of reality.

This was beautifully expressed in a letter by Bernhard Riemann, then a graduate student at Göttingen University, to his brother. In this he describes his life's work, the outlines of which he had already substantially conceptualized: He wrote: "My principal task concerns a new conception of known laws of nature—an expression of the same by means of different fundamental concepts—through which the use of experimental data concerning the interaction between heat, light, magnetism, and electricity would be possible for investigation of their complexity."

Here we see an anticipation of the task picked up by Albert Einstein, and yet to be drawn to a successful conclusion: the elaboration of a true unified field theory.

Riemann demonstrated that physical space-time cannot be properly understood in terms of classroom mathematics; in other words, as the flat space of Euclidean geometry. On June 10, 1854, he presented a paper titled *On the Hypotheses Which Underlie Geometry*. This was his habilitation paper (a thesis presented as a prerequisite for acceptance to a university teaching position).

In this paper he wrote: "The question of the validity of the postulates of geometry in the indefinitely small is involved in the question concerning the ultimate basis of relations of size in space. . . . Either then the actual things forming the groundwork of a space must constitute a discrete manifold, or else the basis of metric relations must be sought for outside that actuality, in colligating [grouping conceptually] forces that operate upon it. . . . This path leads into the domain of another science [other than pure mathematics], into the realm of physics, into which the nature of this present occasion forbids us to penetrate."

In the Footsteps of Riemann

When Max Planck recognized the physical reality of the quantum of action, he was courageously following in the footsteps of Riemann. It is precisely this same question of metrical relations in the indefinitely small realms of physics—in this instance within the solid state—that is raised by the discovery of Martin Fleischmann and Stanley Pons of the phenomenon popularly known as cold fusion (or chemically assisted fusion).

A Fifth International Cold Fusion Conference took place in Monte Carlo this year, April 9-13. Continued progress in pinning down the phenomenon was reported at the conference, although there have been no extraordinary breakthroughs. The Fall issue will cover the conference; here we comment upon the vehement attacks still leveled against this research by major scientific societies and their journals.

Perhaps progress in pinning down cold fusion either experimentally or theoretically has been disappointingly slow, but the failure to make rapid progress should be seen in the context of the kind of attack to which researchers are still exposed.

The attempt to suppress continued work on cold fusion, despite the wide array of experimental evidence that now substantiates the existence of the phenomenon—if not all of the experimental claims that have been made—warns us that all fundamental discoveries in the science are in grave danger of being suppressed. Even if cold fusion were somehow shown to be a mere artifact of the experiments—something that the variety of successful experimental methods makes extremely unlikely—the attempt to stop research in this field constitutes an outrageous attack upon science.

For Huizenga, the laws of physics won't allow cold fusion—or 21st Century's coverage of it.

The vicious attack to which Fleischmann, Pons, and their collaborators have been subjected is intended as a warning to all scientists that they must conform to existing prejudices or risk being barred from their profession, if not prosecuted for fraud.

The Huizenga Story

John R. Huizenga conducted the original review of cold fusion for the Department of Energy in 1989. The DOE review panel, which he chaired, issued a report in November 1989 recommending against any major funding of cold fusion. In 1992, his book on the subject (*Cold Fusion: The Scientific Fiasco of the Century*) was released by the University of Rochester Press, and subsequently the book has been reprinted by Oxford University Press in English and Japanese—most recently in 1994.

Huizenga's essential conclusion then—and now—is that cold fusion cannot exist because it violates the precepts of accepted physics. In an epilogue appended to the most recent edition of his book, Huizenga directly attacks *21st Century Science and Technology* editor Carol White. To do this he quotes from White's report in the Fall 1991 *21st Century* on the Second Annual Cold Fusion Conference, held in Como, Italy, in summer 1991.

White wrote: "What I find most exciting about being there [at the conference] was being present at the birth of a new advance in science. . . . Cold fusion is likely to be the most important discovery of this half century, and the conference was a celebration of this fact: Two years after the initial March 23 announcement by Martin Fleischmann and Stanley Pons, an international team of top scientists unequivocally confirmed their 1989 results, and their conclusions that what was occurring was a nuclear event—not merely electrochemical."

Huizenga then quotes a comment on cold fusion by Lyndon H. LaRouche, as follows: "The Aristotelian cult that runs science in the United States and Britain today will not tolerate a challenge to their hegemony. Here, with cold fusion, is another anomaly, which may tip over the whole apple cart, and open up a whole new generation of—not gimmicks . . . but fundamental science. [O]nce scientists start looking back at history in the light of the discovery of cold fusion then they will have to revise their thinking about such basic subjects as the periodic table. And this will mean revising their thinking about the universe as a whole."

Perhaps Huizenga thinks that these quotes are a damning refutation of cold fusion or of this magazine, which he accuses of having a secret political agenda. Rather, it is he who is exposed as using every political trick—including the political slanders against LaRouche, which also appear in his book—to justify the disgraceful record of the scientific establishment.

Note to Readers

21st Century subscriptions have increased to $25 for 6 issues and $48 for 12 issues in the United States. In addition, the cover price is now $3.50 in the United States and $4.50 in Canada. Both changes take effect July 1, 1995.

NEWS BRIEFS

EIRNS

The Schiller Institute's photogenic bull in Berlin. Its sign says, "The Climate Apostles are predicting the end of the world, and they want your money."

GLOBAL WARMING CHALLENGED BY BULL AT BERLIN IPCC CONFERENCE

Global warming proponents who attended the Intergovermental Panel on Climate Change (IPCC) March 28-April 4 in Berlin met up with some surprises: bitter cold and snowy weather and a huge, helium-filled balloon shaped like a bull, sporting a sign that asked (in German), "Do you really believe my that my emissions could warm up the climate?" The bull was supplied by the Schiller Institute, which also distributed the "Open Letter to the IPCC" by atmospheric scientist Hugh W. Ellsaesser (see p. 58), which reviews the scientific evidence against the IPCC's global warming scenario.

The prominently displayed bull got the attention of the international media, upstaging the usual Greenpeace demonstrators. This was too much for the German media, however. Deutsche Presse Agentur (DPA) put out a wire story and picture on the bull, but gave it both a sex and lifestyle change: The photo was retouched to blur the bull's sign, and the text used the German idiom "the international cow must be brought off the ice," meaning that catastrophe must be averted. The DPA caption stated: "At the Berlin climate conference, ecologists demonstrated yesterday, saying the 'environmental issue has to be solved.'"

GLOBAL WARMING PROPONENTS LAUNCH BREAKAWAY ICEBERG SCARE

The latest global warming scare story was a report in late March that warming had detached a chunk of the Antarctic ice cap that would melt and flood coastal cities. In fact, this event is neither predicted nor explained by the global warming theory, which holds that ambient air temperatures will increase and, centuries later, cause ocean temperatures to increase. The opposite has happened, however. Ambient air temperatures in Antarctica have not changed; they remain well below 0°C, while ocean temperatures are increasing.

Ignored by the global warming theorists is the role of underwater volcanism in determining ocean temperatures and currents. More than 1,100 underwater volcanoes were discovered in a recent geophysical expedition to the South Pacific, close to Antarctica. From 3 to 20 volcanoes were spewing lava, gases, debris, and nutrients into the ocean at any one time. Geophysicists have connected the volcanism to the El Niño phenomenon and the ongoing change in ocean currents and temperatures.

Greenpeace lost its lawsuits in France to stop reports of the 1993 Danish documentary, "The Man in the Rainbow," which exposed the organization's collaboration with Earth First!, among other things. Pictured here are scenes from the film, including Greenpeace founder Bennett Metcalfe calling David McTaggart, the former head of Greenpeace International, a Frankenstein "monster."

GREENPEACE STRIKES OUT FOUR TIMES IN FRENCH COURT

Greenpeace-France lost a series of legal actions in France, taken against publications that made use of *21st Century*'s documentation of Greenpeace's collaboration with the ecoterrorist Earth First! organization. Greenpeace sued Editions Alcuin and two of its publications, the magazine *Fusion* and the newsletter *Industrie & Environnement* for refusing to print its rebuttal to the publications' charges. "It is urgent that Greenpeace's honor be restored," said Greenpeace. But Greenpeace lost this case on a technicality.

When *Industrie & Environnement* issued a press release on the loss, noting that Greenpeace could have sued for defamation but chose not to, the head of Greenpeace-France promptly sued again for defamation. Later, however, Greenpeace asked the Paris High Court to drop both cases. Most recently, in March, the court granted *Fusion* magazine 5,000 French francs from Greenpeace in compensation for legal harassment.

21ST CENTURY'S SPACE PIONEERS BOOK PUBLISHED IN GERMANY

How We Got to the Moon: The Story of the German Space Pioneers, written by Marsha Freeman, was released in a German-language edition in early March by Dr. Boettiger Verlags-GmbH, under the title *Hin zu Neuen Welten: Die deutschen Raumfahrtpioniere.* Reviews have been favorable. The daily *Franfurter Allgemeine Zeitung* in its March 15 review, emphasized how the book conveys the "unshakable

belief in technology" of Wernher von Braun and other space pioneers. *Jaeger Blatt*, the official magazine of the fighter pilots' association, stated in its review, "Marsha Freeman tells without prettying-up but also without ugly distortion the exciting and inspiring story of . . . these pioneers with . . . much insight into their motivations and their scientific, technical, and political difficulties."

NEW LEGISLATION AIMS TO REVERSE DAMAGE OF OZONE HOAX

A bill to repeal the provisions of the Clean Air Act dealing with stratospheric ozone protection, H.R. 475, was introduced into the House of Representatives Jan. 11, 1995, by Rep. Tom DeLay (R-Tex.). The bill, one of a series introduced by DeLay to amend the 1990 Clean Air Act, states simply, "Title VI of the Clean Air Act (42 U.S.C. 7401 and following) is hereby repealed." In addition, Rep. John Doolittle (R-Calif.) plans to amend and resubmit the ozone bill (H. Res. 291) that he introduced in the last session. The new Doolittle bill is expected to call for the United States to pull out of the Montreal Protocol.

STATE OZONE BILLS PLAY INTO 'STATES' RIGHTS' DANGER

Arizona Governor Fife Symington signed into law April 18 a bill passed by both houses of the legislature that permits the possession, use, manufacture, export, import, transport, and sale of chlorofluorocarbons within the state, "notwithstanding any other law." As we go to press, state representatives in Texas and Colorado plan to introduce similar bills. Although the Arizonans backing the bill see it as "largely a symbolic gesture" and the existing federal restrictions on CFCs have no scientific basis and cause much damage, the state bill is dangerous because it plays into the "states' rights" attacks on the United States that are now being engineered to promote violent confrontations between enraged citizens and the federal government (see Special Report, p. 8).

PROTOTYPE FOR NEW GENERATION OF LARGE TELESCOPE MIRRORS IS PROVEN

Some of the first astronomical images taken with the 1.8-meter Vatican Advanced Technology Telescope on Arizona's Mt. Graham were released Feb. 27 by the Vatican Observatory and the University of Arizona's Steward Observatory. The images are sharp. The Vatican telescope is the prototype using technologies of mirror-making that permit mirrors up to 8 meters of extremely short focal ratio. The Vatican mirror has an unprecedented focal ratio of 1. Among these technologies is the casting and cooling of mirrors in a spinning mold, producing a paraboloid, so that most of the grinding is eliminated. The new technologies are being pioneered by the Steward Observatory Mirror Lab under the leadership of British astronomer Roger Angel.

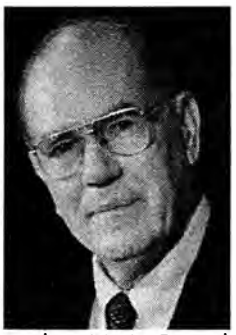
IN MEMORIAM: PALEONTOLOGIST C. BERTRAND SCHULTZ

The editors of *21st Century* were saddened to learn of the death of a good friend and scientific advisor, Dr. C. Bertrand Schultz. Schultz, a world-renowned paleontolgist, died March 7 at age 87 in Lincoln, Nebraska. A former director of the Nebraska Academy of Sciences, Schultz was internationally known for his work on the Tertiary and Quaternary periods and served as the official delegate appointed by the National Academy of Sciences to many world congresses of the International Association for Quaternary Research. Schultz's closest collaborator was his wife, Marian, who died in 1992, and with whom he had explored more than 50 countries. Until his death, Schultz fought to promote the truth about climate change, through the organization he had co-founded, the Institute for Tertiary/Quaternary Studies (TER-QUA) and the Center for Climate-Change Research and Water Resources.

How We Got to the Moon: The Story of the German Space Pioneers *is now available in German.*

Dr. C. Bertrand Schultz, 1908-1995

Affordable Energy Is Not Enough



by Lyndon H. LaRouche, Jr.

The Spring 1995 issue of *21st Century* featured an article by Dr. Bernard L. Cohen ["The Breeder Reactor—Affordable Energy Forever," *21st Century,* Spring 1995, p. 46]. While I agree with the author about the desirability of developing breeders, I do not agree that availability or affordability are the "yardsticks" for the development of energy policy.

To put the point in context, I would like to reference the discussion of energy policy contained within my original proposal for a 40-year Mars-colonization perspective as the basis for a revitalized U.S. space program.[1] This was the policy later featured in my 1988 campaign for the Democratic Party's presidential nomination.

The notion that energy policy should be premised primarily on duration of relevant types of energy supplies, such as "fuels" available, or related matters, is a plausible but unscientific way of approaching the matter. At issue here is something that goes back to Sadi Carnot's initial discussions of the question of thermodynamic efficiency, which subsumed the highly relevant notion of the importance of energy flux density. Even though that use of the term "energy" is more the engineer's pragmatism than a scientific concept, up to a point, it does the job.

The Example of Spaceflight

Up to a point, there is a rather neat correlation between the energy-flux density of a mode of power generation, which can be indicated as a characteristic of that mode, and the economic and other efficiency of the mode. A more refined view of the subject matter than that confronts us when we examine the topic from the standpoint of the Peenemünde aerospace pioneers: We must consider both the specific impulse supplied (for example, energy-flux density applied), and the ratio of effective impulse to fuel-mass carried (and depleted) in flight outside the atmosphere.

In this regard we will want eventually to consider the power-to-mass advantage of matter-antimatter reactions over the best-guess performance for second-generation thermonuclear fusion. This is the point I stressed in my objections to the program which NASA issued shortly after the publication of my own design. NASA's own proposed version of a Mars-colonization perspective would rely upon non-nuclear fuels, at least in its first phase. My earliest design emphasized the necessity of developing a fusion rocket which could transport personnel to and from Mars orbit rapidly.

Up to this point, the issues addressed are fairly well known, and also fairly well understood among relevant professionals who have worked in the field of thermonuclear fusion.

I put it in the following terms of reference: Let us pose the issue of thermonuclear fusion versus matter-antimatter reactions in terms of round-trip capabilities of spacecraft using continuous power for acceleration/deceleration during flight. For this purpose we may consider several facts that are known at present:

(1) Extended exposure of persons to microgravities is bad for their health, and we may presume that there are levels of fractional gravity that are also thresholds for a qualitative degree of the kinds of damage suffered in microgravity environments. Thus, it is useful to examine extended-range intrasolar manned spaceflights from the vantage point of 1-g continuous acceleration/deceleration.

(2) Present experience with matter-antimatter reactions indicates approximately three decimal orders of magnitude of potential advantage in power-mass ratio over best-guess thermonuclear fusion modes.

The result of this estimate is that without refueling, such round-trip flights, in thermonuclear modes, would not reach farther out than approximately the mean asteroid orbit. Matter-antimatter modes would be desired for full intrasolar explorations.

A Science City in Space

As I stated the case in my first published proposal announcing a 40-year Mars colonization policy, the initial mission for Mars colonization should be the establishment of a "Los Alamos"-echoing "science city." Its function would be to support an array of telescopes, relatively nearby. These would be used to accumulate deep-space spectroscopic surveys of crucial anomalous phenomena, and would pursue space-laboratory work of a related nature.

While all crucial anomalies available should be examined, the highest priorities should be assigned to a special class of anomalies: those in which the receiver arrays would be examining principles of physics also being studied otherwise in the domain of nuclear and subnuclear microphysics, and in respect to those characteristics of living processes that uniquely distinguish living from nonliving ones.

So far, that is no more than a good, engineering-grade insight into the matter. To move beyond such shrewd insights into a scientific resolution of the point, one must proceed from the standpoint of my work in the science of physical economy: No other standpoint would be a successful choice.

Physical Economy

To reach a deeper level of understanding than is possible within the domain of today's leading mathematical physicists, we must consider two interrelated characteristics of technological progress's role in fostering increased potential relative population density.

The first, relatively more readily accessible, is in modes of production, and in the required quality of infrastructure development required by improved modes of production.

The second is more fundamental and beyond the capacity of any mathematician per se: The role of those axiomatic-revolutionary advances in science and culture which cannot be comprehended by, and which, characteristically, overthrow all preexisting mathematical systems.

When we consider the effective increase in the required quantities and "energy-flux densities" of available power, per capita, per household, and per square kilometer of land area in use, relative to maintaining and increasing any existing level of potential relative population density, we observe a "geometric" increase in both the quantity and quality of power sources required for successfully continued human existence.

This is applicable for the case of human life on Earth, alone; the less speculative case—that is, the case which conforms to the actually emerging situation—is that mankind is in transition from mankind on Earth to mankind in the solar system, and beyond that.

This latter standpoint, referenced in my proposal for a 40-year Mars colonization mission, provides the only valid set of premises for estimating mankind's power requirements, on Earth, and in space, alike.

Implications for Science

Thus far, my standpoint is strictly that implicit in Bernhard Riemann's argument of 1854, as that argument is reinforced by my own unique accomplishments in pinpointing the axiomatic absurdity of the so-called information theory and systems analysis of Norbert Wiener, John von Neumann, et al.[2]

I have always defined a "Keplerian" kind of coincidence of proven, anomalous principles among astrophysics, microphysics, and distinguishing characteristics of living processes, as the precondition for establishing a valid improvement, in quality of principle, within science.

This argument is premised upon a point which can be shown to be implicit in Riemann's work, but which is first explicitly developed in my redefinition of the science of physical economy and the broader implications of Riemann's habilitation dissertation, approximately a century later. This relates directly to the question of energy policy when we relate the existence of these anomalous characteristics to quantum physics as such.

Here I refer to Max Planck's original discoveries, of the "Keplerian" distribution, according to relative ranges of wavelengths of different quanta of energy, which we may look at as qualitatively different species of energy. Then we are able to coordinate such a view of "species" with modes of power generation. The inverse relationship between wavelength and "energy-density" correlates with our study of these.

For a correct energy policy, it is implicitly necessary that it begins with an understanding of those points that were the plain intent of Riemann's 1854 habilitation dissertation and that have been largely misunderstood by scientists and mathematicians, with the qualified exception of Einstein and some of his followers in this matter.

To bring this back to the question of fuels referenced in the nuclear breeder article by Dr. Bernard Cohen: Were mankind doomed to rely solely upon nuclear fuels, then this would impose an unacceptable limit not only in the realm of technology but also in the realm of science.

Economist Lyndon LaRouche is a "precandidate" for the 1996 U.S. Presidential race.

Notes

1. LaRouche's Mars colonization program was the cover story of the Nov.–Dec. 1988 issue of 21st Century, "Designing Cities in the Age of Mars Colonization," p.26.
2. Bernhard Riemann's habilitation paper of 1854, "On the Hypotheses Which Lie at the Foundations of Geometry," appears in David E. Smith, A Source Book in Mathematics (New York: Dover Publications, 1959), p. 411.

   For the concept of physical economy in opposition to the work of John von Neumann, see Lyndon H. LaRouche, Jr., "An Economist's View of Gauss's 'Pentagramma Mirificum'," *21st Century* (Summer 1994), p. 44.

Letters

Cold Fusion Featured at ACS Meeting

To the Editor:

The American Chemical Society (ACS), the most conservative of the major scientific organizations, has given the proponents of "cold fusion" another hard-to-believe idea: space at its 209th meeting in Anaheim, Calif., in March to show their evidence. And show they did. Nine poster sessions presented evidence for excess energy production as well as for several nuclear products including helium and tritium. Most of the work was done in the United States, but there were also several excellent studies done in Japan.

Although the work shown at this meeting is only a very small sample of the amazing positive results now being obtained, the sample made a good case for the generation of significant excess energy without radiation or radioactive products.

The absence of significant radiation, both gamma and neutron, is a blessing as well as a curse. The curse results because the absence of such expected radiation has made the claims very hard to believe. Yet, people keep seeing helium as well as smaller amounts of tritium, two elements that are shown to result only from nuclear reactions produced during the experiment. The dry land available to skeptics is being washed away as the level of good data rises.

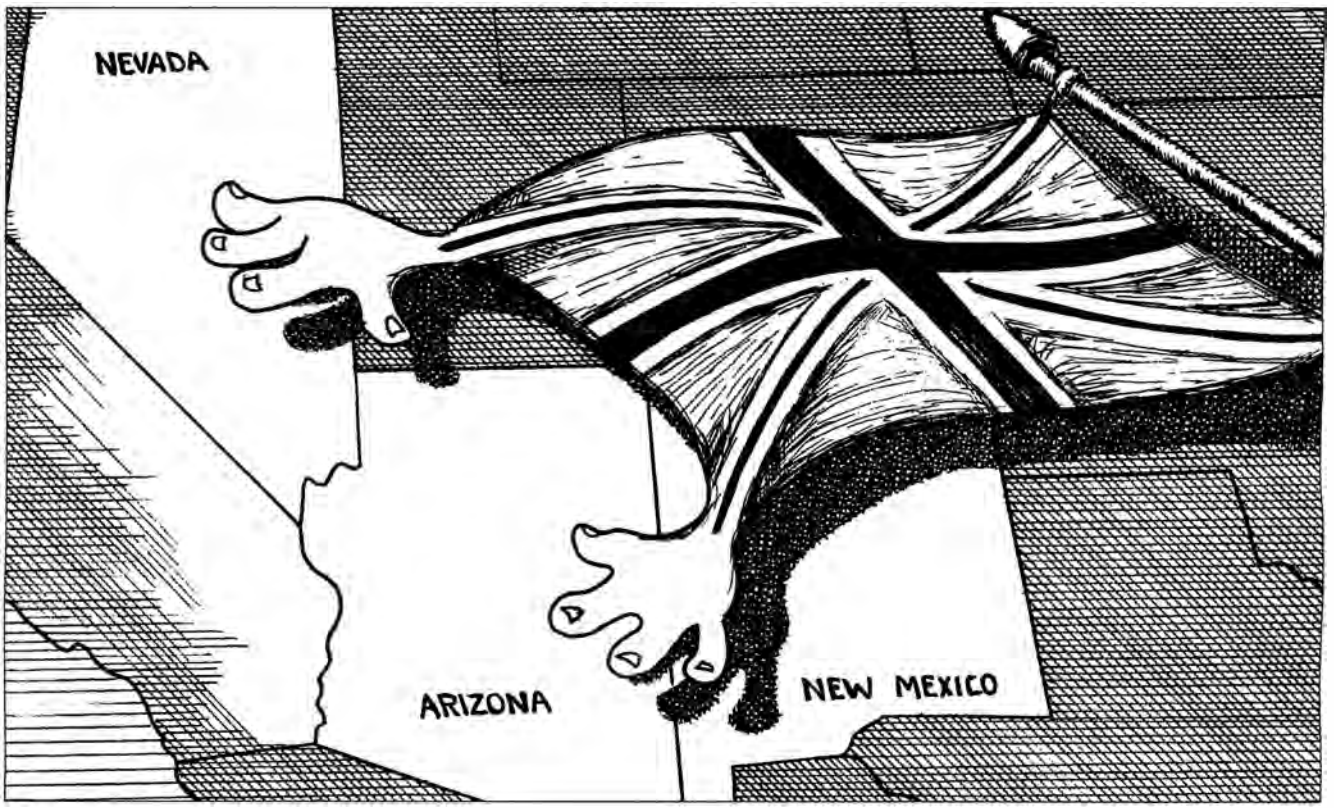
The blessing is that this phenomenon promises the ideal energy source—nonpolluting, cheap, and inexhaustible. This claim is hard to believe in its own right. How many times has this promise been made only to be withdrawn when overlooked radioactivity production or overlooked difficulties in making the basic concepts behave properly were revealed?

In this case, the claims appear genuine although still far from a practical device. In spite of the long road to a useful product, the claims need to be given at least the benefit of doubt. Everyone who welcomes a safer, less polluted world needs to hope this promise is not withdrawn.

Edmund Storms
Los Alamos, N.M.

'Wise Use' and Environmentalists Both Played by Same Forces

by Marjorie Mazel Hecht



Like Paul Revere riding from Boston to Lexington 220 years ago to warn fellow patriots that the Redcoats were coming, this Special Report warns Americans, especially those in the West, of an imminent threat: U.S. farmers, ranchers, loggers, miners, and other groups are being set up for violent confrontations with federal officials by the very same forces that fund and direct the environmental radicals. Nye County, Nevada, is an immediate case in point, but there are many more.

The Nye County Scenario

Reacting to the increasingly restrictive federal regulations that prohibit any use of public lands, local officials in Nye County declared in November 1993 that the state and the federal government have "equal footing" in respect to the management of public lands. The county based its ruling on a 1979 Nevada resolution asserting states' rights over public lands.

The situation heated up when a federal memo went out to U.S. Forest Service employees Feb. 24, 1995, in which regional special agents are asked to supply employees with contact numbers to call "in the event that they are detained or arrested by local authorities." A week later, on March 8, the Environmental and Natural Resources Division of the U.S. Department of Justice filed suit against Nye County to permanently enjoin the county from enforcing its resolution.

Meanwhile, antigovernment propaganda coming from British intelligence agent Lord William Rees-Mogg (as described in the accompanying article, p. 12), is aimed at inciting local militias to violence. Rees-Mogg, it should be noted, is allied with the same people who made the policies of public land set-asides and conservation that he is urging Americans to rebel against.

As we go to press, there are reports of bombings at two U.S. Forest Service sites in Nevada.

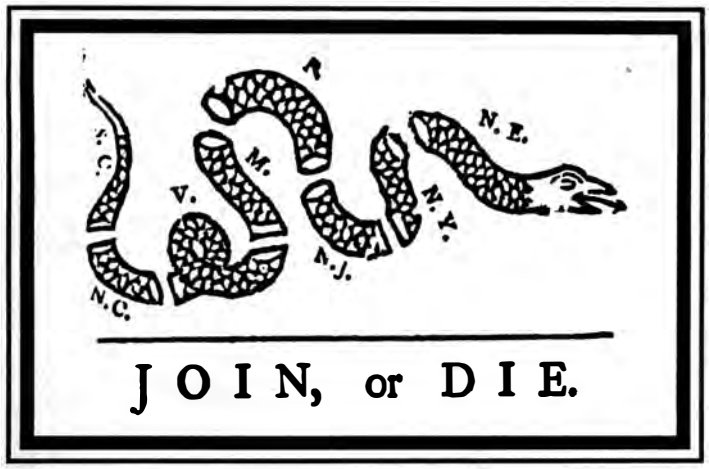
This latest setup for violence follows the nation-destroying formula that the British colonialists have perfected over the past 300 years—the gang vs. countergang model. Both sides of a conflict are set up and controlled in order to ensure British hegemony over the nation as a whole. Palestine, Ireland, Pakistan/India, and South Africa are a few of the bloody examples of the past 50 years, where the British have pitted sections of

a population against each other—including training both sides in terrorism—as a way of maintaining British dominance.

Colonial Rule: Playing Both Sides

The overall British objective today, as it has been since the time of the American Revolution, is to obliterate the republican ideas of our Founding Fathers, who created the United States as a nation that would use the most advanced science and technology to develop and industrialize its vast, unexplored territories and create a new world where individuals could develop to their fullest potential.

The Founding Fathers deliberately created a *federal* system of government, with a strong, central, national government, so that, as George Washington said, ". . . it can never be in danger of degenerating into a monarchy, an oligarchy, an aristocracy, or any other despotic or oppressive form, so long as there shall remain any virtue in the body of the people."



The Founding Fathers fought to establish the Union in opposition to British imperialist policy, which they saw as committed to looting the colonies and preventing industrial and agricultural development. The "Join or Die" cartoon was part of Benjamin Franklin's educational campaign to convince the colonies that without such a Union, the British would subjugate the entire American population, fostering disunity by pitting town against country and farmer against landlord around narrowly perceived immediate interests.

This federal concept of a United States devoted to making progress is precisely what the British tried to wipe out in 1776, in the Civil War, and still today. For a nation based on scientific progress and the development of the individual is bound to succeed—and to leave the old order, the oligarchs, in the dust.

Cui Bono?

21st Century readers understand how the radical environmentalists are shutting down this nation's industrial and agricultural productive capability from coast to coast. Across the nation we see this happening every day, and many have been personally affected by the unjust regulatory bureaucracy—whether it's paying hundreds of dollars more for car air-conditioning or having to find another job as entire industries are forced to shut down.

Less well understood is the fact that these environmentalists are not just a group of misguided Earth-lovers but that their marching orders are coming top-down from a small group of oligarchs, centered on the British crown. This Malthusian faction, as *21st Century* has documented, created the environmentalist movement specifically to carry out policies of deindustrialization, depopulation, and destabilization worldwide.*

The same small group of European royalty and its wealthy friends and agents, including top-level British Intelligence figures like Rees-Mogg, is also manipulating *anti*-environmentalists. Its aim is to finish off what is known as the American system, so that an industrial American giant can never again threaten the British colonial system. America is to be dismembered and its separate, squabbling local territories will be too poor—and too impotent—to have any effect in the world.

We urge readers, and especially those connected to the so-called Wise Use movement, to read this Special Report and ask themselves "cui bono?"—who benefits from the ideology and confrontation being foisted on American citizens who have legitimate grievances against an out-of-control environmental regulatory system? How did it happen that the same small oligarchical group is directing both sides of this issue? Where are those citizens of "virtue," as described by George Washington, who can see through this setup and fight to save this nation and what it stands for?

Notes

* See "The Really Shocking Royal Secret: British Crown Rules the Greens," *21st Century*, Winter 1994-1995, p. 9; "The Coming Fall of the House of Windsor," *Executive Intelligence Review*, Oct. 28, 1994, p. 12.

Thomas Paine on Defending the Country

In 1780, when states were lagging in their efforts to send funds to the Congress to support Washington's war effort, Federalist Thomas Paine exhorted them to act on behalf of the nation as a whole. In an essay titled "The Crisis Extraordinary," he wrote:

"So extensively right was the ground on which America proceeded, that it . . . made it the direct interest of every class and order of men to defend the country. The war, on the part of Britain, was originally a war of covetousness. . . . The fertile fields and prosperous infancy of America appeared to her as mines for tributary wealth. She viewed the hive, and disregarding the industry that had enriched it, thirsted for the honey. . . ."

What Is Wise Use?

The Wise Use movement is a loose conglomeration of diverse groups—including farmers, ranchers, loggers, miners, and many others—who are fighting against unjust and often irrational environmentalist regulations that restrict human development. It is not a membership group, but comprises probably 1,200 local and national organizations with varying special interests. The lowest common denominator, which Wise Use has focused on, is private property rights.

A Warning on the 'Wise Use' Movement

by Anton Chaitkin

Operatives of British intelligence and international banking are meddling dangerously in the United States through the so-called Wise Use movement. They are involved in promoting a confrontation pitting ranchers and others, especially in Nye County, Nevada, in a legal battle and potential manipulated violence against the U.S. government.

These anti-Americans, the same British overlords who *run the environmentalists,* are playing upon real grievances of Western U.S. citizens long victimized by environmentalist antigrowth tyranny.

The "Wise Use" concept stems from the deceptive initiatives of the Anglophile U.S. President Theodore Roosevelt and his chief forester, Gifford Pinchot, to bring anti-U.S. programs, designed by the British Empire in India, into the United States disguised as a "conservative" alternative to more radical environmentalist paganism.

Roosevelt and Pinchot claimed to sponsor the "wise use," or conservation, of resources rather than its total lockup as the radicals wanted. Teddy Roosevelt then shut down settlement, froze Western land, and *overturned* the Abraham Lincoln program of *government-subsidized* railroad building, ending Lincoln's government grants for homes, farms, colleges, factories, and mines.

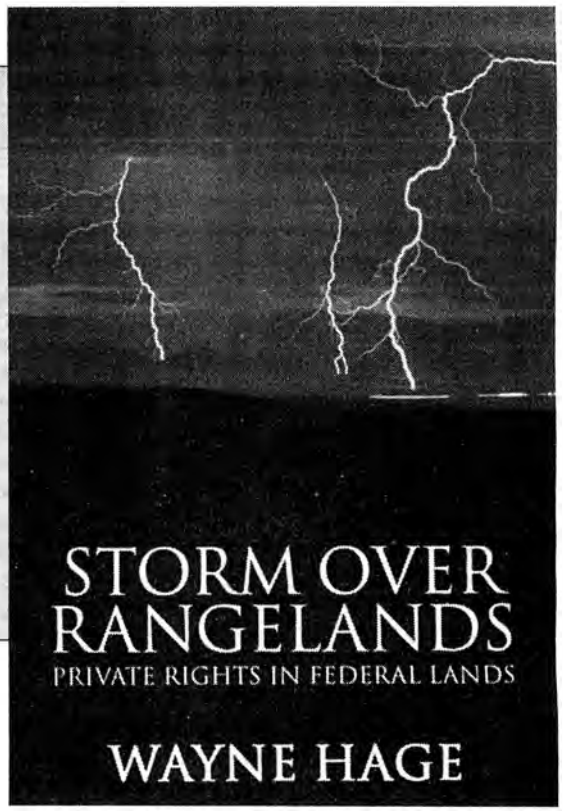
Working in close cooperation with Britain's King Edward VII, Roosevelt used his newly formed Federal Bureau of Investigation to arrest prodevelopment Westerners, including Congressmen.

The Rangelands Storm

Ron Arnold, who heads the Center for the Defense of Free Enterprise in Washington state, revived the fraudulent Roosevelt-Pinchot "wise use" theme. It now has the effect of steering Americans away from the fight for a national policy of technological progress and into the trap of fighting against the existence and authority of the U.S. government.

There is a whole witches' brew of British-instigated, FBI-riddled antigovernment militias and populist organizations in the field. They operate alongside their supposed opposites—British-organized environmental terrorists deployed into the same field on the "left."

Storm Over Rangelands: Private Rights in Federal Lands, a book by Wayne Hage, names Steven Hanke of Johns Hopkins University as the "intellectual leader of the privatization movement of the 1980s." The book rewrites American history, defending the British system of landed gentry and attacking the U.S. "homestead" policy of settling the West by selling land—private property—at reasonable prices to family farmers.



A book published in 1989 by Ron Arnold's Free Enterprise Press for the Wise Use movement, titled *Storm Over Rangelands: Private Rights in Federal Lands,* circulates among credulous people as the "bible" of this movement. It well illustrates this dirty British intelligence game.

In the name of protecting private property from too much government, the book sets up the United States of America—the very concept of the nation itself—as the enemy of the Americans! It attacks the federal Union, taking the standpoint of the southern slaveowners' Confederacy. Using British lies about American history, the author attacks the American Revolution's commitment to national industrial and technological progress as a violation of "rights" that it says are derived from feudalism. Most important, the book violently assails the fundamental U.S. preference for human rights over *usury.*

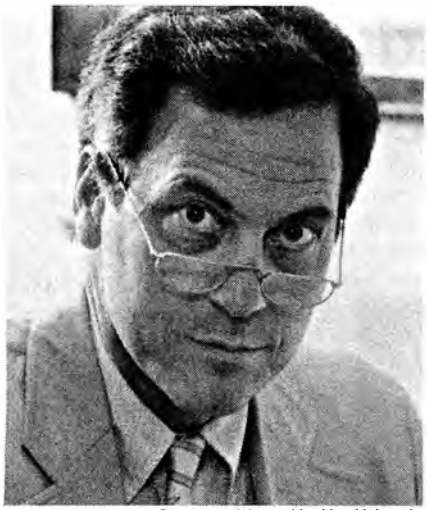
The author of the *Storm Over Rangelands* book, Wayne Hage, is a resident of Nye County, Nevada, where county authorities have announced that U.S. laws have no local effect—a tested recipe for civil war.

In the book's preface, Hage thanks "the intellectual leader of the privatization movement of the 1980s," Steven Hanke, for stimulating the start of the movement. Arnold confirms that Hanke is credited with coining the word "privatization," which is synonymous with their Wise Use initiative.

Hanke: The British Bankers' Guru

Hanke, who is also a professor at Johns Hopkins University in Baltimore, has rare credentials as the guru of a "radical antigovernment" movement. He is a consultant to British Empire and allied bankers with his headquarters in Canada. He is a close collaborator of Margaret Thatcher's chief economic adviser, Sir Alan A. Walters, with whom he has coauthored a series of books.

Hanke is also a radical advocate of international bankers' dictatorship over the nations of the world, and for the sweeping away of all laws everywhere that would interfere with the speculative plundering, gambling, drug-pushing



Courtesy of Johns Hopkins University

Library of Congress

Is Stephen Hanke today's Bakunin? Russian anarchist Mikhail Bakunin 1814-1876 (right), was an aristocrat and a terrorist bomber, working on behalf of Britain's Lord Palmerston in the 1848-1849 revolution in Europe, along with German composer Richard Wagner. Later Bakunin became the spiritual father of Russian terrorism.

Hanke has repackaged Bakunin's doctrine of destroying all governments (except the British) under the label of "privatization." Like Bakunin, Hanke serves as an errand-boy for the enemies of the U.S. Constitution in London; in this case, Baroness Margaret Thatcher's crowd.

forms of finance. In this strategy, the International Monetary Fund and the United Nations are to police each country to prevent even a hint of national sovereignty.

As one of the world's leading spokesmen for imposing "currency boards" over developing countries, the mode of bankers' dictatorship traditionally practiced by the British Empire over its colonies, Hanke has been much quoted recently demanding this solution for such nations as Mexico.

Hanke's fascist book, *Currency Boards for Developing Countries,* was published by a Panama-based institute chaired by narcotics-banker Nicolas Ardito-Barletta. Among the institute's overseers are Gustavo Cisneros, notorious leader of the pronarcotics party in South America; Paul Volcker, former Federal Reserve chairman who cracked the U.S. economy with 20 percent interest rates; and Mahbub ul-Haq and Ellen Johnson Sirleaf, executives of the United Nations "Development Program," the antinational environmentalist enforcement bureaucracy.

Guru Hanke teaches *derivatives* (super-speculative bets on which banks and governments now have $30 trillion outstanding at risk) at Johns Hopkins University, and he writes columns for *Forbes* magazine defending derivative speculation from the threat of regulation. He draws his inspiration from British-based Austrian fascist Friedrich von Hayek, of whom a photograph hangs over his desk. The British are imposing their "Conservative Revolution" on American politics through a tight network of Hayekian organizations. Thatcher adviser Alan Walters is now resident at Johns Hopkins University as Hanke's partner in this subversion.

Ron Arnold's proud assertion that the Wise Use movement is "not Christian" is echoed by a jingle in the frontispiece of guru Hanke's *Currency Boards* book, which starts out:

"In the beginning God created sterling and franc.

"On the Second day He created the currency board and Lo, money was well managed.

"On the third day God decided that man should have free will and so He created the budget deficit."

In the Confederate Tradition

Steven Hanke was briefly an economic ("privatization") adviser in the Reagan-Bush administration. An ally of George Bush, Hanke was in a factional war against former interior secretary James Watt, who was closer to the progrowth, protechnology elements of the "Sagebrush Rebellion"—the Western Reaganites.

Hanke, and the other British-party designers of the "Wise Use" movement, would destroy the United States faster than the Greens could do, by breaking up the government and the Union, without which there is no development of technology and no human survival.

In *Storm Over Rangelands,* the defense of the American Union is portrayed as a contemptible trick by the free North to impose its "particular political persuasion" instead of the supposedly morally equivalent Southern slave society. When the Civil War came, writes Hage, "Nevada found itself saddled with Union war objectives." Following in this Confederate tradition, today's Nevadans are supposed to throw off this unwelcome bondage of American citizenship.

Storm Over Rangelands attacks Lincoln's Homestead Act as a trick. It attacks all U.S. infrastructure initiatives. There is the 1841 law that, according to the book, "donated 500,000 acres of public lands directly to nine western states and promised the same gift to all new states that might be admitted into the Union. . . . Proceeds [from sale of the lands to settlers] were to be '. . . applied to objects of internal improvement, namely: roads, railways, bridges, canals, and improvements of water courses, and draining of swamps.' " Hage calls this law "anti-western sectionalism"!

The book attacks the nationalist Whig Party, which "saw government as an active instrument of progress and improvement. . . . Their rhetoric was anti-Western. . . ." Even President Thomas Jefferson is ridiculed, as a sellout of the no-government cause, because he signed "the Ohio Enabling Act of 1802 into law . . . [to] create the state of Ohio, committing [his] and all future administrations to contracting internal improvements within the states."

Rewriting American History

British atheist philosopher John Locke, who wrote the original feudalist constitution of American slave colony South Carolina, is falsely portrayed as the father of American law. The book applauds Locke's insistence that the *usurer's* concept of property rights—including slave "property"—takes precedence over human rights or national sovereignty, even when the Declaration

Continued on page 13

Rees-Mogg: Black Propagandist For Blood in America's Streets

by Scott Thompson

Lord William Rees-Mogg, a member of the highest level of British intelligence, is publishing black propaganda to stir up a civil war in the United States. The March 22, 1995, issue of Rees-Mogg's newsletter, *Strategic Investment,* features a flagrant piece titled "Waco^2," which seeks to foment an uprising of militias in the United States against a purported "declaration of martial law" by "Field Marshal [U.S. Attorney General Janet] Reno."

Rees-Mogg's newsletter co-editor and frequent co-author, it should be noted, is James Dale Davidson, founder and chairman of the National Taxpayers Union, which in January formed a "Green Scissors" alliance with Friends of the Earth and other green groups to cut advanced technology projects from the U.S. budget.

Members of the Montana Militia, which has spawned other militias across the country, report that they have been inundated by faxed copies of the Rees-Mogg article. But, so far at least, they are not prepared to be drawn into a "flight forward" response to the poison that Rees-Mogg et al. are peddling.


– behind the lines

Waco^2

The slaughter of dozens of women and children in Waco by government stormtroopers under the command of Field Marshall Reno may pale in comparison to what has been planned for late March: a nationwide BATF/FBI assault on private militias as the prelude to a possible declaration of martial law throughout the United States. All leaves and vacations have been canceled for BATF/FBI personnel, and for various State Police and National Guards such as California's. The Army's infamous Joint Task Force Six (which did the training for Waco) has been training BATF jackbooters with Bradley Assault Vehicles at Ft. Bliss, Texas. Government agent provocateurs are set to plant fully automatic and heavy weapons, like rocket launchers, on the property of militia leaders. Every militia in the country—and there are dozens, many of which are well-armed and well-led by former or even active-duty officers—is on a state of Red Alert. Should Reno be stupid enough to actually attack them militarily, there is going to be a lot of blood.

The establishment media is programmed to immediately thereafter thunderously bellow for nationwide gun confiscation and even martial law. The Senate Armed Forces Committee has been alerted and is questioning key Defense and Justice people behind closed doors. Hopefully, Reno's Waco^2 can be stopped in time. But that it was plotted in the first place should be a sobering lesson as to what a horrifying extent liberalism, the political philosophy of the administration and the Democratic Party, has been converted into a close cousin of fascism.

Real civil rights

Another Deflationary Shock

strategic investment

Lord William Rees-Mogg spelled out his view of the conservative economic future in a Jan. 5, 1995, article in The Times, *where he states that "Britain must concentrate on educating the top 5 percent" of the population for "the employment of the 95 percent will depend on the success of the few." Shown here is Rees-Mogg in 1980 and a page from his* Strategic Investment *newsletter, March 22.*

AP/WideWorld

Black Propaganda

The "Waco^2" article states:

"The slaughter of dozens of women and children in Waco by government stormtroopers under the command of Field Marshal Reno may pale in comparison to what has been planned for late March: a nationwide BATF/FBI assault on private militias as the prelude to a possible declaration of martial law throughout the United States. . . . The Army's infamous Joint Task Force Six (which did the training for Waco) has been training BATF jackbooters with Bradley Assault Vehicles at Ft. Bliss, Texas. . . . Government agent provocateurs are set to plant fully automatic and heavy weapons, like rocket launchers, on the property of militia leaders. Every militia in the country—and there are dozens, many of which are well-armed and well-led by former or even active-duty officers—is on a state of Red Alert. Should Reno be stupid enough to actually attack them militarily, there is going to be a lot of blood. . . ."

The article concludes by restating the slanders that Lord William Rees-Mogg and company have thrown at President Bill Clinton:

"Hopefully, Reno's Waco^2 can be stopped in time. But that it was plotted in the first place should be a sobering lesson as to what a horrifying extent liberalism, the political philosophy of the administration and the Democratic Party, has been converted into a close cousin of fascism."

The Role of British Clones

The irony behind this kind of scare propaganda is that certain elements within the federal law enforcement bureaucracy—under the influence of such British-cloned outfits as the Anti-Defamation League (ADL) and the Cult Awareness Network (CAN)—were responsible for instigating the original Waco holocaust by false reports that children of the Waco sect were in danger from severe abuse.

Both the ADL and CAN were also operative in the Randy Weaver tragedy in Idaho, and now they are trying to instigate the government to take steps against groups like the Montana Militia. Senior Department of Justice officials, such as the British-influenced Mark Richard, are quite capable of colluding with the ADL and CAN to stage-manage exactly the kind of insurgency the City of London is so anxious to unleash against the Clinton administration and the American people in this instance.

Who is Lord William Rees-Mogg anyway? Born on July 14, 1928, he attended Charterhouse public school, then Balliol

College, Oxford. After working at the *Financial Times* from 1952-1960, he got a job with the London *Sunday Times*. From 1967-1981, Rees-Mogg was editor of *The Times* of London and since 1992, he has been a *Times* columnist.

Who Is Rees-Mogg?

Rees-Mogg was also vice-chairman of the Board of Governors of the British Broadcasting Corp. (1981-1986) and vice-chairman of the Board of Standards Council (1988-1993). He has also been a director since 1968 of J. Rothschild Holdings, the holding company for the junk bond buyout and derivatives speculation of Baron Jacob Rothschild.

Rees-Mogg's first major book, coauthored with James Dale Davidson, who holds a masters degree from Pembroke College, Oxford, appeared in 1987. Its title, *Blood in the Streets: Investment Profits in a World Gone Mad,* came from Baron Nathan Rothschild's maxim, "The time to buy is when blood is running in the streets."

Among other things, the authors claim to have forecast the Los Angeles riots as symptomatic of a collapsing of the welfare system. A second book by Rees-Mogg and Davidson, *The Great Reckoning: How the World Will Change in the Depression of the 1990s,* forecast a collapse of the global economy—including the United States—as a result of cumulative debt. This event will end the 500-year cycle since the start of the Renaissance, the authors said, and will be accompanied by great chaos, which the authors are not loathe themselves to foment. It will end, they say, in the transition from the Industrial Age to the Information Revolution.

In the coming Information Age, Rees-Mogg and Davidson say, only a 5 percent elite will need any significant education; the remaining 95 percent of society will be thrown on the scrap heap. Actually, the authors note that through biogenetic engineering, people who are half man and half robot will be induced to love jobs like garbage collection under the lordship of the Information Age elite.

Thus Lord William Rees-Mogg does not hesitate at the prospect of causing chaos in the United States today.

Clinton Innocent? So What?

In fact, Lord William Rees-Mogg has declared war on President Bill Clinton through a series of sleazy Whitewatergate "exposé articles," because President Clinton is the first President since John F. Kennedy to consciously break the "special relationship" between the United States and Britain. In one of his numerous articles on the topic, on Feb. 6, 1995, Rees-Mogg crowed: "President Clinton is trapped in a process of inquiry from which he would be unlikely to escape even if he were wholly innocent of any wrongdoing."

And, in a recent interview with a Washington journalist, Rees-Mogg gave negative confirmation that the British onslaught against President Clinton was motivated in part by Clinton having overturned the "U.S.-British special relationship." "I don't worry about the Anglo-American special relationship," said Rees-Mogg. "It functions when it's needed, and I don't think Clinton is going to be around for more than two years, when we shall have someone else to deal with."

'Scumbag' Journalism

This Whitewatergate plotting against Clinton got the goat of *Chicago Tribune* columnist Mike Royko, whose Feb. 16, 1995, column was titled "Rupert Murdoch's Scumbag Connection." Royko wrote:

"The English have a knack for making the Americans feel clumsy and self-conscious. . . . So it is always jarring to look at the English press and find that the journalists seem to be a bunch of sc-mb-gs. . . . In this case the sc-mb-g is William Rees-Mogg, a featured writer for *The Times,* the big influential English newspaper. . . . A few days ago this William Rees-Mogg wrote a column in *The Times* that set out to reveal how much trouble President Clinton is really in."

After quoting from it, Royko asks:

"So why would he write something that is so off the wall? A hint:

"His paper is owned by journalism's No. 1 scumbag—Rupert Murdoch. . . . Murdoch, a billionaire, loathes Democrats. He prefers Republican politicians, to whom he can give multimillion-dollar book advances.

"He owns Fox Network and several American newspapers. So if Rees-Mogg's story is true, the Murdoch empire has the resources to dig it out and give us the facts. Instead, his lackeys nip at the heels."

When a journalist's vituperative attack is too unbelievable to satisfy even the vituperative Mike Royko, you know that Rees-Mogg is using smoke and mirrors in his Whitewatergate plotting to cripple the American presidency. Having tried to envelop the President in scandal, thereby paving the way as well for the option of his assassination, Lord William Rees-Mogg et al. are now trying to create a strategy of tension that will make the United States ungovernable.

Wise Use Movement

Continued from page 11

of Independence rejects this notion.

U.S. President John Adams, a nationalist, is presented dishonestly as a supposed advocate of these British atheist concepts. Claiming that "During revolutionary times John Adams saw private property as the most important single foundation of human liberty," Hage rips from its context an Adams phrase, that property should be as sacred as the laws of God. Hage gives it the opposite meaning from Adams's actual writing—from which the reader is diverted by a false footnote citation!

In the actual Adams text (see *Works of John Adams,* Cambridge, Mass.: Little and Brown, 1851, Vol. 6, p. 9 and preceding pages) Adams condemns anarchical mob leaders and calls for a strong, central, national government as the only guardian of the people's liberties and property. Adams warns specifically about the dangerously flawed person who looks out for his own narrow self interest and doesn't care a whit about the fate of the entire nation.

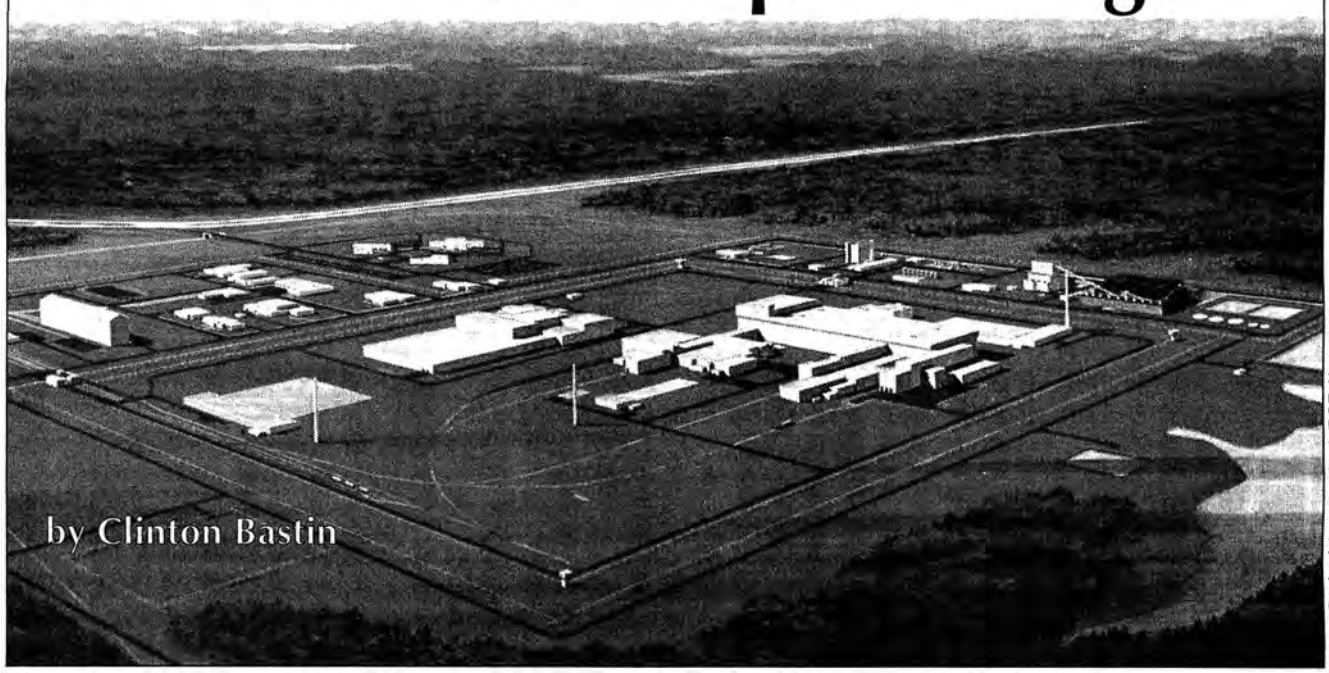
The high point of this British offensive against American nationality is the book's complaint that thoroughout U.S. history Americans have wrongly stigmatized *speculators* as morally inferior to actual settlers. Americans, Hage complains, have viewed the difference between speculators and others the same way that they viewed the difference between Satan and Christ. This is supposedly a deliberate plot by the North to squelch the development of the West.

According to the Hayek-Hanke-Hage doctrine, (Satanic) speculators are the same thing as ordinary settlers!

One would hope that real Americans, even today, can tell the difference.

STOP THE $1 TRILLION CLEAN-UP SCAM:

Restart Nuclear Reprocessing!



DuPont Design Integration Study/DOE, Nov. 1978

by Clinton Bastin

EDITOR'S NOTE

Since the U.S. Atomic Energy Commission was abolished in 1975, U.S. nuclear policy has regressed from one of development to one of a "green maid brigade." Today, the Department of Energy (DOE) has junked the development of new nuclear technologies and instead is spending hundreds of billions of dollars cleaning up radioactive waste at DOE civilian and military sites.

Yet, as nuclear expert Clinton Bastin points out: "Radioactive waste and plutonium cannot be cleaned up. It can be moved from here to there and it can be stabilized, but it cannot be 'cleaned up.'"

Instead, Bastin proposes spending just a small fraction of the planned clean-up fund on protecting the public from any danger at waste sites and, at the same time, on accelerating the research and development that will help the United States regain its former lead in nuclear technology. Developing of reprocessing plants and breeder reactors would turn DOE's trillion-dollar clean-up operation into an asset that could supply the nation with its next 500 years of electricity.

In this report, Bastin, a chemical engineer, who has worked with the U.S. spent fuel program since 1959, tells the story of what happened at the DOE over the last 20 years to kill programs like reprocessing of fuel. Most startling is his evaluation of the "secret" to safe reprocessing—a function of the plant configuration more than the actual chemical process—and how the United States prevented other nations from learning this reprocessing plant design. Also startling is his frank evaluation of the poor design of the never-operated Barnwell Reprocessing Plant in South Carolina.

Bastin provides an inside look at what was going on at the DOE while nuclear technology suffered the dual death blow of the Carter administration's antinuclear policy and of the Reagan administration's "privatization" policy. He provides the personal documentation of how competent assessments of technologies were ignored as part of the larger political decision against nuclear energy.

Although Bastin gives a plausible explanation for nonproliferation policy and the need for international controls over nuclear technology, we note that 21st Century *has countered this view with a specific historical account of how Bertrand Russell and his utopian faction intended to use the making and dropping of the atomic bomb as a way of furthering their plans for one-world government—"The Great Atom Bomb Hoax," (Fall 1994, p. 28). As discussed in that article, the Russellites campaigned to stop the spread of civilian nuclear power, particularly in the developing sector.*

Bastin was responsible for the AEC's reprocessing, plutonium and plutonium scrap operations, plutonium-238 production, transuranic materials processing, tritium and deuterium production for weapons programs, radioactive waste management, and related activities at the Department of Energy's Savannah River Plant. He also was involved in the diplomatic side of U.S. international nuclear efforts.

▲*This design for a reprocessing plant, based on the successful operation of the Savannah River plant, was killed on the drawing board.*

Currently Bastin works at the DOE headquarters where he is president of the employee union. This article is adapted from the many technical memos he has written to DOE administrators, including most recently to Hazel O'Leary, urging the DOE to restart reprocessing at the Savannah River Plant.

In the best reprocessing concept, essentially *all* of the fission products produced in nuclear reactors could be recovered and put to beneficial uses.[1] With good reprocessing techniques and recycling of fuel into fast reactors, where *all* of the long-lived actinides are used for energy production and burned up, nuclear wastes remain significantly radioactive for only a few hundred years, compared with hundreds of thousands of years for unreprocessed fuel.

Decision makers for every light water reactor built in the world to date had the full expectation that spent fuel would be reprocessed, the remaining energy values would be recycled for production of energy, and the weapons-usable plutonium would be destroyed in producing pollution-free electricity.

Right now, the United States has a policy not to reprocess spent fuel but to bury it in a repository. This plan, which has been tied up in very expensive red tape for years, does not solve the spent fuel/plutonium problem.

The planned U.S. repository at Yucca Mountain, Nevada, would store spent fuel containing enough plutonium and fuel to supply all of the electricity needs of the United States for about 200 years, at present rates of use.

Reprocessing History

Reprocessing requires competent management, as described below, because there are major safety concerns associated with handling weapons-usable material.

In 1974, after India's detonation of a nuclear explosive brought major international attention to the concerns of nuclear proliferation, the United States proposed to the rest of the world that reprocessing plants be operated under *multinational* control. The International Atomic Energy Agency started a major study of this multinational reprocessing concept, which it named the Regional Fuel Cycle Center.

The IAEA study concluded that the concept of a multinational reprocessing plant was feasible and would provide good assurances that potential nuclear weapons material would not be diverted to such purposes. However, because the United States at the time wanted to stop reprocessing throughout the world, the concept was abandoned.

In 1976, in a speech before the United Nations General Assembly, Presidential candidate Jimmy Carter endorsed the multinational reprocessing plant concept and proposed for it the Barnwell Nuclear Fuel Plant, a reprocessing plant near Barnwell, S.C., which was partially completed by Allied General Nuclear Services (a subsidiary of Allied Chemical Company and General Atomics and wholly owned by Gulf and Shell Oil Companies).

This plant became a political football and was never licensed to operate by the Nuclear Regulatory Commission. However, unlike the plant design based on Savannah River, Barnwell had major design deficiencies and could not have been operated successfully. The Barnwell plant was about one fourth the size of any successful reprocessing plant, but was designed to process more than 10 times as much radioactivity. The tight space and large amounts of radioactivity, combined with inability for remote maintenance, virtually guaranteed long periods—years—for shutdown and inability to contain radioactivity and protect workers from high radiation exposure.

Later in 1976, President Ford undertook a major study of reprocessing and fast reactors, but there was no input from persons knowledgeable of reprocessing and a conclusion was reached that reprocessing should *not* move forward and fast reactors should *not* be deployed.[2]

When he became President, Carter undertook a restudy of reprocessing and fast reactors, again with no input from persons knowledgeable of reprocessing. Carter concluded that reprocessing and fast reactor development should be deferred, pending a study of alternative reprocessing methods. This study was known as the International Nuclear Fuel Cycle Evaluation or INFCE.

In reality, it is the *facility design concepts,* not the technical processes themselves, that make the real difference in reprocessing, but design concepts were largely ignored and no information on the best design concept was included in the study. Results of INFCE were inconclusive.

Getting Rid of Waste By Completing the Fuel Cycle

Reprocessing spent fuel, instead of treating it as "waste," creates new fuel for power reactors and was considered by the nuclear pioneers to be essential. When reprocessing is combined with the introduction of fast reactors, there is virtually no nuclear waste problem. The nuclear fuel cycle is complete.

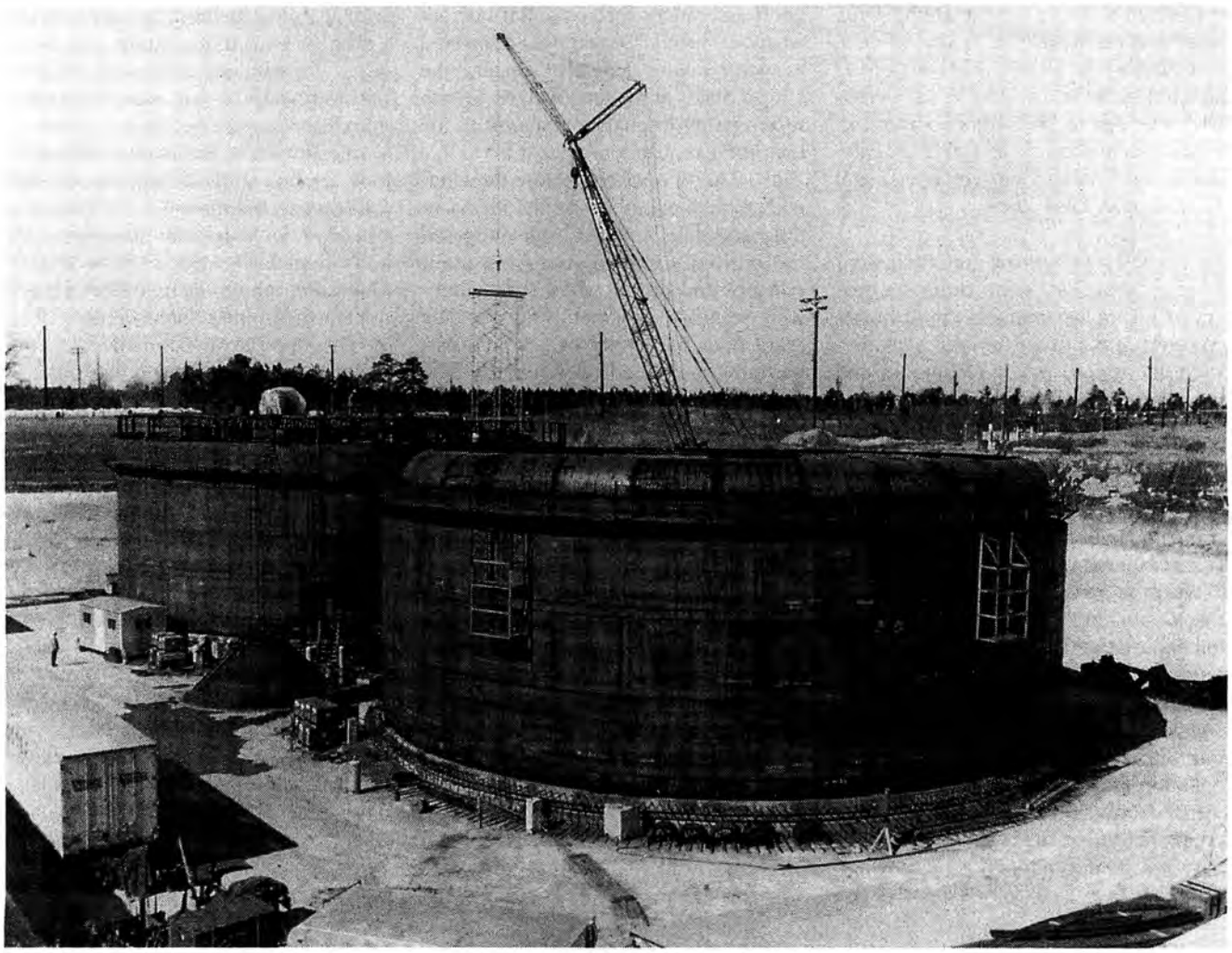
Existing nuclear reactors use only about 1 percent of the total energy value in uranium resources; fast reactors with fuel recycle would use essentially 100 percent, burning up *all* of the uranium and actinides, the long-lived fission products.

In a properly managed and safeguarded system, the plutonium produced in fast reactors would remain in its spent fuel until needed for recycle. Thus, there need be no excess buildup of accessible plutonium.

The plutonium could also be fabricated directly into new reactor fuel assemblies.

Design studies of a fuel recycle complex by the DuPont Company during the mid-1970s, which included technology based on the world's best reprocessing experience, also incorporated direct fabrication of fresh fuel assemblies from recovered plutonium (and uranium).

In addition, the individual facilities were connected by underground, heavily reinforced tunnels, and access to any of the facilities was through such tunnels—a feature of existing reprocessing plants at Savannah River. These design studies provided the world's best opportunity for safeguarding potential weapon material. Unfortunately, information on this facility concept was never made available to Presidents Ford or Carter, or to the Congress.



Carbon steel high-level waste storage tanks at the Savannah River Plant in South Carolina, shown before they are encased in 3-foot-thick concrete 40 feet underground. Tanks are also equipped with cooling coil assemblies to remove the heat produced by radioactive decay.

In the meantime, the Congressional Office of Technology Assessment (OTA) began a major study of safeguards and proliferation that focused on reprocessing. Fairly late in the study I was asked by an OTA staff member to review a section on reprocessing technology, and I informed the staff person that the information was in error.

A few days later I was called by the staff member and told that their consultant had reconfirmed the original information. Again, I stated that the information was incorrect, and that our differences could not be reconciled without direct discussions. A few days later I was given the name of the OTA consultant, who turned out to be a long-term colleague at Los Alamos National Laboratory whose experience was in plutonium operations, not in reprocessing. After a few minutes of discussion, he agreed with my position.

Having thus established credibility with the OTA staff member, I was asked to review the entire document. I did so and found many errors and misleading statements. But it was too late. Prior to my meeting with the OTA staff member, DOE officials had approved and issued the document, which then became the basis for the Nuclear Non-Proliferation Act of 1978.

The Secret of Safe Reprocessing

This act precluded transfer to another nation of important technology on reprocessing unless that nation gave the United States consent rights on its reprocessing activities—which, of course, other nations did not want to do. Thus reprocessing plants built elsewhere were denied access to many design features that could have increased viability, safeguardability, diversion resistance, environmental protection, safety, radiation protection, and so on.[3]

It is generally believed that the crucial information on reprocessing is the details of processes and process equipment. In fact, the important information for a successfully operated reprocessing plant is in the facility concepts: installation of equipment for good remote operations and maintenance; protection from radiation; and sampling of process chemicals for material safeguards, accountability, and process control. These systems in a reprocessing plant would be similar to those in a high-level waste processing plant.

The United States abandoned the design concept for what would have been the world's best power reactor fuel re-

processing plant for political reasons and because of bureaucratic folly. France and Japan had each sought detailed information on this concept, but it had been denied.[4]

One of the frequent criticisms of reprocessing is that it costs too much. Let's look at some of the figures.

Cost of Reprocessing

The French and British have a monopoly on reprocessing and charge less than $1,000 per kilogram for the service, including solidification of the resulting high level waste. The French plants operate at about 20 percent of ultimate capacity (average throughput per year divided by daily capacity times 365 days).

The plant designed by DuPont in the mid-1970s, incorporating the world's best technology, would have operated at *80 percent* of capacity with a daily capacity of about 10 tons per day. Thus, the DuPont facility, which was estimated to cost about the same as that of the French, would have had about 15 times the capacity. It is certain that the cost per kilogram of reprocessing would have been much, much less than the approximately $1,000 price established by the French and British.

Let's also compare this to the costs of a waste repository. The United States plans to spend huge sums of money at Yucca Mountain, Nevada, to investigate, explore, characterize, and so on. Yet, will this convince those who don't want the waste stored at Yucca Mountain that the waste should be stored at Yucca Mountain? And even if it does, will we really leave the wastes there? What is planned for safeguarding of the potential weapons-usable material? How will we generate electricity in the future?

The spent fuel that is now defined as waste must be used for future power generation. Until that is done, the spent fuel can be safely and inexpensively stored at reactor sites.

The Department of Energy should halt wasteful expenditures on the repository at Yucca Mountain and simply accept responsibility for the fuel at reactor sites—as the Atomic Energy Commission did at the Dresden I and Yankee Rowe Nuclear power plants pending availability of commercial reprocessing. Spent fuel should be stored in dry casks on site in a facility provided by DOE.

Development of fast reactors once was, and should be now, one of this nation's highest priorities. As part of our best energy development program, we should maintain good surveillance of the radioactivity at all DOE sites and perform needed cleanup. We can undertake these needed development programs, and properly manage them, including surveillance and cleanup, for a fraction of the expenditures planned for so-called environmental restoration.

The most important gift ever received by this nation is the Statue of Liberty, a gift of the people of France. Perhaps of equal value, if we follow the advice, are the words of the Premier of France, François Mitterrand: "The denial of technical progress, the fear of the creative act, are the mark of lost societies. The danger for humanity is not that man invents, but that he does not master what he has created."

How Reprocessing Works

Separation of uranium and plutonium from high-level waste and from each other in a nuclear fuel reprocessing plant is accomplished using mixer-settler chemical process equipment.

Think of this operation as like a bottle of Italian dressing. The vinegar/water mixture on the bottom simulates the nitric acid/water solution of uranium, plutonium, and fission products in the feed to a mixer-settler. The salad oil on top simulates the tri-butyl-phosphate/kerosene mixture used to extract the uranium and plutonium.

Add the proper chemicals to the kerosene (oil) in the top of the bottle, shake thoroughly, and the plutonium and uranium are extracted into the kerosene, leaving the fission products (high level waste) in the nitric acid/water at the bottom of the bottle. Pour off the kerosene containing the plutonium and uranium, add some different chemicals, then mix the kerosene with concentrated nitric acid. The plutonium is extracted into the nitric acid, leaving the uranium in the kerosene.

Simple. Except not so simple in a radiation field where exposure for about 20 seconds would be a lethal dose of radiation. As the short-lived fission products in spent fuel decay over a period of time, the radiation is reduced, and after a few hundred years the process becomes almost as simple as described here.

Notes

1. For example, cesium-137 is being used for irradiation of blood plasma to reduce patient rejection tendencies, an application that is of increasing importance in immune system deficiency cases.
2. A person knowledgeable of reprocessing is a person who has been significantly involved at a responsible management level for an extended period of time in a reprocessing program that includes one or more reprocessing plants that process ton-per-day quantities of highly irradiated nuclear materials. Such a program must routinely achieve excellent safety and environmental and radiation protection goals, production commitments (including quantities and material specifications), safeguard assurances, containment of radioactivity, good radioactive waste management, and other important criteria, and routinely carry out proper reporting to higher management and reporting of accidents to the news media.
3. The actual processes used in reprocessing are only one component of reprocessing "technology." Also critical to successful operation are the plant configuration, equipment and piping layout, type of equipment, remotability features, remote maintenance system, intersystem tankage, sampling systems, ventilation, containment, safeguards and accountability, and so on. Significant differences in these nonprocess components could make as much as two orders of magnitude difference in operability or unit cost of operations—and could in some cases preclude operations.

   During the mid-1950s to mid-1970s, the Idaho Chemical Processing Plant (ICPP) and the reprocessing facilities at the Savannah River Plant used similar processes, but operability and many other important parameters were vastly different. On-stream time during periods of product demand was more than 80 percent at Savannah River, and about 2 to 3 percent at the ICPP. Failure of a major piece of equipment resulted in one day of lost operating time at Savannah River, and up to one to two years at ICPP. Return to equilibrium (that is, productive operation) after shutdown for maintenance, accountability, or other reasons at Savannah River would take a few minutes; it would take about 30 days at ICPP and about 8 days at Hanford PUREX.

   Equipment maintenance at ICPP resulted in large radiation exposure to personnel, because personnel were required to enter process cells for direct maintenance of equipment. Average radiation exposures to operating and maintenance personnel at ICPP were about a factor of 3 higher than at Savannah River and Hanford on an overall basis, and a factor of some 50 to 100 times higher on a unit of production basis.
4. Germany did obtain full information on this concept from the United States through collaboration on high-level waste management during a period of maximum embargo on the export of technology on reprocessing, and it designed the WA-350 reprocessing plant on the basis of this concept.

A TRAGEDY OF SCIENCE

The Life of Max Planck

Planck's discovery of the quantization of energy posed a challenge that modern physics never answered. He foresaw disaster for society in the noncausality of Bohr's Copenhagen interpretation. His character and honesty made him a target of the Nazis, who finally killed his son.

by Caroline Hartmann

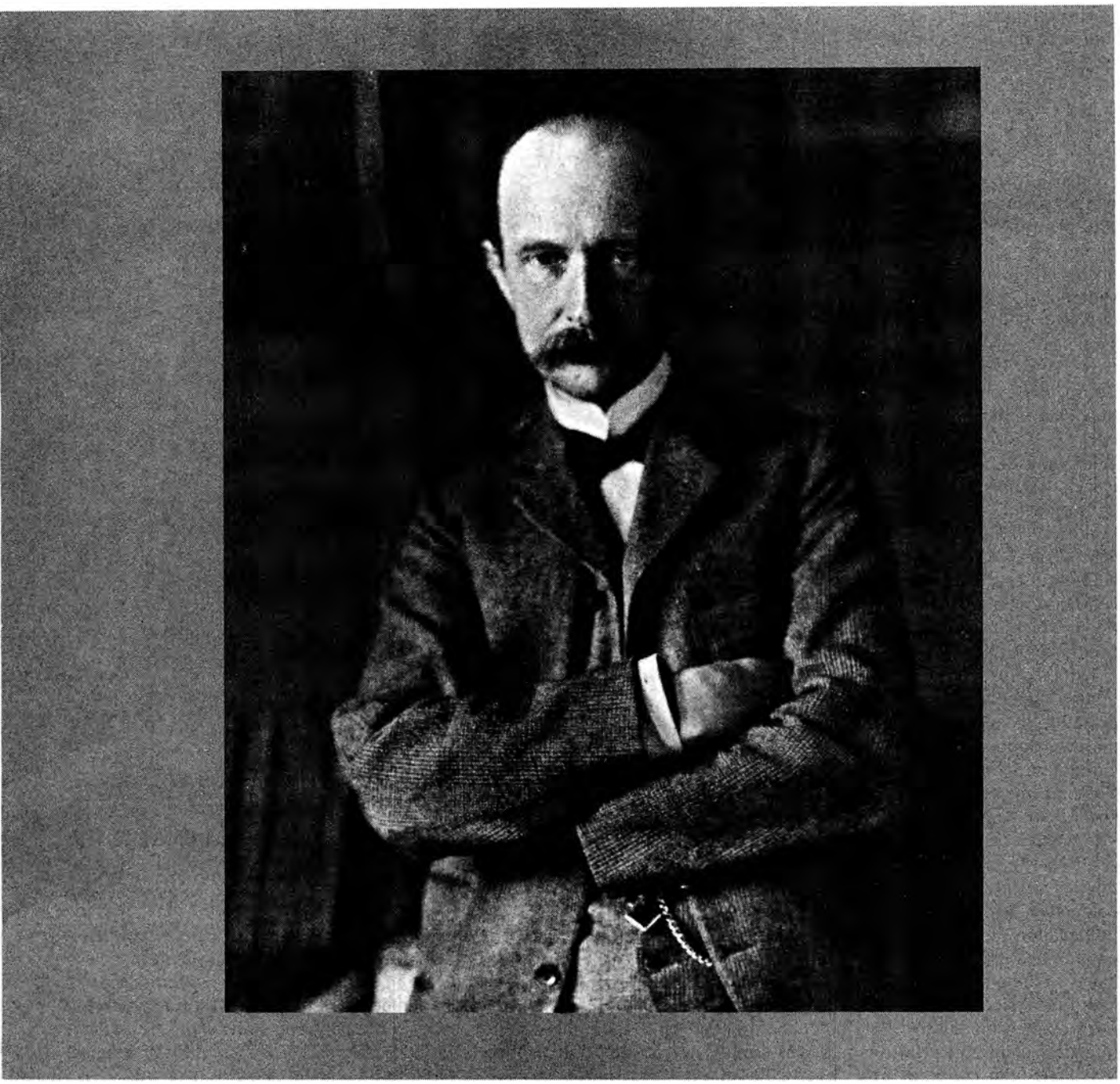
If a young person, inspired by the great scientists of the past, decides to study physical science today, he will undergo a profound sobering when, after a few semesters spent developing his knowledge about the laws of nature through experiments and theoretical work, he confronts quantum physics.

On the one hand, the student wishes to find solutions to every unsolved problem and intuitively he knows that each step of progress in the history of mankind has been achieved by pursuing this aim. On the other hand, he comes to realize that today's science has secretly made a compromise, occupying itself with reckoning probabilities to the smallest possible decimal places, rather than pursuing solutions for unresolved problems. His professors reply to the student's doubts, "We can calculate perfectly well using our formulas," and, depending on how deeply the student loves truth, the student says either, "Well, if I can earn money that way, so be it"---or, he revolts.

The Quantum Paradox

When Max Planck discovered the existence of quanta of energy (that is, that bodies emit radiation not continuously but in distinct "packets" called quanta), the unsolved question of whether light is an electromagnetic wave or a stream of particles returned to the center of discussion. For Planck, these quanta were defined by the so-called constant of action, the *Wirkungskonstante.*

Since the time of Leonardo da Vinci (1452-1519), the ability



Emilio Segré Visual Archives, American Institute of Physics

Max Planck, 1858-1947, fought against the Copenhagen school's adoption of Heisenberg's uncertainty principle, which made it meaningless to speak of exact simultaneous values of momentum and position: "This is an intolerable limitation of the freedom of thought and a mutilation of the main work the theoretician has to deal with," he wrote.

of light rays to pass through each other and, under certain conditions, to mutually reinforce or to cancel each other (interference) like waves on water had suggested that light is a wave phenomenon, later understood as an electromagnetic wave. This picture of things, however, cannot be reconciled with the existence of quanta, at least not within the bounds of so-called classical physics. For Planck, "the question of whether rays of light are themselves quantized, or whether this quantum effect exists in matter only, is, in fact, the first and most acute dilemma facing the entire quantum theory."

After Leonardo, opposing schools of physics developed: Isaac Newton's followers insisted that light must consist of particles, while others, like Christiaan Huygens (1629-1695), pursued the wave theory. A third, more dangerous school began to emerge at the beginning of the 19th century. This last school claimed that the question did not need to be solved; natural phenomena could simply be represented by "models" adapted to empirical phenomena. The most important representative of this school was James Clerk Maxwell (1879-1931).

The scientists who continued to make serious attempts to solve this puzzle were willing to turn established physical theory upside down, if necessary, in order to succeed. The young Austrian physicist Erwin Schrödinger, for example, proposed in 1925 to describe the distribution of energy within an atom as a superposition of a number of waves. His initiative was supported by several scientists at the University of Berlin, most emphatically Max Planck, but also by Albert Einstein, Wilhelm Wien, and Max von Laue. Planck described this theory as "wonderful" and "epoch-making." He wrote to Schrödinger: "I am reading your essay as a child eagerly listens to the solution of a riddle which it has labored over for a long time."

This group of "revolutionary" scientists, however, failed to overcome the massive opposition of the Göttingen School and the Copenhagen group led by Niels Bohr. This latter faction wanted at all costs to protect the established physics worldview, which calculated the continuous propagation of waves in space using Maxwell's electrodynamic equations. Indeed, the empiricism of Maxwell, Hermann Helmholtz, Leopold Kronecker, and Emil DuBois-Reymond pronounced all epistemological questions moot. They were content merely to "describe" natural phenomena; the question of lawful relationships was simply not posed. Maxwell even claimed in his essay "Faraday's Lines of Force," written in 1856:

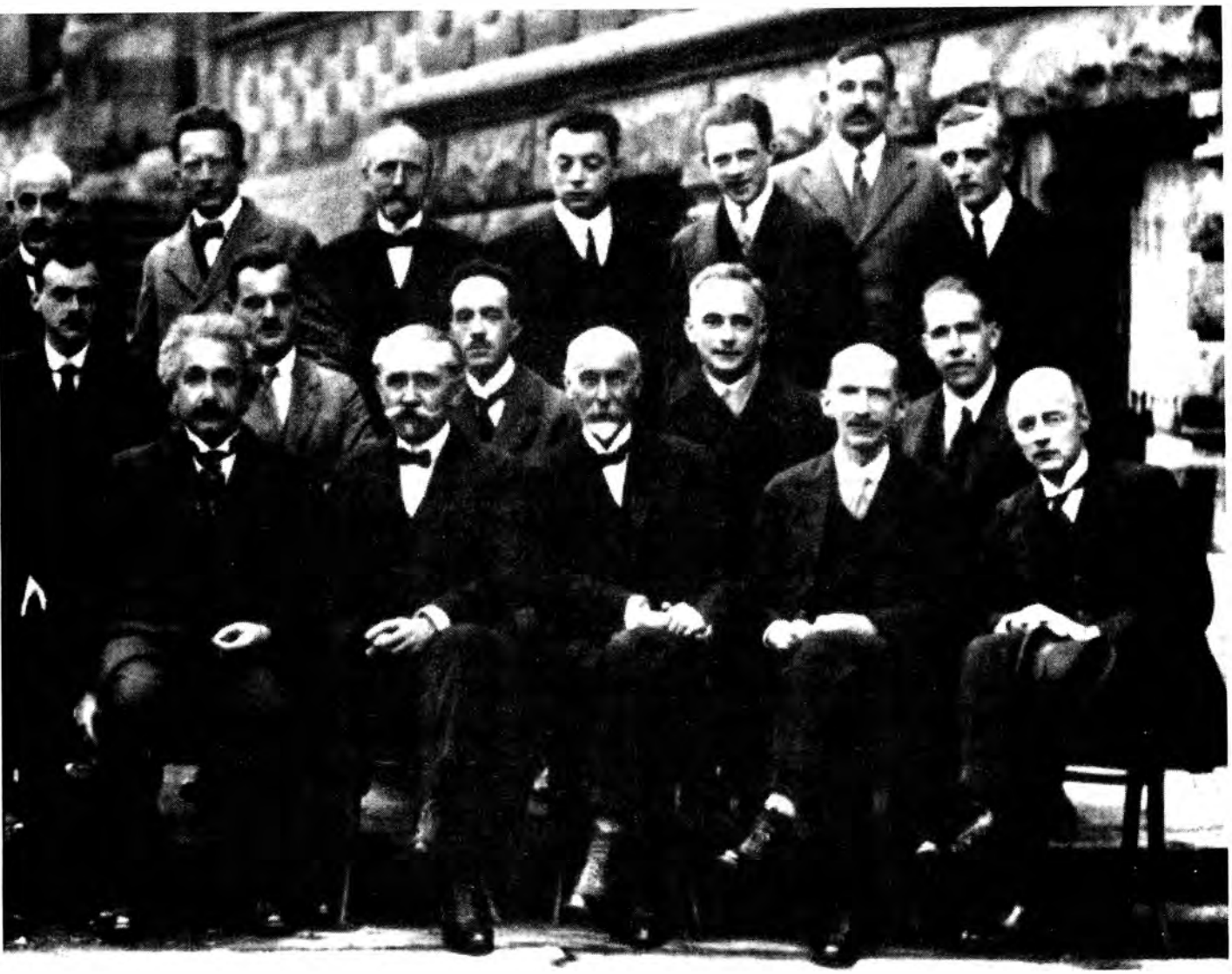
> In order to get a physical conception, or to construct a specific physical theory, we have to get acquainted with the existence of physical analogies. Physical analogy I understand as a partial similarity between the laws in one area of phenomena to those in another, which has the effect that the former illustrate the latter. . . . Thus, in formal terms, we find perfect conformity between the laws of two different areas of phenomena, which both have become the point of departure for a physical theory of light.

Thus, at the famous Solvay physics conference in 1927, Niels Bohr decreed the following "compromise": He laid down the law that the nature of light was not open to discussion by the Copenhagen School. Light would simply be treated as a wave *or* as a particle, depending on the formulation of each particular experiment. According to Max Born, quantum theory is just a method of calculating probabilities. Thus, probability theory was born—and is still the last word in quantum mechanics. In order to be able to calculate with "precision," Werner Heisenberg's "uncertainty principle" was employed, according to which one cannot calculate with a high degree of accuracy both the position and the momentum of a subatomic particle at the same time.

Planck Defends Causality

Denouncing this approach, Max Planck declared that the uncertainty principle would make it meaningless to speak of exact values of momentum and position, p and q: "This is an intolerable limitation of the freedom of thought and a mutilation of the main work the theoretician has to deal with," Planck said.

The idea of a lawful ordering of the universe, an idea that had been the moving force behind scientists' passionate search



Institute International de Physique Solvay, courtesy of Emilio Segré Visual Archives/American Institute of Physics

The famous Solvay physics conference in 1927, where Niels Bohr ruled that the nature of light was not open to discussion: Light would simply be treated as a wave or as a particle, depending on the particular experiment. In the front row, from left: I. Langmuir, M. Planck, M. Curie, H.A. Lorenz, A Einstein, P. Langevin, C.E. Guye, C.T.R. Wilson, O.W. Richardson. In the second row, from left: P. Debye, M. Knudsen, W.L. Bragg, H.A. Kramers, P.A.M. Dirac, A.H. Compton, L.V. de Broglie, M. Born, N. Bohr. In the third row, from left: A. Piccard, E. Henriot, P. Ehrenfest, E. Herzen, T. De Donder, E. Schrödinger, E. Verschaffelt, W. Pauli, W. Heisenberg, R.H. Fowler, L. Brillouin.

for truth, had now been outlawed. Planck considered it unacceptable that the Copenhagen school refused to keep seeking for the truth and accepted a state of ignorance concerning issues that had been of the utmost importance for earlier physicists. He was amazed at their complacency toward what Einstein called the "Heisenberg-Bohr philosophy, or religion, of consolation." As Max von Laue characterized it, "This exalted pessimism, this eagerness to submit, is nothing else than an expression of that deep cultural pessimism which darkened everything during that time."

Nevertheless, the Copenhagen school prevailed, not least because of the Solvay conferences of physicists, where figures like Bohr, Heisenberg, and Born preached these theories to the world's leading scientists. The efforts of the scientists around Planck and Schrödinger, who became Planck's successor at the Prussian Academy of Science, came to nought.

Was that failure the result of the two world wars that had severely constrained pure science and research and killed many students and young scientists? Was it the result of hesitation to attack the "indeterminacy" theory aggressively enough, because its opponents expected truth to prevail some day if only they continued their work?

Planck warned, "The introduction of noncausality into the physical world view might bring about opinions that could have disastrous consequences for our society." But his warning was not heeded. Indeed, Planck's own all-too-tolerant attitude toward the empiricists was certainly one of the most important factors inhibiting a solution to the questions about the universe

posed by the quantum theory. Maxwell's equations were based on empiricism and determinism and were thus incapable of describing any "leaps" in nature.

Planck, of course, recognized the difficulties created by the wave/particle paradox. "It is obvious," he wrote, "that in this situation the differential equations of classical physics lose their fundamental importance." He also stated:

> But the very existence of an objective limit of the kind represented by the elementary quantum of action has to be considered a sign of the governance of a *certain lawfulness of a new kind,* which itself cannot be attributed to statistics. . . . [O]bviously, there is nothing left but the manifestly *radical* assumption that the elementary terms of classical physics do not suffice any more in nuclear physics [emphasis added].

Yet neither Planck, nor Schrödinger, nor Einstein, made use of the theory of cardinal numbers proposed by the mathematician Georg Cantor (1845-1918). In his unique and revolutionary approach, Cantor considered the universe to be a negentropic self-developing unity. He was convinced that the human mind itself possesses an unlimited potential for self-development, which allows it to understand the development of the universe, and that he could develop mathematics in such a way as to be able to express this process. "I believe that the words 'limited reason,' which one hears so often," Cantor said, "are in no way truthful: As limited indeed as human nature is, a great deal of infinity clings to it."

"Mankind makes every effort to further extend the present limits of its capacities, and we hope to achieve many things in the future which at present are perhaps considered by many people to be impossible."

Cantor draws on the *Monadology* of Leibniz and on Plato's *Parmenides* dialogue, which identifies the paradoxes of developing levels of knowledge. He took the principle of development as the foundation of his new mathematics and, because of this, he was attacked by the empiricists, especially by Leopold Kronecker, who tried to muzzle Cantor in a most ugly way.

Unfortunately, Planck and his fellow scientists in Berlin never recognized that Cantor was the only mathematician who, in the tradition of Karl Gauss and Bernhard Riemann, had taken up the challenge to explain the "leaps" in the universe as singular points in a self-developing unity. Thus, they themselves did not rigorously pursue the task of developing a new mathematics; thus, after Cantor, truth-seeking in its fullest scientific sense faded away.

Who Was Max Planck?

Max Planck was born on April 23, 1858, in Kiel, Germany. Planck's mother came from a family of pastors. His father was a highly respected law professor, who in 1867 was invited to the University of Munich in Bavaria, to fill an important position representing his colleagues in the university administration.

Planck's great-grandfather, Gottlieb Jakob Planck (1751-1833), was an adherent of Gottfried Wilhelm Leibniz. In 1781, when the great poet-to-be Friedrich Schiller left the Karlsschule in Stuttgart, Gottlieb Jakob Planck arrived there as a professor and pastor. In 1784, he was invited to the University of Göttingen, where he stayed for 49 years, rejecting a number of positions at other institutions. One of the characteristics that Gottlieb shared with his great-grandson, Max, was tolerance and justice toward those whose views differed from his. As Hans Hartmann, a nephew of Planck's wife, reports in his biography of Max:

> Whoever got to know Max Planck was struck by his chivalrous attitude, which expressed itself not only in his ever-honorable methods of battle, but also in his judgment about other people. For him, it was utterly impossible to attribute to others a bad motive, unless they clearly demonstrated it.

Max Planck nearly became a musician instead of a physicist. As a young student, he composed songs and even an operetta for a family theater group's performances. With perfect pitch, he sang solo soprano in the great oratorios for the boys' choir. He became assistant master of the academic choir, played the organ for university church services, and became a director of the orchestra association of laymen and professional musicians. While studying in Berlin, he considered starting a musical career, but he finally decided on physics, although he continued to study harmony and counterpoint.

Later, working in Berlin, Planck and the other theoretical physicists thought of themselves as artists. Planck remarked:

> It is not logic but creative imagination which ignites the first flash of an idea in the mind of a researcher who is pressing toward a dark area . . . and without imagination, fortunate new ideas cannot be presented. If there is one thought strengthening and uplifting our minds and bodies when they are consumed by patient and exacting work on details, it is this, that in physics, we are not working for the present, for momentary success, but, so to speak, for eternity.

Music was essential in the lives of the Berlin physicists in the late 1800s. Einstein pointed to Planck's "truly artistic side" and to his "artistic needs, which were the motor of his creative accomplishments." Planck played the piano like a professional, and often Brahms's friend, the great violinist Joseph Joachim, visited Planck to perform Beethoven sonatas for piano and violin. Many professional musicians admired Planck's sensitivity to the intentions of the composer and his energetic performances. Together with other physicists, including Einstein and Arnold Sommerfeld, Planck invited physics students to join trios and quartets. Hans Hartmann noted in his biography of Planck that Planck did not perform music for mere relaxation but that music was an essential part of his life, a realm in which he could freely develop his spirit.

Work on Thermodynamics

Planck studied for three years at the University of Munich and then went to Berlin for a year to study under Hermann

Helmholtz and Gustav Robert Kirchhoff (1824-1887). He reported:

> Unfortunately, I have to admit that I did not really profit from these lectures. Helmholtz apparently was never really prepared; he always spoke hesitantly, looking into his little notebook for the necessary details; in addition, he constantly made miscalculations at the blackboard, and we got the impression that he was at least as bored as we were.

Planck in no way defended Helmholtz's mechanistic conception of nature but he did admire him as a celebrity of the scientific world. Planck never made an all-out attack on the mechanists and their linear image of the world as Georg Cantor had dared to do.

In 1878, Planck, who was only 20 years old, wrote his doctoral thesis in less than four months. A year later, after extended studies of Rudolf Clausius's works, he finished his dissertation on the two major laws of thermodynamics. Planck tried to oppose a too-narrow formulation of Clausius's law concerning the increase of entropy. Clausius had deduced his "proof" of the Second Law of Thermodynamics from the hypothesis that "heat does not move by itself from a colder body to a warmer body." Planck commented on this:

> This hypothesis demands a special clarification, because it says not only that heat does not move directly from a colder body to a warmer one, but also that it is impossible to transport heat from a colder body into a warmer one without leaving behind a lasting change in nature as compensation.

Planck proposed a simpler and more appropriate wording of the hypothesis: "There is no way in which the process of transport of heat can be completely reversed." He called this kind of process "natural." Today it is called "irreversible." Planck wrote:

> But the mistake that is being committed in interpreting Clausius's law too narrowly, and which I have tirelessly fought against all my life, cannot be eradicated, it seems. Instead of the definition cited above, I see the following definition of irreversibility still being used today: "An irreversible process is one that cannot proceed in the opposite direction." This is not sufficient, however, because it is quite conceivable that a process which cannot proceed in the opposite direction can be completely reversed in some way.

After the discovery of the quantum of action, Planck stated explicitly in a 1908 speech titled "The Unity of the Physical Worldview":

> The original definition of irreversibility suffers a significant defect, as we have seen, from presupposing a specific magnitude of human ability, while in fact, we cannot prove the existence of such a limit. On the contrary: Mankind makes every effort to further extend the present limits of its capacities, and we hope to achieve many things in the future which at present are perhaps considered by many people to be impossible. Could it not occur that a process that up to now has been considered irreversible, could be proven reversible by some new invention or discovery? Then the whole edifice of the Second Law [of Thermodynamics] would inescapably collapse, for the reversibility of one single process means, as can easily be demonstrated, the reversibility of all other processes.

Yet Planck himself, in his famous paper "The Discovery of the Quantum of Action," later used the Clausius equations for entropy in deriving his formula.

Not surprisingly, the 21-year-old doctoral candidate found no sympathetic ear for his critique in a world of science dominated by Helmholtz, Maxwell, Clausius, and William Thomson, later Lord Kelvin (1824-1907). Planck, therefore, adapted to his environment and chose the path of relentless work to refine his own conception of Nature. In the end, this untiring effort enabled him to turn upside down the established physical worldview through his mathematical explanation of blackbody radiation.

In Munich, Planck's professors, such as Phillip von Jolly, did not understand Planck's doctoral thesis, and Helmholtz paid no attention to it. Planck's repeated attempts personally to present Clausius with a copy of his dissertation were futile.

Planck Defends Leibniz

After his habilitation in 1880, Planck left the University of Munich and took a position at the University of Kiel, where the professor of physics, Gustav Karsten, was a close friend of his father. Planck first gained public recognition when he won an essay competition on the "nature of energy," sponsored by the philosophy faculty at Göttingen University.

In the paper written for this contest, Planck not only demonstrates his fascination with the principle of the conservation of energy, but raises one of the most profound questions in the history of science. He discusses the differences between Gottfried Wilhelm Leibniz's notion of "living force" (*vis viva*) and Newton's notion of force, and Leibniz's battle on this subject with René Descartes as well as with Newton's ally Samuel Clarke.

Leibniz distinguishes living force from "dead" force:

> Thus, a new, twofold distinction of force arises: The one—which I call dead force—contains only the element of force, because here we have no motion, but only an impulse for motion, as in the case of a stone being whirled in a sling which tries to move in the direction of the tangent, even if the sling prevents it from doing so. The other force, which I call living force, is the normal one, which is endowed with actual motion. . . . For living and dead force, speed and tendency of movement, have a relation to one another like a line and a point, or a plane and a line.

Planck wrote in his paper on the conservation of energy:

> . . .[D]ifferences of opinion were quite possible as to whether Descartes's quantity of motion or Leibniz's living force is the true measure of this notion. If the fight had

been fought in a more rigorous manner, Leibniz would have prevailed.

Concerning Newton, Planck acknowledged:

> Newton's concept no longer has anything to do with the "living force" of Leibniz. . . . [Newton's concept] obviously has nothing to do with the conservation of "force," and this may have been one of the reasons why interest in this principle was lost to some degree. Leibniz's notion of force today appears as the accomplishment of work on the part of Newtonian force; the latter represents merely a necessary, but not a sufficient, condition for accomplishing work. . . . Newton himself apparently never really worked on the notion of accomplishment of work by a given force.

Later, in France, Sadi Carnot (1796-1832) applied the principle of the conservation of energy to heat. It was Robert Mayer (1814-1878) who explained how energy is conserved in heat phenomena. Mayer discovered the mechanical equivalent of heat and with it "the common measurement of all the phenomena recognized as equivalent, which are movement, chemical affinity, cohesion, electricity, light, heat, and magnetism."

In his work on heat equivalence, Mayer closely follows Leibniz's *Monadology*, where Leibniz says:

> There can never be an effect without any cause, or a cause without any effect: *Ex nihilo nihil fit* [nothing comes from nothing], or, turned around, *nil fit ad nihilum* [nothing leads to nothing]. Rather, every cause has a well-defined, precisely corresponding effect, not lesser or greater; the cause thus contains precisely everything which leads to a certain effect, and this is completely reflected in the effect, although in a different form. Thus, cause and effect are in a certain sense equivalent: *Causa aequat effectum.*

Robert Mayer decided to use the term "force" in the Leibnizian sense because he considered it more fundamental. Planck fittingly remarked:

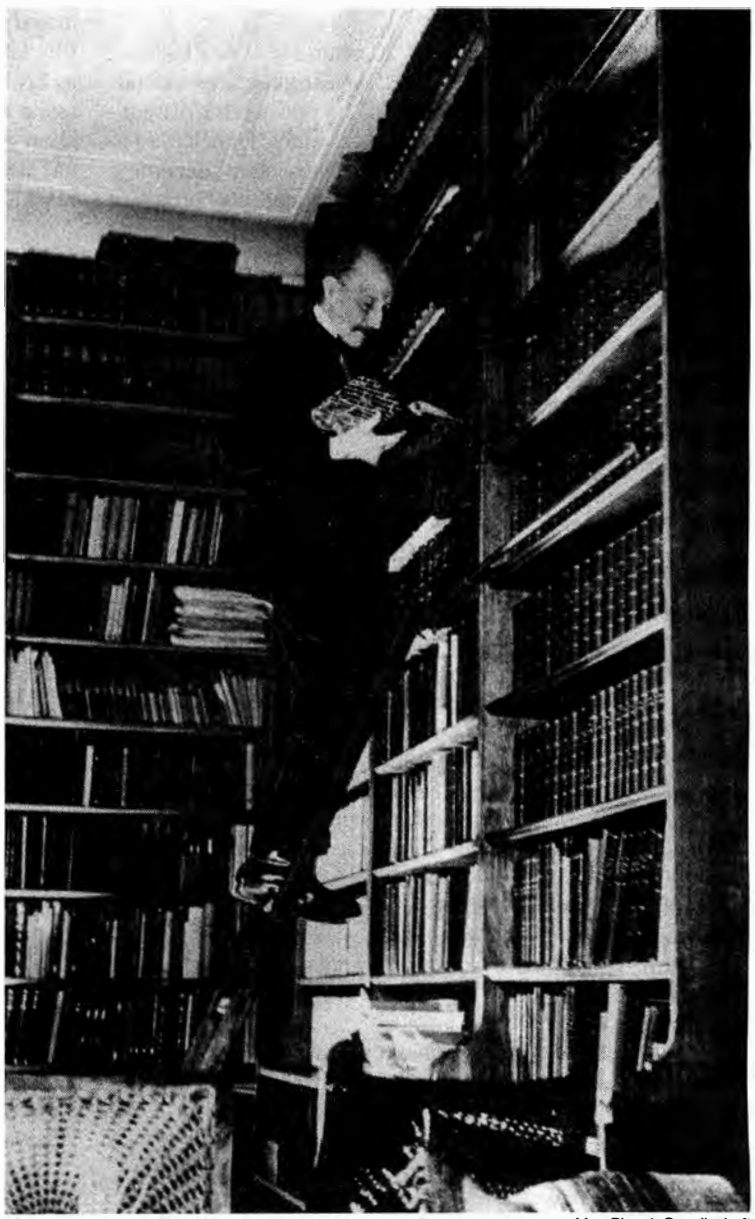
> Mayer may be right to take this into consideration: According to the present state of natural science, Leibniz's notion has indeed become more important; but he did not take into account the strength of the historical development of science. Physical science was based on mechanics, and in mechanics, Newton's notion had been adopted too solidly to be replaced by another term. . . . This inconsistency, which today at least no longer runs the danger of generating a misunderstanding, can only be explained by deference toward history.

But it was not "accidental" historical developments that pushed Newton's notion to the fore. This is documented by the intense battle against Leibniz's influence and Leibniz's works, a battle that was launched while he was still alive and that succeeded after his death in banning Leibniz's principles from science. In most physics textbooks today, Leibniz's name is not even mentioned.

Planck's fascination with the principle of the conservation of energy may be explained by his knowledge that nature bares its secrets in the simplest and most general phenomena.

Planck Resists Helmholtz

After Kirchhoff's death, the philosophical faculty of Berlin University appointed Planck to succeed him as professor of theoretical physics in spring 1889. Planck soon ran up against



Max Planck Gesellschaft

"If there is one thought strengthening and uplifting our minds and bodies when they are consumed by patient and exacting work on details, it is this, that in physics, we are not working for the present, for momentary success, but, so to speak, for eternity." Here, Planck in his library.

Helmholtz and his mechanistic outlook, which considers any elementary forces to be "central forces"; that is, they attract or repel with an intensity depending solely on their distance.

In his work on the conservation of energy, Planck had already recognized the errors in this conception:

> It is remarkable that with the discovery of the mechanical equivalent of heat and the development of the universal principle of the conservation of energy, the concept that all natural phenomena of nature are based on motion emerged so immediately, and was even more or less identified with it. For the principle, strictly speaking, does not imply anything other than the transformability of one natural force into another according to clearly defined relationships, while it tells us nothing about the way in which this transformation occurs. Thus, the validity of this principle does not permit us to deduce from it the necessity of the mechanistic outlook, while conversely, the principle itself turns out to be a necessary consequence of this outlook, at least if we proceed from the idea of central forces.
>
> This latter circumstance, in combination with the need to develop a unified conception of the working of natural forces, explains sufficiently the rapid, unopposed acceptance of this mechanistic theory, which in fact has up to now been spectacularly confirmed; at least, I do not believe at present that I share the fears about this theory's universal applicability as a too narrow reading of natural phenomena.

The proponents of the mechanistic outlook reduced any phenomenon—whether heat, magnetism, or mechanics—to the reciprocal effects of mechanical bodies. Moreover, Helmholtz, one of the most prominent spokesmen of the mechanists, spread Lord Kelvin's ideology of the "heat death" of the universe, asserting that nature will run down like a combustion engine running out of fuel. Their fellow mechanist DuBois-Reymond, who admired Charles Darwin as the "Copernicus of the organic world," presented his "seven world riddles" in a lecture to the Prussian Academy of Sciences on July 8, 1880—problems that he proclaimed were "insoluble for the human mind."

Planck was convinced that this outlook would prove untenable in the long run:

> I knew with absolute certainty that my claim of a difference in principle between the conduction of heat and the reduction of weight would ultimately be proven right. . . . Thus, in the end, things developed so that my claim of a difference in principle between the conduction of heat and a purely mechanical process won the victory over the outlook defended by prominent authorities; but my involvement in this battle was absolutely unnecessary, because without my involvement, the change would have come about anyway.

In another location, Planck remarked with dry humor:

> Thus, I had the opportunity to make an observation which I believe was a remarkable one. A new scientific truth does not usually prevail by persuading its opponents to acknowledge that they have learned something, but it prevails only as its opponents die off, one after another, while the generation growing up has been acquainted with the truth from early on.

Unfortunately, this is not true. As we can see in the disastrous state of science today, quite the opposite has occurred. As the history of the battle between wave and particle theorists has demonstrated since the time of Leibniz, Huygens, and Newton, the degraded conception of natural forces as purely linear reciprocal action, as simple forces of attraction and repulsion, has always found new proponents, as if it were a many-headed hydra—whether under the banner of Newton's "emanation theory," Helmholtz's "mechanical doctrine of nature," or Bohr's "uncertainty principle." As Lyndon LaRouche recently commented, "The proponents of evil die, but evil itself does not, unless it is destroyed."

With regard to physics, this last statement translates: If we do not get rid of the mystical idea of particles moving linearly in rectilinear space according to probabilities and restore the idea of a universe developing to ever higher beauty and harmony in a way that can be presented geometrically in an intelligible way, science will not progress in any fundamental way. Only this method, associated with Leibniz, Huygens, Cantor, and Riemann, is adequate for man as *imago viva dei,* in the living image of God, and history demonstrates that no other method has produced truly fruitful new scientific insights. This battle remains undecided, and never in the past 600 years has mechanistic thinking been more prevalent than today.

Discovering the Quantum of Action

In 1894, Planck was elected a member of the Prussian Academy of Sciences. In the following years, he attempted to apply thermodynamics to broader areas. He recognized that this would require limiting both the principle of entropy and its applications. In his dispute with Leopold Boltzmann, Planck stated, "It would be absolutely without foundation to assume that changes in nature will always occur in the direction from the lower to the higher probability."

Planck was convinced as well that the essential problem in physics was to reconcile mechanics and thermodynamics and, therefore, he was attracted to the phenomenon of what is called normal distribution of energy in blackbody radiation. He reports:

> The measurements taken by O. Lummer and E. Pringsheim of the Physikalisch-Technische Reichsanstalt in their research on the heat spectrum directed my attention to Kirchhoff's law, that in an evacuated chamber, whose walls reflect any radiation whatever, over time a state emerges in which all bodies in the chamber will have the same temperature, and radiation in all its properties, including its spectral energy distribution, will not depend on the properties of the body, but only on the temperature. Therefore, this so-called normal distribution of energy is something absolute, and since I considered striving for the absolute the most beautiful task of research, I eagerly went to work.

Max Planck Gesellschaft

In the early 1930s, Planck predicted "fateful consequences" if physicists failed to solve the problem of causality. Concerned with the growing antiscience mood in the country, he toured Germany to give public lectures on the value of science and its relationship to religion. Here, a meeting of the secretariat of the Berlin Academy of Sciences in 1930. From left: Heinrich Lüders, Ernst Heymann, Max Planck, and Max Rubner.

Interestingly, some British physicists, especially James Jeans, tried to persuade Planck not to investigate blackbody radiation any further, after Wilhelm Wien's established formulas failed to work for infrared radiation. In a letter to Wien, Planck wrote that Jeans "is the image of a theoretician as he should not be, exactly what Hegel was in philosophy—all the worse for the facts, if they do not fit the theory."

Within three years, Planck solved the problem. He discovered the quantum of action, h, which is part of the equation $E = h\nu$, where E is the energy of a specific frequency, ν. The factor h (Planck's constant of action) meant that the energy could not be released in just any amount but was *quantized;* that is, it appeared in small, discrete "packets." This quantization of energy did not conform to the well-established notion of a continuous distribution of energy. Planck had proven a true inconsistency between the generally accepted classroom physics—especially Maxwell's equations—and the results of his work.

In 1907 and 1908, his Berlin colleagues nominated Planck for the Nobel Prize in physics. To everyone's surprise, the award went to the British physicist Ernest Rutherford instead. Apparently, Planck's "atomistic energy" was not acceptable. The Swedish Academy cited in this matter the authority of Hendrik Antoon Lorentz, a professor of theoretical physics at the University of Leyden in the Netherlands, who was considered one of the greatest physicists of the day. Lorentz had declared that although Planck's formula had been proven experimentally, it lacked a satisfactory theoretical foundation.

At a mathematics conference in April 1908 in Rome, Lorentz presented his proof that Planck's formula could not be deduced from classical physics. Never mind that classical physics had been proven wrong by Planck! Lorentz's argument remains a common method today: The scientist who discovers that an accepted concept is wrong is immediately challenged to produce a new theory that conforms to the already well established axioms. This is obviously impossible when the discovery is a refutation of precisely these axioms.

Planck was embarrassed by the turbulence he had caused in physics but he insisted that "there are not enough facts and too few physicists with a sense of the urgent necessity of reform." He saw the necessity to revise "untouchable" premises of physics.

In order to prevent this from happening, some of the leading physicists of the time, among them Lorentz and Walter Nernst, persuaded the Belgian industrialist Ernest Solvay to finance an "urgently needed" physics conference to be held Nov. 21, 1911, in Brussels. They wanted either to explain the

quantization phenomenon somehow within the limits of established classroom physics or, preferably, to stop any research in this area. In any case, the prevailing consensus should not be challenged.

However, to revise the established theory was precisely Planck's aim. He was convinced that the development of science had reached the point where revision was inescapable. Twenty-one of the leading physicists of Europe heard Planck argue at the Solvay conference that the gap between the quantum theory and the classical theory was too large to be bridged by any of the generally accepted concepts in physics.

As Planck had anticipated, the Solvay conference could not solve the questions it was supposed to address. He found the sessions exhausting and was relieved when the conference came to an end.

As part of his effort to revise the existing theory, Planck tried to draft Einstein at the University of Berlin as a theoretician, because he took such great pleasure in the paradoxes of relativity, of contraction of space and expansion of time. Later, Planck declared that paradoxes arise only from the limitations of man's perceptive faculties:

> The ability of physicists to transcend deeply rooted intuitions like space and time nourishes hope that mankind will succeed in developing a truly universal physics—a physics that will be applicable for Martians just as well as for human beings.

Responsibility for Research and Education

Planck's work at Berlin's Friedrich Wilhelm University and the Prussian Academy of Sciences, then among the most important scientific institutions in the world, bore more immediate fruit. After the death of the university's professor of experimental physics, August Kundt, Planck actively lobbied for the appointment of Emil Warburg, who shared Planck's outlook. Experimental physics had become increasingly important for technology and was attracting more and more students. Planck also devoted himself intensively to the German Physical Society, publisher of the *Annalen der Physik,* the most prestigious international scientific journal of the time.

As a follower of Leibniz, Planck was an ardent defender of the principle that causality must underlie all natural phenomena. Thus, he felt compelled to protect students from charlatans like the leading positivists of the time, Ernst Mach and Wilhelm Ostwald. He vehemently opposed a proposal to insert Mach's crude, mechanistic outlook into the seminar curriculum for prospective physics teachers.

Mach had attacked Planck publicly, claiming that his own positivism remained unrefuted and refusing to take Planck's objections seriously. Mach finally went so far as to contest Planck's competence to participate in the work on the epistemology of physics. Planck defended himself in a number of speeches and lectures. He closed his public appearances by ironically citing the New Testament, "By their fruits, ye shall know them."

In 1912, Planck and Wilhelm Waldeyer were elected two of the four permanent secretaries of the physical-mathematical section of the Prussian Academy. Now Planck had one of the most influential positions in the administration of science in Germany. The four secretaries rotated every three months as presidents of the academy, convened the assembly under their chairmanship, supervised its ongoing projects, regulated its budget, and arranged for publication of the proceedings of its sessions.

In addition, Planck was elected vice chancellor of the University of Berlin. Here, his first official act was to create a second professorial chair for theoretical physics and to offer Albert Einstein an honorary professorship. He also brought in two American guest professors, intending to transmit to the university the vitality and the optimism of the United States that he had come to know and admire during a visit there. Comparing his nation to the United States, Planck said: "In Germany, we lack confidence in the future and belief in our goals, and there exists a general disease of disproportionality between wishing and doing."

Sanctions against German Science

In 1919, the victorious powers of World War I founded the International Research Council as a replacement for the International Association of Academies of the prewar period, which had been dominated by the Prussian Academy of Sciences. This was clearly a move against German science and research; the bylaws of the new research council prohibited citizens of the defeated Central Powers from participating in the administration, meetings, and projects organized by the council's member associations.

Along with many of his scientific colleagues, Planck was convinced that Germany had been drawn into World War I by the machinations of the British and French, the leaders of the Entente Cordiale. Together with other representatives of German culture and science, he signed the "Proclamation of the 93," a document published in German newspapers on Oct. 4, 1914, and translated into 10 foreign languages. The proclamation rejected the Entente Cordiale's charge that Germany was responsible for the outbreak of the war. Shortly afterward, the proclamation was republished with the signatures of 3,016 academics.

Planck, like many other scientists, was disgusted by the Versailles Treaty and demanded its revision. The treaty was one of his reasons for joining the German People's Party.

Many scientists noted that the war was motivated not only by politics in the ordinary sense, but also by fear and envy of German science and technology: Only four weeks after the outbreak of the war, for example, on Aug. 28, 1914, Great Britain authorized its Board of Trade to allow British companies to appropriate German patents.

Given these circumstances, Planck's close collaborator, Wilhelm Wien, believed that "peaceful relations between the [German and British] peoples" had been irreparably destroyed by these events. Wien issued an appeal to German physicists to break off relations with British scientific journals, except to answer personal attacks on German scientists. "British physicists claim German discoveries for themselves, mix up truth and lies, and argue in bad faith," Wien said, asserting that Germany's worst enemies were in Britain. Planck remarked that he himself "often felt exactly the same way."

From abroad, immense pressure was put on German scientists to withdraw the "Proclamation of the 93," including threats to suspend resumption of international scientific relations until the statement was revoked.

But when the war had ended, physicists like Walter Nernst, Planck, Fritz Haber, and Wilhelm Waldeyer concluded, after some discussion, that in light of the cruel Versailles peace treaty imposed on Germany, there was no need for any further concessions. Planck wrote, "As things stand, I think it would be totally unproductive, from the point of view of personal morality as well as from a practical standpoint, to draw back from the 'Proclamation of the 93' addressed to the civilized world in any form."

None other than Hendrik Antoon Lorentz pressured Planck, again and again, to renounce the "Proclamation of the 93" in the interest of peace. He even had a statement printed for Planck to sign. In a memorial address on Lorentz, Planck later charged that the World War I victors "initiated an unnatural involvement of science in politics, with no material justification."

The International Research Council's sanctions had the effect of excluding German and Austrian scientists from more than three-quarters of all international scientific congresses. Only after the treaty of Locarno was signed in 1925, and Germany was admitted to the League of Nations, were these sanctions reduced.

Efforts for the Next Generation

Within the space of a few years in the first decades of the century, Planck's younger son was killed in the war, and each of his twin daughters died shortly after giving birth to her first child. Despite these personal tragedies, he never lost his sense of responsibility for others, especially for the next generation. Without Planck, his students Otto Hahn, Lise Meitner, and Fritz Strassmann would not have achieved what they did in the field of nuclear fission.

After the Swedish Nobel Prize committee received a report from the leading theoretical physicists of the European continent—Einstein, Born, Wien, and Sommerfeld—arguing emphatically that physics had become a physics of quanta, Planck was awarded the Nobel Prize in physics in 1919.

After World War I, Max Planck—then 60 years old—headed the Prussian Academy of Sciences and worked hard to rebuild Germany's scientific institutions. Together with former Prussian culture minister Friedrich Schmitt-Ott and Professors Fritz Haber and Adolf von Harnack, Planck organized the Wissenschaftliche Notgemeinschaft (Scientific Emergency Committee), which united German scientists of all political colorations and specializations to raise the necessary funds to continue their work.

Although he formally retired in 1926, Planck continued his work as editor of the *Annalen der Physik* and cofounded the Deutsches Museum of Science and Technology in Munich.

Then, in 1927, the most famous Solvay conference took place. Niels Bohr and his Copenhagen school knocked down every attempt to pursue the full implications of the quantum theory and forced a standoff. Planck, Heisenberg, and Born were the only German physicists invited. After this conference, no one but the small group around Planck continued to try to solve the quantum paradox.

Planck's successor at the Prussian Academy of Sciences was Erwin Schrödinger, whose appointment was greeted with optimism by the other Berlin physicists, all of whom vehemently opposed probability theory. Schrödinger wrote to Planck, "In light of emerging new aspects, I believe that we are obligated to renew this battle with the same amount of seriousness as before."

The coming years, however, would put an end to this optimism.

The Garden of Science Wilts

The emergency committee's financial resources were hard hit by the economic crises in Weimar Germany. Extremism and antisemitism spread among scientific administrators. Positions were exclusively given to "Aryan" scientists, even though Jewish scientists were often better qualified. An anti-science mood spread among the public, blaming science and technology for the growing unemployment and alleged overproduction.

Various charlatans took advantage of the increasing disorientation in the realm of science. Just as Planck had anticipated, even theologians used Heisenberg's uncertainty principle as a proof for indeterminism. In the early 1930s, for example, Pascual Jordan attempted to justify his theory of "vitalism" and to prove the existence of extrasensory perception using a principle of noncausality that he based on quantum physics. Jordan also used physics to try to bolster Freud's psychoanalytic theory, while the physicist Wolfgang Pauli tried to do the same for Carl Jung's psychology. Later Jordan joined the Nazi Party.

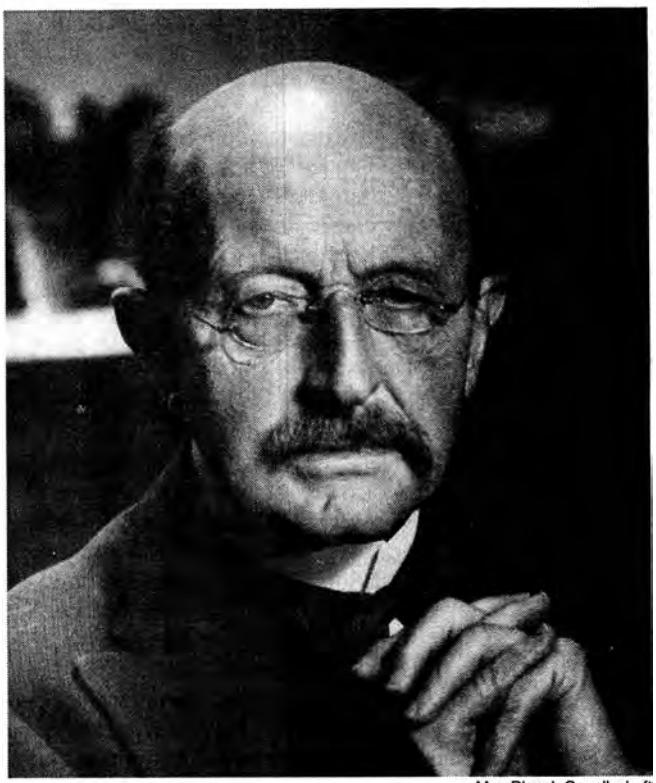
Planck tried to defuse the general misconceptions in physics by touring Germany to deliver an urgent series of public lectures. He predicted "fateful consequences" if physicists failed to solve the problem of causality. He lectured on the value of science and its relationship to religion.

But the most ominous development for the work of the Berlin scientists began after the Nazis were placed in power in 1933. Scientific leaders like Erwin Schrödinger were forced to leave the country; others left in protest. Max Planck considered retirement from his positions, but his sense of duty to his students prevailed. When Heisenberg wanted to leave the country because of the Nazis' incessant attacks on "Jewish" quantum physics, Planck told him that such a gesture would accomplish nothing and that he would render much more service to science if he stayed in Germany and directed the gifted young students who would be indispensable for the future of science. Heisenberg stayed.

In 1933, Planck met with Hitler, hoping to convince him that the emigration of Jews would ruin German science. Shocked by the fanaticism of the Nazis, he declared that it was impossible to talk with Hitler:

> When I remarked that it was a self-mutilation to force valuable Jews to emigrate, since we badly needed their scientific work, which otherwise would only benefit other countries, he did not answer, but launched into generalities. Finally he ended with: "Some say that I suffer occasionally from weakness of nerves. That is a slander. I have nerves like steel." While saying this, he punched his knee, talked faster and faster, and worked himself into such a rage that there was nothing more to do but leave in silence.

After many Jewish scientists had fled, the garden of mathematical physics in Germany became a wasteland. Planck and



Max Planck Gesellschaft

The Nazi regime tried to break Planck's spirit and his influence. At the end of the war, the regime executed his son, Erwin, as a co-conspirator in the attempt to kill Hitler. The news of his son's death nearly killed the 87-year-old Planck, but he continued fighting for truth, giving lectures until his death at age 89. At left, Erwin Planck at his "trial"; at right, Max Planck in 1935.

Heisenberg put out the watchword: "Stay in Germany, keep up the work, preserve and rescue." But in the following years, it became more and more difficult to tell the truth.

The Kaiser Wilhelm Gesellschaft, of which Planck was the president, was accused of always having pursued "Jewish physics," spearheaded by Einstein and his relativity theory. In the Nazi newspaper *Völkischer Beobachter* Planck was attacked for his "wicked" influence on German science. The *Physikalische Zeitschrift,* a physics news bulletin, wrote that Planck had gained fame and recognition for his formula only through the intrigues of "Einstein's clique," and that his formula was only an "elementary mathematical accessory" to the measurement of the "original groundbreaking physical discovery" it reflected.

Shortly before the end of Planck's term as president of the Kaiser Wilhelm Gesellschaft, in May 1938, the Kaiser Wilhelm Institute for Physics was founded. Planck stressed: "The future development of physical science in Germany will greatly depend on whether we succeed in finally giving life to a first-rate modern physics institute, which we painfully lacked in Germany."

In the same year, Planck's 80th birthday was observed with a grand celebration, at which the Max Planck award was given to the French physicist Louis de Broglie. Planck warned on that occasion, "May a good fate bring Germany and France together, before it is too late for Europe."

Toward the end of his life, Planck joined the anti-Nazi Resistance in his own way. As a faithful Christian, he had been an elder of his parish in Grunewald, a suburb of Berlin, since 1920. In his speeches, he declared again and again that true science presupposes belief in something higher than science:

> Might such a deeper conception of science be the foundation for an outlook useful in life? The surest answer to this question will be rendered by a look at the men in history who adopted this outlook, and who indeed benefitted from it. Among the many scientists whom science helped to bear earthly hardships, we recall . . . first of all . . . Johannes Kepler. Viewed from the outside, he lived amidst wretched conditions, heavy disappointments, bitter want of food, and constant pressure for his livelihood. . . . What carried him through all this, and enabled him to work, was science: not the data of astronomical observations as such, but his belief in the prevalence of rational laws in the universe. This is seen most clearly through a comparison with his employer Tycho Brahe. The latter had the same scientific knowledge, the same observational data, but he lacked the belief in great and eternal laws. Thus Tycho Brahe remained one among many scientists of merit, but Kepler became the founder of modern astronomy.

In his many lectures and writings, Planck again and again cited Leibniz and his *Theodicy,* pointing to the principle of least action as the most comprehensive of all scientific principles and one that provided proof of a reasonable world order:

> It is the never-ending, never-retreating battle against skepticism and dogmatism, disbelief and superstition, which is

jointly waged by religion and science, and the guiding watchword in this battle has always been and will be throughout the future: "On to God!"

In the following years, it was tantamount to a felony even to mention the names of leading Jewish scientists like Einstein or refer to relativity theory. Under these circumstances, a speech Planck gave to Nazi Party cadres in the Foreign Office in 1943 or 1944 is exceptional. The Swedish journalist Gunnar Pihl, who was present, reported:

> Planck presented his convictions about existence: calm, modest, wise. . . . He mentioned the Jew Einstein as a leading and pioneering personality in the realm of our ideas; his view reached far beyond primitive prejudices and fanaticism, without any regard for where he was giving the speech. In his soft voice . . . he pleaded for a vision of the sanctity of life and a world of justice. . . . This small man in the black suit . . . was too great to be affected by any attempts of the Nazis to alter the universe. . . . It was as if a solemn celebration or a sermon were taking place. A forceful antithesis to the prevailing spirit of the place. . . .

The Nazi regime continued its efforts to break Planck's personality and his power, which had consoled and inspired so many. If they did not dare to touch him directly, they found their revenge at the very end of World War II by taking away what he loved most of anything that remained to him: his son. Father and son were very close to each other and they both participated in the Wednesday Society for scientific discussion, which was a meeting place for the 20th of July resistance movement against the Nazis. At the end of 1944, Erwin Planck and his longtime friend, Ernst von Harnack—the son of the founder of the Kaiser Wilhelm Gesellschaft—were convicted as co-conspirators in the attempt to kill Hitler and were sentenced to death. The Nazis executed Erwin Planck on Feb. 23, 1945. The news nearly killed his 87-year-old father.

Nevertheless, Planck continued his activities at many universities. He traveled to his last lecture during the middle of winter in an unheated rail car, suffering from a highly painful ossified spine. Asked why he was burdening himself so much, he replied:

"Being 89 years old, I cannot be scientifically productive; what is left to me is to follow the progress made possible among others by my work, and, by repeating my lectures from time to time, to help those striving for truth and discovery, especially the young people."

> Being 89 years old, I cannot be scientifically productive; what is left to me is to follow the progress made possible among others by my work, and, by repeating my lectures from time to time, to help those striving for truth and discovery, especially the young people.

Max Planck died on Oct. 4, 1947. His life stands as an impressive reminder of our responsibility to study our scientific precursors, to pass on their knowledge and wisdom to the next generation, and to implant new ideas in this soil. Planck lived in faithfulness to a great precept of Leibniz: "Heed what you do; declare why you are doing it, for time flies."

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The Max Planck Gesellschaft

Two years before Planck's death, on Sept. 11, 1946, the successor organization to the Kaiser Wilhelm Gesellschaft was founded. It was named Max Planck Gesellschaft (MPG) for the advancement of science, in honor of Planck, who had headed the Kaiser Wilhelm organization until 1935 and for several months immediately after the war.

Today the MPG serves as an umbrella organization for all government-sponsored basic research institutes in Germany. Based in Munich, it is one of the most influential scientific organizations worldwide.

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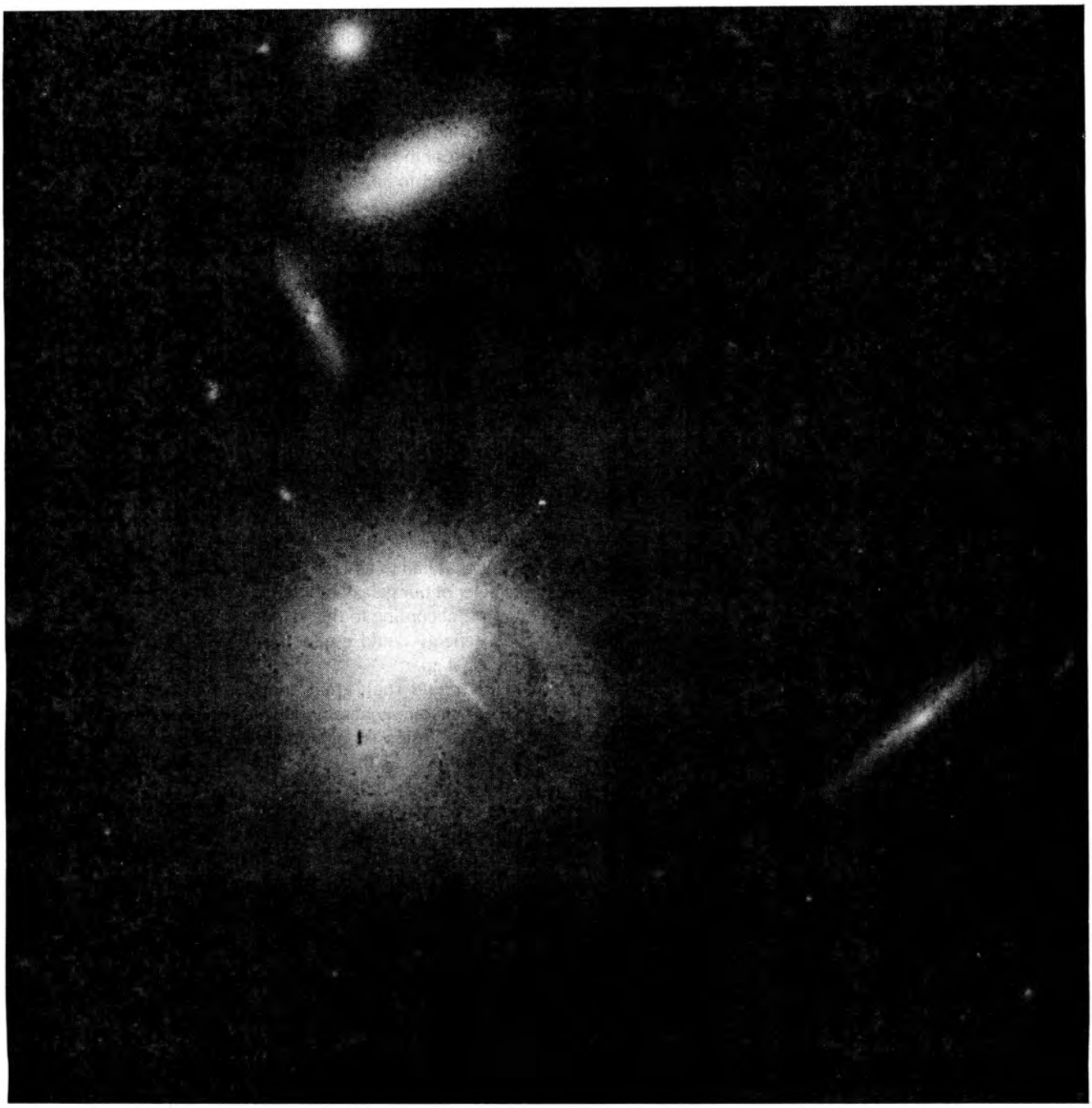
Hubble's Quasar Images

A MOMENT OF TRUTH

by David Cherry



John Bahcall, Institute for Advanced Study/NASA

According to the standard theory held for the past 30 years, the quasar phenomenon results from the infall of a galaxy's matter onto a black hole at the galactic center. Here, a Hubble Space Telescope image of quasar PKS 2349 from a study by John Bahcall of the Institute for Advanced Study. Surprise: There is no surrounding galaxy.

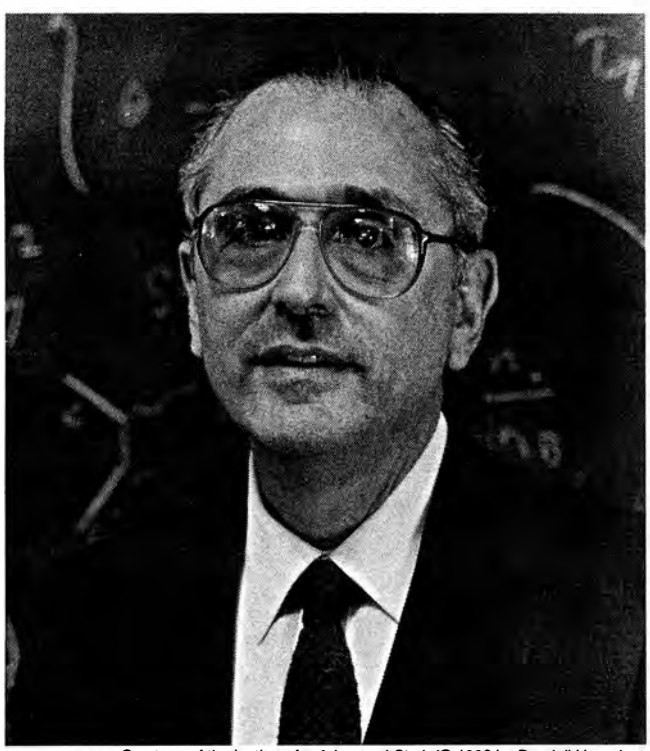
Quasar observations from the Space Telescope were instantly fatal to the accepted theory of quasars, but they support the theories of Victor Ambartsumian and Halton Arp.

The Hubble Space Telescope has been trained on 14 of the brightest quasars, with the result that the standard model of the quasar for the past 30 years is now decisively overturned.

Quasars are the stars that are not any kind of star at all. According to the traditional story, Allan Sandage, in 1963, was the first astronomer to bag a quasar and nobody knew what it was. Its spectrum, taken repeatedly, was indecipherable. Eventually, his Caltech colleague Maarten Schmidt, agonizing over another quasar's indecipherable spectrum, realized that the familiar pattern of certain hydrogen lines was present, although greatly shifted toward the red.

Actually it was Fritz Zwicky, also at Caltech, who first noticed quasars, and some of their high redshifts had already been identified when Sandage announced his find.[1]

When initial excitement over the work of Sandage, Zwicky, and Schmidt had subsided, it was clear that a new class of objects had been identified, objects with high redshifts, nonthermal emission, and more ultraviolet in their light than any stars have. Additionally, unlike most stars, the energetic output of these objects was unstable. It could increase or decrease in just a few days—or in a month or a year. And quasars might, or might not, emit radiowaves and X-rays.



Courtesy of the Institute for Advanced Study/© 1990 by Randall Hagadorn

John Bahcall: Most of the 14 quasars in his Space Telescope study had no surrounding galaxy. "We were shocked. . . . It's in nobody's theory," he said.

The Standard Model

What sense could be made of these characteristics? The redshifts could only mean that quasars were speeding away from us as part of the universal expansion or, at least, almost everybody agreed to say so. Such high redshifts—under this interpretation—also meant that the quasars must be exceedingly distant. Despite such distances, however, the quasars were often very bright. Their intrinsic brightnesses (energies) would therefore have to be incredibly great.

Some bright quasars' rapid variability, however, was the basis for concluding that the tremendous energies must be pouring out of objects of relatively tiny physical dimensions. The argument for this is that an object, as a whole, cannot vary its output faster than the time required for an internal change to communicate itself throughout at the speed of light. The argument, based on textbook (Galilean) physics, was and is generally believed (although false) and shaped the discussion of quasars.[2]

Quasars had to be emitting 10 to 100 times the energy of an entire galaxy like the Milky Way, but—according to textbook physics—it had to emerge from a region only a millionth of the diameter of our galaxy (not more than 0.1 light-year). For some quasars, according to this calculation, it was not clear how so much energy could escape from so small an object without blowing it apart.

How could such great energies be produced in the first place? Stars are generally believed to be powered by nuclear fusion, but fusion is not efficient enough to explain the quasar phenomenon. The simplest model was to suppose that quasars were outpourings of energy resulting from the infall of galactic material onto a black hole at the galaxy's center. Although black holes—those theoretical constructs—do not allow any light to escape, the infall itself would cause intense emission of light at a safe enough distance from the black hole's threshold.

The black hole model had the advantage that it solved (at least in the sense of a mathematical solution in textbook physics) the problem of intense energy emission from a small object.

But where was the galaxy of which the quasar was the putative nucleus? Wisps of matter could be detected around some quasars and so it was concluded that all were at the center of galaxies, but that the brilliance of the quasar simply obscured the galaxy by washing it out. No other mechanism for such prodigious energy production could be found within the bounds of Einsteinian physics.

The standard model of the quasar thus emerged with very serious problems relegated to a large quantity of very fine print. There was a reluctance to take the salutary step of admitting ignorance. Science suffered as astronomers bought in to the only game in town.

Years later, another serious problem with the energy-producing mechanism crystallized. Quasar specialist Daniel Weedman wrote in 1988: "[N]one of the black hole models can make sufficient predictions to lead to true observational tests. In fact, the primary observations that led to the black-hole model in the first place turn out to be inconsistent with its theoretical predictions."[3] This remarkable defect didn't seem to damage the model's popularity, however.

The Hubble Observations

In 1994—three decades after the character of quasars was seemingly settled for good—John Bahcall of the Institute for Advanced Study at Princeton and his colleagues[4] took advantage of the Hubble Space Telescope's long-awaited capabilities to get a closer look at 14 quasars. In January 1995 at a meeting of the American Astronomical Society in Tucson, Bahcall told a news conference what they had found.

He announced that 11 of the 14 quasars had no surrounding galaxy and only 3 showed host galaxies of moderate brightness. One of the 11 had faint, wispy material near it, proving that if there were any faint matter near the quasar, it would have been detected by the Hubble.

"We were shocked to see them," Bahcall said of the "naked" quasars. "It's in nobody's theory. . . . All I can say is, 'Who ordered them?' " Co-investigator Donald Schneider commented, "This is the most enigmatic data I have ever analyzed." Bahcall added, "This is a giant leap backwards in our understanding of quasars. . . ."[5]

In Nobody's Theory?

Surely John Bahcall knows whose theory has for years considered quasars as the precursors of galaxies, thus predicting the existence of some quasars with, and some without, a surrounding galaxy. Bahcall chaired the 1989-1991 Astronomy and Astrophysics Survey Committee of the National Research Council, which was appointed to chart the future of the field. It would mean a substantial gap in his knowledge if he did not know. Let us see who his "nobody" is.

Even before quasars had been identified, Victor Ambartsumian, founder and first director of the Byurakan Astrophysical Observatory in Armenia and a member of the Soviet Academy of Sciences, had developed a theory of types of activity in galactic nuclei. According to Ambartsumian's theory, explosive ejections of "prestellar" matter from the nuclei were the seeds from which new galaxies formed.

Ambartsumian's theory was most unwelcome to the mainstream of academic astronomy in that he rejected the prevailing concept that gravitational condensation and collapse is the general rule in the universe. Instead he began his theoretical work in the 1930s and 1940s by noting that the processes we *observe* are diffusion, explosion, and ejection. The general direction of astrophysical evolution, he argued, runs from dense states to diffuse ones.[6]

Ambartsumian's work was hardly obscure. After an address on the evolution of galaxies at the 1958 physics conference of the famed Solvay Institute in Brussels and an invited discourse on problems of extragalactic research at the General Assembly of the International Astronomical Union in Berkeley in 1961, Ambartsumian served as the president of the latter association from 1961 to 1964.

Courtesy of Prof. Vahagn Gurzadian

"In nobody's theory"? Armenian astrophysicist Victor Ambartsumian wrote in 1969 that explosions in the nuclei of galaxies eject quasars that do not have surrounding galaxies, but from which galaxies eventually form. Here, Ambartsumian in Moscow in 1990.

Today it is still true that what we observe are diffusion, explosion, and ejection. In 1988, astronomers wishing to observe the process of gravitational condensation in the birth of stars had to report that

> not a single object in the actual act of stellar formation has been conclusively identified. . . . The unambiguous identification of such a protostellar object is . . . crucial. . . . It is a vital test of our present theoretical conceptions. It requires the direct detection of infall motions. . . . During the last decade or so extensive millimeter-wave molecular line observations of protostellar candidates have been made. . . . However, these studies have produced the unexpected result that most embedded infrared objects are sources of energetic *outflow* of molecular gas rather than infall. Convincing evidence for infall motions around infrared protostars has so far eluded detection.[7]

Ambartsumian on Quasars

With the discovery of quasars, Ambartsumian made the case that they were one of the kinds of explosive ejecta that evolved into new galaxies. *Problems of Modern Cosmogony* (1969), written by Ambartsumian and his students, states:

> Finally, to the forms of activity of [galactic] nuclei already mentioned must be added explosions, which lead to the

formation of quasars. In scale and magnitude these explosions exceed all other forms of nuclear activity and indicate the formation of a new galaxy, even of a galaxy cluster or of a group of galaxies.[8]

As the ejecta of galactic nuclei, quasars would not initially be surrounded by a galaxy, which would develop later. What Bahcall and colleagues reported in January—some quasars surrounded by a galaxy and some not—is predicted by Ambartsumian's theory. The finding by itself does not, of course, prove the theory.

Ambartsumian's theory, however, was just the beginning. After the close of the 1960s, Ambartsumian did not elaborate further his theory of the activity of galactic nuclei. In early 1966, the American astronomer Halton Arp, then on the staff of Palomar Observatory in California, independently reached the hypothesis that luminous bodies, including quasars, were ejected by galactic nuclei and represented the kernels of new galaxies. The idea emerged from studying images in the *Atlas of Peculiar Galaxies,* which he had just finished compiling. Later Arp discovered Ambartsumian's work.[9]

Arp asked, where do we see quasars in the big picture? If quasars are always at the distances indicated by their redshifts, then they should be concentrated in those parts of the sky where distant galaxy clusters are found. They were not. He also asked, if quasars are always at their redshift distances, then, on average, fainter quasars should have greater redshifts—that is, they should form a linear or near-linear Hubble diagram as galaxies do. But a plot of quasars in terms of brightness versus redshift forms a blob.

Conclusion: Redshift is not a reliable indicator of distance for quasars, which must therefore acquire some variable part of their redshift from a property that is not distance-related. Further conclusion: Without the hindrance of redshift as an erroneous measure of distance, the contradiction of impossibly great energy emerging from too small a body can be resolved by "bringing the quasars in." (Again, the physics of the contradiction was only apparent, but was accepted as real by both Arp and his opponents.) If quasars are not so distant, their intrinsic brightnesses are less stupendous.

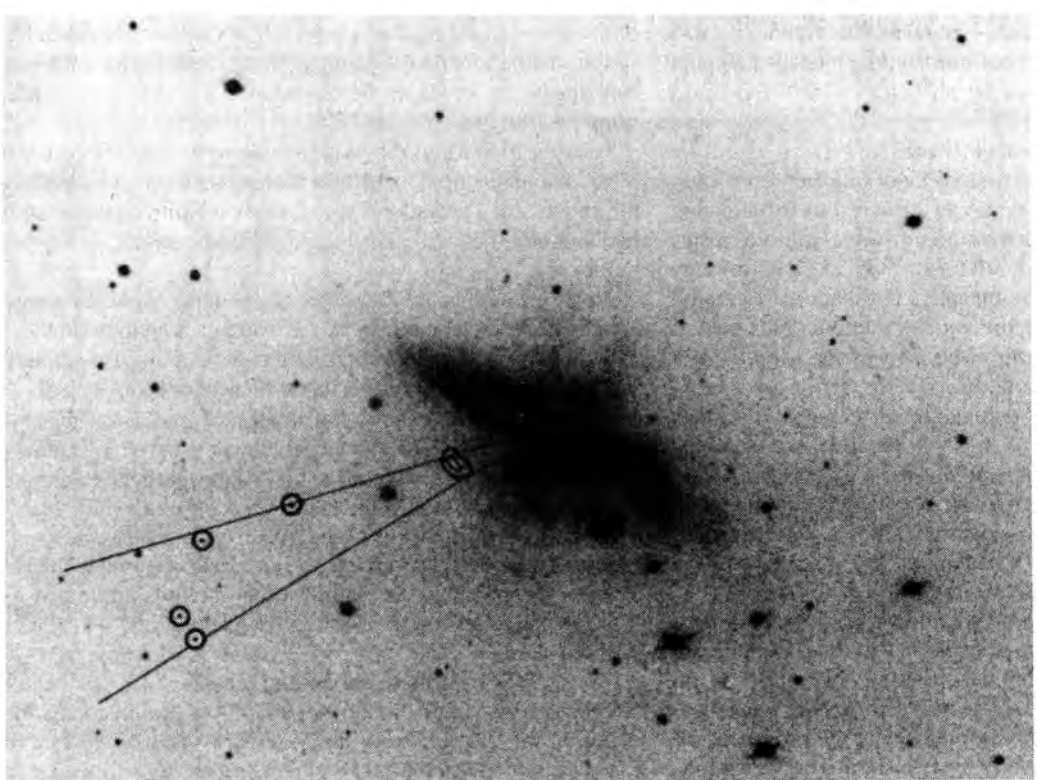
But if quasars are nearer, where do they fit into the picture? If quasars were ejected from galactic nuclei, they should be found in greater numbers immediately around galaxies. The quasars bright enough to be readily detected should be mostly concentrated around the nearest galaxies. Were they? In a bitter, 20-year fight, Arp showed that they were.

This success came in several steps.[10] First it was conceded that there was an *apparent excess* of bright quasars around nearby galaxies, but this was explained away as the result of gravitational lensing of background quasars by faint stars in the spherical halos around the galaxies: The quasars' light would be made brighter by this gravitational effect (microlensing), without the effect being so strong as to create double images of the quasars. The phenomenon would affect the counts of bright quasars by bringing fainter ones into the bright category.

Then some diligent astronomers (with no sympathy for Arp's views) sought a rigorous test of the *adequacy of observed quasar counts* to produce by microlensing the necessary excess of apparently bright quasars around galaxies. They showed that to produce the effect, there had to be a rapid increase in quasar counts as one went to fainter apparent magnitudes. But they found that there was no such rapid increase.

A new attempt confirmed the excess of quasars around galaxies at "more than the 99.99 percent confidence level," but resurrected the microlensing thesis by invoking dark matter in the spherical halos around galaxies—hypothetical matter that does not radiate enough to be seen, but can be known by its gravitational effects.

Again, this explanation was tackled by astronomers unsympathet-



Halton Arp, *Quasars, Redshifts, and Controversies*

The disturbed galaxy M82 provides evidence that quasars are ejected from galactic nuclei. Four quasars found near M82 are circled here, along with a radio source (the donut). Their placement suggests they have all been ejected from the asymmetrical notch in the galaxy.

Ambartsumian with students of astrophysics at Yerevan University in 1961. Ambartsumian, trained at Leningrad University, was the founder and first director of the Byurakan Astrophysical Observatory, not far from Yerevan, Armenia.

ic to Arp's hypothesis, but having detailed knowledge of the dynamical (gravitational) behavior of galaxies. They concluded that the required dark matter "is much too close to the luminous parts of the galaxies to be consistent with other dynamical mass measurements." In other words, if the dark matter were there, it would have a gravitational effect on the visible matter—an effect that is not observed.

"Within a conventional understanding of galactic systems we can find no model to explain the large enhancement" in numbers of quasars around galaxies, these astronomers concluded.

Despite this success of Arp's hypothesis, it continued to be evaded on another front. Astronomers pointed out that "fuzz" could be seen around some quasars; on that basis it was argued that all would be seen to be the nuclei of galaxies when a powerful enough telescope was available. (Moreover, it was said, since all quasars are the nuclei of galaxies, and since galaxies are at *their* redshift distances—which is not entirely true—quasars also must be so.)

The leap from the fuzz to presumed host galaxies was insisted upon even though Arp pointed out that the dimensions of the fuzz in some cases were much larger than those of normal galaxies (under conventional assumptions about the quasars' distances). He also pointed out that there was no spectroscopic evidence for the existence of stars in the fuzz. One would expect a galaxy to have stars.[11]

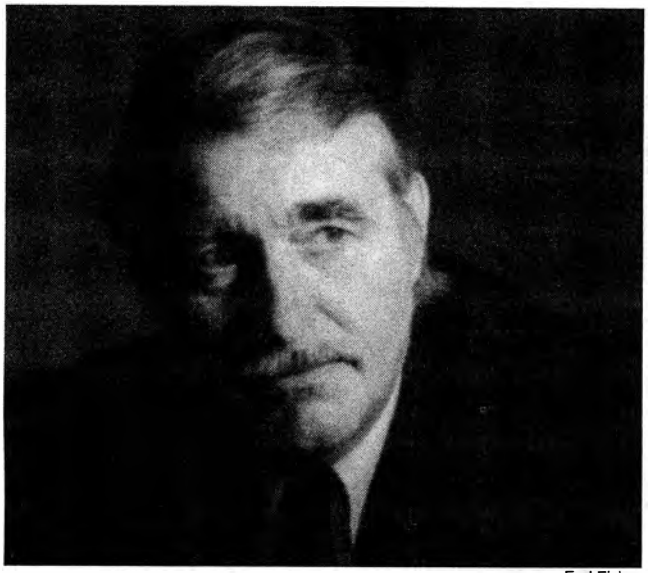
Later it became generally accepted that all galaxies were formed during a single phase of the Big Bang expansion. This put the idea of ejected quasars evolving into galaxies-and continuing to do so today—at odds with the almost universally accepted Big Bang theory.[12]

The state of affairs today, in sum, is that (1) there is a strong argument that quasars are not always at their redshift distances; (2) it is clear that there are more quasars immediately around galaxies than should be there by chance; and (3) Bahcall's study—showing some quasars to be nuclei of galaxies and some "naked"—is consistent with the concept of quasars as the ejected seeds of galaxies that later settle in as the nuclei of those galaxies.

A Moment of Truth

It is ungenerous for a scientist to deny the work of a colleague or predecessor.[13] Unfortunately, the practice is widespread in science today, and there is a long and hoary tradition of such ungraciousness running back to Newton and Galileo. But often more is involved than mere self-promotion. There is the more serious matter of the process of scientific discovery being aborted through excessive self-assurance.

To understand this, take the example at hand. Ambartsumian and Arp develop a highly original theory of the behavior of galactic nuclei that includes certain predictions concerning quasars. The theory arises from the use of an unfashionable



Earl Fisher

American astronomer Halton Arp independently concluded that quasars are ejected from the nuclei of galaxies and in the 1970s and 1980s showed—as one might then expect—that there are more quasars in the sky immediately around galaxies than elsewhere. The most recent counterargument—that this excess was only an illusion produced by the gravitational microlensing of background quasars—has not withstood close examination. Arp's 1972 debate with Bahcall, published as The Redshift Debate, *is still provocative reading today.*

method, one that gives priority to *astronomical observation* and to ideas suggested by observation, and does not give priority to Einsteinian theory or the limits of Earth-bound physics results. Method and theory alike are unacceptable to leaders of the field.

A key prediction of the theory, however, proves correct. What to do? The tried and true remedy is to weave the undeniable fact into the preferred theory that did not predict it, while ignoring the theory that did predict it. (Indeed, in this case, Bahcall seems to be considering the idea that quasars are the seeds of galaxies that somehow suddenly emerge in their great compactness from the primordial gas of the early Big Bang expansion.) Repeated applications of this patchwork remedy, however, have a profoundly deadening effect on the minds of those who submit to it.

Ambartsumian's friend, the late Jan Oort, director of the Leyden Observatory, who never subscribed to either Ambartsumian's method or theory, nevertheless said, "I have ceased to be surprised at how all of Ambartsumian's hypotheses, which he prophetically put forward many years ago, are confirmed one after another."[14]

Isn't it time to ask why this is happening?

David Cherry is an associate editor of 21st Century Science & Technology.

Notes

1. Dennis Overbye, *Lonely Hearts of the Cosmos-The Scientific Quest for the Secret of the Universe* (New York: Harper Collins, 1991), pp. 79-82).
2. It is actually false because we cannot assume that quasars' variations are controlled by a means that has anything to do with the speed of light, nor that we know the upper limit of the speed of light under the internal conditions of quasars.
3. For details, see Daniel Weedman, 1988, "Quasars: A Progress Report," *Mercury* (Jan.-Feb.), pp. 12-17.
4. Donald Schneider, Pennsylvania State University, and Sofia Kirhakos, Institute for Advanced Study at Princeton.
5. "A Galactic 'Smoking Gun'" by Kathy Sawyer, *The Washington Post*, Jan. 13, 1995, p. 2, and Space Telescope Science Institute press release 95-04. The press release says "no current models predict. . . ."
6. For an overview of Ambartsumian's work on the origin of stars, see Ludwig V. Mirzoyan, "The Origin and Evolution of Stars: An Observational Approach," *21st Century,* Winter 1991, pp. 43-51. For his work on stars and on galaxies, see "The Problem of Protostellar Matter" by the same author, *21st Century,* Fall 1994, pp. 68-74.

   There is, however, no substitute for reading Ambartsumian's papers themselves. A significant number are in English, as seen in the references to these *21st Century* articles. He is no advocate of Big Bang or Steady State cosmology, both of them being essentially mathematical elaborations of General Relativity, and to his mind, insufficiently grounded in the observations.
7. From a conspectus of the tasks and the technology of the now completed Heinrich Hertz Submillimeter Telescope on Mt. Graham, Arizona, issued in early 1988, Sec. 2.3.1. In Sept. 1993, astronomer John Bieging of the Hertz telescope confirmed to the author that the state of affairs had not changed.

   Richard N. Thomas and his colleagues concur: "Unfortunately for such conjectures, mass-infall models do not well represent the strong and variable H-α emission profiles characterizing [T Tauri] stars. . . . [T]he authors of Chapter 4 of this Volume 7 [Lawrence E. Cram and Leonard V. Kuhi] . . . conclude that the observations are best represented by a mass outflow. . . . Based on my own efforts at modeling T Tauri atmospheres, I accord." T Tauri stars are believed to be stars still in the process of formation. The quotation is from Thomas's "Perspective" that opens *FGK Stars and T Tauri Stars* (Volume 7 in the NASA-CNRS Monograph Series on Nonthermal Phenomena in Stellar Atmospheres, edited by Lawrence E. Cram and Leonard V. Kuhi, NASA SP-502, 1989).
8. This work is available in Russian, German, and French. The passage quoted here, translated by this author from the 2nd German edition of 1976 (*Probleme der modernen Kosmogonie*), appears there in Sec. 2.3, p. 115.

   Much of Ambartsumian's argument in this section is stated or strongly foreshadowed in his English-language publication "On the Nuclei of Galaxies and their Activity," in *Proceedings of the 13th Conference on Physics* of the Solvay Institute, Brussels, Sept. 1964 (New York: Wiley Interscience, 1965).
9. Halton Arp, 1987. *Quasars, Redshifts and Controversies* (Berkeley, Calif.: Interstellar Media), pp, 7-16, 134-135.
10. The microlensing story that follows here is told in more detail, and with references, in "Why Are There More Quasars Around Nearby Galaxies?" by David Cherry, *21st Century,* Fall 1991, pp. 78-82. The article also reports a new class of positive evidence developed by Arp.
11. Arp summarizes these and other observational arguments against the omnipresence of host galaxies—arguments that were available long before the new Hubble study—in "Naked Quasars," *Mercury* (Journal of the Astronomical Society of the Pacific), March—April 1995, p. 35.
12. Donald Hamilton, 1985. "The Spectral Evolution of Galaxies. I. An Observational Approach," *Astrophysical Journal,* Vol. 297, pp. 371-389.
13. For Bahcall not to know the Ambartsumian-Arp theory, he would have had to miss not only numerous papers of Ambartsumian and Arp, but a sizable number of articles—especially by opponents of the theory who addressed the microlensing of quasars near bright galaxies—appearing in the *Astrophysical Journal, Astronomy and Astrophysics,* and *Nature* throughout the 1980s and into the 1990s. (See note 10 above for references.) But Bahcall has studied microlensing and read a paper on it at the January 1995 meeting of the American Astronomical Society in Tucson.

   Bahcall would also have had to close his eyes to Arp's book, *Quasars, Redshifts and Controversies* (note 9 above), read by many an astronomer under the bedcovers by flashlight; the quasar chapter of an important recent Russian-American collaboration, *Astrophysics on the Threshold of the 21st Century,* edited by N.S. Kardashev (Philadelphia: Gordon and Breach, 1992); and numerous other books and articles.

   Also, two participants in the controversy over the Ambartsumian-Arp theory of quasars, Claude Canizares and Wallace Sargent, were members of the 1989-1991 Astronomy and Astrophysics Survey Committee of the National Research Council, which Bahcall chaired.

   Finally, he would even have to have forgotten his own debate with Arp on Dec. 30, 1972, at the meeting of the American Association for the Advancement of Science in Washington, D.C., published in *The Redshift Debate,* edited by George Field (Reading, Mass.: W.A. Benjamin, 1973).
14. Quoted on the flyleaf of a Russian-language biography, *Victor Ambartsumian,* by Ludwig V. Mirzoyan (Yerevan, Armenia: Aiastan, 1985).

FROM HOT TO COLD FUSION

A Look at the Life of Yoshiaka Arata

Japanese cold fusion scientist Yoshiaka Arata has pioneered new technologies since the 1950s, when he was the the first Japanese scientist to work on controlled thermonuclear fusion.

by Carol White

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▲ *Yoshiaka Arata was the first Japanese scientist to carry out experiments in controlled thermonuclear fusion. This photo of Arata checking his ultra-high-voltage electric discharge apparatus after its first successful fusion test appeared in Japanese newspapers Feb. 12, 1958.*

Yoshiaki Arata's research has spanned the 40-year period of postwar nuclear research in Japan. The story of his achievements in the broader field of plasma engineering, which he created, proves the stupidity of using a cost-accountant mentality to evaluate the success of fundamental research work.

Because genuine scientific advances—as opposed to technological elaborations—imply reconsideration of generally accepted assumptions, not just inventiveness but a certain tough-mindedness is required of the scientist willing to take up the challenge of a genuinely fundamental discovery. In the six years since the Fleischmann-Pons discovery, not only has the cold fusion experiment proven to be difficult to replicate and hard to understand, but those hardy souls who have been willing to pursue the cold fusion genie have been subject to extraordinary abuse. Even in Japan this has been the case, although to a lesser degree than in the United States or Europe.

Despite the fact that as eminent a scientist as Julian Schwinger resigned from the American Physical Society in disgust at the attitude of his peers, despite the credentials of Fleischmann himself (a Fellow of the Royal Society) and of numbers of other scientists in the field, calumniators present cold fusion as though it were named kook fiction. Therefore it is a particular pleasure to report on the work of Dr. Yoshiaki Arata.

Arata was one of the earliest researchers in the field of hot fusion—and he is now a recognized world leader in the field he created, plasma engineering. He received his doctorate in engineering from Osaka University in 1956, the same year that he began studying nuclear fusion reactions. This work was supported by Hideki Yukawa, who in 1949 had been awarded the Nobel Prize for his work in anticipating the discovery of mesons and the role that they play within the nucleus. (Even before nuclear research in Japan was allowed to resume after World War II, Yukawa had worked to create the conditions for its resumption.)

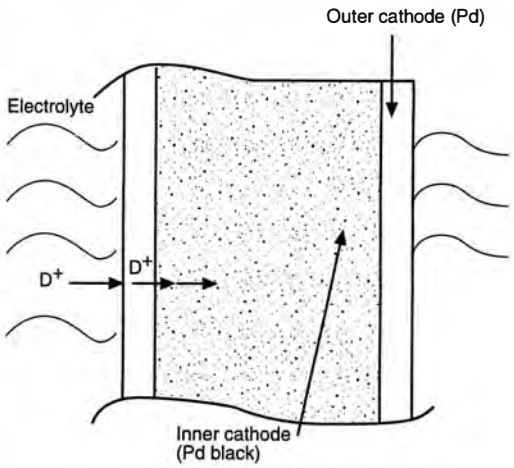


Figure 1
CROSS SECTION OF DOUBLE-STRUCTURED CATHODE FOR COLD FUSION

The double-structured cathode permits deuterium to be directly loaded without gasification into finely ground palladium. Its structure is double because it consists of a vacuum bottle of palladium metal that is packed with fine palladium powder. With ordinary cathodes, high loading ratios depend upon using a high current density. This is not true of the double-structured cathode, and a large cathode size is not a problem.

The incubation period depends upon the thickness of the outer cathode, the volume of the palladium black, and the size of its grains.

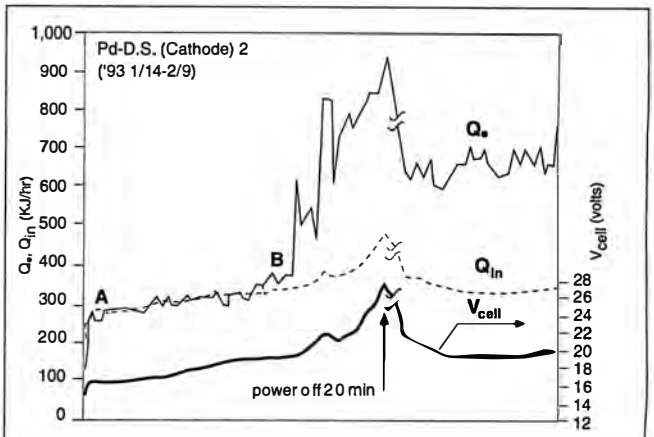


Figure 2
EXCESS HEAT WITH DOUBLE-STRUCTURED ELECTRODE

In this 600-hour cold fusion experiment from January and February of 1993, effective output ($Q_{.}$) and electric input (Q_{in}) diverge sharply after an incubation period of 270 hours of electrolysis (A to B). Cell voltage (V_{cell}) is also indicated.

Source: Y. Arata and Y.C. Zhang, *Proceedings of the Japanese Academy*, Series B, Vol. 70, No. 7, pp. 106-111

Along with his Chinese collaborator, Professor Yue-Chang Zhang, currently a visiting professor at Osaka University, he has been studying the Fleischmann-Pons experiment since its 1989 announcement. Arata and Zhang have also designed a unique experimental apparatus that involves electrolysis in its first phase as a way for deuterium to be directly loaded without gasification into finely ground palladium at the cathode.

They call their configuration a *double-structured cathode* (Figures 1, 2). The hollow cylinder is filled with very fine microcrystals of palladium (palladium black). The density of the deuterium is almost that of a liquid metal. Deuterium (or hydrogen) is released from the electrolyte by electrolysis and sucked through the cathode. It is then absorbed by the palladium black, with which it is highly reactive.

Reactions have continued for as long as 3,000 hours, and over this almost two-month period, 50,000 times more heat was released than could be accounted for by an exothermic release of heat from chemical reaction energy as a result of loading. In fact, this excess energy was about 200 megajoules, of which only 4 kilojoules can have been produced as chemical energy from reaction with the 0.1 moles of palladium black. The average rate of heat output was between 50 and 100 kilojoules per hour. The rate of excess heat generation was on the order of 60 percent. Although the total excess heat was not large, it continued even after the power was turned off. This, even though the most successful, is only the latest in a series of experiments that the two scientists have conducted since 1989.

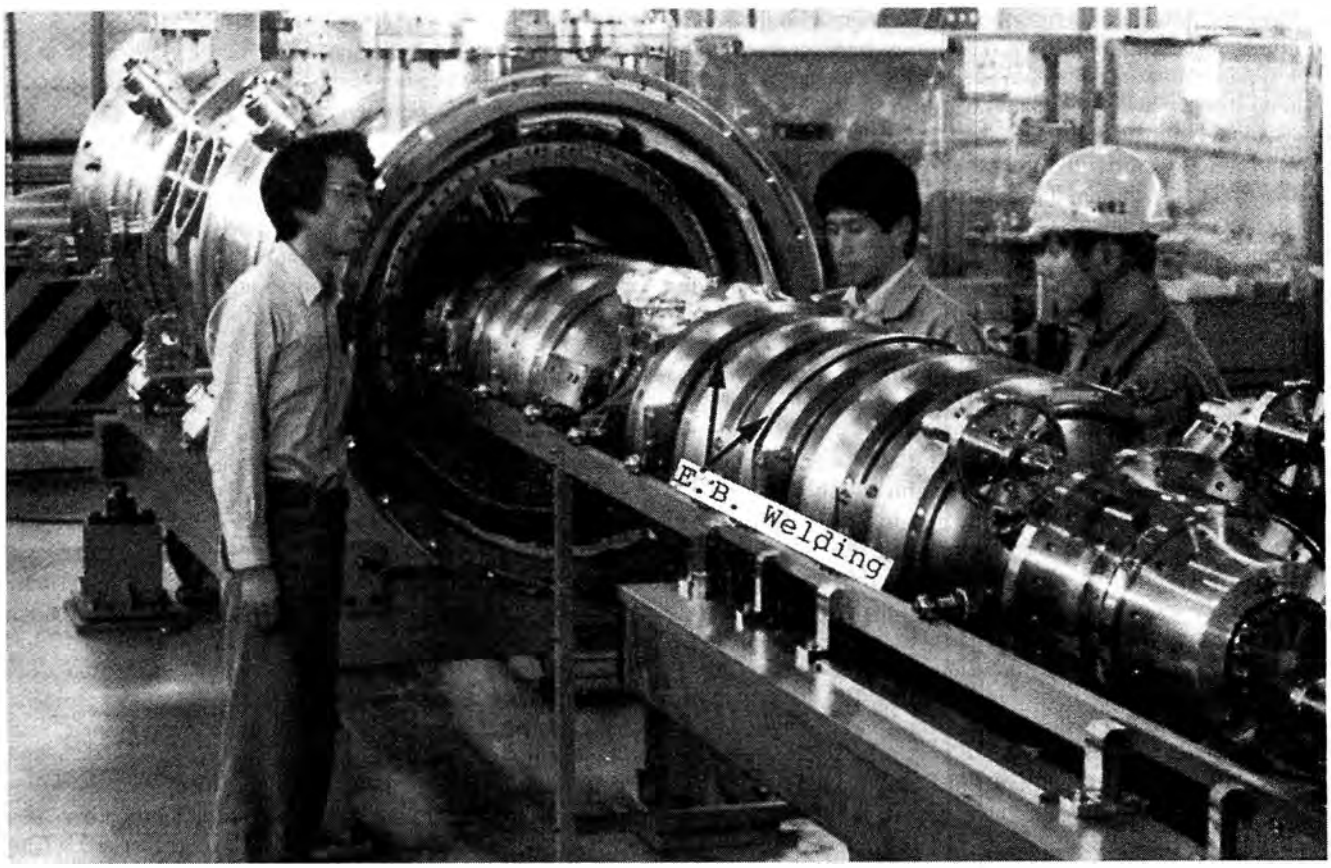
The Theory of the Experiment

Zhang and Arata were guided from the beginning by a belief that microdefects in the palladium have an important role in the cold fusion reaction by producing zones of extremely high concentration of deuterium in or near these microdefects. Around certain of these cracks (known as Griffith cracks), three-dimensional stress fields would be induced in many cases. These should also help to concentrate the deuterium. This tendency is well known in the field of welding engineering, an area in which Arata has great expertise. In the case of steels, for example, the concentration of hydrogen gas in such a stress field is about 10 times higher than that in the stress-free area.

Since Arata is a world-renowned expert in plasma and laser welding, it was a natural step for him to construct a cathode—in an earlier experiment—by spraying palladium onto nickel. Not only did this surface have many microdefects, but the area of the surface layer was greatly enlarged by the irregularities, which generated local regions of high stress and strain.

Although they believe surface microdefects are important in promoting the loading of deuterium into the palladium, they do not consider that cold fusion is induced only on the skin surface of the metal. Nonetheless, because the surface will tend to have the greater number of defects, they naturally looked to powders in order to maximize the surface-to-volume ratio of the palladium. In fact, when Arata first heard of the Fleischmann-Pons discovery, this was his first thought, even though at the time, like many other people, he had what he calls "slight doubts" about the reported experimental results.

Unlike those who either dismissed the experiment out of hand or were easily discouraged by initially poor results from their own experiments, Arata and Zhang began the course of experiments that now, after six years, appear to be yielding highly promising results.



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Electron-beam welds on the superconductive high-frequency cavity for the 33 GeV electron-proton-collider-type accelerator.

The Experiments

They began in 1989 with two separate experiments carried out in parallel, using two different cathodes. In one, the cathode itself was made of powders, and in the other, palladium powders were sprayed in order to produce a surface layer on the cathode. Dealing with the powders in this way caused many technical problems, so that they never published results from these experiments but learned a good deal that led to their final design. One lesson was that the smaller the powder crystals, the greater the surface area and the greater the possible activation of this surface.

Arata considered the question of substituting gas-loading in place of electrolysis. In some ways it is easier to manage. However, to achieve an absorption ratio of hydrogen into palladium of 0.9 is not so easy and for deuterium it is even more difficult (Sieverts' law). If solid palladium is replaced by powdered, however, Arata believes the absorption will occur much more quickly and reach a far higher ratio. When the crystals are less than 10 nanometers in size, with a sufficiently high pressure of deuterium within the cylindrical cathode, then the powders should absorb deuterium virtually instantaneously, and achieve a loading ratio of D/Pd = 1.

In their earlier experiments, Arata and Zhang had used simple electrolysis (with a lithium hydroxide electrolyte) without the double-structured cathode. Their cathodes were surrounded by a cylindrical anode of platinum.

One of their earliest concerns was to directly measure the temperature of the cathode rather than inferring an increase there as the electrolyte became warmer. In these early experiments an attempt was made to detect a neutron flux, but this was found to be little greater than one neutron per second. Different neutron detectors were used, one helium-3 detector, and one boron-fluoride detector. A low neutron flux (maximum 420 counts in five minutes) was repeatedly observed from the deuterated cells but not from light water cells.

In this experiment, it was observed that a cathode with a sprayed layering of palladium underwent a large heat emission when the deuterated target was removed from the electrolyte and placed in air, as compared to much less heat from an ordinary palladium rod. This was because of oxidation of the deuterium, but the interest lies in the fact that that absorption was obviously so much greater in the cathode with a sprayed palladium layer. In steels, the concentration of hydrogen in the stress field is about 10 times higher than in stress-free areas, a fact that is working knowledge in welding engineering. Arata thinks many such concentrated zones exist everywhere in the sprayed layer, and therefore the use of a sprayed cathode is superior for achieving a high concentration level.

These experiments were reported at the 1993 International Conference on Cold Fusion (ICCF-3) held in Nagoya, Japan.[1] Since then, however, they have completely redesigned their experiment, and are now finding an impressively high, repeatable heat flux. The same principles have guided Arata and Zhang in the present experimental design as before. Their palladium cathode with an interior of palladium microcrystals

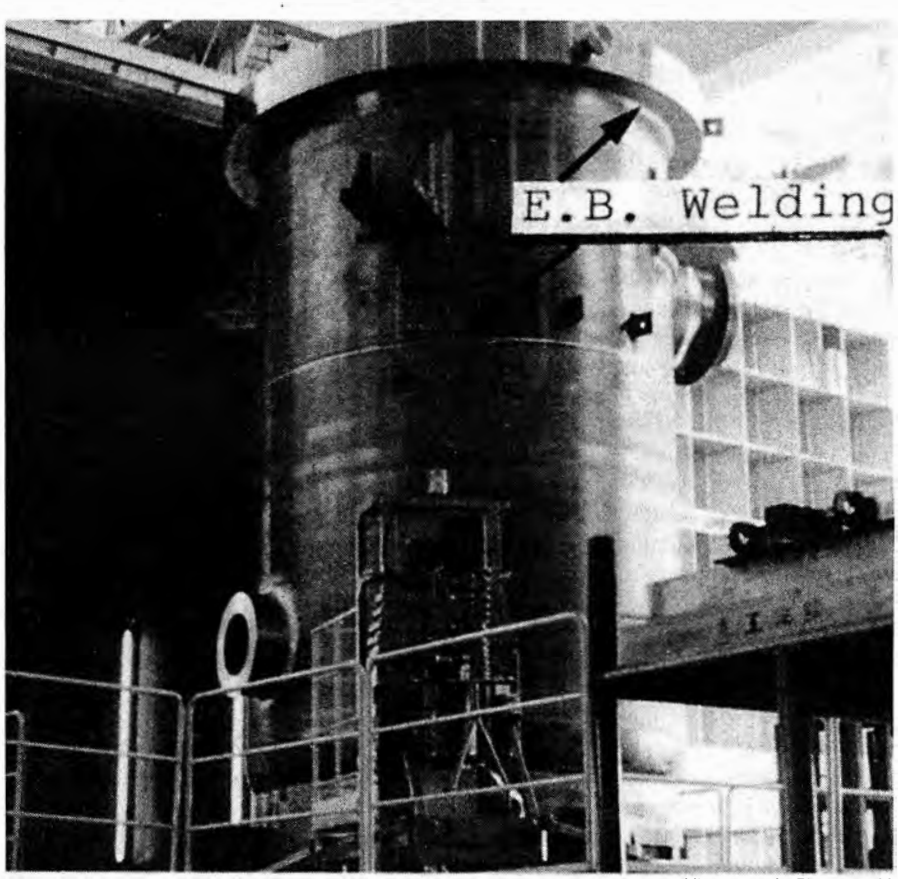
is designed to have a high surface area with structural discontinuities. Whereas initially in 1990 they had sprayed powdered palladium onto the cathode surface, they are now containing it in what is essentially a 50 mm × 20 mm diameter cylindrical bottle.

The pressure of deuterium gas inside the cathode is well above 200 bar, although it has only been precisely determined up to this point. It might well go as high as 700 bar; however, the cell is not sealed in order to prevent too high an energy buildup. This is a safety precaution that Arata considers well warranted, especially since they are already achieving a high heat excess under the existing conditions.

Several different kinds of blank experiments have been run to establish that the heat excess is being generated by the palladium black contained within the cylinder, rather than by electrolysis on the palladium cylinder itself. One indication is that the measured temperature is highest within the cylinder—a temperature of about 1 degree higher is maintained inside the active cathode, as compared to that of the electrolyte. Furthermore, heat was not generated in an empty cell.

The experiment is run in a continuous manner, and the crucial element, in Arata's opinion, is the attainment of a loading ratio of deuterium to palladium at or above 1-to-1. For him, this is an indispensable condition. The density of the deuterium within the cylinder would be somewhere between that of a liquid and a metal. Although the McKubre group at SRI in California and Kunimatsu at IMRA Japan have determined that they begin generating excess heat at lower loading ratios, it should be remembered that they are measuring an average rather than local loading ratios.

This phase of their experimental work was begun in September 1992, and they submitted a patent application based upon it before the end of that year. Many aspects of it had also been confirmed in a preliminary way by earlier experiments. But they first reported on it publicly in 1994. On two occasions Zhang and Arata have witnessed very high heat bursts for a 17-hour period. Heat was measured by heat flow calorimetry.



Electron-beam welds on the pressure vessel of a nuclear power reactor.

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From Hot to Cold Fusion

Arata developed his uniquely designed cathode, which he calls the double-structured cathode, some 40 years ago, at a time when he was experimenting in the field of hot fusion. Today he uses this electric discharge electrode to investigate solid-state fusion.

In 1955, deuterium was not commercially available in Japan and so he used the design in order to produce the deuterium necessary to conduct fusion experiments. At that time, of course, he was not concerned to load the palladium with deuterons (deuterium nuclei) to achieve cold fusion, but merely to use the cylinder packed with crystals to collect the deuterium under vacuum conditions. The electrolysis device which he designed then is the basis for his double-structured cathode, which remains substantially unchanged today. It employed a palladium bottle for the cathode and platinum for the anode.

He investigated the characteristics of palladium quite thoroughly at that time.

He remarks about his work then: "I shall never forget how strongly shocked I was by the anomalous characteristics of palladium—[capable of] a high concentration of deuterium, and the violent change in concentration by a temperature change of several degrees, as well as intensive hysteresis at low temperatures." Hysteresis is the lag of an effect behind its cause, exhibited in this instance by the slow change of the palladium's characteristics as it absorbs and then releases hydrogen. "This effect was deeply etched into my memory over the 40 years between then and the Fleischmann-Pons discovery. It provided a link between my hot plasma fusion research and work on solid-state plasma fusion.

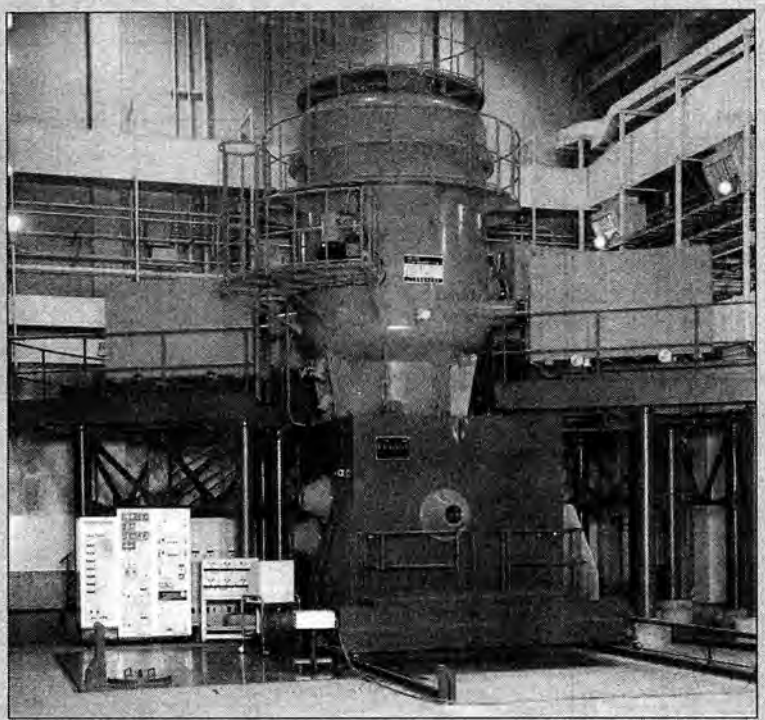
"In fact, 40 years ago the possibility of solid-state plasma fusion in a palladium lattice occurred to me. Of course, at that time, I had no idea that fusion could be achieved by means of electrolysis alone. I certainly did not think that a fusion reaction could be induced only by thermal motion at approximately room temperature. Instead, I

A Career on the Cutting Edge

Arata has been honored internationally for his groundbreaking work in the field of plasma engineering. From 1955 to 1958, his fusion work centered on the use of an electrical discharge device that achieved record-breaking plasma temperatures. He developed a high power pulse current generator capable of producing a pulse of 3 × 10^6 amperes, the largest pulse current in the world at the time, and used it to produce a deuterium plasma with a temperature far above 1 million°C.

In 1966, he developed the world's first high-power carbon dioxide laser for use in welding and cutting, and also pioneered intense electron beams for the same purposes. These electron beams are emitted from an ultra high power, high-density electron gun enabling instantaneous through-welding of steel plates as thick as 30 centimeters.

In 1977, Arata invented a means of maintaining a vacuum tunnel within a high-pressure gas. He succeeded in generating a powerful plasma beam in this vacuum tunnel. A gas tunnel plasma jet has a high energy density and an extremely high temperature—as much as 30,000°C, even at atmospheric pressure. Among other applications, it is used for thermal spraying, melting, and other materials processing, although Arata originally developed the tunnel in order to study fusion plasmas.



Milestones of a Pioneer, p. 71

The ultrahigh power electron beam heat source (600-kilovolt, 300-kilowatt class) developed by Arata in 1980 for high-quality welding of extremely thick plates and high precision large-scale structures.

The American Society for Metals published his book, *Plasma, Electron & Laser Beam Technology, Development and Use in Materials Processing* in 1986. These technologies, representing a technological revolution in progress, represent new heat sources in which high energy plasmas play a crucial role. These high energy density beams are expected to become the processing energy sources in the development and manufacture of very large scale integration devices and of new materials, as well as for materials surface modification involving the melting, refining, and heat processing of composite materials. These energy sources are also already used for high-precision welding, laser alloying, and beam cutting.

In addition to his many international honors, an annual prize in the science and technology of welding is awarded in Arata's name, and Arata Hall at Osaka University is named in his honor.

In 1993 the Okada Memorial Japan Society for the Promotion of Welding published a memoir of Arata's career, *Milestones of a Pioneer,* in Japanese with some parts in English. It includes reprints of many newspaper accounts of his accomplishments over the years and is intended to inspire Japanese young people to follow in his footsteps.

thought it would be necessary to bombard the deuterium of the lattice with concentrated energy from an external energy source" (Figure 3).

Obviously what is occurring in cold fusion, in a solid-state experiment, is vastly different from hot fusion, although there are almost as many theories as to what constitutes these differences as there are experimenters. In Arata's case, he believes that whereas high energy electrons play a crucial role in hot fusion, for example in inciting plasma oscillation, this is not so with cold fusion, where in his view deuterium ion oscillations in the lattice—caused by what he calls "latticequakes"—are actually far higher than those of the electrons, yielding a far higher kinetic temperature in the deuterium ions. For this temperature to be maintained there must be a continuous application of high power.

Arata says of his model: "The basic major problem with respect to cold fusion, however, is that deuterium exists in an ionic state in palladium, and that unlike hot plasma fusion, deuterium ion movement is limited by the powerful constraining force of the palladium lattice. In other words, the location and direction of reaction, and the reaction conditions, are severely restricted, and the reaction process occurs under differ-

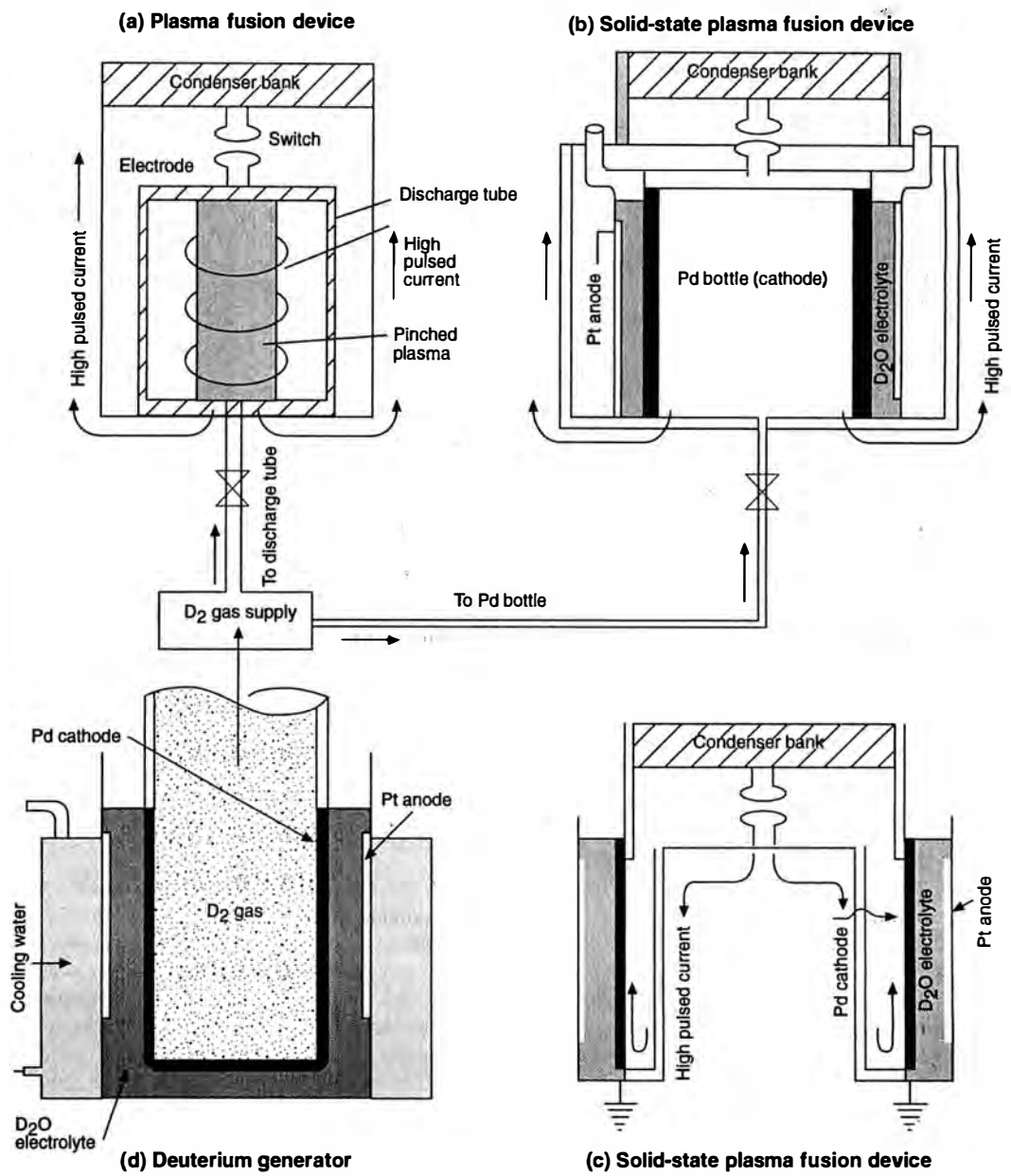


Figure 3
PRECURSORS OF THE DOUBLE-STRUCTURED ELECTRODE (1955-1958)

Because deuterium was not commercially available in the 1950s, Arata developed his own deuterium generator (d), which supplies deuterium to experimental fusion devices (a) and (b). Devices (b) and (c) were designed simultaneously for solid-state experiments.

In the generator, heavy water is electrolyzed, and deuterium gas is released into the vacuum chamber as a result. The deuterium is supplied to the discharge tube (a), where a current of maximum 1.5 to 3 × 10^6 amperes confines (pinches) the deuterium plasma to produce fusion. Deuterium is also supplied to the solid-state fusion device (b). The palladium bottle has walls of palladium and is packed with fine palladium crystals. Deuterons (deuterium nuclei) penetrate the wall of the bottle from both sides, and fusion reactions can take place in the palladium lattice of the wall with sufficient loading of deuterons. The solid-state device (c) uses no deuterium gas and no palladium crystals. Deuterium is loaded into the palladium cathode only from the electrolyte.

The double-structured cathode emerged by combining devices (d) and (b).

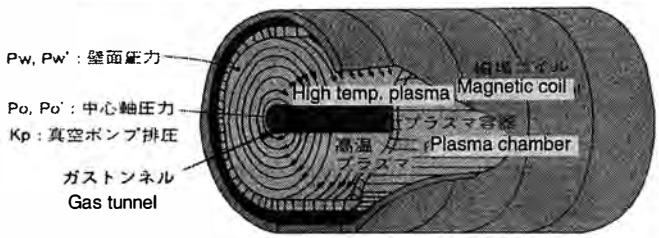


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Figure 4
THE GAS TUNNEL HIGH-TEMPERATURE PLASMA JET
A plasma jet can propagate in a vacuum (less than 1/100 atmosphere) at the center of a "supervortex" of gas in the plasma chamber. Arata invented the device, which is useful as a high energy density heat source for thermal spraying, alloying, heat processing, and other applications.

ent dynamics than hot fusion.

"There are two aspects to cold fusion: academic interest and practical importance.

"The former means the birth of a new academic field, while the latter could contribute to the development of a new energy source. Both, however, are extremely important as separate pursuits, just like the balancing weight of the wheel. In practical terms, however, output less than approximately 10 watt/cc is basically meaningless, and yet from a theoretical perspective it must be possible to explain how the 10^{13} reactions/second required to achieve this output can be sustained continuously."

The Latticequake Model

Arata believes he has obtained a model that explains cold fusion in terms of lattice dynamics involving a resonant relationship between the palladium and deuterium ions, the latter normally being located at what are called octahedral sites of the palladium lattice. The octahedral sites are the midpoints of the 12 edges of the face-centered configuration of palladium ions. Deuterons or protons absorbed by the palladium will normally locate there and at the center of the cube. The palladium cube is face-centered: the palladium ions are located at the centers of the six faces of the cube, but also at the eight vertices.

"For cold fusion to occur," he says, "the deuterons must be vigorously tossed around by a latticequake." This creates a gigantic distortion of the lattice, with just the right kind of vibration of the deuterons of about 10^{-11} sec. The latticequake acts as a "lattice accelerator," accelerating the deuterons as the octahedral sites are tremendously expanded and compressed, and this gives the deuterons a high kinetic energy if they are densely loaded to a ratio equal to or greater than 1. This would be the equivalent of several tens of millions of degrees kelvin, even though the lattice itself is at room temperature.

Arata explains, "The idea of the latticequake came to me as a result of my personal experience during the recent Kobe earthquake, which occurred at 5:46 a.m. on Jan. 17, 1995. My house is located in the most terribly collapsed and destroyed disaster area of Kobe, in the vicinity of the seismic center. When it occurred, I had the experience of being so horribly tossed about on my bed that for a minute I thought my life was coming to an end. Almost all of the glass and ceramic kitchenware was thrown from the kitchen shelves and smashed on the floor. This led me to clarify a vague idea which I had had for 40 years that deuterons in solid-state plasma fusion also should have high energies, comparable to those found in hot fusion.

"At that very moment the thought flashed into my mind. For a latticequake to occur there must be what I call a first 'shock of God'—which may be cosmic rays or some other types of collision or impulse energy-into the lattice, which would create an intense deuterium pressure inside the double-structured cathode. This could allow continuous, powerful, cold fusion to be achieved by the occurrence of a 'latticequake,' which would be produced first in one place and then another through a process of ignition. In this way a chain reaction could be developed. I think of this chain reaction as similar to the kind of chain reactions that occur in nuclear fission and with the growth of a crystal."

In a recent communication to the Japan Academy and the High Temperature Society, Arata compares hot and cold fusion. In cold fusion, he says, the field of the palladium lattice plays the role of the magnetic field in hot fusion. The solid-state plasma of cold fusion is characerized by high density and low temperature, while in hot fusion, low density and high temperature prevail. In each case, according to Arata, there is a crucial condition: For hot fusion it is stability with respect to plasma oscillations and runaway electrons, while for cold fusion the crucial condition is a D/Pd loading ratio equal to or greater than one, which is crucial for effective latticequakes. But the end result in each case, he says, is the same: highly energetic deuterons, and nuclear fusion is the result.

Arata and the Progress of Science in Postwar Japan

The conditions for conducting research in Japan at the end of the World War II were very hard, yet the kind of training that Arata got was actually irreplaceable. As a young graduate student he was faced with the task of constructing the very instruments with which he worked. Compared to the experience of a young researcher today, his situation was certainly more difficult, but from it he learned far more. Innovations in applied science can come from the creation of new technologies for conducting scientific experiments.

Too often today computer simulations are substituted for experiment. Yet by confronting anomalies, the assumptions of the accepted scientific paradigm that are built into such simulations are overturned, and new fundamental discoveries—such as that of Fleischmann and Pons—become possible. Arata's life story illustrates this.

Arata says of his student days, "The Second World War ended only a few years before I was graduated from the Faculty of Engineering of Osaka University in 1949, and began my graduate research. The university had been severely damaged during the war, and there were virtually no research tools or equipment available other than optical microscopes. My first and primary task was therefore to build the equipment needed. This included an electron microscope, X-ray generators, electron diffraction apparatus and so on–all of the equipment that would allow me to pursue research.

"My initial research involved the construction of an intense

Courtesy of Y. Arata

Arata's collaborator, Dr. Yue-Chang Zhang, was awarded the first prize for science and technology by the shipbuilding ministry in China in 1985. She won the Thesis Award of the Japanese Welding Society in 1985 and the Okada Science and Technology award in Japan in 1989. Zhang received her Ph.D. from Osaka University in 1987 and has been associated with Shanghai's Jiao-Tong University since 1985, where she became a full professor in 1992. Almost continuously since 1984 she has also been a visiting professor at the Osaka University Welding Research Institute.

ultrasonic wave generator and improvement of the radar which had been used during the war, so that it could be applied to the analysis of the solidification of materials and also of welds. This was in the general area of defect analysis, which was necessary to establish quality control in manufacturing. I believe that this research was the first of its kind in Japan and the world.

"Next I developed an 'AC magnetic analyzer' that was the first device of its kind in the world. This device proved to be a powerful tool for the analysis of phase transformation (including the analysis of martensite, the hardest steel, produced by rapid quenching in cold water) and heat treatment in steel, and particularly for the analysis of dynamic behavior of these phenomena. The results of this research were a part of my doctoral thesis-I received my doctorate from the University in 1956.

"Because I had conceived of and developed so many kinds of apparatus in succession, which were, for that time, state-of-the-art tools for specific research objectives, I had no misgivings about dramatically changing my field of research and challenging the then-unknown field of hot plasma fusion. The nuclear fusion problems defined in my research from 1955-1959 became the basis for all of my subsequent research."

A Hot Fusion Pioneer

There were two severe problems to overcome in order to realize hot fusion at that time. One was to generate and maintain a stable plasma at a temperature of several hundred million degrees K, and the other was to confine it-to develop a discharge tube resistant to intense radiation. In 1977, Arata developed a concept for a new fusion plasma confinement system that he calls a "gas tunnel" because it is a vacuum tunnel within a high-pressure gas (Figure 4). In order to create the gas tunnel he invented a "supervortex" which he likens to an intense typhoon. At sufficiently high temperatures a vacuum tunnel forms at the eye of the vortex. This was a major discovery in the basic phenomena of gas dynamics. While the theoretical minimum pressure in the eye of the typhoon phenomenon is a little less than half of 1 atmosphere, the pressure within Arata's supervortex can be reduced to less than one hundredth of an atmosphere.

The plasma is confined by the high-pressure gas within which the tunnel is formed. Within these walls the temperature of the plasma could be maintained at a temperature of 100,000 K under vacuum conditions. He conceived of this as as a sort of base point from which it would be easy to increase the temperature within the tunnel by a thousand steps to the hundred million K necessary to achieve a hot fusion reaction. In this way he hoped to be able to overcome the instability of a magnetized plasma in a high vacuum, while at the same time protecting the solid wall of the discharge tube with the high pressure gas wall.

Arata also recognized that his invention could have immediate practical applications for engineering, and indeed it did open up what became the new field of plasma engineering. A plasma beam could be generated in the gas tunnel at 30,000°C, with important technological and theoretical uses.

Although he was not able to procure sufficient funding to continue his work in hot fusion, doubtless because of the unusual nature of his concept, his career was extremely fruitful in the area of plasma engineering, where he turned his attention to developing practical ultra high energy density heat sources, such as strongly focused electron beams and high power carbon-dioxide laser beams. He was also able *to* establish that whatever the character of the beam-be it plasma, electron, or high power laser beam, the characteristic interaction of beams with metals is only dependent upon energy density and power—a very important discovery. In this way he has contributed to the creation of many new materials processing technologies.

Although Arata retired from Osaka University in 1988, he and Zhang have collaborated on cold fusion experiments since 1989. He has never lost his interest in hot fusion research even though he was prevented by circumstances from working to realize his own idea. "Even though the hot fusion methods currently being tried have not succeeded," he says, "and no one knows which method will ultimately prove to be the best. In addition, no one can predict when hot fusion will be achieved, and whether it will be practical as an energy source.

"I am convinced that achieving hot fusion is important for all mankind and I am therefore convinced that long-term investment in hot fusion research on even a 100-year time scale is worthwhile. I would therefore be immensely pleased to have some young researcher become interested in my hot fusion concepts, which are fundamentally different from conventional concepts, compare these concepts with other methods current today, and achieve in my stead those dreams which I myself did not have time to achieve."

Notes

1. See also an earlier account by Arata and Zhang of these experiments in *Fusion Technology*, Sept. 1992, pp. 287-295.

Statistical Tricks and 'The Big Lie about AIDS'

by Wolfgang Lillge, M.D.

Wolfgang Lillge is the editor of the German-language magazine Fusion *and has covered the AIDS issue since the early 1980s. His article first appeared in the Sept.-Oct.-Nov. 1994 issue of* Fusion *and was translated by Susan Johnson.*

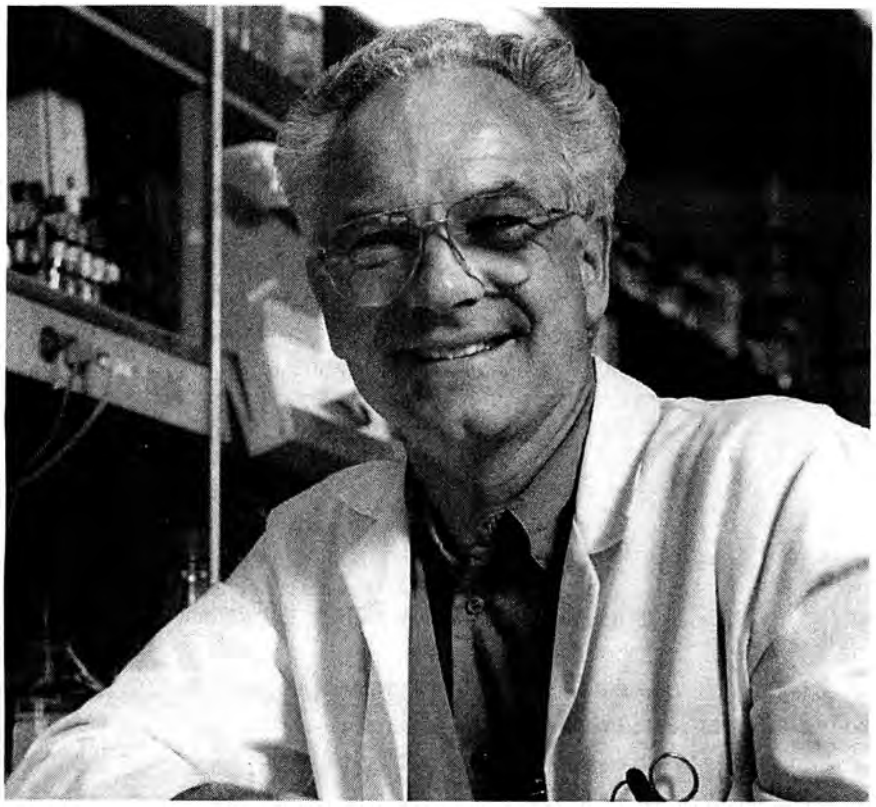
It is an astonishing phenomenon of the period we live in that in the view of some scientists, the AIDS epidemic, whose species-threatening potential has now become more and more apparent in Africa and Asia, does not exist. More precisely, the existence of disease symptoms and the existence of a retrovirus called HIV are not disputed, but the connection between the two is denied.

Since the end of the 1980s, increasing international circulation has been given to the assertions of Peter Duesberg, professor of molecular and cell biology at the University of California at Berkeley, a respected expert on retroviruses. According to Duesberg, AIDS does not exist; it is either an illusion or the effect of drugs and of the AIDS medication AZT. In Germany, Duesberg has found an active fan club among the readership of the journal *Raum und Zeit* [*Space and Time*], which has published several runs of a special issue headlined "AIDS: The Disease That Doesn't Exist."

This document popularizes "the Big Lie about AIDS," the danger of an "AIDS dictatorship," and the likelihood of "nasty doings" using the pretext of AIDS. It also says that it is unnecessary to test donated blood for HIV antibodies and it is a criminal act to administer the drug AZT in the effort to prolong the life of AIDS patients.

▲ *The scientific establishment has rejected Peter Duesberg's claim that HIV is not the cause of AIDS, but it reaches the same conclusion: No public health measures are necessary to stop its spread.*

At first, Duesberg might seem to be playing devil's advocate with his provocative theses in order to stir up discussion within a sphere dominated by a few AIDS "authorities." However, his litany of arguments calls to mind an effort at esoteric conversion, and his adherents exhibit a missionary fervor that has nothing to do with science.



Chris Duffey/ University of California at Berkeley

Peter Duesberg. His adherents "exhibit a missionary fervor that has nothing to do with science."

It is obvious why Duesberg finds such a receptive echo in some circles: A great deal of unclarity still prevails about the actual workings of HIV infection. Despite huge international expenditures, only very fragmentary knowledge exists about the molecular and immunological processes that lead to the breakdown of the immune system and to the well-known symptoms of AIDS. The evidence is contradictory and anomalous, and above all, no one has succeeded in developing either an effective cure for AIDS or an immunization against it—a deplorable situation that certainly casts light on the deficiencies of current methods of scientific research.

Throwing Out the Baby

To draw the conclusion, however, that HIV is in no way the "AIDS agent" is, of course, to throw the baby out with the bathwater—all the more so because basic facts about HIV have been established that leave Duesberg's arguments without foundation.

Professor Manfred Eigen, a Nobel laureate who heads the Max Planck Institute for Biophysical Chemistry in Göttingen, Germany, took note of Duesberg's views as early as 1989, in a contribution to the journal *Naturwissenschaften* [*Natural Sciences*] (No. 76, pp. 341-350), in which he reviewed the central aspects of Duesberg's claims point by point. Because it has lost none of its saliency, portions of Eigen's critique are presented here.

The most important question to clarify is whether an unambiguous relationship exists between infection with HIV and the appearance of "AIDS."

Here Eigen takes up Duesberg's claim that the yearly incidence (increase) of AIDS among HIV-positive individuals in the United States varies from almost zero to more than 10 percent, and that the average conversion rate of seropositive Americans to patients with AIDS symptoms is *only* 1.5 percent. If this were true, Eigen comments, the correlation between HIV and AIDS would, in fact, be more than dubious. But Duesberg's calculations do not add up.

Eigen's Statistics

Eigen presents the following counter-statistics:

"Duesberg bases his calculations on totals varying between 9,000 and 29,000 (corresponding to the changing Centers for Disease Control definition of the illness) for the yearly increase in AIDS cases in the United States for the year ending in August 1988, and juxtaposes them to the estimated 0.5 million to 1.5 million HIV-seropositive Americans. In this way he arrives at the cited average annual incidence rate of 1.5 percent. What does this figure mean?

"Given that $n(t)$ is the (time-dependent) cumulative total of AIDS cases at any arbitrary time t, then $dn(t)/dt \approx \Delta n(t)/\Delta t$ signifies the rate of change of $n(t)$, which is itself a function of time, if the increase is not secularly linear. Duesberg assumes that Δt represents one year and accordingly uses a later estimate for $\Delta n(t)$. We now designate as $N(t)$ the number of HIV-seropositive persons. The rate $dN(t)/dt \approx \Delta N(t)/\Delta t$ is, once more, in all probability a time-dependent magnitude. Duesberg correlates the rate $\Delta n(t)/\Delta t$ (Δt is 1 year) with the overall total $N(t)$ (t is the present) and calls this the rate of incidence, a number that is obviously meaningless, if the conversion does not immediately occur but instead there is a latency period of 6 to 8 years.

"A significant magnitude in this case is $\Delta n(t = t_1)/\Delta N(t = t_0)$, in which t_1 and t_0 are reference points in time (i.e. mean/average/intermediate intervals) in the relevant time periods, and t_1–t_2 signifies the latency period. Naturally, the actual value of $N(t)$ is not known, and the yearly estimates presented (which relate to risk groups which are already partly saturated) simply reflect this uncertainty.

"(Duesberg is thus correct when he criticizes the invariance of this estimate in past years.) On the other hand, $n(t)$, the number of reported AIDS cases, is far more reliable than $N(t)$, and if we assume that the growth characteristics of $N(t)$ are similar to those of $n(t)$ (Figure 1), we maintain, insofar as this is possible with the estimates at hand, a 100 percent correlation of $n(t = t_1)$ with $N(t = t_0)$, if we assume a latency period of 6 to 8 years.

"In other words, the annual incidence of AIDS cases now corresponds to the annual incidence of HIV-seropositive persons 6 to 8 years ago. Naturally, this is still a simplified representation, since all the functions cited are average/mean values for statistical distributions. Since the inception of the infection must be extremely variable among different geo-

graphic areas, countries, and risk groups, and there exist further dependencies on saturation, reciprocal effects, and so forth, the numbers for 'fluctuations between zero and over 10 percent' as defined by Duesberg must be rejected. Moreover, the incidence rate of blood transfusion recipients must continue to show an increase (as is reported), since at the outset 3 years of the 6- to 8-year latency period have elapsed. . . .

"Duesberg could reply to this interpretation that it presupposes an existing correlation between HIV infection and AIDS; in other words, *N(t)* can be constant or fluctuating and still be correlated overall with *n(t)*. Even if we concede that, Duesberg cannot deny that the accurately calculated correlation contradicts his low rate of incidence. Either we assume that a correlation exists, and then the data for incidence support the correlation, or we deny the existence of any correlation, and then it is simply impossible to use the data as an argument."

The Details Matter

We have quoted Eigen so extensively because in this case it is the details that matter. Calculations and statistics cannot be arbitrarily thrown together to suit the researcher's purpose. When Duesberg simply "forgets" to take account of the long AIDS latency period, that does not augment his credibility.

Eigen's remaining arguments against Duesberg, which relate to the evolution and etiology of the disease, can be found in Eigen's useful article in *Naturwissenschaften*. It is scarcely comprehensible that Duesberg, who is otherwise respected among virologists, would unreasonably stick to his thesis despite all refutations—and this, in the view of many, draws him close to the position of a sectarian tub-thumper for whom personal opinion counts, not the truth.

Many AIDS researchers are rightly furious about Duesberg's extravagancies. Serious research exists by means of hypothesis and experiments. If a colleague presents opinions that so grossly contradict every result of daily work, then sooner or later he loses his credibility. When, in pursuit of a vaccine, monkeys are inoculated with SIV (simian AIDS virus) and regularly develop AIDS-like symptoms, while inoculated animals show neither seroconversion nor disease symptoms, then Duesberg's denial of a direct relation between HIV and AIDS is not intelligible for the researcher.

"If we were to learn more precisely how HIV disables the body's immune response, this sort of speculation would quickly disappear, and the search for a cure would have a solid basis."

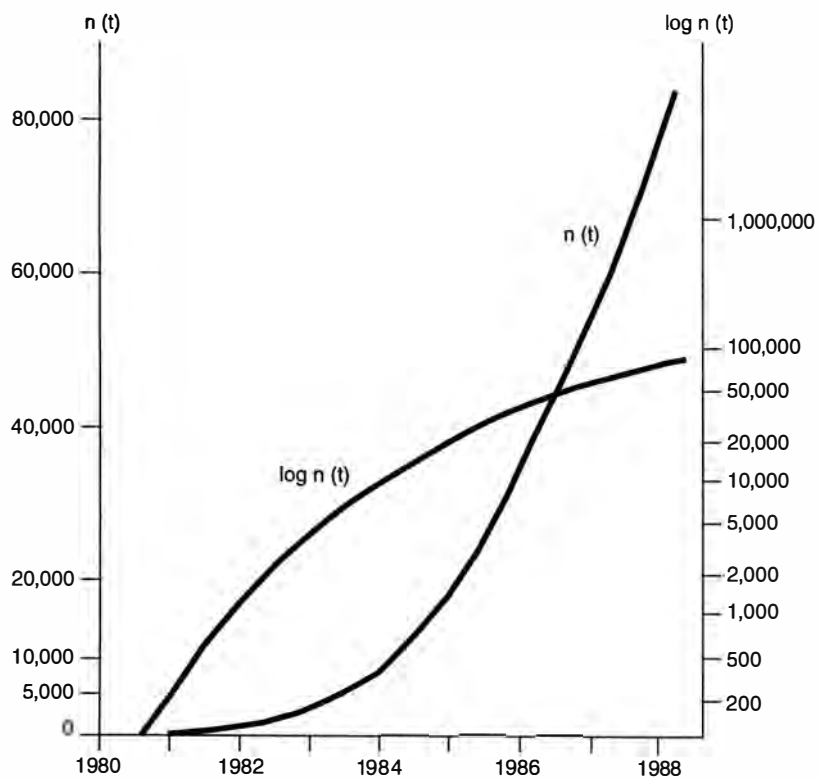
The practical implications Duesberg draws from his conclusions are also dubious. He says that his "analysis offers several advantages. It ends the anxiety about HIV infection and especially about HIV antibodies. . . ." Moreover, Duesberg says, "efforts on behalf of AIDS prophylaxis should focus on AIDS risks rather than on the transmission of HIV."

A Public Danger

The internal logic of his argument propels Duesberg into clearly reckless inferences that, in fact, represent a public danger. He gives carte blanche to everyone with AIDS or HIV infection to ignore the potential danger to fellow human beings. If HIV is decoupled from AIDS, then HIV infection no longer presents any risks and all public health measures to combat epidemics—whether simple reporting of cases, investigation of infection routes, or special provisions for the infected—are ineffectual and inappropriate.

Rejection of such measures by certain political and social circles is not new; now Duesberg endows it with the imprimatur of science. Professor Eigen considers Duesberg's conclusions not only unjustified but dangerous because they promote a risk-laden, wishful delusion among those who are in the greatest jeopardy.

If we were to learn more precisely how HIV disables the body's immune response, this sort of speculation would quickly disappear, and the search for a cure would have a solid basis.



Cumulative totals n(t) *(and their logarithms) of reported AIDS cases in the United States as a function of time* t. *Note that a purely logarithmic increase in the log representation would appear as a straight line.*

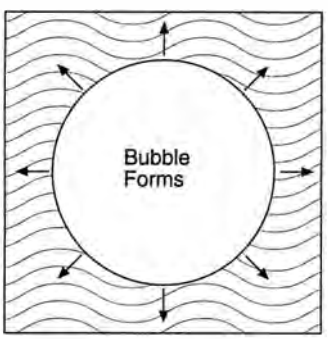
Source: Manfred Eigen, *Naturwissenschaften*, 1989, No. 76, pp. 341-350

SONOLUMINESCENCE

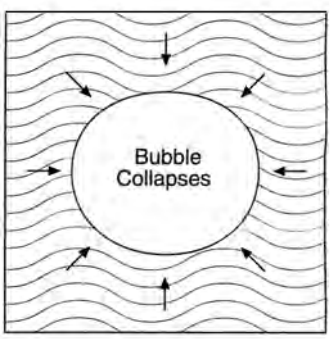
Tapping the Light Fantastic

by Mark Wilsey

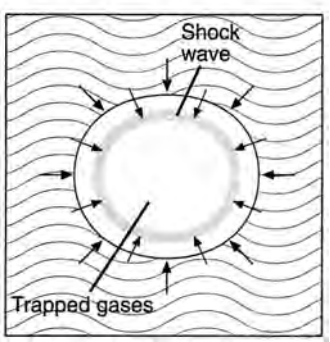
(a) Sound waves cause low pressure. Water molecules move apart, creating a bubble.



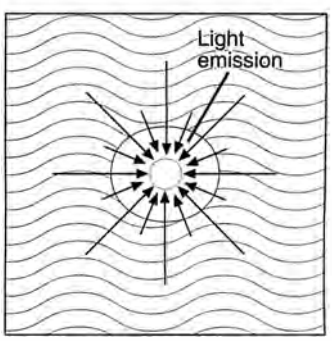
(b) Sound-wave pressure increases; the gases are compressed as the bubble collapses.



(c) Bubble collapse accelerates and a shock wave forms, further compressing and heating the trapped gases.



(d) Shock wave slams into the center of the bubble. Temperatures and pressure are very high. Light is emitted.



MAKING LIGHT FROM SOUND

Bubbles are very familar things. Whether it's a child's soap bubble floating in the air or the refreshing fizz in a carbonated drink, there seems to be something comforting in the simple beauty of bubbles. Well, consider the case in which a bubble that is created in a liquid with ultrasound (sound at frequencies above the range of human hearing) collapses and emits light. This phenomenon of producing light from sound is called sonoluminescence.

Michael Moran at Lawrence Livermore National Laboratory, who has studied sonoluminescence, says that it is "an essential mystery that eludes everyone's best efforts" to understand. Although ultrasound has long been used in industry and medicine as a diagnostic tool, the sonoluminescence effect has remained largely unexplored.

Scientists have known of sonoluminescence for decades. In the mid-1930s, scientists observed that photographic plates submerged in a solution could become fogged when exposed to an ultrasonic field. Later it was determined that the light emissions were coming from bubbles that had formed at the pressure nodes of standing acoustic waves. The nodes are areas in which ultrasound and its reflections interfere with each other, either increasing or diminishing their intensities. Because the ultrasound is usually of a single frequency this interference pattern will appear to be fixed or stationary.

Depending on the shape of the container and how the ultrasound field is applied, a large number of these nodes, and thus bubbles, can form in the liquid. This case is called multibubble sonoluminescence.

The ultrasound produces areas of high and low pressure in the liquid. Under certain conditions, the pressure is low enough to allow a bubble to form from the dissolved gases in the liquid. As the pressure increases, the bubble shrinks as the trapped gas is compressed; again, if the conditions are right, the gas in this collapsing bubble will give off a brief flash of light. This cycle of bubble formation and collapse occurs very rapidly at ultrasonic frequencies.

Until recently, multibubble sonoluminescence was the only form known. Kenneth Suslick of the University of Illinois at Urbana-Champaign, an expert on ultrasound who is at the forefront of

sonochemistry, uses the multibubble effects of ultrasound to make new materials and enhance the rate of chemical reactions in solutions.

For the chemist this is fine, but for the physicist trying to study the phenomenon of sonoluminescence, the multiple bubbles are a difficult case.

Single-Bubble Sonoluminescence

The breakthrough in the physics of sonoluminescence was made several years ago by researchers at the University of Mississippi, Lawrence Crum and his doctoral student Felipe Gaitan. Crum and Gaitan were able to produce sonoluminescence in an isolated bubble in the middle of a container. Equally important, they could now coax the phenomenon into producing a steady glow instead a brief flash. Now physicists had something that was much more accessible for probing.

Suslick explains that single-bubble sonoluminescence is distinctly different from the multibubble phenomenon. "They're first cousins but not identical twins," he says.

In multibubble sonoluminescence the temperatures inside collapsing bubbles reach several thousand degrees. The emission is produced by highly excited states of molecular species like diatomic carbon, C_2 (a molecule made up of two atoms of carbon).

"In single-bubble sonoluminescence, however, it appears that the collapse is much more efficient and generates a shock wave that causes much higher temperatures," Suslick said. "The emission is not molecular but looks to be some kind of plasma emission." It is not known whether a shock wave forms in the multibubble case, although it is possible.

Since Crum and Gaitan's discovery, other laboratories have begun investigating sonoluminescence. Most notable is the University of California at Los Angeles, where a great deal of work has been done. There researchers were the first to attempt to measure the duration of the light emissions. Their work showed that the steadily glowing bubble was emitting light with each cycle of the acoustic field, which is measured in microseconds (10^{-6} sec). However, the flash itself was found to be much shorter, on the order of picoseconds (10^{-12} sec).

UCLA researcher Seth Putterman and graduate student Bradley Barber found another remarkable aspect to these flashes. They found that the average interval between flashes in a 30-kilohertz field was 33 microseconds, with a fluctuation of only 50 picoseconds over a period of 100,000 cycles. This stability greatly exceeded that of the acoustic frequency generator used.

Imagine a simple mechanical device that would ring a bell once a week and not vary the interval by more than a second, week after week, for 2,000 years. That is the precision of these intervals—an achievement that would make any watchmaker happy!

Measuring Sonoluminescence

Another laboratory studying sonoluminescence is the Naval Postgraduate School in Monterey, California. Anthony Atchley, who had done his doctoral work at the University of Mississippi and knew Gaitan's work with single-bubble sonoluminescence, invited Gaitan to the Postgraduate School to continue his research.

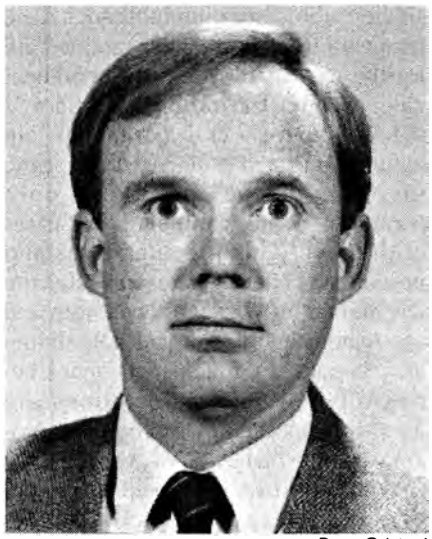
There are three areas in which Atchley and his colleagues are working: measuring the optical spectrum of sonoluminescence, the size of the bubble, and the duration of the pulse.

In measuring the spectrum they looked at different liquids for sonoluminesence, primarily water and mixtures of water and glycerin. The spectrum was found to be broad, increasing in intensity toward the ultraviolet, which is consistent with what other researchers had found.

The spectrum was measured by placing an optical fiber of quartz close to the bubble to try to eliminate some of the light absorption caused by the water. The quartz, however, did not help much. Atchley explains that water absorbs wavelengths shorter than about 210 or 200 nanometers (10^{-9} m) and quartz cuts off somewhere around 170. In any case, there would still be a little water present between the end of the quartz optic fiber and the bubble.

The experimenters wanted to "push that down by a factor of 2, to really get down into the ultraviolet and see what happens," Atchley said.

Another area involved measuring the size of the bubble with a laser scattering technique. A laser is shone on the bubble, which scatters the light. Two detectors are used to look at the scattered light from two angles for greater accuracy.



Bryan Quintard

Anthony Atchley's team at the Naval Postgraduate School was able to measure the bubble's size to within 10 nanoseconds of its final collapse and emission. But after that is "when everything interesting happens," Atchley said.

The amount of scattering is then used to determine the bubble size. By using a pulsed laser, Atchley's team could look at the bubble at various parts of its cycle.

They were able to measure the bubble's size to within 10 nanoseconds of its final collapse and emission. "Of course that's when everything interesting happens," Atchley said. At this time the bubble is still a few microns in radius. At times closer to emission, the bubble is so small that its diameter is approaching the wavelength of the laser light and the scattered signal becomes very weak.

The third area of research concerned measuring the duration of the pulse. Researchers at the Naval Postgraduate School asked Michael Moran at Lawrence Livermore for help in measuring the optical spectrum of sonoluminescence and the time-dependence of the emissions. Yet, even with the ultrafast cameras available at Livermore, the duration of the pulse could not be definitively measured.

The results indicated that the pulse was very fast, possibly faster than the 50 picoseconds that other researchers had indicated. "But the instrument was pushed to its limits," Moran explains. "It was not clear, precisely, what the result was."

Computer Models

Suslick notes that there is as yet no experimental measure of temperature in

single bubble sonoluminescence. The temperatures and pressures reported are for the most part based on theoretical calculations. The problem he sees is that although shock-wave models are appropriate for the macroscopic scale, they may not be appropriate on a nanometer scale, particularly for gases at these very high temperatures and pressures. "There's a reason why the Department of Energy at Livermore and Los Alamos has always had state-of-the-art computers," Suslick said, "that's because bomb code calculations are among the most complex computer programs on the planet."

William Moss at Lawrence Livermore agrees with this assessment. For him it is an important point that in studying sonoluminescence they can make use of all of the skills that have been acquired in the nuclear weapons program over the past 40 years at the lab. Regarding the theoretical, computational, and experimental talent at Livermore, Moss said, "this is a perfect place to do this work."

Moss has done some of the most sophisticated calculations to date on bubble growth and collapse. He has performed fully compressible nonlinear hydrodynamic simulations, which start with equations of state for the gas and incorporate the liquid and even the glass flask in an effort to simulate as much of the problem as possible. Moss began with a standard hydrodynamic program, but is now using some of the weapons codes, "which are optimized a little better for these kinds of problems," Moss says.

Shock Waves

When a bubble contracts, a shock wave is generated that slams into the center of the bubble. The bubble radius, at least in the calculations, is about half a micron. It is only its inner portion that gets really hot—between 100,000 and 1,000,000 degrees, according to his calculations—with pressures reaching 100,000,000 atmospheres. These conditions last for about 10 picoseconds as the shock wave crashes in and then bounces out.

Moss believes that the rapid bounce is caused by the intermolecular potential; that is, as the atoms are pushed closer together, the repulsive force between them become stronger, which also causes the short timescale. "What we're talking about," Moss explains, "is just the mechanical process."

William Moss at Lawrence Livermore National Laboratory: A well-timed spike of positive pressure on the acoustic wave could "give the bubble a real good whomp at just the right time."

Moss notes that one of the factors controlling temperature is ionization. Ionization of a material removes electrons, thus removing energy that would otherwise go into temperature. Therefore, something that becomes significantly ionized is not going to get as hot as something that does not ionize as much.

It was this realization the led Moss and Moran to look at deuterium, an isotope of hydrogen. It has only one electron. Once the electron is gone, it was thought that the energy could then go into raising the temperature, thereby making the deuterium very hot compared to air.

Unfortunately, it turns out that deuterium is much more compressible than air at high density, so it is harder to get it as hot as air, given the same kind of driving conditions. The calculations indicate that the air will get hotter because it has a stiffer repulsion potential.

Moss believes that one way to overcome this limitation is to shape the pulse on the driver. By putting a well-timed spike of positive pressure on top of the oscillatory field, one could "give the bubble a real good whomp at just the right time." His calculations have shown that such an approach would have a large effect, but this has yet to be borne out experimentally.

Sonofusion?

This research process is what led them to start working on a deuterium experiment and to look at the "remote possibility" of fusion, Moss said.

In comparing sonoluminescence to inertial confinement fusion, there are some similarities, but also big differences. There is an enormous amount of material in a fusion target as compared to a sonoluminescing bubble. The temperatures and densities are also much higher in the fusion target.

But the important difference, Moss is quick to point out, is that laser fusion works: It produces fusion. However, Moss added, "I would say, to be as optimistic as we can and to be scientifically honest, that what we think we've shown is that it may not be impossible to get fusion this way."

Although Moss is hopeful, he said that even if fusion does not occur, there should be a wealth of physics coming out of this. "It seems to me that you can't lose scientifically," Moss said.

For Suslick the possibility of fusion from sonoluminescence is an open question. "To date no one has detected neutrons, no one has produced excess energy out compared to what's gone in, and so I think we're at a very tantalizing early stage," he noted.

Atchley pointed out that nobody knows what the limitations of sonoluminescence are in terms of temperatures and densities. "It may turn out that the limitations are exactly the same ones that people trying to do fusion research are butting up against," he said. Yet, he added, "maybe bubbles are a nice, spherically symmetric environment that people haven't thought about before for doing this kind of work."

On a broader point Atchley noted that sonoluminescence puts in the experimenter's hands a new regime to study, a region that in general has not been studied before. "It is a different window on the world," he said, "and who knows what you could find with that."

The Next Step

So where does sonoluminescence research go from here? There are a number of ideas on how to enhance the phenomenon to better study it. Suslick suggests that to achieve a bigger bubble—with the idea that a larger amount of gas would produce more light—would require going to lower frequencies. Most single-bubble sonoluminescence work has been done at between 20 to 40 kilohertz. One of the problems

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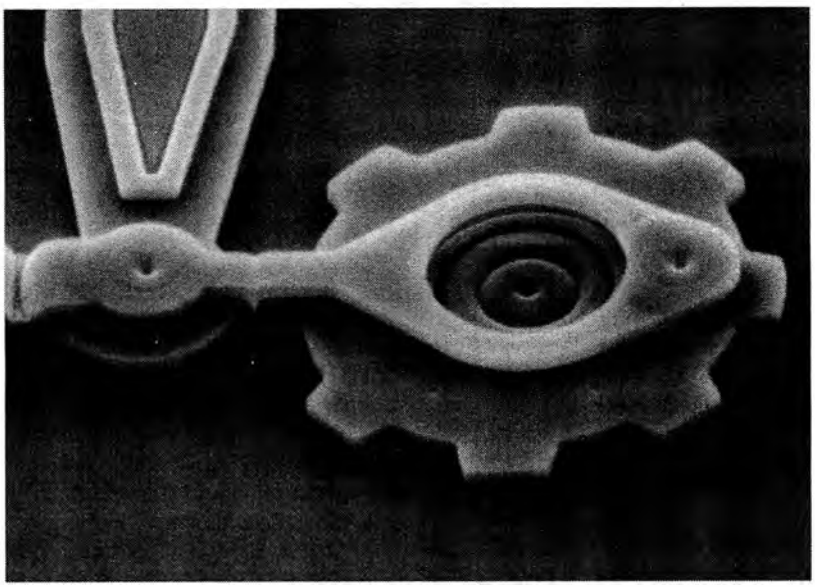
THE INVISIBLE REVOLUTION

Microelectromechanical Systems

by Jim Olson

During the last several decades, from the stunningly successful effort to miniaturize the components and circuitry of the computer has come a parallel quiet revolution. This revolution centers on the development of microelectromechanical systems (MEMS), and it is doubly invisible. It does not get the same headline coverage in the mass media that is devoted to the onrush of new computer and computer-related capabilities—the so-called information superhighway—and it involves building devices so small they are far below the ability of the human eye to see.

These devices are not computer electronics but are rather electrical, mechanical, and sensing devices that imitate, on a micron scale (millionths of a meter), many of the ordinary devices that are a vital part of modern life—electric and other motors and pumps, mechanical actuators, accelerometers, and a whole array of other sensing devices, including temperature, pressure, and light sensors able to detect intensity and frequency in different bands of the electromagnetic spectrum (see box p. 52).



Sandia National Laboratory

Figure 1
A MICRON-SCALE GEAR
Close-up of a high-rpm gear with a diameter of about 50 microns.

Enabling Technology

The basic enabling technology for all of this miniaturization is an old one, lithography. Lithography has been a method for making printing plates and electronic circuit boards. For circuitry, it has been described as "a process in which the desired circuit pattern is projected onto a photoresist coating a silicon wafer. When developed, portions of the resist can be selectively removed with a solvent, exposing parts of the wafer for etching and diffusion."* The same lithographic processes are also used in making microelectromechanical devices.

An important adjunct was the discovery of the remarkable properties of silicon as a semiconductor, as well as its other very useful physical and chemical properties. Because of these unique properties, silicon, in the form of a wafer, serves as the basic building block for both computer circuitry and microelectromechanical (MEMS) applications.

MEMS Devices

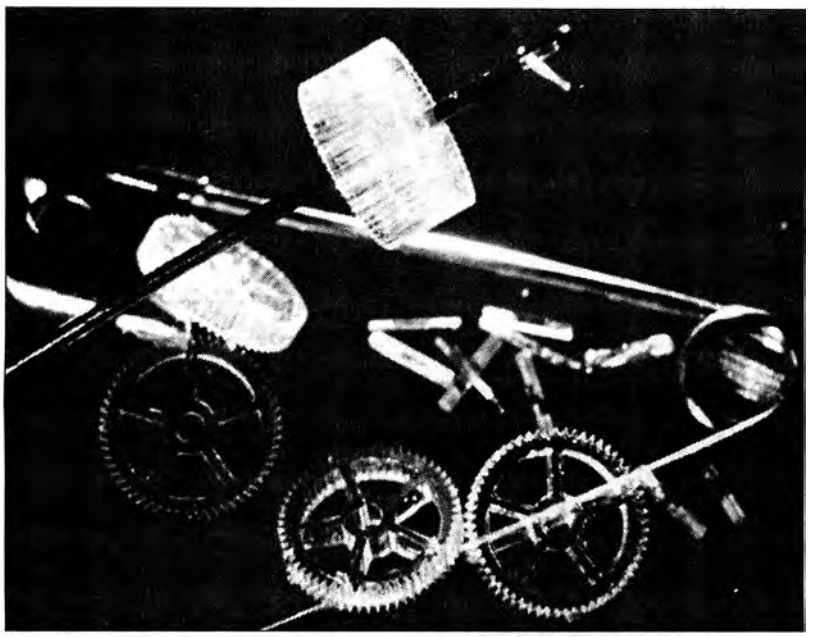
MEMS technology is being applied to two areas, actuators and sensors. Actuators cause a mechanical force or motion usually in response to an electrical signal. Generally, actuators involve devices with moving parts, as in an electric motor, or a solenoid-actuated valve. Sensors convert physical conditions such as temperature, pressure, acceleration, and light level into an electrical signal, and devices to measure temperature, pressure, acceleration, fluid flow rates, chemical composition, and light intensity and frequency are starting to move out of the laboratories and into the market.

Using lithography, these minute devices can be built on a single silicon (or other) wafer, by means of successive and repeated operations of resist coating, pattern-making (using visible light, ultraviolet light, and in some cases X-rays as the exposing energy source), washing with solvents, etching, and deposition of materials. By repeated application of these steps, a fairly complicated device can be built as a single process.

For example, a gear can be built on its shaft and freed to rotate, all in a single, unified in-situ process (no assembly of individual parts, as in ordinary manufacturing processes, is required). Furthermore, it is likely that many of them can be manufactured on a single wafer (batch fabrication).

Seeing the Unseen

Because it is highly desirable, perhaps essential, to be able to see what is going on in this micron-scale process, the ordinary optical light microscope is of limited utility, and most imaging is done with some variation of the elec-



Peter Horton, Brookhaven National Laboratory

Figure 2
PRODUCTS OF X-RAY LITHOGRAPHY
Precision gears made at Brookhaven National Laboratory using high-energy X-ray lithography.

tron microscope. In addition, various forms of the electron microscope are used to determine characteristics other than the mere size and shape of the object, properties such as crystal structure and composition.

Think of any area of human endeavor, and it is most likely that one of these emerging capabilities will have a very useful role—manufacturing, chemicals, medicine, quality control, transportation (including aviation), agriculture, energy production, consumer products, and so on. The list is endless.

High-speed Motors and Steam Engines

Scientists at Sandia National Laboratory in Albuquerque, N.M., using micromachining techniques and equipment mostly developed at the University of California's Berkeley Sensor and Actuator Center, have added their own contribution: a unique linkage to convert linear motor motion to rotary motion to drive the little gear shown in Figure 1. Although they do not have the ability at present to measure the rpm, they estimate it could be as high as 500,000. This has potential applications in medicine ". . . in unclogging arteries, destroying abnormal cells, or operating procedures inside eyes, ears, or perhaps even the brain," the Sandia scientists say.

In 1993, Sandia scientists succeeded in making the world's smallest steam engine, with a rectangular piston 6 micrometers wide by 2 micrometers deep, and a travel of 20 micrometers. The working fluid is water and the heat source is a hot wire filament. Steam power is capable of much more power and displacement than state-of-the art electrostatic micro-actuators. Again, potential applications abound in medicine where more power is needed to move micromechanical parts, and in other fields as well.

The Invisible Made Visible

Scientists at the National Synchrotron Light Source (Brookhaven National Laboratory) in New York are using their unique capabilities at the micron level to make larger parts also, up to sizes of about 2 centimeters (nearly an inch). They use powerful X-ray machines to make the exposures in the lithographic process. Dr. Peter Siddon explained, "We use X-rays with a peak energy of 20 kilo-electron volts. Because X-rays at this energy can penetrate thick structures, relatively large objects can be fabricated without any loss of precision."

They pass the X-rays through a form of masked plexiglas called PMMA and, using solvents to wash away the irradiated portions, are left with a plastic gear. Several examples of these are shown in Figure 2.

Reversing the process, they can form a mold of the gear, which can then be filled with metal by electrolysis and used as is, or used as a mold for making plastic parts. What is unique about this enlarging from the realm of the invisible to about the size of a thumbnail is the extraordinary precision—micron scale on all surfaces. At present, a German firm is exploiting this technology for production. Peter Siddon told *21st Century* in a January interview that Brookhaven MEMS scientists are also working on a way to separate DNA into its components, with obvious medical applications.

Current Applications

Analog Devices, Inc. of Wilmington, Mass., is currently selling a high-impact (50 g's) micro-accelerometer to both foreign and domestic auto manufacturers for triggering dash-mounted airbags. The complete unit, including electronic circuitry, is about the size of a transistor. The company claims the devices are low-cost, reliable, easy-to-use, and self-testing.

Analog Devices is about to begin to market a low-impact (5 g's) accelerometer that has many applications, ranging from triggering side-impact airbags, to serving as the backup navigational device for the Global Positioning System of navigational satellites, as a monitoring device for heavy rotating machinery, and even as a triggering mechanism to shut off gas or oil pipelines in the event of an earthquake.

Notes

* "Miniaturization Technologies," Office of Technology Assessment, U.S. Congress, publication OTA-TCT-514, Nov. 1991, p. 44.

How Small Is Small?

One micron is 1 millionth of a meter, or about 40 millionths of an inch. The ratio of 1 micron to an inch is roughly the ratio of 1 foot to 5 miles. Human hair varies from 50 to 100 microns in thickness.

Sonoluminescence

Continued from page 50

is that as the bubble becomes larger, it becomes more susceptible to structural deformation, limiting the size that can be spherically imploded.

The limitation now is that the bubble is bright enough to see with the human eye but too dim to be seen by some instruments. If the bubble could be made brighter, it might permit more accurate measurements. Another approach, Atchley points out, is to determine what conditions are necessary to produce sonoluminescence in different liquids and with various gases dissolved in those liquids.

"What we think we've shown is that it may not be impossible to get fusion this way."

Work at UCLA has shown that while sonoluminescence in air bubbles is strong, bubbles of pure oxygen or nitrogen do not work nearly as well, and sometimes they do not work at all. However, adding trace amounts of argon or xenon greatly improves the sonoluminescence of the nitrogen bubble.

Other ideas include changing the temperature of the liquid or increasing the pressure on the liquid to alter the rate of diffusion of gas from the liquid into the bubble.

One approach that does not seem to work is simply to crank up the sound field. There seems to be only a narrow range of acoustical amplitudes over which the bubble is stable. "If you drive it too low, the bubble doesn't glow," Atchley explained, and "if you drive it too hard, the bubble disappears." So the problem is, how does one more efficiently concentrate energy into the bubble? Moss and his pulse-shaping approach may provide the answer.

For Further Reading

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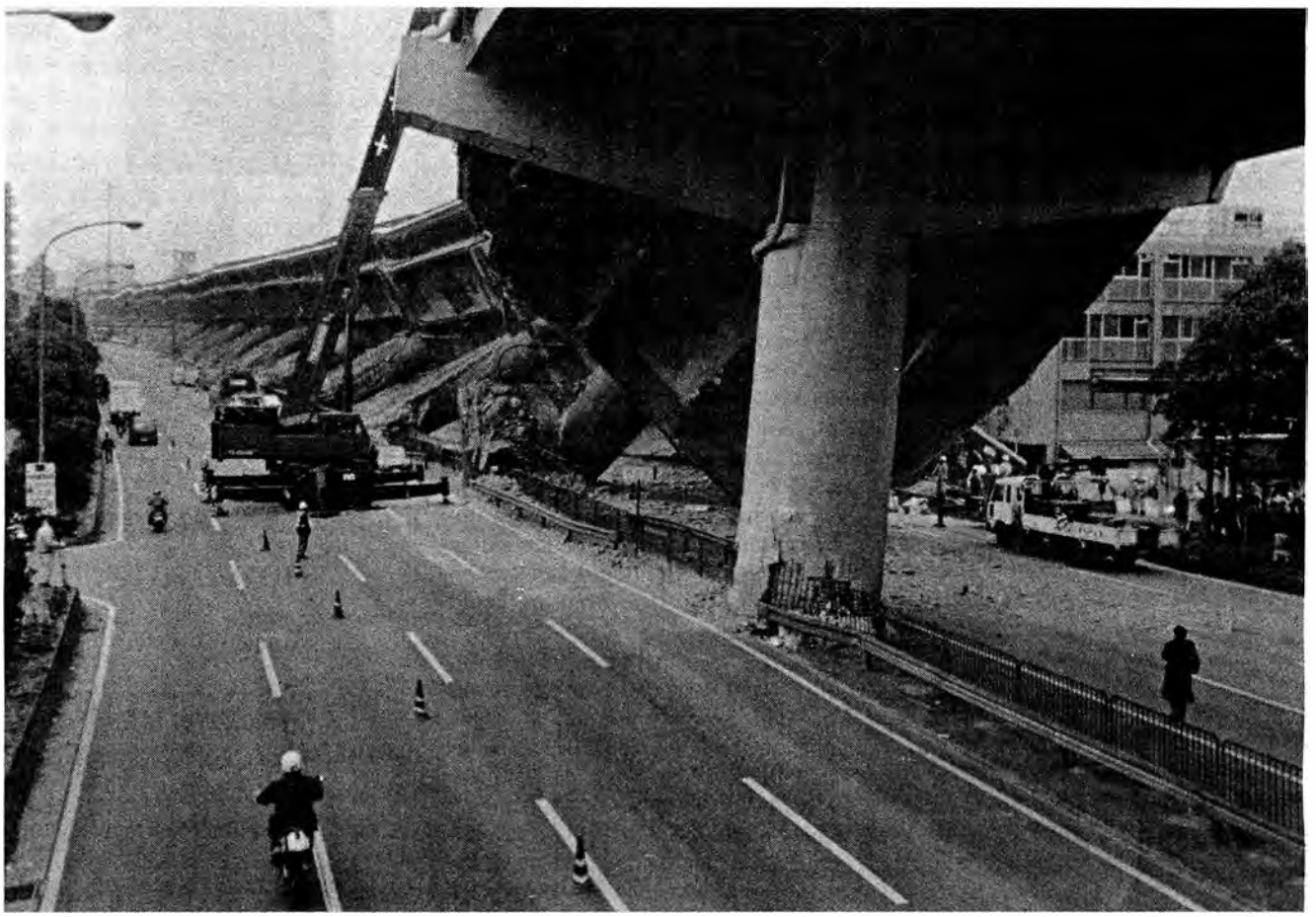
KOBE EARTHQUAKE SOUNDS ALARM

New Infrastructure Can Lessen Future Quake Damage

by Rogelio A. Maduro



Gerald Brady/U.S. Geological Survey

▲*Kobe's "earthquake-proof" highway toppled by the Great Hanshin quake in January.*

On Jan. 17, 1995, the Japanese cities of Kobe and Osaka were hit by one of the most destructive earthquakes of this century. The earthquake's toll in lives and collapsed infrastructure was enormous. More than 5,470 people were killed and 34,400 were injured—the greatest number of casualties from an earthquake in Japan since the great Kanto earthquake of 1923, which killed 140,000 people.

The quake, now known as the Great Hanshin Earthquake, either damaged or destroyed more than 170,000 houses, buildings, and factories. In addition, major lines of transport were also destroyed, including highways, rail lines, and the port of Kobe, one of the largest and most modern ports in the world. The estimates of the cost of the earthquake now range between $50 billion and $200 billion, and the damage the earthquake wrought may take more than a decade to repair.

As awful as it was, the Kobe earthquake may be just the first of several major earthquakes that are expected to strike urban areas in Japan, California, the Himalayas, and other highly populated areas in the years to come. For this reason, it is imperative that the scientific and engineering community, as well as national and local governments, learn the lessons of Kobe and immediately start implementing measures that can re-

duce the amount of destruction from future earthquakes and lay the groundwork to mobilize the necessary resources to deal with such disasters once they happen.

The Destruction

The earthquake, measuring 6.9 on the Richter scale, struck early on the morning of Jan. 17. Its epicenter was located at the small island of Awajima, 20 kilometers south of the port city of Kobe in the Seto Inland Sea. It took place shortly before 6 A.M. local time. As with the Northridge earthquake in California last year, there would have been many more fatalities had the quake struck later in the morning, when people would have been on their way to work.

The impact of the earthquake was devastating. Television footage showed expressways, bridges, and railroad tracks that had been constructed to withstand earthquakes broken or collapsed on the ground.

Several hundred fires broke out, mostly throughout Kobe. Fires raged out of control in Kobe as firemen were prevented from reaching the blazes by bridges that had collapsed and roads that were blocked by fallen buildings. With power lines down in many areas there was no electricity or water supplies in most parts of Kobe. Ruptured gas lines fueled the raging fires.

The impact of the quake was significantly greater than one would expect from its magnitude. The reason is that the epicenter of the quake was very shallow and the fault line went right through Kobe. According to Professor Megumi Mizoe, head of the Earthquake Research Institute at Tokyo University, "The quake jolted the area sideways first and then shot vertically, which bounced the land up several times. It was the strongest quake to date."

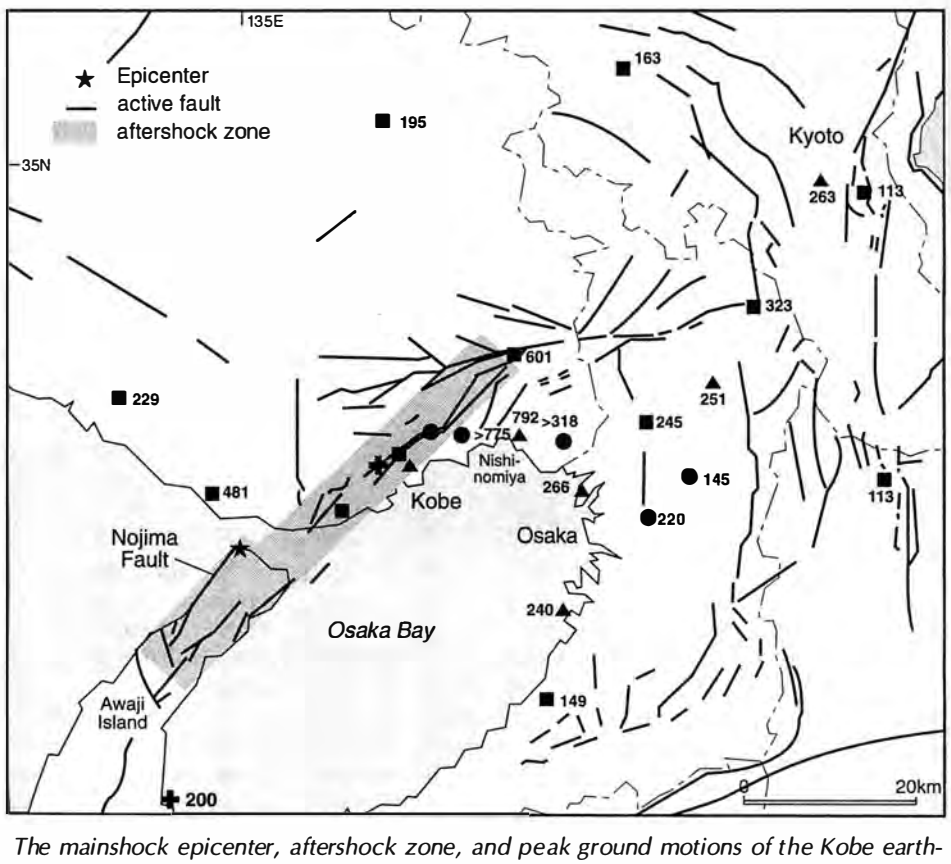
The underlying reason behind Japan's propensity for earthquakes is that it sits in an area of intense tectonic activity. The earth's crust is composed of several plates that are constantly shifting. These shifts occur along fault lines. When a shift occurs, an earthquake takes place. The intensity of the quake will be determined by many factors, including how much stress has been built up along the fault line. Areas where two or more plates collide, such as the Japanese islands, are dotted with major fault lines, and are sub-

Predictions for Los Angeles

In January 1995, no less than three separate scientific studies were released warning that the Los Angeles area faces a very high probability of being hit by a major earthquake in the next 30 years.

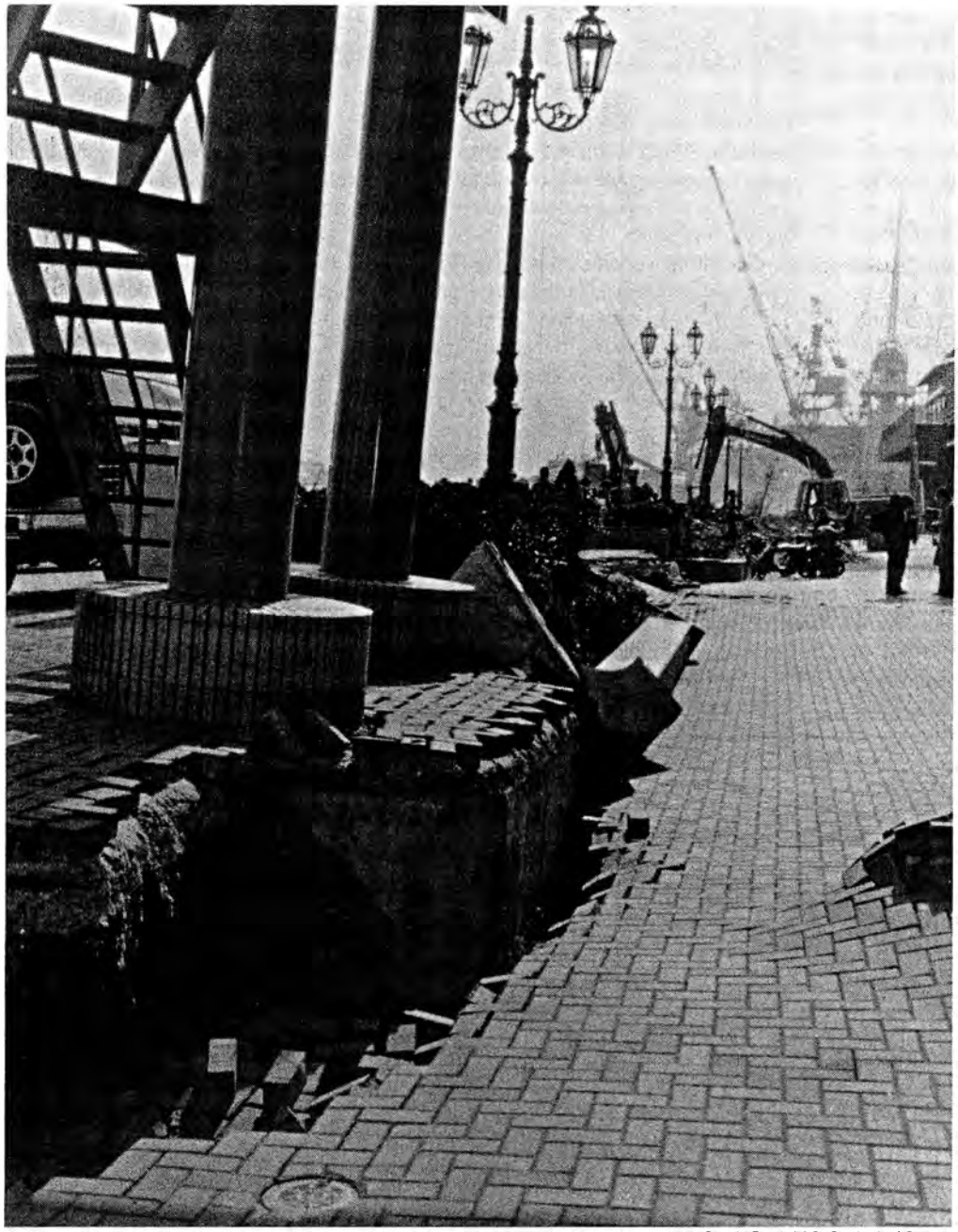
One of the reports, released by the Southern California Earthquake Center, a coalition of academic and government scientists, warned that Southern California faces an 86 percent chance of suffering an earthquake of magnitude 7 or larger by the year 2024. The calculated probability of an earthquake has been increased with the discovery of a large number of thrust faults in the area (similar to the kind of fault that caused the Northridge earthquake near Los Angeles a year ago).

In addition, historical earthquake data in California indicate that Southern California should expect six magnitude 7 earthquakes every century. So far this century, Southern California has suffered only one such quake. That is one of the factors convincing scientists to expect either a truly big earthquake, or several major ones.



The mainshock epicenter, aftershock zone, and peak ground motions of the Kobe earthquake, superimposed on a map of active faults. The numbers refer to ground motion.

Source: *EOS*, Transactions, American Geophysical Union, Vol. 76, Feb. 7, 1995, as adapted from K. Koketsu, Earthquake Research Institute, University of Tokyo



Gerald Brady/U.S. Geological Survey

Vertical ground failure in Kobe. In the background is the port.

ject to intense earthquake activity.

Mizoe says that other recent earthquakes that have struck Japan were far deeper. "This is the reason why this earthquake could be considered one of the biggest and a special case in Japan."

Scientists Not Surprised

Although the earthquake surprised the Japanese government and the public, it did not surprise the scientific community. Just one week before the quake, Kazuo Mino of the Ritsumeikan University in Kyoto had warned that the tectonic fault that stretches along the western coast of Japan had built up enough energy to cause a very powerful earthquake.

Mino predicted that a series of earthquakes registering more than 7 on the Richter scale would hit the region in the coming century. Mino's was not the only warning, however; many other Japanese scientists had made similar warnings in the past. Furthermore, there have been several major earthquakes in the same area in the past century.

For example, an earthquake measuring 6.1 on the Richter scale struck Awajima Island in 1916, killing more than 1,000 people and devastating the city of Osaka. Several earthquakes hit the area in the mid-to-late 1940s, but so much of Kobe and Osaka had already been destroyed by Allied bombers during World War II that the earthquakes caused little damage.

After the Great Hanshin earthquake, many leading Japanese researchers redoubled their warnings that several major earthquakes may strike Japan in the coming period. They are urging the Japanese government to drastically increase the pace of preparations for dealing with such natural catastrophes.

Kiyoo Mogi, chairman of the Liaison Council for Earthquake Prediction, told the press, "In west Japan earthquakes have entered a new stage of activity." Katsuhiko Ishibashi, head of the Applied Seismology Department of the Construction Ministry said, "There is a high possibility of severe earthquakes happening in several parts of the Chubu (centered on Nagoya) and Kinki (centered on Kyoto, Osaka and Kobe) regions, where there is a high density of dangerous, active fault lines."

Other seismologists are pointing out that Japan has entered a stage of earthquake activity after decades of relative tranquillity. Some Japanese scientists are predicting that earthquake activity will increase toward the end of the century into the start of next century in the Kanto region, which includes metropolitan Tokyo. Professor Yoichiro Fujii of Ibaraki University, told the press, "There is a high possibility of a type of earthquake directly under an urban area following the active period of earthquakes."

Japan's National Land Agency issued

a study in 1988 warning that a major earthquake in the Tokyo metropolitan area could destroy as many as 866,000 houses and buildings and affect more than 3,750,000 families.

Lessons from Kobe

There are several important lessons that have to be learned from the Great Hanshin earthquake. First and foremost, as with the Mexico City and Northridge earthquakes, most of the damage was caused by ground liquefaction. This phenomenon happens when seismic waves travel through soft soils or landfilled areas. These soils amplify the seismic waves and at a certain point they "liquefy," opening up the ground and toppling even earthquake-proof buildings. The greatest danger from this is, as with Kobe, that many of the great cities built in earthquake-prone areas, including Los Angeles and Tokyo, sit on top of soft soils.

Ground liquefaction can be prevented, however. Kobe demonstrated the success of a Japanese program to stabilize loose soils. In the past 20 years, more than 200,000 special gravel drains and buried stone columns were installed in certain landfilled areas of Kobe. These areas suffered minimal quake damage, while other landfilled areas, without benefit of these improvements, suffered severe damage. A similar program has been started in the United States.

The earthquake destroyed most of the urban transportation infrastructure, including highways, railroads, and the port. In addition, miles of water and gas pipes broke. Fires caused by gas from broken gas pipes, and worsened by the lack of water and the fact that the roads were impassable, were major factors in the high death toll.

The importance of a very solid urban infrastructure was made clear by these tragedies. A great deal of damage was done to the poor suburbs of Kobe, one of the weakest areas in Japanese earthquake damage-prevention efforts. In Kobe, as in many areas of Japan, older homes use a wooden post-and-beam construction style, where vertical posts brace long horizontal roof beams. Moreover, the traditional roofing for these structures in Japan is heavy terra cotta tile. This housing design is excellent for preventing damage from typhoons. However, it makes the structures inflexible and inherently unstable in earthquakes.

An examination of the pattern of destruction reveals that buildings and other structures that were built to the latest earthquake-proofing standards survived very well. Unfortunately, buildings built to earlier standards did poorly.

Can something similar to the Kobe horror take place in the United States? Unfortunately, yes. As many safety experts point out, Japan was much better prepared than the United States.

Perhaps the most important lessons from Kobe, as well as the Northridge and Santa Cruz earthquakes, are that these are natural disasters that will take place and will have devastating impacts on human habitation. Can something be done about it? Yes.

Steps such as anchoring loose soils do work. Many complain it is too expensive to undertake such infrastructure projects. In fact, the money is readily available. The United States and Japan are now spending well in excess of $30 billion a year funding studies and programs to protect people from nonexistent threats, such as global warming and ozone depletion. There is enough science to prove these alleged future "disasters" are scientific frauds. It is time to shift those funds to deal with real disasters.

Major Earthquake Expected in the Himalayas

A massive earthquake could hit the central Himalayan region of India at any time, geophysicists are warning. A group of Indian and American geophysicists has been studying historical data and more recent data collected using the latest satellite technology.

The data indicate that the central Himalayas in India are due to suffer a major earthquake, of magnitude 8 or 9 on the Richter scale. (The Kobe earthquake was magnitude 6.9. Because the scale is logarithmic, the predicted quake would be 10 to 100 times greater than the Kobe earthquake.)

Such an earthquake would devastate a region with a population of more than 200 million and several major dams. "It is like the Sword of Damocles hanging over you," said Roger Bilham of the University of Colorado at Boulder.

The Himalayan range was formed as the Indian subcontinent drifted northward and collided with the Asian continent, a process that began 40 to 50 million years ago. Bilham and his colleagues used the Global Positioning System (GPS), a network of satellites and ground stations, to chart the progress of a set of points on the Indian and Asian tectonic plates between 1991 and 1994. They found that India is still crunching into Asia at a speed of 2 centimeters per year, the same rate at which the two sides of the San Andreas Fault in California are sliding past each other.

These are the first direct measurements of the movement of the Indian subcontinent in relation to Asia, according to Vinod Gaur, former director of the Indian Geophysical Institute. Gaur is now based at the Center for Mathematical Modeling and Computer Simulation in Bangalore. Bilham, Gaur, and their colleagues recently presented their data at a meeting of the American Geophysical Union in San Francisco.

According to Roland Burgmann, a geophysicist at Stanford University in California, the India plate is moving down and under the Asian plate. The Global Positioning System data, however, indicate that all along the border with Nepal, the margins of the plates are stuck. Instead of one plate sliding smoothly under the other, the plates are colliding, storing energy like a spring. When the plate margins finally slip to release this energy, an earthquake results.

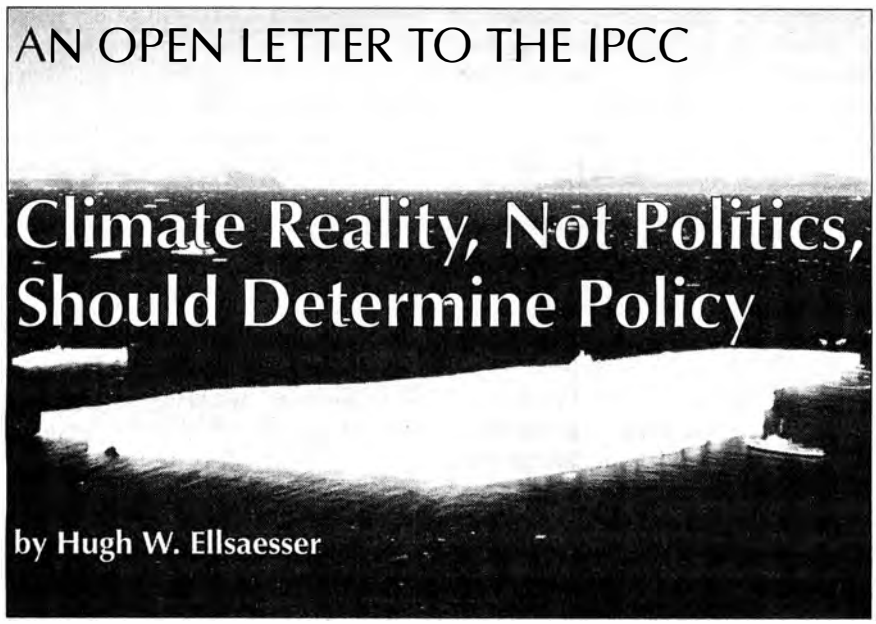
How big the earthquake will be depends on how much stress has accumulated along the boundary of the two plates.

—Ramtanu Maitra and Rogelio A. Maduro

AN OPEN LETTER TO THE IPCC

Climate Reality, Not Politics, Should Determine Policy

by Hugh W. Ellsaesser



Official U.S. Coast Guard Photograph

◀ *A U.S. Coast Guard icebreaker approaches an iceberg in Greenland.*

EDITOR'S NOTE

This open letter was distributed to the delegates at the Intergovernmental Panel on Climate Change meeting in Berlin March 28-April 4, along with other materials demonstrating that apocalyptic theories of climate change don't stand up to the facts. The IPCC meeting discussed how to meet the climate goals decided upon at the 1992 Earth Summit.

Dr. Ellsaesser is an atmospheric scientist with 43 years in climate research with the U.S. Air Force and at Lawrence Livermore National Laboratory.

Most discussions of greenhouse warming begin with at least the implication that the Earth's climate and atmosphere existed in natural, unchanging states before man intervened; that is, until the preindustrial era, circa 1850. In reality, the annually and globally averaged surface temperature is believed to have cooled some 5° to 10°C (9° to 18°F) since the time of the dinosaurs, approximately 100 million years before the present.

Over the same period, the carbon dioxide content of the atmosphere is believed to have decreased so that in the preindustrial era it was only 10 to 20 percent of the level that produced the lush vegetation on which the dinosaurs feasted.

The Antarctic ice cap began about 15 million years before present, and the Arctic ice caps, such as Greenland, began 3 to 5 million years before present. At about 2 million years before present, we dropped into the present Pleistocence Glaciation or Ice Age. This ice age has been characterized by some 17 glacial/interglacial cycles. The most recent cycles have typically shown a prolonged staged cooling lasting about 90,000 years, followed by a comparatively abrupt warming to the interglacial stage, which has typically lasted about 10,000 years.[1]

It is estimated that the mean global temperature was 3° to 5°C (5.4° to 9°F) colder than now at the climax of the glacials. We are currently in an interglacial stage called the Holocene, which began about 10,700 years before present. Thus, by present understanding, the onset of the next glacial cycle, with ice sheets building up to 3 km (10,000 feet) thick over Hudson Bay and Scandinavia, is now due. Some believe it is already under way.

Why do we not hear the argument that we should be adding carbon dioxide to the atmosphere deliberately to prevent or at least delay the onset of the now-due next glacial?

Students of the climate of the Holocene recognize some three cycles of warming and cooling, lasting up to 2,500 years each. Best recognized is the so-called Climatic Optimum, about 6,000 years before present, when temperatures are believed to have been 1° to 2°C (1.8° to 3.6°F) warmer than at present.

The most recent warm and cool periods are recorded in our history books: the Little or Medieval Climatic Optimum about 1,000 years before present when the ice in the North Atlantic melted back and the Norsemen were able to colonize Iceland and Greenland, and the following Little Ice Age (circa 1430 to 1850) when the Greenland colony died out and history recorded glacier advances and abandonment of farms and villages in parts of Europe, particularly in Norway.

By present estimates, the roughly 0.5°C (0.9°F) warming since the beginning of our temperature records has taken us only about halfway from the nadir of the Little Ice Age to the temperature believed to have prevailed during the Medieval Climatic Optimum. In short, we have two rather well documented periods of climate during the Holocene in which the mean surface temperature was warmer than it is now and our ice core data say that the carbon dioxide in the atmosphere was at the preindustrial level.

That is, although we still have no clue as to the cause of these temperature cycles of the Holocene, a natural recovery from the Little Ice Age is the least controversial explanation of the warming we have seen to date.

These temperature cycles also show that our climate is capable of warming at least 1°C (1.8°F) above our present temperature with carbon dioxide at the preindustrial level. In other words, it did not need increased carbon dioxide to warm this much 6,000 years before present. Note also that the periods of warmer climate have been called *climatic optima*—and well they must have appeared to the colonist left in Greenland and to the Norwegians who were pushed out of their farms and villages by advancing glaciers during the Little Ice Age.

The Failure of Climate Models

Since the first model-produced estimate of 2.36° of greenhouse warming for a doubling of carbon dioxide by Suki Manabe and Dick Wetherald in 1967,[2] the observational temperature record has consistently failed to reveal climate warming as rapidly as predicted by the climate models. This inconsistency has grown both because the warming predicted by the models has increased and

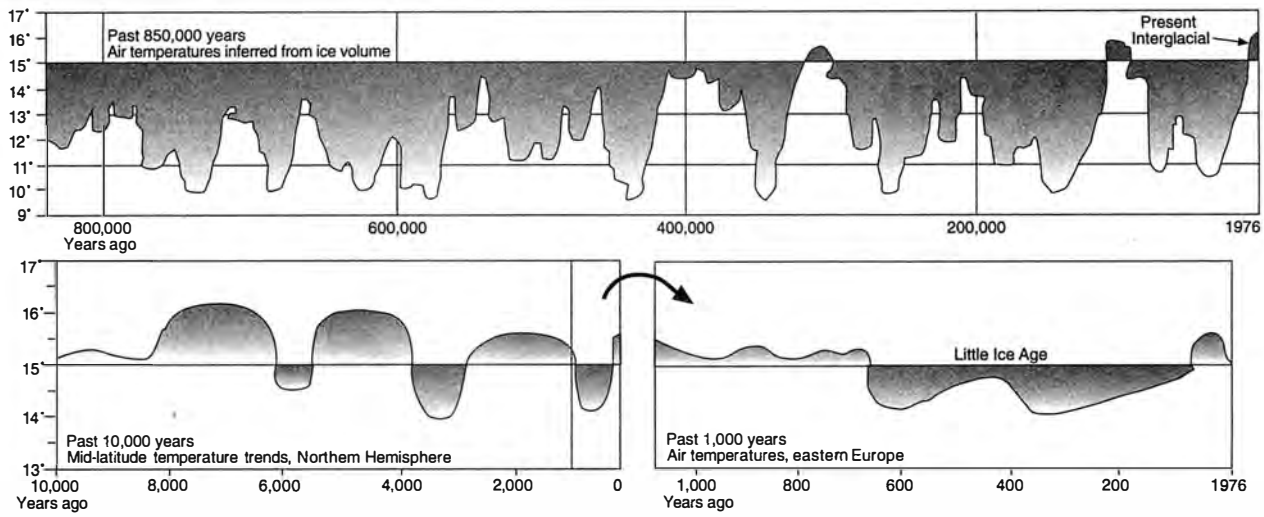


Figure 1

RECONSTRUCTION OF THE EARTH'S CLIMATE OVER THE MOST RECENT 850,000 YEARS

This artist's rendition shows the mean global temperature for the past 850,000 years (a) and in more detail for the past 10,000 years (b) and the past 1,000 years (c). The air temperatures are inferred from ice volume. There were at least three cyclic warmings and coolings in the past 10,000 years, lasting about 2,500 years each. Periods warmer than usual until recently were called climatic optima, not climatic catastrophes.

Source: Adapted from S.W. Matthews, 1976, "What's Happening to our Climate?" *National Geographic* (Nov.), p. 576

because other greenhouse gases such as methane, nitrous oxide, the freons, and so on, have been included, so that we are already halfway to an effective doubling of the carbon dioxide in the atmosphere. Under equilibrium conditions, we should have seen slightly more than half of the greenhouse warming predicted for a doubling of carbon dioxide; that is, 0.75° to 2°C (1.25° to 3.6°F). Until recently, the only explanation offered for this failure was lag caused by the long time required to warm up the oceans to considerable depth.

The IPCC reports of 1990 and 1992 contained the statements: "global mean surface air temperature has increased by 0.3° to 0.6° over the last 100 years. . . . [T]he size of this warming is *broadly consistent* [emphasis added] with predictions of climate models."[3]

At no point do either of these reports state the model-predicted temperature rise for 1990, but Figure 8 of the Policymakers' Summary (IPCC 1990, p. xxii) is a graph of "Realized Temperature Rise above 1765." The ordinates for 1990 of the "Low," "Best," and "High" estimate curves are 0.7°, 1.0°, and 1.4°C. In other words, there is no overlap between these two estimates that are claimed to be "broadly consistent" in the texts.

Recently, one of the major contributors to the IPCC reports released the following public statement:[4] "In earlier calculations, the cooling effects of sulphate aerosols and stratospheric ozone depletion were not included. When they are, the observed warming trend lies right in the middle of the range of values simulated by models. In other words, *there is no longer any inconsistency between models and observations* [emphasis added]."

Politically Shaded

From the above, one can only conclude that the IPCC quote emphasized

Continued on page 61

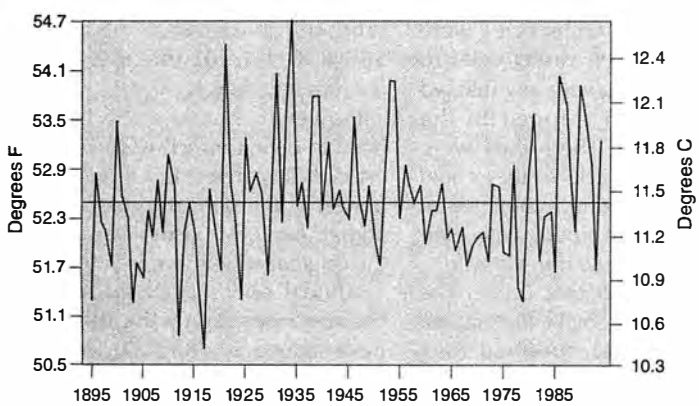


Figure 2

U.S. MEAN ANNUAL TEMPERATURE, 1895-1994

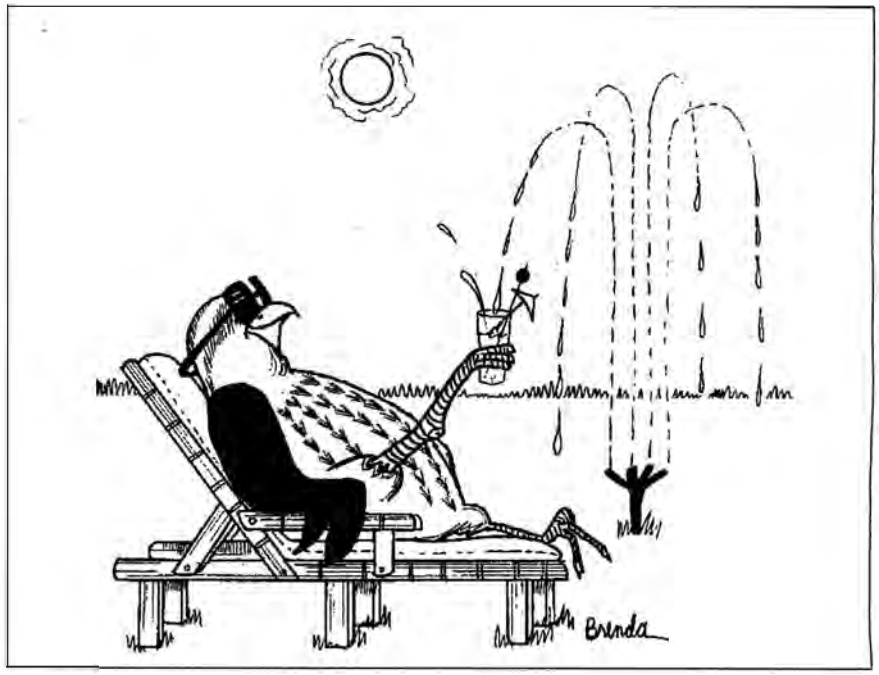
This 100-year temperature record, based on data from the National Climatic Data Center, is considered to be "the greatest combination of areal extent and number of observing stations of any in the world," according to the World Climate Review, *with 16,000 measuring stations.*

These data don't match the dire predictions of the global warming alarmists. Since 1935, there has been no net change in temperature. The tiny rise that occurs in these 100 years takes place before 1935 and hence before the alleged industrial culprits were in business.

Source: *World Climate Review*, Winter 1995, p. 17

Solid Gold (X 10) Quail

by R.S. Bennett



Deep in southern Arizona, near the Mexican border, there is a flock of possibly as many as 300 quail that have cost taxpayers more than $90,000,000. It is a classic story of bureaucratic deception and incompetence.

The story begins in the early 1980s, when a biologist for the Fish and Wildlife Service of the Department of the Interior conceived the idea of "reintroducing" the masked bobwhite quail into southern Arizona. It was not important that the bird had not been seen in Arizona for 80 years or that prior to that time, sightings had been occasional and sporadic. The quails' demise was blamed on cattle grazing that had allegedly depleted the plants that provided food for the quail.

The only known masked bobwhite quail still living were in the Mexican Sonoran Desert near Hermosillo—some 300 miles from the United States. The plan that the Fish and Wildlife Service first developed was to create the 115,000-acre Buenos Aires National Wildlife Refuge (BANWR) in southern Arizona and then transplant quail captured in Mexico to this refuge where they would breed in the wild and become established.

These early attempts were unsuccessful but the coyotes in the area did look fatter.

The land acquired for the refuge was partially privately owned and additional acreage was obtained by land exchanges between the state and federal agencies. It had all been put to productive use and property and income taxes and grazing fees were being paid to local, state, and federal governments.

Under the authority given to them under the Endangered Species Act, the Fish and Wildlife Service now declared the masked bobwhites an Endangered Species. Originally, there was some question whether this could be legally done, because no birds had been found in the United States in more than 80 years, but that issue was skirted very nicely using the fact that the quail had been "reintroduced" from Mexico.

Planned Parenthood

The next plan was much more elaborate in size and scope. The Patuxent Wildlife Research Center of the Fish and Wildlife Service in Laurel, Maryland, was to be the source of newly hatched quail chicks. Adult male and female birds (at least they got that part right) were transported from Mexico and the breeding program began. Female quail normally lay eggs only once a year until they get enough for a brood of 10 to 12 birds, but these brood females were tricked into laying eggs on a continual basis by taking away the eggs as they were laid.

The chicks were fed on pellets for a period of time and then shipped to the refuge in Arizona. Meanwhile, about 200 male quail of a different species were trapped in Texas, given vasectomies to keep them from mating with any masked bobwhite hens, and shipped to the Buenos Aires refuge. There they were each given 10 to 12 chicks so they could serve as brood surrogate fathers. After about two weeks, the broods with their new fathers were released into the wild.

Since 1985, the Patuxent Center has shipped 19,654 quail chicks to Arizona. Of these only 15,931 survived long enough to be released into the wild—an 81 percent survival rate. And what of the released birds? At the bird census conducted by Fish and Wildlife personnel in late 1993 there were approximately 300 quail on the Buenos Aires refuge—a survival rate of 1.5 percent of the birds received from Patuxent.

However, there is considerable doubt about the accuracy of this figure. Each year the Audubon Society conducts a bird survey on the Buenos Aires Refuge as it does throughout much of the country. For the last two years—in December 1993 and 1994—not a single masked bobwhite quail has been sighted on or near the refuge.

Paying through the Beak

And the cost? The original refuge consisted of 21,282 acres in 1985 and cost $9,794,304. Since that time, an additional 96,512 acres with a value of $42,046,646 have been acquired. The total cost, with the inclusion of $1,996,000 scheduled to be used for land purchases in 1995, has been $53,836,950 for the 117,800 acres puchased to date.

However, because the budget has been in deficit for many years, the interest cost (8 percent for 30-year Treasury bonds) of the borrowed money must be added. Now, 10 years later, the cost of the original acquisition is $79,623,146.

Annual operating, construction and maintenance costs for the 10-year period have totaled $7,439,800. The breeding program at Patuxent has cost another $816,550; the total cost of the program to date is $87,900,000 or $293,000 for

each of the 300 quail. And this does not take into account the lost tax monies paid by the former productive enterprise of the set-aside land!

To get some perspective: an adult quail weighs 7 ounces. A pound of gold is worth $4,320. Each surviving bird, *not counting land costs,* has had an obscene $27,500 expended upon it. So each bird has cost $3,930 per ounce, more than 10 times the value of gold. These are indeed solid gold (X10) quail.

Does this bother the Fish and Wildlife Service? Not at all, judging by their latest scheme not only to carry on the "reintroduction" program but to *expand* it. On the present site they plan to try habitat modification by discing areas to seed to new forage plants, half-cutting and chain-sawing to remove woody vegetation, and a program of prescribed burning, introduction of cattle for grazing (Fish and Wildlife Service cattle are apparently more beneficial to the land than privately owned cattle) and *installing sprinkler systems so the plants and birds will have plenty of water.*

Foreign Aid?

Even more arrogantly, the Fish and Wildlife Service wants to spend more than half a million dollars in Mexico to give technical assistance to the Mexicans to manage their flock of some 1,500 native masked bobwhite quail. (It is unfortunate there is not a futures market for Mexican quail; short buyers should do very well.)

There's more. The last straw in the new plan is to acquire another noncontiguous refuge in southern Arizona for an expanded "reintroduction" area.

Even the most amateur of biologists would question at this point whether the habitat in southern Arizona is suitable for masked bobwhites. But not the Fish and Wildlife Service. Its guideline is that if the habitat is not suitable, then modify the habitat! No matter that the Endangered Species Act prohibits habitat modification for Endangered Species.

Since its establishment in 1985 the Fish and Wildlife Service has been actively expanding the refuge from 21,282 acres to the present 117,794 acres. The 1995 budget contains a $2 million appropriation for additional land purchases at the refuge. The latest plan is to establish another masked bobwhite "reintroduction" area along the Santa Cruz River, east of the present refuge.

The Fish and Wildlife Service has stated that it intends to do this only on "private" land. This is simply not true. And even if it were, how does the Fish and Wildlife Service plan to spend public monies on private land?

Fiscal Madness

Unfortunately, this is the kind of fiscal madness that permeates much of the Department of the Interior, the parent agency of the Fish and Wildlife Service. Deception, incompetence, and misuse of public monies are not uncommon.

It is time to stop the senseless programs that serve only as a drag on the productive sectors of the economy. Otherwise, the coyotes will continue to gain weight at your expense.

R.S. Bennett is executive director of the Society for Environmental Truth, Tucson, Arizona.

Correction

An editorial error in the Spring 1995 issue on p. 53 misstated the name and date of a volcanic eruption mentioned by Dr. Hugh Ellsaesser ("Atmospheric Scientist Shocked by NASA Ozone Announcement"). The volcanic eruption in Iceland that put out enough fluorine to kill hundreds or thousands of people and animals was Mt. Laki in 1783.

Climate Reality

Continued from page 59

earlier was a politically shaded statement, not a scientifically objective statement, of the views of the IPCC participants. This, in turn, raises questions as to whether other IPCC statements are more political than scientific. Such questioning was strengthened by events at the Sept. 15, 1994, IPCC meeting in Maastricht, Netherlands, and the resultant articles, such as the Dec. 1, 1994, commentary in *Nature* titled "A Scientific Agenda for Climate Policy?"

This, in turn, raises the question as to what or who induced William Stevens to write his Jan. 27 1995, article in *The New York Times,* "A Global Warming Resumed in 1994, Climate Data Show." The included graph of global temperature data shows only a rise from a 1992 minimum and 1994 only the 5th or 6th warmest year of the record (by surface data—16th by satellite data).

The record warmth of 1990, by the way, itself lies on shaky ground because it is supported only by surface-based observations. Satellite data indicate that the record warm anomalies over Eurasia causing 1990 to be the warmest year were largely balanced by large negative anomalies over the Arctic Ocean where there were few if any surface observing stations to record them.

In other words, the record warmth of 1990 was the result of a fluke in the distributions of the temperature anomalies and of the network of surface observing stations recording them. By satellite data, 1990 was only the fourth warmest year in the record since 1979.

Notes

1. An account of this process appears in "The Coming (or Present) Ice Age" by Laurence Hecht, *21st Century,* Winter 1993-1994, p. 22.
2. S. Manabe and R.T. Wetherald, 1967. "Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity," *J. of the Atmospheric Sciences,* Vol. 24, No. 3, pp. 241-259.
3. IPCC, 1990. *The IPCC Scientific Assessment,* eds. J.T. Houghton, G.J. Jenkins, and J.J. Ephraums (Cambridge: Cambridge University Press); IPCC 1992. *Climate Change 1992, The Supplementary Report to the IPCC Scientific Assessment,* eds. J.T. Houghton, B.A. Callander, and S.K. Varney (Cambridge: Cambridge University Press).
4. A press release containing this statement accompanied the publication by T.M.I. Wigley and S.L.B. Raper of the article "Implications for Climate and Sea Level of Revised IPCC Emissions Scenarios," May 28, 1992, p. 293.

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An Open Letter to the President of the United States

Officials Call for LaRouche's Exoneration

On Jan. 26, 1994, the American statesman and physical economist Lyndon H. LaRouche was freed on parole after having served five years in federal prison as a political prisoner.

His freedom came only after an unprecedented international mobilization. Close to 1,000 of America's foremost legal experts had petitioned the court as *amici curiae,* calling the case "a threat to every politically active citizen." The case was brought before the United Nations Commission on Human Rights, the Organization of American States, and the Commission on Security and Cooperation in Europe (CSCE). Literally thousands of parliamentarians and other elected officials joined with religious leaders, artists, scientists, and human rights figures from across the globe to demand an end to LaRouche's unjust incarceration. Hundreds travelled in delegations to Washington, D.C. to lobby for LaRouche's freedom.

Finally, after five long years, Lyndon LaRouche was freed on parole. But the fact remains that a terrible crime still goes unanswered. Not only was an innocent man framed, convicted, and wrongfully imprisoned for five years, but, it is now clearly the case, documented by six volumes of unchallengeable evidence, consisting chiefly of government documents and admissions of government-led task force officials, that the U.S. government knew at all relevant times, from 1979 to the present day, that Lyndon H. LaRouche and his co-defendants were innocent of the false charges for which they were convicted. This proof, that the government fraudulently charged, convicted, and imprisoned LaRouche and his associates, knowing they were completely innocent, is part of the public record on file with the Federal appeals court in Richmond, Va.

Yet to this day, not only have the U.S. Federal courts and the Justice Department failed to rectify this fraudulent conviction, but, while this critical evidence sits gathering dust without ever being heard, five of Mr. LaRouche's associates still sit in prison, serving decades-long sentences.

We, the undersigned, are compelled to act in the name of law, to demand that you, Mr. President, along with Attorney General Janet Reno, and the appropriate committees of the U.S. Congress, take any and all measures necessary to ensure the full and immediate exoneration of Lyndon LaRouche. The failure to do so does not stain the honor of Lyndon LaRouche, who has paid a terrible price for his innocence, but the honor of the U.S. justice system and Constitution, which, for more than 200 years prior to this dark episode, stood as the symbols of liberty and justice for all.

The following statement is not part of the Open Letter and has not been endorsed by those who endorsed the Open Letter.

Judges in LaRouche Case Cite Gov't Misconduct

Disregard for the U.S. Constitution and the rule of law was the mode of operation in the illegal railroading of Lyndon LaRouche, Jr. and his associates. Three judges, having heard evidence of prosecutorial misconduct, have all strongly rebuked the government for their conduct in the LaRouche case:

• In 1988, U.S. District Court Judge Robert Keeton of Boston found "institutional and systemic prosecutorial misconduct" during the trial of LaRouche and others in Boston. [*U.S. v. LaRouche, et al.* (Memorandum and Order "Emerson Hearing" August 10, 1988, at p. 56).] That case ended in a mistrial.

• In 1989, U.S. Bankruptcy Judge Martin V.B. Bostetter found that federal officials had acted in "objective bad faith" and by a "constructive fraud on the court" when they illegally put three publishing companies into involuntary bankruptcy as part of the political prosecution of LaRouche and his associates. [*In re Caucus Distributors, Inc.* (E.D.Va. 1989), 106 B.R. 890.]

• In a Feb. 16, 1995 ruling vacating convictions by New York State of three associates of Mr. LaRouche, New York State Supreme Court Judge Stephen G. Crane found that the conduct of New York and Federal Government agents "raises an inference of a conspiracy to lay low these defendants at any cost both here and in Virginia."

The evidence of government misconduct was summed up in September 1994 by former U.S. Attorney General Ramsey Clark. Appearing before an independent body of international legal experts who reviewed the evidence in the LaRouche case, Mr. Clark said that the LaRouche case, viewed in context, "represented a broader range of deliberate cunning and systematic misconduct over a longer period of time utilizing the power of the federal government than any other prosecution by the U.S. Government in my time or to my knowledge."

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(The following list of current and former government and elected officials is a selection of signers of the above statement. Affiliations are for identification purposes only.)

(f) indicates former
MP indicates Member of Parliament

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Sen. Khurshid Ahmad, MP, Pakistan

BOOKS RECEIVED

The Earth Summit CD-ROM. New York: United Nations, 1993. Software, one disk, $495.

Eco-Sanity—A Common-sense Guide to Environmentalism, by Joseph L. Bast, Peter J. Hill, and Richard C. Rue. Lanham, Md.: Madison Books, 1994. Hardcover, 316 pages, $22.95.

The Guide to the Galaxy, by Nigel Henbest and Heather Couper. New York: Cambridge University Press, 1994. Hardcover, 265 pages.

Health Effects of Low-level Radiation, by Sohei Kondo. Madison, Wis.: Medical Physics Publishing, 1994. Paper, 213 pages.

International Cooperation in Space: The Example of the European Space Agency by Roger M. Bonnet and Vittorio Manno. Cambridge, Mass.: Harvard University Press, 1994. Cloth, 163 pages, $39.95.

Life in Moving Fluids—The Physical Biology of Flow, by Steven Vogel. Second edition, revised and expanded. Princeton, N.J.: Princeton University Press, 1994. Cloth, 467 pages, $49.50.

Modern Theories of the Universe: From Herschel to Hubble, by Michael J. Crowe. New York: Dover Publications, 1994. Paper, 435 pages, $9.95.

The Origin of the Solar System—Soviet Research 1925-1991, edited by Aleksey E. Levin and Stephen G. Brush. Woodbury, N.Y.: AIP Press, 1995. Hardcover, 415 pages, $60.00.

The Perfect Machine: Building the Palomar Telescope, by Ronald Florence. New York: Harper Collins, 1994. Hardcover, 451 pages, $27.50.

Phyllotaxis—A Systemic Study in Plant Morphogenesis, by Roger V. Jean. New York: Cambridge University Press, 1994, Cloth, 386 pages.

Prospects in Nanotechnology: Toward Molecular Manufacturing, edited by Markus Krummenacker and James Lewis. New York: John Wiley & Sons, 1995. Hardcover, 297 pages, $49.95.

The Quest for Comets: An Explosive Trail of Beauty and Danger, by David H. Levy. New York: Plenum Press, 1994. Cloth, 280 pages, $23.95.

Radioactivity and Health: A History. Vol. 1: Laboratory Research; Vol. 2: Environmental Aspects; Vol. 3: Applied Aspects, Instrumentation, and Conclusions, by J. Newell Stannard. Columbus, Oh.: Battelle Press, 1988. Cloth, 1,909 pages. $97.50 each.

Radio Amateurs Guide to the Ionosphere, by Leo F. McNamara. Melbourne, Fla.: Krieger Publishing Co., 1994. Paper, 166 pages, $39.50.

Rivers of the United States, Vol. II, Chemical and Physical Characteristics, by Ruth Patrick. New York: John Wiley & Sons, 1995. Cloth, 237 pages, $89.00.

Secrets of the Night Sky, by Bob Berman. New York: William Morrow, 1995. Hardcover, 320 pages, $23.00.

Solar and Stellar Activity Cycles, by Peter R. Wilson. New York: Cambridge University Press, 1994. Hardcover, 274 pages.

Stairway to the Stars: The Story of the World's Largest Observatory, by Barry Parker. New York: Plenum Press, 1994. Cloth, 350 pages, $27.95.

Structures in the Stream—Water, Science, and the Rise of the U.S. Army Corps of Engineers, by Todd Shallat. Austin, Tex.: University of Texas Press, 1994. Cloth, 276 pages, $34.95.

Understanding Radioactive Waste, Fourth edition, by Raymond L. Murray. Columbus, Oh.: Battelle Press, 1994. Paper, 212 pages.

Plant seeds of knowledge.

The Holes in the Ozone Scare: The Scientific Evidence That the Sky Isn't Falling
by Rogelio A. Maduro and Ralf Schauerhammer
$15 each, plus $3 shipping
OR $10 postpaid with a subscription

Video on the ozone hoax "Fair Skin—Stay In"
1-hour documentary produced by the Belgian television network BRTN. VHS, English narration, some subtitles.
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How We Got to the Moon: The Story of the German Space Pioneers
by Marsha Freeman
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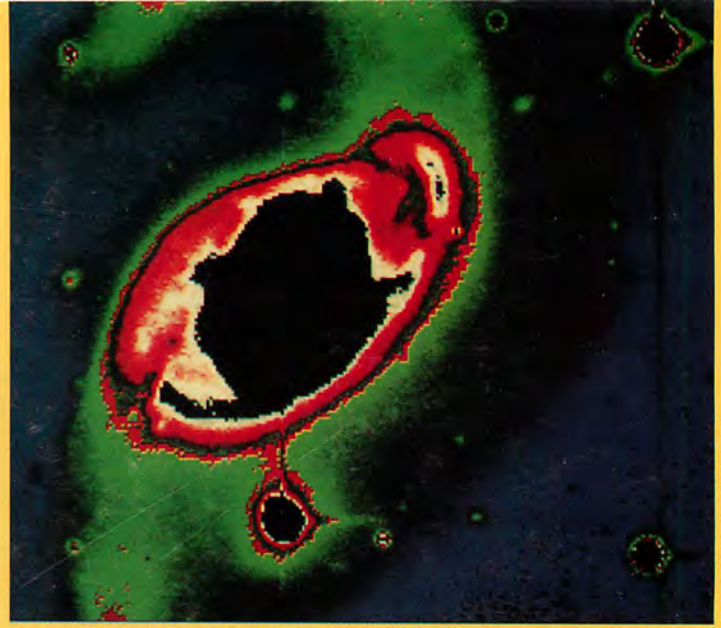
Max Planck (1858-1947)

BRING BACK THE METHOD OF MAX PLANCK!

Max Planck's dramatic discovery of the quantization of energy shook the scientific establishment of his day. He and the small group who supported him had to fight even to get his ideas taken seriously, and the implications of his work still remain a challenge. The story of Planck's life and work, told by Caroline Hartmann, provides a rich historical perspective for those fighting for truth today against the same enemies of science.



Halton Arp and Jack Sulentic

Galaxy NGC 4319 and below it quasar Markarian 205, apparently connected by a narrow bridge shown in red in this false-color computer image. Because the redshifts of the two objects are very different, the science establishment has insisted that the quasar is an unrelated background object.

HUBBLE RESULTS SHAKE ACCEPTED QUASAR THEORY

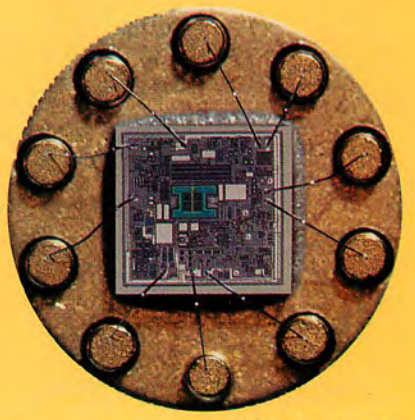
A single set of Hubble Space Telescope observations delivers a knock-out blow to the hegemonic theory of quasars. The new observations support evidence for the theories of Armenian astronomer Victor Ambartsumian and American astronomer Halton Arp. Both argue that quasars are ejected from the nuclei of galaxies and are themselves the seeds of new galaxies. David Cherry sketches the history of the controversy.

Joseph T. Carlson/Naval Postgraduate School

Time-lapse photograph of a sonoluminescence experiment at Lawrence Livermore National Laboratory. Transducers surround a 500-milliliter flask with a flash of light in the center.

PROBING THE MYSTERIES OF SONOLUMINESCENCE

Sonoluminescence is the phenomenon of producing light from sound. In the Research Frontiers section, Mark Wilsey reports on the latest work toward understanding the physics of a bubble created by ultrasound in water that emits light as it collapses. More and more scientists are intrigued by the possibilities of harnessing this highly intense energy.



Courtesy of Analog Devices

This tiny 3 x 3 millimeter chip is the first fully integrated surface-micromachined accelerometer on the market. It is intended for use as an automotive air bag controller.

THE INVISIBLE REVOLUTION OF MICROELECTROMECHANICS

Imagine motors, pumps, actuators, and sensing devices so small that the human eye cannot see them at work. As Jim Olson reports in the Research Frontiers section, such devices not only are being built, but in the near future may be performing useful work in your car or in your bloodstream.