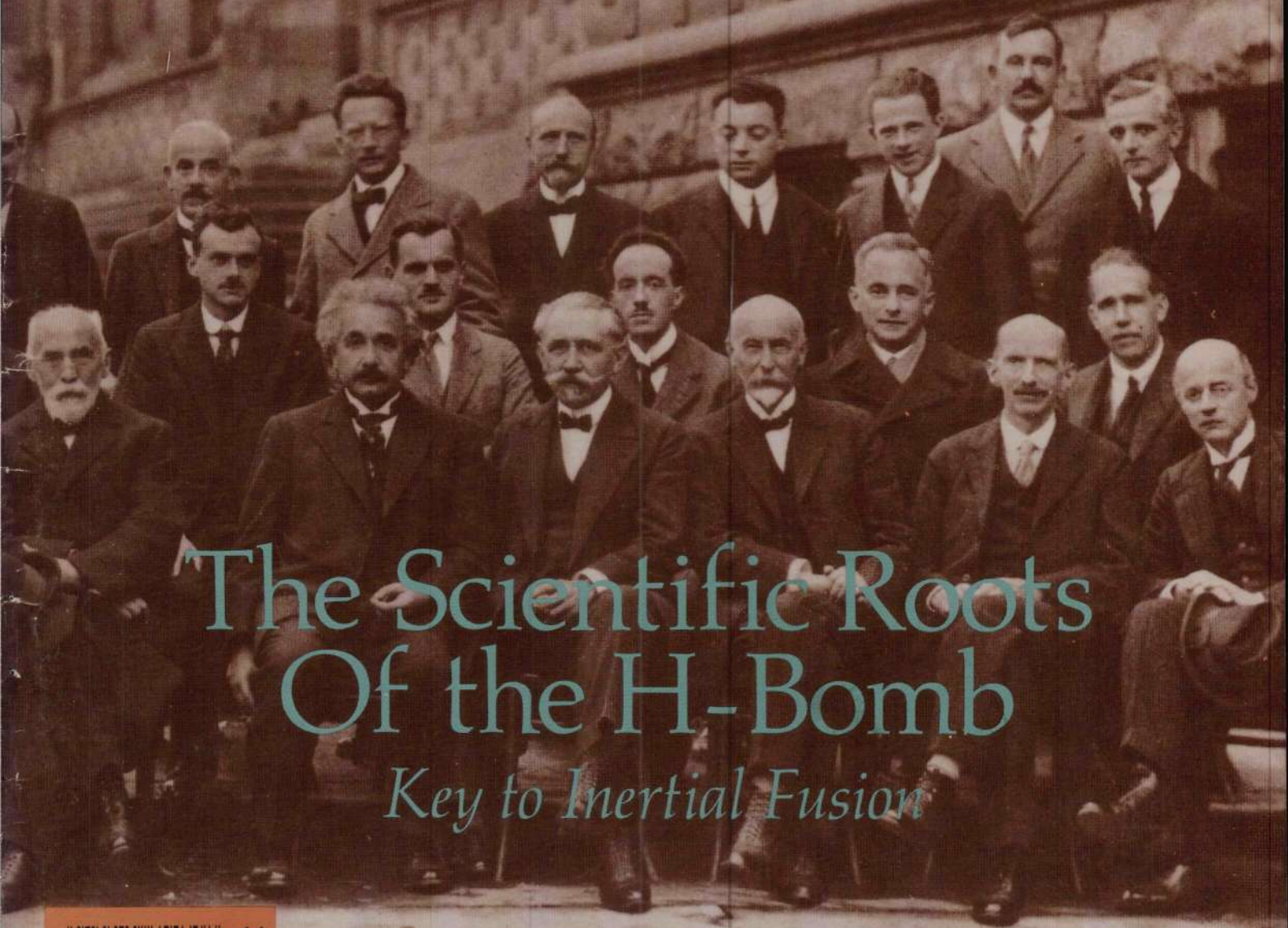


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# FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION  
November 1979

\$2.00



## The Scientific Roots Of the H-Bomb

*Key to Inertial Fusion*



# FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION

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### Note to Readers

The Fusion Energy Foundation and Fusion magazine have moved to more spacious quarters. Please address all correspondence to 888 Seventh Avenue, Suite 2404, New York, N.Y. 10019.

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## Stop Killing Fusion Research

Recent investigative work by the *Fusion* magazine staff has revealed a pattern of Department of Energy actions to contain and bleed the fusion program to death.

Consider the following items:

(1) The Department of Energy insists on an absurd 20- to 30-year scenario for fusion test reactor development, when an immediate engineering project could cut this time schedule to as little as 10 years. So far, there has been no appropriate reply from the DOE to the request by Congressman Mike McCormack for an analysis of why we cannot meet the accelerated timetable.

(2) The DOE is withholding publication and has classified key sections of the Foster Committee recommendations for beefing up laser fusion development. The Foster Committee is an independent fusion review committee appointed by the DOE.

(3) Cuts in the budget of the basic plasma physics program are wreaking havoc at important university-based fusion research and training programs. Taken together with point (1), this means there will likely be no fusion scientists left when the DOE timetable is completed.

(4) At the same time that the DOE is preventing an industrial gear-up to build a tokamak test reactor, it is talking out of the other side of its mouth in designating the Elmo Bumpy Torus tokamak at Oak Ridge National Laboratory as a "mature" experiment that must now be farmed out to industry for development. This inconsistent though calculated move has tied up fusion managers in bureaucratic and legal red tape instead of project management and threatens to destroy the outstanding scientific team in the Oak Ridge fusion division.

(5) The top posts of the DOE have been flooded with former Defense Department officials who have no scientific or research management competence. This group has no interest in promoting fusion breakthroughs. Its sole concern, like that of its predecessor, former energy secretary James Schlesinger, is promoting the most costly and inefficient energy technologies and playing the game of crisis management.

(6) The government has used the contrived dropping of the *Progressive* magazine "H-Bomb Secret" case to tighten its grip on basic research through continued abuse of classification. The entire fusion scientific community has been chilled by government threats to investigate whether scientists at Los Alamos and Livermore laboratories leaked classified information to "inquiring" reporters. (See national news, this issue.) A casualty of this climate was the director of Lawrence Berkeley Laboratory who recently resigned, charging interference with laboratory functioning from high DOE officials.

It is probably true that the nation will not get the Apollo-style fusion program it needs until a new administration and Congress take office in 1980. The pronuclear forces in the present Congress, however, can provide a valuable service to the nation by stopping the antifusion shenanigans now.

It is past time to put the investigative spotlight on misuse of the classification system and other bureaucratic harassment of basic research. It is also necessary to maintain the funding levels and visible support for all the vital research projects that are now threatened.

## Victory at Seabrook

As this issue goes to press, the forces of decency in the country have scored a major victory at the Seabrook nuclear plant in New Hampshire. Midday reports Oct. 6 from the site indicate that barely 1,400 of the originally projected 10,000 antinuclear demonstrators appeared on the scene. With police forces from five states and the New Hampshire National Guard on duty, the integrity of the plant's perimeter has been maintained.

This is a victory that the pronuclear coalition, including the Fusion Energy Foundation, can take pride in.

### How It Was Done

The main lesson of Seabrook is the method used to defeat the would-be antinuclear stormtroopers. A number of crucial ingredients went into the recipe for victory.

For many weeks, organizers representing the pronuclear presidential candidacy of Lyndon H. LaRouche, Jr. reached practically every voter in New Hampshire with the reasoned arguments for nuclear power. The intelligence arm of that same organization uncovered the plans for a violent occupation of Seabrook and its shutdown. (See special report, this issue, for details.) This background work provided the basis for two crucial tactics.

The first was widespread dissemination in New Hampshire and many other parts of the country of a dossier on the anti-Seabrook operation—its funders and political controllers as well as its links to the European terrorist movement.

Second, LaRouche announced that any political figure, such as presidential aspirant Senator Ted Kennedy (whose organization showed significant overlap with the Seabrook plotters), would be held politically accountable should a violent demonstration and occupation occur.

The tactics worked. Local press throughout New England, including press reports in the *Manchester Union Leader*, covered the news that the environmentalists planned violence at Seabrook. And despite the drug-infested crowd of 200,000 that showed up in New York City for an antinuclear rock concert Sept. 23, within the next few days every big name associated with the Seabrook demonstration was forced to publicly dissociate himself or herself from the Seabrook event. With the "respectable" Fonda-Hayden types gone, only the hard-core fanatics remained.

The final stiffening of pronuclear resolve was furnished on the eve of the demonstration by a half-hour prime time television briefing and call-in show on the Manchester ABC affiliate station WMUR on the necessity of nuclear energy versus the Seabrook demonstration. The show featured candidate LaRouche, FEF director of nuclear engineering Jon Gilbertson, and Sten Caspersson, a nuclear engineer and expert in reactor core design.

LaRouche introduced the discussion by saying that 55 percent of the population is pronuclear, with another 20 percent generally in favor of nuclear power but confused. "Nuclear power must be a top issue in the 1980 election," LaRouche said, noting that the cost of electric power per kilowatt must come

(Continued on page 4)

## Calendar

### NOVEMBER

5-9

7th Water Reactor Safety Research Information Meeting  
Gaithersburg, Md.

7-9

16th International Thermal Conductivity Conference & 7th International Thermal Expansion Symposium  
Chicago

11-16

1979 ANS Winter Meeting  
San Francisco

11-15

1979 AIF Annual Conference  
San Francisco

13-16

8th Symposium on Engineering Problems of Fusion Research  
Livermore, Calif.

19-23

5th International Conference on Laser Interaction and Related Plasma Phenomena  
Troy, N.Y.

26-29

International Symposium on the Scientific Basis for Nuclear Waste Management  
Boston, Mass.

Readers are invited to submit calendar items. Address correspondence to *Fusion*, Suite 2404, 888 7th Ave., New York, N.Y. 10019.

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Celebrate the  
American Tradition  
of Science  
and Progress  
with a contribution  
to the  
Fusion Energy  
Foundation

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(Continued from page 3)

down, not up in the next few years. As LaRouche has pointed out in his energy program, this can be accomplished by constructing thousands of nuclear plants for domestic use and export and developing more advanced nuclear technologies in the transition to fusion—all financed by a new gold-backed monetary system based on real production.

### The Lesson of Seabrook

The lesson of Seabrook? Don't pull your punches on the necessity for nuclear power and a nuclear-based energy policy. Focus on the role of nuclear power in making possible both international development and a revitalization of the U.S. economy. Don't try to compromise with the 20 percent antinuclear minority. (Our ideas work and theirs don't; our principles are right and theirs are wrong.) And, finally, don't depend on or play to the corrupt national media.

If progress industrialists, trade unionists, scientists, and representative local political machines of both major parties adopt this winning strategy, the nation's majority can have nuclear power as a by-product of taking back the country for the American System in 1980.

# The Lightning Rod

My dear friends,

Your kind acceptance of my former labors has encouraged me to continue writing, tho' the general approbation you have been so good as to favor me with has excited the envy of some and drawn upon me the malice of others. These ill-willers of mine, despised at the great reputation I gained by exactly predicting another man's death (tho' owing to a delay at the printer's that announcement of Dr. Schlesinger's political demise appeared but tardily on your doorsteps)—these ill-willers, as I say, have endeavored to deprive me of my credit all at once in the most effectual manner, by reporting that I myself am no longer alive. They say in short that *there is no such a man as I am*; and have spread this notion so thoroughly in the country, that I have been frequently told it to my face by those that don't know me.

This is not civil treatment, to endeavor to deprive me of my very being and reduce me to a nonentity in the opinion of the public. But so long as I know myself to walk about, eat, drink and sleep, I am satisfied that there really is such a man as I am, whatever they may say to the contrary. And the world may be satisfied likewise; for if there were no such man as I am, how is it possible I should appear publicly to thousands of people, as I have done for several months past, in print? I need not, indeed, have taken any notice of so idle a report, if it had not been for the sake of my printer, to whom my enemies are pleased to ascribe my productions; and who it seems is as unwilling to father my offspring as I am to lose the credit of it.

Therefore to clear him entirely, as well as to vindicate my own honor, I make this public and serious Declaration, which I desire may be believed: to wit, *That what I have written heretofore and do now write, neither was nor is written by any other man or men, person or persons whatsoever.* Those whose are not satisfied with this, must needs be very unreasonable.

Yr. obt. svt.

*Benj. Franklin*

## Letters



### The Great DDT Hoax by Tim Pike

#### THE GREAT DDT HOAX

To the Editor:

Just a note to tell you how much I appreciated your "The Great DDT Hoax" in the June 1979 *Fusion*.

Having been employed in the pesticide industry for 13 years and now a farmer for the past 7 years, I have never read such an in-depth analysis on the DDT ban.

Moreover, I have never read an intelligent article by a nonagricultural publication until I read this article by Tim Pike. He certainly did his homework. . . .

I was in the pesticide business before, during, and after the DDT ban and it's been several years but I can't remember reading or hearing about any deliberate attempt by the government to distort the facts about DDT. The industry fought back to save DDT, but this article makes me wonder if the pesticide industry didn't succumb to the Environmental Protection Agency by accepting their facts and figures (at least some of them) without doublechecking them. For example, I had accepted the "fact" that the half-life of DDT is 50 years—somewhat longer than you report.

I'm sure time has eroded my mem-

ory as to all the pro's and con's of the furious battle over DDT. But my point is: As well as the pesticide industry fought back (and I'm sure well versed on the subject), I wonder if because they were out-financed to disprove all government "data" they may have been forced to accept them since they had neither the allotted time or money to disprove them.

If you need new recruits, get that issue delivered to all agricultural interests. It will win you some friends, support, and money.

Allen Kime  
Wilcox, Arizona

### The Editor Replies

Bulk reprints of "The Great DDT Hoax" article are available from the FEF, and a few agricultural publications have reprinted the article in full or excerpted it. Readers who have the means to mass distribute the article to agricultural groups should contact the FEF.

### OIL HOAXED

To the Editor:

It's really incredible! I subscribed to *Fusion* magazine because I thought I would at last get an accurate report on the nuclear industry. I read it avidly, totally convinced I was getting the true facts. That was until I read "How James Schlesinger Set Up the Oil Hoax" in criminal collusion with the Seven Sisters by your Energy News Editor William Engdahl [July 1979].

The article is all the more incredible because you, a proponent of one kind of energy which has been maligned and discredited by the news media, are castigating another form of energy which is also under the gun of the news media.

Disliking James Schlesinger is your prerogative, but accusing the oil majors of "withholding supplies selectively, diverting other supplies in such a way as to create the appearance of shortages, thus enabling the companies to drastically increase prices" is hogwash. It's been shown time and time again that you are dead wrong.

Petroleum is a finite resource. If there is no shortage, please in your infinite wisdom tell me when there will

be one. Certainly petroleum production will be enhanced by financial incentives just as nuclear or any other form of energy will be, but the days of practically total dependence on petroleum are numbered . . . .

Lee P. Morris  
Medford, Oregon

To the Editor:

. . . I know something about the energy business and believe your article [July 1979] is pure fantasy. There is a real shortage of oil. Oil is a finite, not renewable, resource. U.S. production has topped out and is in decline, while our imports have increased. The main reason that nuclear power is needed is to replace energy growth that would have come from imported oil. If oil is plentiful, as you suggest, there would be no need for nuclear power. Oil is cheaper and poses less severe problems of safety and waste disposal. Your failure to see this, and to publish such shallow analysis of a serious problem appalls me.

D.C. Aubrey  
Wilton, Conn.

To the Editor:

I subscribed to *Fusion* because I am pronuclear power and pro free enterprise. I did not expect to read the anti-oil company type of article such as that by William Engdahl in the July 1979 issue. I had hoped to read factual, objective, and unbiased commentaries on the energy situation. Charges such as, "criminal collusion," "diverting other supplies in such a way as to create the appearance of shortages," and "unexplained and conveniently timed accidents" cause me to seriously question your objectivity and your credibility as a proponent of nuclear power.

Dorr H. Etzler  
Moraga, Calif.

### The Editor Replies

First of all, to analyze the oil problem properly, one has to consider it in the short, medium, and long term. In the short term—the next 5 to 10 years—there is an abundance of oil here in the United States, in Mexico, and in Saudi Arabia and the rest of the Middle East. This oil is easily accessible at low

cost in quantities so massive that there is no need to revert to the costly and inefficient coal synthetic programs now being promoted by the administration.

Over the medium term—by the end of the century—and into long term, we must eliminate the wasteful diversion of these valuable petrochemical feedstocks into transportation fuels by developing and substituting hydrogen and hydride fuels.

It goes without saying that in the short and medium terms we must accelerate the use of nuclear power for power generation and rapidly develop and phase in fusion power as the main power source for the 2000s.

Second, the facts my article was based on are irrefutable and in the public domain. It is sad to say, but true, that there are men guilty of criminal collusion in the top positions of some of our leading corporations. At the same time, it is also true that the overwhelming majority of engineers, petrogeologists, and others employed by Exxon and the other "Seven Sister" multinationals—many of whom I have recently talked with in a tour of the Southwest—are dedicated, hard-working, and committed to supplying America with energy; they simply are not being informed of the treason going on in the board rooms.

A careful reading of the article in question would make it clear that I in no way support the populist, liberal, antibusiness demagoguery coming from spokesmen like Ted Kennedy. However, it's time to let the chips fall where they may. We have to get this country moving behind an industrial development policy. We can't let inflated energy prices manipulate the U.S. economy and world economy into the worst depression in history.

Among other accounts documenting the manipulation of an oil shortage, read the report published by the General Accounting Office. Or talk—as I have—to some of the honest independent petroleum producers who are fighting an uphill battle against the deliberate morass of regulatory strangulation developed by former energy secretary Schlesinger and his collaborators.

William Engdahl  
Energy News Editor

## News Briefs

nattan with revenues of up to \$500 million in printing and computer services. The Fusion Energy Foundation, which is exempt from Federal taxes, has denied Federal campaign funds for the Presidency because of irregularities. I try for them again next year. I am free, of course. I am not a member of any political groups that are in the line of the Powell Commission. I am not a member of any party trains me. I am not a member of any party that treats its members as objects for official

The New York Times witchhunt

## NEW YORK TIMES ATTACKS FEF TAX-EXEMPT STATUS

The *New York Times* featured a front-page article Sunday, Oct. 7 that reiterates an earlier slander by William F. Buckley's *National Review* magazine aimed at crippling the Fusion Energy Foundation financially. The *Times* article alleges that FEF revenues are used for political purposes that violate the foundation's tax-exempt status.

In a press release issued Oct. 9, FEF executive director Dr. Morris Levitt stated: "The *New York Times* charges are all lies, as the *Times* editorial board well knows. All contributions and payments to the FEF are used strictly for foundation business. Our activities include a variety of educational and scientific research efforts and the publication of *Fusion* magazine, which informs tens of thousands of readers monthly on developments in the energy field. The foundation's activities and finances are a matter of public record."

"The point is that the *New York Times* is not interested in the truth of the matter," Levitt continued. "The slander article reflects the *Times*'s growing fear about the FEF's growth in size and influence among the nation's scientific and technological communities on the issue of nuclear development."

Levitt noted that the *Times* had simply republished lies previously circulated in the *National Review* March 29 by editor William F. Buckley and writer Gregory Rose, whom the FBI had previously characterized as a pathological liar. "While the *New York Times* told its liberal audience that the FEF was funding the U.S. Labor Party, which the *Times* characterized as "right wing," the *National Review* told its conservative audience the equally untrue line that FEF contributions were funding the Palestine Liberation Organization," Levitt said.

The FEF is initiating a libel and defamation action against the *National Review* magazine.

## MEXICAN PRESIDENT CALLS FOR WORLD ENERGY PLAN

The power of human reason is mankind's most powerful weapon for solving the international energy crisis, and the building of a new world economic order cannot be separated from a solution to the pressing problem of world energy supplies, Mexican President Jose Lopez Portillo told the United Nations General Assembly Sept. 27. This crisis, the Mexican president said, has brought humanity to a branch point from which either a world war or a new era of development dedicated to the "continuity of progress" will result.

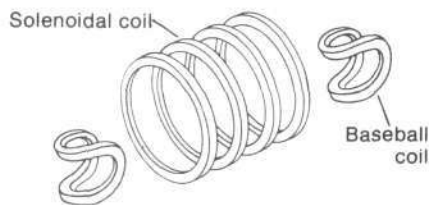
"I therefore propose the adoption of a world energy plan that covers all nations, both the haves and the have-nots . . . and has as its fundamental objective the assurance of an orderly, progressive, integrated, and just transition from one age of man's history to the next," Lopez Portillo told the UN delegates.

Programs under the plan, he said, must guarantee full sovereignty, increase exploitation of both conventional and nonconventional sources of energy; allow the means for national energy programs to be compatible with world policy; promote developing sector industries of importance for energy development, particularly capital goods; set up short-term relief for poor importing nations; and provide new financing for transfer of technology from the industrialized sector to the Third World.

## LLI TANDEM MIRROR REPORTS ENCOURAGING RESULTS

The Lawrence Livermore Laboratory's Tandem Mirror Experiment reported encouraging results at the completion of its initial shakedown series of tests. In this experiment, a central cell plasma, which is confined between two mirror plasmas shaped like a baseball seam, must be kept stable and attain significant temperatures and densities. The main objective of the experiment is to demonstrate the scientific principles on which it is based.

Although further tests will be needed to corroborate the first measurements, it appears that the central cell plasma is achieving reasonable temperatures as well as densities greater than those obtained in the 2XII single mirror experi-



The tandem mirror design adds magnetic field coil configurations in the shape of the stitching on a baseball at each end of a solenoidal magnet coil.

ment several years ago. (The 2XII achieved very high densities and peak betas greater than 100 percent.)

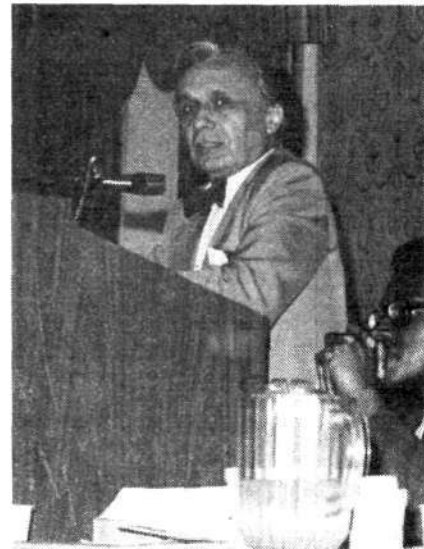
The tandem mirror approach promises to provide the basis for economical and technologically feasible fusion electric power plants, with the possibility of running on an advanced all-deuterium fusion fuel cycle.

#### NATIONAL ANTI-DRUG COALITION FORMED

One-thousand representatives from 15 states and several nations met in Detroit's Cobo Hall Sept. 29 for the founding of a National Anti-Drug Coalition. The conference was hosted by the Michigan Anti-Drug Coalition, whose work has spread into 17 other states since its formation in December 1978.

Dozens of trade union, religious, law enforcement, community, and youth leaders represented their organizations at the day-long conference. At the initiation of Michigan Anti-Drug Coalition President Juan Torres, the conference resolved to set up task forces for, among other purposes, fundraising, the defeat and repeal of all marijuana decriminalization legislation, and support of efforts toward the November 1979 founding of an international antidrug coalition in Bogota, Colombia.

Representing the Fusion Energy Foundation at the conference was Ned Rosinsky, MD, of the FEF's biological sciences staff. Speakers included Michigan Anti-Drug Coalition officials Juan Torres and Salahuddin Mohammed, world-renowned drug expert Dr. Gabriel Nahas, Highland Park, Mich. Mayor Jesse Miller, Colombian antidrug leader Fausto Charris, 1980 presidential candidate Lyndon H. LaRouche, Kena Moreno, a deputy in the Mexican House of Representatives, and Ganesh Shukla, editor of the Indian weekly newspaper *New Wave*.



Dr. Gabriel Nahas

#### BRITISH TURN DOWN JOINT FUSION WORK WITH U.S.

British authorities recently canceled a joint fusion program proposed by the Los Alamos Scientific Laboratory in New Mexico and Culham Laboratory in Britain for work on the donut-shaped reverse field pinch fusion approach. Both laboratories had completed successful programs with smaller experiments, and the joint project, proposed last year, was to pool resources and build a major \$8 million experiment that could demonstrate the scientific feasibility of this approach to magnetic confinement. The British turned the project down reportedly because they wanted the experiment to be designed solely according to their own criteria.

The reversed field pinch is based on a unique scientific approach that forces the plasma in a tokamak-type machine to virtually turn around and form a reversed field closed magnetic structure. The results clearly demonstrate the existence of force-free plasma field structure.

#### LOUSEWORT AWARD TO ONTARIO GOVERNMENT

This month's lousewort laurels award goes to the provincial government of Ontario, Canada for its \$26,000 grant to the Lake of the Woods hospital in Kenora to hire a "medicine man" to help serve Indian patients.

Indian culture has "a more holistic approach to health and spiritual problems than we would have," explained the medical advisor to the hospital's community mental health program in an interview with the *New York Times*, and he cited "a number of areas where the doctors don't feel comfortable when working with native people." According to the *Times* report, the medicine man is guided by spirits that appear to him in visions after he has poured tobacco and whisky over an open fire as an offering.

The lousewort committee notes that the March 1979 lousewort award went to Senator Ted Kennedy for his Jan. 29 speech to a Washington conference on pharmaceuticals for the Third World that laid out the "appropriate medicine" philosophy. The senator said: "The American industrial, high-technology model [of health care] has hurt medical care in the United States and we cannot allow it to be established elsewhere . . . We need primary care facilities . . . that will be run by local people to solve local problems . . ."







## Antinuclear Groups Plan Violence At Seabrook

The recent announcement by leaders of the U.S. antinuclear movement that they will adopt tactics of violence makes it imperative that every American citizen understand the how and why of the well-publicized environmentalist cause. Contrary to its popular image as a "spontaneous" protest against the alleged dangers of nuclear technology, the environmentalist movement was deliberately created to carry out a preplanned policy of zero growth, deindustrialization, and the destruction of advanced science in the United States. The environmentalists are actually the lowest level of a carefully structured political machine whose hierarchy can be traced to the patrician circles of the New York Council on Foreign Relations.

It is no accident that the current activities of the environmentalists conform to what the Council on Foreign Relations has made public as its *1980s Project* blueprint for the "controlled disintegration" of the U.S. and the world economy. (See the October 1979 *Fusion* for details on the *1980s Project*.) Similarly, it is no coincidence that CFR member and *1980s Project* policy board member Richard Falk also heads the Institute for World Order, which created the antinuclear Mobilization for Survival as one of its action fronts

for implementing what it calls a "preferred world order."

The CFR's environmentalist machine has set its sights on a violent Oct. 6 occupation of the Seabrook, New Hampshire nuclear power plant, now under construction. Organized under the auspices of the same left-wing forces that are defending the Italian terrorist Red Brigades in the United States, and modeled on the tactics of the antinuclear movement in Europe, the violence scheduled for Oct. 6 is intended to be the trigger for a series of antitechnology civil disturbances at nuclear plant sites across the country. Falk's Mobilization for Survival and its associated Clamshell Alliance are in the forefront of planning for the Oct. 6 Seabrook action.

A special investigative report on the blueprint for violence at Seabrook, the Council on Foreign Relations' apparatus behind it, and the Italian model of terrorism on which it is based has been compiled by the Fusion Energy Foundation and the *Executive Intelligence Review*. The report, excerpted here to give readers of *Fusion* the essential outline of the terrorist plan for Seabrook, is now circulating among U.S. law enforcement officials, particularly throughout New England. The full report, with supplementary documen-



*Police successfully repulsed the hard-core environmentalists who tried to break through the fence at the Seabrook, N.H. plant site Oct. 6 (left). As a result of the widespread circulation of the material in this special report, Jane Fonda and her husband, Tom Hayden (r.), along with several other prominent antinuclear supporters, were forced to disassociate themselves from the planned violence at Seabrook.*

tary materials, is available for \$50 from the Fusion Energy Foundation (\$25 for FEF members.)

#### **The Terrorist Plan**

A planning meeting was held Sept. 9 to map out the occupation of the nuclear construction site at Seabrook, N.H. The meeting was held at Mount Holyoke College in South Hadley, Mass. under the aegis of the Coalition for Direct Action at Seabrook. The purpose of the meeting was to pull together various groups participating in the action, and to settle on the last few details concerning the scheduled Oct. 6 occupation.

There were approximately 125 people in attendance, most from Massachusetts, New York City, Binghamton, N.Y., Long Island, and Rhode Island.

An on-site observer at the meeting has written a detailed document, verifying who was at the meeting and the content of the discussions.

According to this person, the meeting was led by Harvey Halpern, a leading member of the New England Clamshell Alliance, and the Coalition for Direct Action at Seabrook, the two groups leading the planning for the Oct. 6 action. People in attendance all agreed on the necessity to forcefully take over, and permanently occupy, the nuclear construction site at Sea-

brook, until all plans to continue the construction of the plant are permanently called off.

It was agreed by the people in attendance that all previous peaceful means to stop the construction of nuclear plants had failed and that more direct means had to be taken. Two groups at the meeting, one from the Clamshell in Newburyport, Mass. and the other consisting of three communes from Vermont, talked directly about the need for special operations, to be done in secret, most to precede the arrival of the demonstrators Oct. 6.

There are to be three main areas of assault, from the north, southwest and south, all converging on the construction site at 4:00 a.m., Oct. 6. According to the handbook prepared for the occupation and documents described below, the fences are to be ripped down and the plant taken over. Should the initial assaults fail to immobilize police defending the plant, repeated assaults, over days if necessary, will be launched, from numerous staging areas.

#### **The Planning Documents**

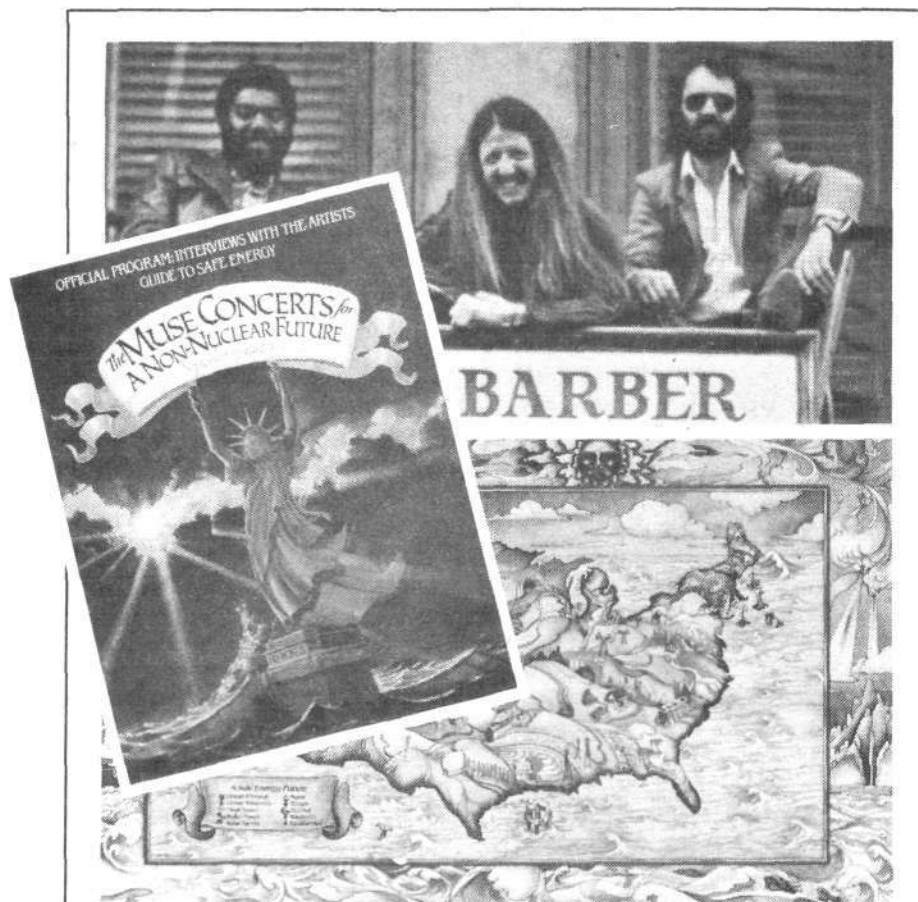
• *Rhode Island Logistics Proposal, by the R.I. Clamshell.* This document centered on a proposal to take over the plant site from the north. It was pro-

posed that this be done with the aid of the Washington, D.C., Vermont, New Haven, Conn., Maine, and Newburyport, Mass. groups. The logistics for this operation are complex and dangerous: It entails crossing swamps and fording a river at precisely low tide, at four in the morning.

The details on this military operation indicate that hundreds of man-hours of time have gone into its planning, including mapping, photo surveillance, trial runs, and even the construction of temporary bridges to cross the river. It envisions crossing the river and swamp land to the north of the plant, cutting holes in the fence, and proceeding to occupy the area where the reactor is to be located.

The inclusion of the Newburyport group is significant. They have been designated as the coordinators of "special operations" including secret operations that will begin an evening in advance of the regular troops' arrival. The document also acknowledges that retreat from the area is nearly impossible as the tide rises.

• *Rising Free, P.O. Box 852, SUNY Binghamton, (607-754-4657):* This document is similar to material contained in the handbook issued for the occupation by the Coalition for Direct Ac-



*Drugs, rock music, no nukes, and no industry—the message of the slick four-color magazine put out by MUSE in support of Seabrook and other antinuclear demonstrations.*

## Rock Concerts for Seabrook

The major source of funding for the Oct. 6 occupation of the Seabrook nuclear facility is coming from a nonprofit organization set up in May 1979 called MUSE, Musicians United for Safe Energy. The chairman of the board of MUSE is Sam Lovejoy, the environmentalist who was arrested and indicted in the early 1970s for destroying property on a nuclear plant construction site in Montague, Mass. Other board members include Harvey Wasserman, Tom Hayden, Becky Hardy, Sara Nelson, and Kitty Tucker.

MUSE is sponsoring a series of rock concerts in New York City's Madison Square Garden late in September to raise money for the Seabrook action. The concerts are organized by Ron Delsner, the largest rock concert promoter in New York, and are receiving the support of the record companies of many of the singers who are scheduled to perform, including Warner Communications.

At a Sept. 19 press conference in New York City, Lovejoy promised that MUSE would make the shutdown of the Seabrook plant, and nuclear energy in general, a major issue in the 1980 election campaign. Challenged from the floor of the conference on the "poor press coverage to the movement and to nuclear 'accidents,'" a CBS spokesman assured the gathering, "We plan major coverage of this event and from here on out."

tion but takes the justification for the action much further. Rising Free proclaims: "... We are no longer going to appeal to the authorities. We will shut down nuclear power: we will do it ourselves: and we will use whatever means are necessary to see that this happens!"

As other documents have stated, this occupation is modeled on the antinuclear occupations in Europe, almost all of which have been violent in nature, and many of which either preceded or shortly followed terrorist bombings.

- *Affinity Group Check List:* In this document, the military precision of the operation is again laid out in detail. Every contingency concerning the activities of the groups of people in the event (affinity groups) has been mapped out. This not only includes back-up funds and legal and medical assistance, but also positions in which spare military equipment will be hidden previous to the assault on the site.

The policies this document details make very clear that despite the claims of "nonviolence," it is the intention of the demonstration to provoke a violent confrontation. That will be blamed on police, and set up an immediate violent reaction from the demonstrators.

- *Boston Logistical Proposal:* This is perhaps the most detailed of the proposals, from a military logistical viewpoint. Every aspect of military planning from the meeting areas at the Commons in Boston to the tearing down of the fences at the construction site has been planned out. This includes every possible route that leads into New Hampshire, and what to do if road blocks at any point or other preemptive actions are taken, as well as a great number of preliminary staging areas near the site, including 100 acres near the plant donated by the owners of the land, to the shopping plaza on Route 1.

At every stage of the assault, every possible tactic launched by police, from gas, to water hoses, to dogs, has been taken into consideration, and at each point an alternative plan or set of options has been laid out to give maximum flexibility to the demonstra-

tors. Detailed mapping has taken into consideration every group of trees, fences, and so on, in the landscape around the plant.

It is clear that the scope of military planning goes beyond that associated with amateurs.

### The Italian Model

The violent tactics being mapped out for Seabrook, which could lead to the death and injury of demonstrators and police personnel, are designed to create an environment of chaos and antitechnology ferment in the United States similar to that fostered in Italy over the past decade. In fact, it is the overseers of Italy's environmentalist movement who are prescribing the turn to violence for the U.S. antinuclear forces.

Over the last few months, a pamphlet titled "Midnight Notes: Strange Victories—The Antinuclear Movement in the U.S. and Europe," has appeared in "movement" bookstores around the country. The authors of the slick, expensively produced document represent themselves as members of the "Midnight Notes Collective," but the tract was in fact written by a group known as the Committee Against Repression in Italy, CARI.

CARI was formed after the early April arrest by Italian authorities of a group of individuals charged with being the controllers of the Italian Red Brigades. The best known of these was Antonio Negri, the "godfather" of the Italian ultraleft movement, *Autonomia*, out of which the Red Brigades were formed.

The address listed for the Midnight Notes Collective, 491 Pacific Street, Brooklyn, N.Y., is a headquarters of CARI in the United States and the residence of the leader of CARI, Sylvia Federici. "Midnight Notes" author George Caffentzis is a member of CARI and also serves on the editorial board of a magazine called *Zero Work*. *Zero Work* is Negri's vehicle for contact with U.S. ultraleft and terrorist networks, and was the cosponsor with Negri of a terrorist conference held in Britain two years ago. It is also the base for CARI staff members. In the view of antiterrorism experts, the new name, "Midnight Notes," is merely an effort to steer the credulous away from the ob-

vious terrorist connections of the document.

For the antinuclear movement, "Midnight Notes" frankly prescribes tactics that are violent—extending to murder. It states, for example, that:

"The antinuclear movement has not always relied exclusively on nonviolent civil disobedience. It has turned to more violent tactics whenever the contract of nonphysical behavior could not work. A clear case in point is the antinuclear struggle in the Basque country of Spain. The nuclear plant under construction in Lemoniz was bombed by the ETA [a Basque nationalist organization] on March 17, 1978, and two workers were killed. This accident did not impede the antinuclear movement, but widened its impact. The ETA was not blamed for the death of the two workers . . . . The movement, far from losing support after the bombing, turned the incident against the plant and continued to sponsor mass demonstrations."

This justification of violence is aimed at whipping up the anarchist-oriented hippie and student layers who frequent antinuclear affairs and who tend to see any action by police or governments as "repressive."

"Midnight Notes" adds: "For the argument that 'violence breeds violence' distorts the real class relations and leads them ['certain nonviolence ideologists'] to blame the state's brutality on the resistance of the working class. Such a logic ends by equating the violence of the Warsaw ghetto fighters with the brutality of their Nazi executioners! But who provokes whom?"

What is meant by "resistance of the working class" is terrorist actions by groups like the Weathermen, the Italian Red Brigades, and now the antinuclear movement.

"Midnight Notes" then turns to the lessons of the European movement for the U.S. antinuclear movement:

"While a part of the movement went back to legalism, other antinuclear activists experimented with acts of sabotage against power lines (France), railroad lines (Switzerland), construction sites (Spain), factories supplying nuclear plants (Switzerland, France), and installations of utility companies

(bombs at the information pavilion in Kaiseraugst, Switzerland in the spring of 1979). Sometimes bombs were placed near nuclear construction sites or plants, not to damage them but to demonstrate their vulnerability. This wave of 'violent' acts has triggered an intensive debate within the European antinuclear movement. At first the 'official' nonviolent organizations denounced these actions as 'directed against the movement and harmful for its growth.' But later this 'hard line' weakened and they sometimes accepted bomb-attacks, if the bombings were carefully and 'cleanly' executed without damage to the environment, nature, or 'living things.'"

### The Kennedy Connection

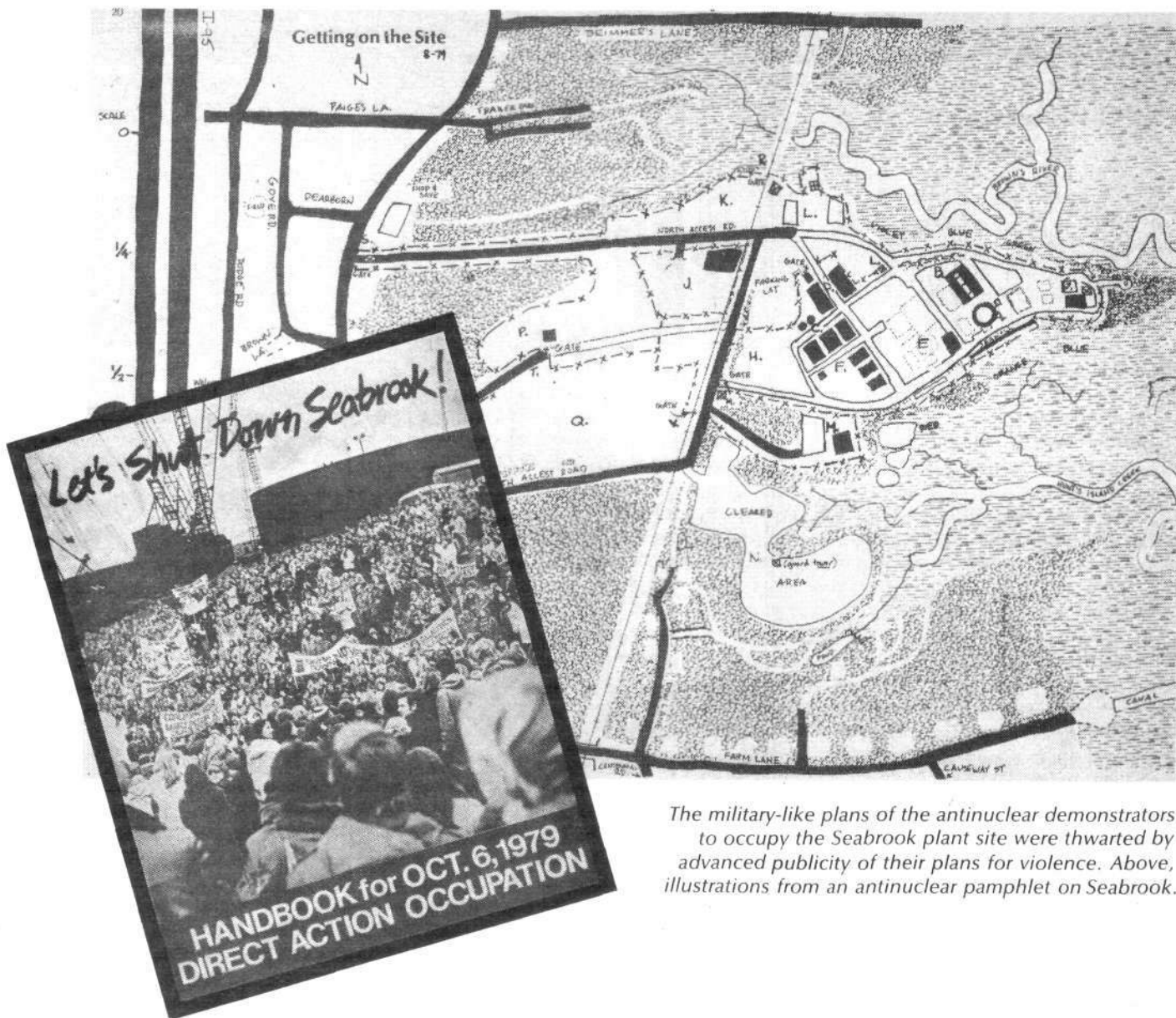
In New Hampshire, the first presidential primary state in the 1980 race for the White House, the threatened violence at Seabrook has become a central issue of the campaign. Perhaps most shocking to New Hampshire residents are the details of Senator Edward Kennedy's connections to the antinuclear planners.

New Hampshire's "Draft Kennedy" state chairwoman, Dudley W. Dudley, was organizing—up until mid-September—for a major fundraiser for the environmentalists, scheduled for late September at the Rye Beach estate of Clinton Seeley. The event, sponsored by the Clamshell Alliance, the New Hampshire Energy Coalition (of which Dudley is a leader), and the Granite State Alliance—all scheduled to participate in the invasion of the Seabrook plant—is part of a national fundraising tour by environmentalist superstar Jane Fonda and her husband Tom Hayden.

Other Kennedy connections to the Seabrook event are as follows:

William Winpisinger, president of the International Association of Machinists, one of the earliest public endorsers of the Kennedy candidacy and the individual responsible for the Americans for Democratic Action endorsement of Kennedy, is actively involved in the support events building toward the Seabrook invasion.

Winpisinger's role is principally through two antinuclear groups, the Progressive Alliance and the Citizens/Labor Energy Coalition. The Progress-



The military-like plans of the antinuclear demonstrators to occupy the Seabrook plant site were thwarted by advanced publicity of their plans for violence. Above, illustrations from an antinuclear pamphlet on Seabrook.

sive Alliance includes United Auto Workers President Doug Fraser, Ralph Nader, Jane Fonda, Tom Hayden, and other prominent antinuclear spokesmen. The Citizens/Labor Energy Coalition was founded in 1978 as part of the Sun Day festival, and Edward Kennedy was the keynote speaker at the founding convention in Washington, D.C.

Both of Winpisinger's groups are listed sponsors of a post-Seabrook demonstration on Wall Street directed at the "right-corporate power structure" that runs the nuclear industry.

Morris Abram, the first Council on Foreign Relations notable to publicly

endorse the Kennedy candidacy, has been a major funder of the environmentalist movement through his 20-year directorship of the Field Foundation. Field awards hundreds of thousands of dollars per year to environmentalist organizations as well as to the left-radical command center, the Washington, D.C. Institute for Policy Studies.

According to first-hand observers, during the next several weeks before the invasion of Seabrook, the entire environmentalist movement is to be put through a "selection process." Those individuals rabid enough to carry out direct acts of terrorist violence

will be tracked into paramilitary training sessions preparing for the beforehand assault on the Seabrook site. Preplanning meetings for these training sessions have already occurred on the campuses of Mt. Holyoke College in Massachusetts, the State University of New York at Binghamton, and in the East Village section of New York City.

Those antinuclear activists who are not psychologically bent toward overt terrorist acts will be tracked into the "Draft Kennedy" operation through such vehicles as the Progressive Alliance, the Labor/Citizens Energy Coalition, and so forth.

# The NRC Report on TMI: Refusal to Investigate Sabotage

The Nuclear Regulatory Commission released an official report Aug. 3 on its investigation of the March 28 incident at the Three Mile Island Unit 2 nuclear plant near Harrisburg, Pa. Although the report poses sabotage or criminal negligence as one of six possible causes of the initiating events of the nuclear accident, the NRC conclusion stops short of what its findings dictate: that the Three Mile Island incident was caused by a willful act of sabotage or negligence. Incredibly, the NRC investigators chose not to pursue an investigation of the sabotage possibility, even after they eliminated the other five possible causes of the initiating events.

The several-hundred-page report, titled "Investigation into the March 28, 1979 Three Mile Island Accident by the Office of Inspection and Enforcement" (NUREG-0600), contains revealing and important information concerning the two initiating events of TMI incident: the loss of main feedwater flow and the consequent loss of all emergency feedwater flow.

The information presented tends to confirm what the investigations of the Fusion Energy Foundation and the Independent Commission to Investigate the Three Mile Island Incident, a group initiated by the FEF, charged back in April: Namely, that the evidence indicates that the events initiating the TMI incident were manually induced; that the loss of main feedwater flow was caused by personnel performing maintenance on the filter system; and that the emergency feedwater systems had been manually put out of service.

Despite the findings that the report lays out at length, the NRC conclusion (as well as all the press accounts of the report) focuses on what happened after the event got started—not on what caused the initiating events of the incident.

## The Valve Question

The key here is the valve question, and the report in fact points out new information indicating that the initiating

events were manually induced. The report reveals that for several weeks before the incident there had been significant and continual leakage of reactor primary coolant water out of the electromatic relief valve (EMOV) and/or one or both of the pressurizer code safety valves that are connected to the pressurizer tank system. It was the EMOV valve that failed to close after opening automatically some six seconds into the incident in order to relieve the initial pressure build up. This stuck valve went undetected by the operators for more than two hours, and it eventually caused the damage to the reactor core fuel.

Without visually inspecting the valve, the NRC investigators could not ascertain whether this coolant leakage contributed to the valve's failure. However, during the same weeks, the valve's temperature was in the range of 180 degrees to 200 degrees Fahrenheit, up to 70 degrees over its specified normal temperature of 130 degrees Fahrenheit. Considering the fact that the valve had a previous history of sticking open and considering the normal engineering judgment of the expected operation of a relief valve that had been operating for weeks well above its normal operating temperatures, it is quite reasonable to assume that the valve would have failed.

If someone knew this condition (and it was generally known among plant personnel), that person could reasonably expect this valve to stick open, particularly if the emergency feedwater system were shut off, which would ensure a high primary coolant system temperature and pressure. Furthermore, with this valve stuck open and all heat-removal capabilities shut off because of the closed emergency feedwater valves, plant operators would have a very difficult time figuring out what had happened.

This is precisely what did happen, as the NRC report points out, and it is important to investigate why and how the valve stuck open in terms of who

manually closed the emergency feedwater valves, one of the two initiating events.

The FEF continues to contend that the two initiating events were caused either by sabotage or by the gross negligence of the reactor plant operators. There is no question that the operators are competent, experienced, and qualified personnel who would not have bypassed every single safety precaution and procedure. Therefore, sabotage remains the most likely cause.

This contention is supported by a report produced by a leading nuclear safety expert at the Massachusetts Institute of Technology—the Rasmussen Report—that places the probability of the sequence of events that occurred at Three Mile Island in the order of magnitude of one in a million.

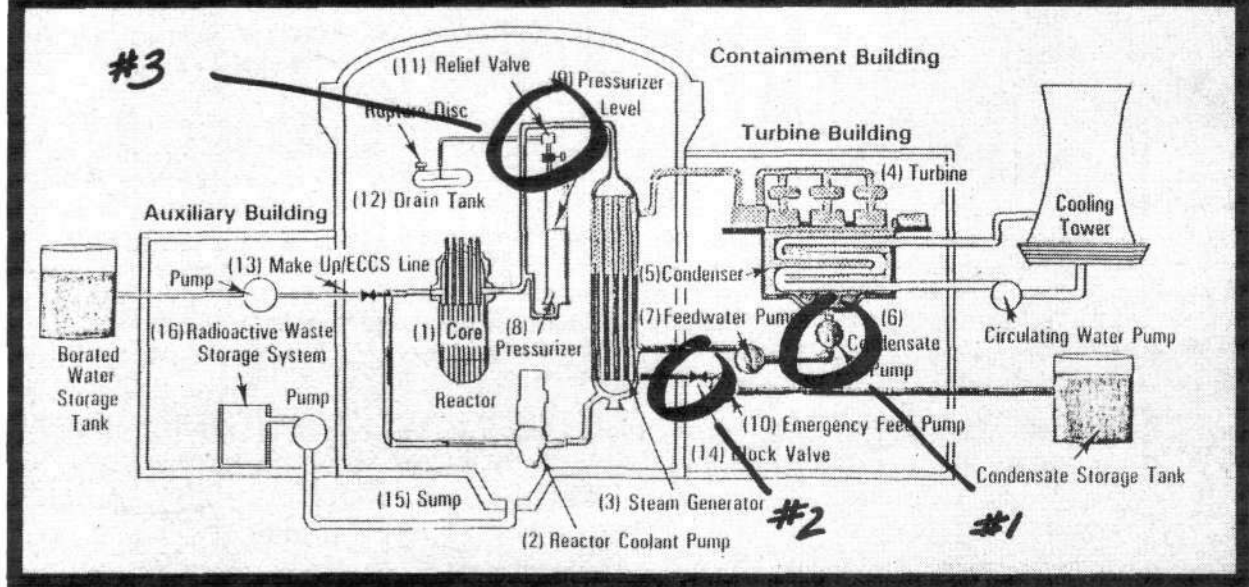
Until it is determined who closed the emergency feedwater valves and why, an investigator has to presume that the reactor was set up, waiting for a loss of main feedwater flow to initiate at least a very serious abnormal operating condition.

## Sabotage or Negligence?

The NRC report posed six possible ways the emergency feedwater valves could have come to be closed, but concluded that a "review of all possible causes revealed no reason to believe that any of them was the specific cause of the closed valves" (p. I-4-7).

However, the NRC findings do not support this general conclusion. In fact, the findings eliminate four of the six possible causes and, if the operators' sworn testimony and signed testing documents are considered, the findings remove a fifth cause. According to all information available to date, including that from the presidential commission's investigation, these valves were manually opened 42 hours before the incident after a surveillance test of the emergency feedwater system.

The report states (p. I-4-7-): "The operators and supervisors responsible for conducting the surveillance test on March 26, 1979 were interviewed . . . . The operator who actually manipulated the valves involved stated that he specifically recalled opening that valve. The investigation found no basis for rejecting his assertion. If his asser-



### THE INITIAL CHAIN OF EVENTS AT TMI

(1) Both main feedwater pumps were shut down, probably as a result of maintenance work on the feedwater filter system. (2) Plant operators then assumed automatic startup of the emergency feedwater pumps, because they were unaware that someone had shut the block valve in each system prior to the shutdown of the main feedwater pumps. The question of sabotage concerns the closing of these valves. (3) Six to eight seconds into the incident, the electromechanical relief valve on the pressurizer tank opened as designed to release small amounts of steam and reduce the reactor coolant system pressure. A few seconds later, as the pressure decreased, this valve failed to close as designed and continued to release steam.

In the first few minutes into the accident, the temperature, pressure, and pressurizer level in the reactor coolant system began to return to what the operators normally expected to happen after a main feedwater flow shutdown. This continued to mislead plant operators into dealing with the situation in a way opposite to what they would have done had they known the true situation.

General Public Utilities Corporation

tion was incorrect and the valves were left closed after the test, the investigation found no information to explain how the closed valves would have gone unnoticed during the 42 hours between the test and the accident."

How these valves got closed therefore, remains a mystery to the NRC. The report then proceeds to the sixth possibility that "the valves were closed by the overt act of an individual." Using a convoluted argument, the NRC report concludes that this isn't very likely either. The NRC says it simply does not know how the valves were closed.

On review of their information and

reasoning on this sixth possible cause, it is clear that the NRC staff never really investigated the possibility of sabotage, nor did they want to. Yet, based on their own information presented in the report, sabotage or criminal negligence is the only possible cause remaining for the closure of the two valves.

The report does devote a small section to the "Possibility of Plant Sabotage"—included "as a result of the high degree of public concern associated with the possibility of sabotage or adverse human actions having caused or contributed in some manner to the severity of the March 28

incident at TMI" (p. I-1-35). The questions were asked by a technical NRC inspector to a technical plant operator or employee in an informal discussion. The report states that the "responses ranged from direct negative responses to disbelief that sabotage could even be considered" (p. I-1-36). Under such circumstances, who would admit to closing or knowing who closed the emergency feedwater valves?

The report goes on to note (p. I-1-36): "Vocal antinuclear sentiment appears to have been relatively absent prior to the incident. Relationships between the local governments

and licensee management appear to have been of a tolerant nature."

Therefore, the report says, "Those conditions commonly associated or viewed as causative factors precipitating industrial sabotage were not identified by the investigation as being present at the time of the incident."

Such a statement comes from the mouths of babes—or of liars. Nuclear power and the nuclear industry have been barraged with environmentalist attacks for years and, particularly since the formation of the Department of Energy, they have faced budgetary cutbacks, court delays, and program cancellations. As many in the industry admit, as a result of this "antinuclear sentiment," the U.S. nuclear industry is for all intents and purposes shut down.

Having thus reasoned, the commission then discusses the amount of effort needed to determine who closed the valves in question and why the question is not worth pursuing (p. 1-1-37):

"This investigation evaluated the effort that would be required to attempt to identify the party or parties who closed the emergency feedwater system block valves for whatever undefined reason that may have motivated them. The investigation revealed that the two valves in question were capable of being operated from three specific locations: the control room, the 480V Substation panels at the 305 elevation of the auxiliary building and the physical location of each valve.

"Checks of the licensee's security access badging records showed approximately 470 licensee personnel and 260 contractor/vendor personnel would have had unescorted access to one or more of these locations on any of the two work days preceeding the March 28 incident. Records exist whereby the identity of the contractor/vendor personnel entering the protected area could be retrieved. However, the 470 licensee personnel are only logged in at the site perimeter and need only display their photo ID badge (issued only after psychological screening and preemployment checks are complete) to secure access to the TMI protected areas (Units 1

and 2, auxiliary building, turbine building and environs).

"Further investigative effort of the magnitude that would be required to specifically identify which of the more than 600 personnel did access the protected areas during the period March 26, 1979 through March 28, 1979 was deemed unwarranted at this time in view of the absence of any intelligence that adverse human activity was involved in the accident."

Far from being an argument against further investigation, the NRC report outlines the sort of major investigative effort that was undertaken a month after TMI by the Virginia Electric Power Company, owners of the Surry-II nuclear plant whose fuel rods were mysteriously damaged. In one month's time, with the help of the FBI, lie detector tests for all personnel, and a thorough investigation of the sabotage possibility, the two individuals responsible for sabotaging the plant were identified and arrested.

#### Contradictions

One might ask at this point why the NRC concluded that it was not worth trying to find out how the valves got closed. Was it not important in the chain of events? Would not the electromagnetic relief valve have stuck open anyway?

Again, the NRC is caught in a contradiction. At the same time that it says the matter is not worth investigating, the NRC's evaluation of the effect of these closed valves is (p. 1-4-10): "The delay in automatic initiation of emergency feedwater for eight minutes contributed to an early recovery toward normal values of certain RCS [reactor coolant system] parameters upon which the operators concentrate. This recovery of key turbine trip/reactor RCS parameters misled the operators into believing that their actions had been successful in limiting the severity of the transient. This erroneous belief led them to initiate the routine subsequent operator actions that were normal for the assumed transient. These actions occupied the operators' attention and detracted from their opportunity to establish a correct analysis of the plant conditions.

"This investigation did not conclude what the ultimate course of events of

the accident would have been, had emergency feedwater been introduced to the OTSGs [once through steam generators] as designed."

Essentially, the NRC is saying, the closure of these valves caused particular pressure, temperature, and pressurizer level conditions in the reactor that led the plant operators to act essentially the opposite of how they would have acted if the valves had been open. In other words, these conditions misled the operators into believing that the EMOV valve had closed when in fact it remained open.

It took nearly 20 minutes (after the valves were finally opened) to get feedwater flow completely reestablished in the two steam generators, which had boiled dry, so that decay heat could be normally removed from the reactors.

The closed valves caused reactor conditions that misled and confused the operators for at least the first 30 minutes into the incident.

Another question unresolved by the investigation is just how the loss of main feedwater flow (and turbine-trip) was initiated in the first place by the filter maintenance crew—a question that also bears on the issue of sabotage.

The loss of main feedwater flow is expected from time to time because the reactor plant protective system is extremely sensitive to the slightest malfunction or abnormal operating condition. The slightest "mistake" by the maintenance crew—intentional or unintentional—during the filter cleaning procedures ongoing at the time could easily have caused the automatic loss of main feedwater flow and trip-out of the turbine.

It is not surprising, therefore, that the report's conclusions, upon which the press accounts of the NRC's findings focused, did not even mention the two initiating events of the incident: the loss of main feedwater flow followed by the loss of all emergency feedwater flow.

Instead, the NRC's conclusions blame the event and its severity primarily on operator error, misjudgments, "mind sets," and equipment failure—conclusions not backed by their own findings.

—Jon Gilbertson



## Gov't Drops 'H-Bomb Case' But Tightens Classification

The U.S. government dropped efforts to block the publication of two articles that it said contained secrets on the workings of the hydrogen bomb Sept. 17, but is persisting in efforts to maintain tight classification of basic scientific information, particularly involving fusion energy.

The Justice Department announced that it was abandoning a six-month-old civil lawsuit barring *The Progressive*, a Wisconsin-based anti-nuclear magazine, from printing an article titled, "The H-Bomb Secret: How We Got It, Why We're Telling It." The government also dropped a two-day-old suit blocking the *Daily Californian*, a Berkeley newspaper, from printing a detailed letter about the H-bomb by Charles Hansen, described as an "amateur researcher" on the H-bomb.

The Hansen letter, published in full in the Sept. 18 *Chicago Tribune*, as well as Aug. 30 in a Palo Alto, Calif. paper owned by the *Tribune*, points out that the key ideas presented in *The Progressive* article were made public by "a Soviet scientist in 1976." The scientist referred to is L. Rudakov, a leading electron beam pellet fusion researcher. Rudakov's 1976 presentations were first reported in the *Fusion Energy Foundation Newsletter* in August 1976.

### Fusion Witchhunt?

As more and more material on the design of the hydrogen bomb was recently published, the government's position that it was protecting secret information became less and less defensible. However, as the FEF has emphasized, the underlying issue in *The Progressive* case is not classification of military information but the Energy Department's classification of basic scientific research under the guise of classifying military secrets.

Since the replacement of James

Schlesinger as energy secretary by Charles Duncan, if anything, the department has tightened its classification procedures. Justice Department threats to institute criminal prosecution of "H-Bomb" article authors, after the government's civil injunction failed, are consistent with such a hard-line policy. Specifically, the Justice Department has intimated that scientists at the two major U.S. nuclear fusion laboratories, Los Alamos and Lawrence Livermore, are "leakers" of H-bomb "secrets."

## Pioneer 11 Yields Data On Saturn

After a six-year journey across 2 billion miles of the solar system, Pioneer 11 passed to within 13,300 miles of Saturn Sept. 1. The U.S. National Aeronautics and Space Administration's spacecraft began transmitting information Aug. 20 from a distance of 634,000 miles from the second largest planet in the solar system.

Information was transmitted in the form of digital computer-generated and computer-analyzed data bits at a rate up to 1,024 data bits per second, traveling for about three hours at the speed of light before reaching the Earth. These incredibly faint signals, about 10-20 watts, represent the most accurate and detailed information yet gathered in the more than 300 years of Earth-based observations of the planet, since Galileo first noticed Saturn's "cup handles" in 1610.

### Composition of Saturn

Preliminary analysis of Saturn's gravitational effects on Pioneer 11 and other data now make it possible to verify some previous conjectures about

the planet's composition. There seems to be a rocky core about the size of the Earth, but three times the Earth's mass. Saturn's diameter is about nine times that of Earth.

This rocky core is surrounded by a compressed layer of water, methane, and ammonia that extends out to nearly one-fourth of the planet's radius. Surrounding this is a very interesting layer composed of metallic hydrogen and extending to nearly 60 percent of the radius.

Hydrogen can be forced into the metallic state under conditions of high compression. Earth-based experiments with ultrahigh compression of hydrogen give some hope that it can be turned into a high-temperature superconducting material, which would have very significant industrial and power transmission uses. The metallic hydrogen region of Saturn, whose currents produce the planet's magnetic field, may prove to be a natural laboratory for research into the properties of this exotic material.

The remainder of the planet's surface consists of a region of less dense liquid hydrogen, then a quite thin layer forming a gaseous cloudy atmosphere.

### Some Banding

The photographs of Saturn do not reveal the kind of spectacular banding and vortical masses of gas seen on Jupiter, although there is a faint indication of some banding in the equatorial region similar to that on Jupiter. A sharp temperature drop within 8 degrees north and south of Saturn's equator indicates that the banding could be the result of the same effect that occurs on both Earth and Jupiter: The relatively high equatorial temperatures force gas to higher altitudes than they reach away from the equator where they condense into high-altitude cool clouds.

Pioneer 11's infrared measurements, a technique that uses the spectral distribution of light below the visible range to determine the temperature of an object, indicate that Saturn emits about 2.5 times the amount of energy it receives from the sun. The source of this internal heating, which was also observed on Jupiter, is still to be explained.

The rings of Saturn have been a

source of romance and legend since Galileo first observed them and called them "cup handles," because the crudity of his telescope did not give him a clear picture of what he saw.

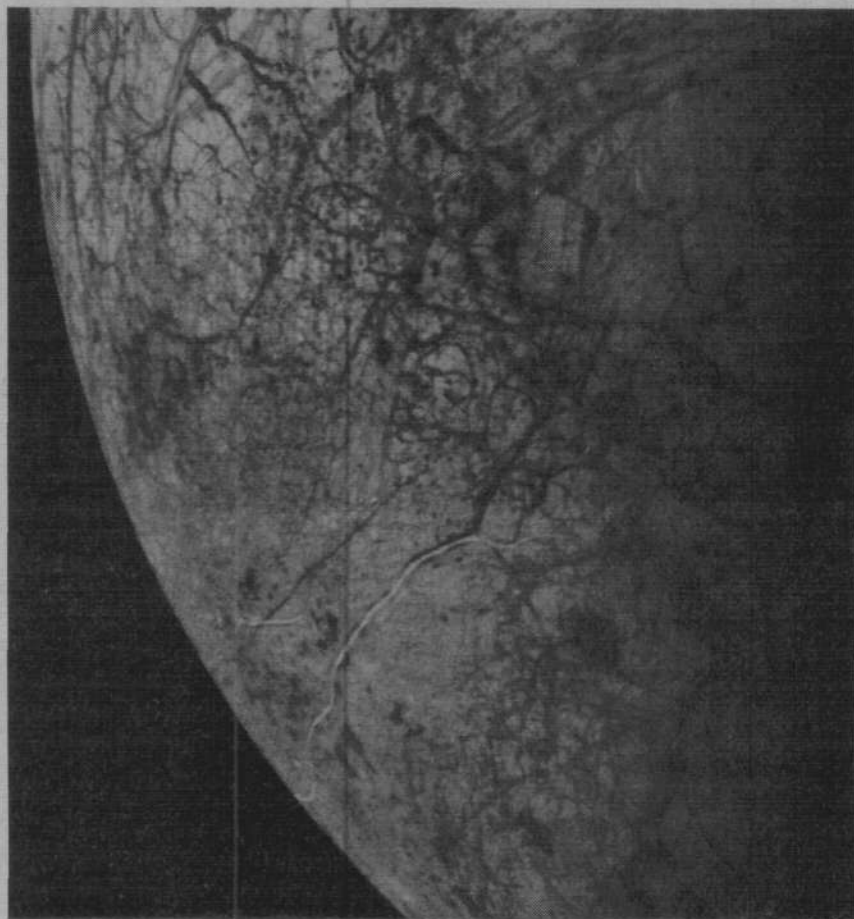
The Pioneer 11 mission has confirmed what most researchers thought—the rings are composed primarily of ice. The structure of the rings is quite complex; there may be as many as seven or eight of them, with some overlapping others. Interspersed among them are gaps, the well-known Cassini Division and the previously unconfirmed French Division, both of which have been observed from Earth-based telescopes, and a new gap, Pioneer Division, discovered on this mission.

Rather than representing distinct entities, though, the rings may be alternating regions of greater or lesser density of the icy material, as evidenced by one of the Pioneer experiments. Saturn's magnetic field is about 1,000 times as strong as that of the Earth, although only about one-twentieth as strong as Jupiter's. In this magnetic field, large numbers of high-energy charged particles are trapped, forming radiation belts that would be fatal to human beings. Measurements done by Pioneer 11 show that when the currents of these fast-moving particles intersect Saturn's rings, there is a dramatic reduction in their intensity, because of absorption by the ring material. This effect occurs even in the Cassini Division, indicating that there is material there although the region is optically transparent and indicating that the rings may have continuous density variations.

#### The Magnetic Field

Saturn's magnetic field has some striking peculiarities that will send the planetary theorists back to work. One of Pioneer 11's major findings is that the axis of the magnetic field is aligned with the rotation axis of the planet. In all previously observed planetary cases, there has been an angular difference of about 10 degrees between the planetary rotational axis and the magnetic field axis.

Researchers have long felt that the difference in orientation was necessary to maintain the field; evidently it is not. Furthermore, for the Sun, Mer-



NASA

*Voyager II took this picture of Europa, the smallest of Jupiter's four satellites, on July 9, 1979. The complex patterns on its surface suggest that the icy surface is fractured and that the cracks are filled with dark material from below.*

cury, Earth, and Mars, the strength of the magnetic field correlates with the body's angular momentum, while for Saturn, the field strength is too weak.

#### Saturn's Moons

Pioneer 11 may be the first spacecraft to discover a new moon; in fact, it may have discovered two. This cannot yet be confirmed since there are two moons whose orbits are not very well known, which may be what Pioneer observed.

The way they were observed is quite interesting. Just as the rings absorb the high-energy particles trapped in the planet's magnetic field, so do its moons. They leave a trail in their orbit of low radiation density, almost as if they were casting a shadow behind them. It was these radiation shadows that Pioneer 11 saw, in addition to a faint photograph of what may be one

of the moons. Because of the uncertainties of Earth-based and spacecraft observation, Saturn may have anywhere from 10 to 13 observed satellites, and perhaps more that have not been yet seen.

The largest moon, Titan, is larger than the planet Mercury and is of special significance since its chemical composition makes it a possible candidate for spawning life. Unfortunately, the preliminary data from Pioneer 11 that would be useful in determining whether Titan bears more scrutiny were lost as a result of solar electrical interference with the signal. However, Voyager 1 and 2, having completed their missions near Jupiter, are hurrying on to Saturn for rendezvous in 1980 and 1981 and may provide more data on Titan.

—Dr. John Schoonover



"Yes" to nuclear power development: A plenary session at the Nonaligned summit meeting in Havana.

## At Havana Summit: Third World Resolves for Development

The sixth summit conference of the Nonaligned Movement in Havana, Cuba marked a potential turning point in North-South relations. After two weeks of discussion, leaders of 94 developing nations announced their program: The Third World intends to rapidly industrialize, will use nuclear power as the means to accelerate the growth of its cities and economies, and wants the collaboration of the advanced nations in implementing a new world economic order to carry out these goals.

The final Economic Declaration of the summit, approved Sept. 9, declares: "The Heads of State or Government called on the developed countries to exercise political will and courage and take steps to seek a solution to the problem of recession in their economies through restructuring the international economy, based on

the generation and growth of aggregate demand and productive capacity in the developing countries. Any other approach based on short-term considerations would in the long run operate to the long-term political and economic detriment of the developed countries themselves."

To accomplish the goal of international economic rejuvenation, the Economic Declaration "reiterated the urgent need to create a new, rational, equitable, and universal monetary system."

### Debt Relief Demanded

The Economic Declaration also issued a stern warning to the advanced nations that no program of increased trade for development can be carried out under the stringent austerity "conditionalities" forced upon the developing nations by the International Monetary Fund. It is the looting policies of

the old order that have left the developing sector with the crushing \$300 billion debt burden that the IMF is now destroying many Third World economies to collect. Urgent debt relief for the developing nations was demanded in the document.

### Energy Policy: Nuclear

A powerful section on energy policy was also written into the final articles of the summit's Political Declaration. It read, in part:

"... The Conference stressed the exceptional importance of international cooperation among the non-aligned and other developing countries in the field of peaceful use of nuclear energy . . . .

"The Conference affirmed the inalienable right of all States to apply and develop their programmes for the peaceful uses of nuclear energy for economic and social development in

conformity with their priorities, interests, and needs. It deplored the pressures and threats against developing countries aimed at preventing them from pursuing their programmes for the development of nuclear energy for peaceful purposes . . . .

"It expressed its concern in this respect, regarding the obstacles which the developed countries place in the way of transfers of technologies related to the peaceful uses of atomic energy by fixing financial and other conditions which are incompatible to the national sovereignty of developing countries and the criteria of financial viability . . . .

"Concern for nonproliferation should not be used as a pretext to prevent States from exercising the right to acquire and develop peaceful nuclear technology . . . ."

#### The Question of Leadership

The summit's resounding endorsement of an action plan for the new world economic order and its broadside against the International Monetary Fund came after the keynote speech by Cuban president and summit host Fidel Castro.

In his Sept. 2 address Castro told the opening plenary session of the conference: "Many governments making noble efforts to develop their countries are overwhelmed and threatened by the unfavorable conditions forced on them by international monetary institutions. What price have you had to pay because of the IMF? We Cubans are excluded from participation in the IMF, but we are not sure whether this is a burden or a privilege . . . . Let us unite for our right to develop."

Under Cuba's leadership, the summit plenary brushed aside attempts by Yugoslavia's Marshal Tito to soften its policy stance against the IMF. In other significant decisions, the body voted to censure Egypt for its participation in the Camp David military pact with Israel and to refuse a seat to representatives of ousted Kampuchea's (Cambodia's) dictator Pol Pot, who had just been convicted in absentia by a Phnom Penh tribunal for the murder of 3 million of his countrymen.

In their scope, determination, and

stated commitment to go beyond words and adopt "determined and effective action," the Havana declarations took the entire Third World way beyond the achievements of the Colombo Action Program, adopted in 1976 at the Nonaligned Movement's last summit conference in Sri Lanka.

At Colombo, the nonaligned nations called for debt moratoria and a new international credit institution to foster development. What the Havana meeting added was the strategy for

forcing the advanced sector to agree with such policies and the political courage to carry it out. As observers noted, the Havana summit put the majority of Third World nations in a position to ally with the European Monetary Fund initiated by France and West Germany.

*This report was compiled from the on-the-scene news releases of Executive Intelligence Review reporters Daniel Sneider and Dennis Small.*

## Terror Wave Set for Persian Gulf Oil Lanes

Iran's Revolutionary Council, led by strongman Ayatollah Khomeini, held a four-day meeting the last week of September to discuss changes in Iran's oil-exporting policy. Among the subjects discussed at the meeting was the possible firing of Hassan Nizah, the director of the Iranian National Oil Company. Nizah, sources say, would be replaced by council member Ayatollah Rafsanjani.

If carried out, Nizah's dismissal could bring to fruition threats of strikes by Iran's restive oil field workers. The fighting between the Kurdish minority and the Khomeini regime in the province of Khuzestan, where the nation's largest oilfields are located, has already disrupted Iran's oil production.

Nazih, a close political ally of the faction within Iran that opposes Khomeini's repressive style of government, had been identified by informed sources as a probable target of a new purge by the Islamic head of state. Nazih has repeatedly warned that Iran's oil workers, a majority of whom identify with the minority Sunni Islamic sect, will not tolerate a member of the opposing Shi'ite branch of Islam as the head of the National Oil Company. Another source of the oil workers' resistance to Rafsanjani is their sympathy with the Iranian left, now under harsh attack from the Khomeini regime.

Oil industry sources believe that a

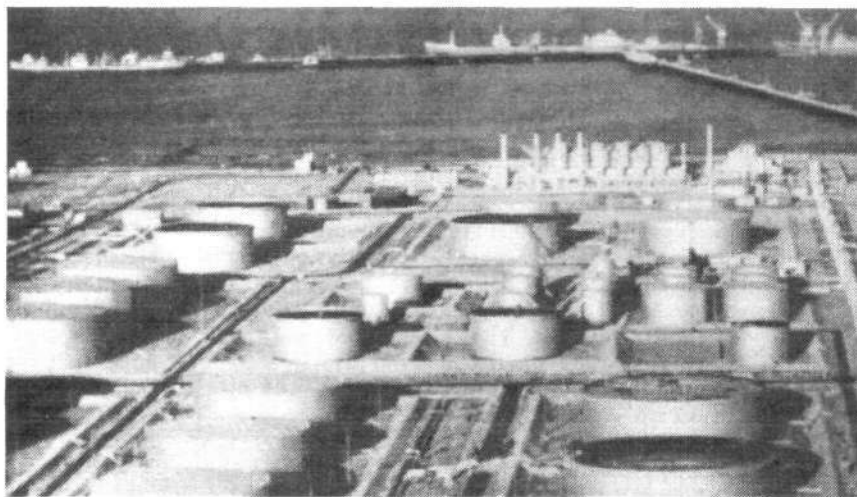
strike by the Iranian oil workers would exacerbate the climate of violence and turmoil that has been developing in the Persian Gulf since midsummer.

#### Climate for Terror

Since then, a series of incidents has suggested that a terror wave aimed at stopping the 20 million barrel per day (mbd) flow of oil through the Persian Gulf may be underway. In late August, two oil tankers exploded and sank within 24 hours of each other after departing from the loading terminal at Abu Dhabi. The preceding week an as yet untraced explosion ripped through a section of the Saudi oil tanker terminal at Ras Tanura, damaging a refinery and killing two workers. As a result, the Saudis have begun to experience a domestic shortage of the petroleum products the refinery produced.

Neither the Saudi nor the Abu Dhabi governments have pointed to possible sabotage as the cause of the mishaps. Industry analysts, however, believe this is due principally to the oil-producing nations' fear of a possible invasion of the region by the United States should major disruptions be threatened. Both Secretary of Defense Harold Brown and former U.S. energy secretary James Schlesinger have endorsed military intervention into the gulf as U.S. policy.

Furthermore, Mideast sources report that the networks around former Secretary of State Henry Kissinger, in-



Target for terrorism? Mina al Ahmadi oil-loading depot in Kuwait.

cluding well-known Anglo-American financial interests, are greasing the wheels for a wave of terrorism.

#### The Lloyds Connection

Less than a month prior to the outbreak of these incidents, on July 22, the U.S. Mapping Agency of the State Department predicted an outbreak of terrorism in the gulf. Shortly thereafter, Lloyds of London announced it was raising all insurance rates for tankers going into the gulf, terming the area a "war zone." At the same time an international conference took place in Jerusalem where similar predictions were put forth. In attendance were some of the leading world experts in predicting international terrorism—notably Henry Kissinger, British journalist Robert Moss, Georgetown University thinktanker Ray Cline, and some prominent Israeli leaders.

Lloyds of London's rate increase was met with unanimous outrage by the gulf oil producers. The head of the Kuwaiti Chamber of Commerce and Industry termed the move "psychological warfare" designed to build up anxiety within the oil consuming sector over the future stability of the gulf.

According to European sources, Lloyds's involvement in spreading an atmosphere of instability in the gulf linked to future terrorism is reminiscent of Lloyds's alleged involvement in Italian terror. The London firm is still under investigation by the Italian law enforcement authorities for alleged involvement in murders and kidnapping.

A high number of kidnap victims in Italy were found to be insured by Lloyds, leading to suspicion that kidnapers might have obtained inside information on victims' security arrangements available to Lloyds.

#### Khomeini and the PFLOAG

Interestingly, since the midsummer disturbances, Iranian Foreign Minister Ibrahim Yazdi, a Khomeini confidant, has met with members of the Popular Front for the Liberation of Oman and the Persian Gulf (PFLOAG), a grouping that Washington sources report is preparing terrorist sabotage against oil installations in the gulf region. PFLOAG was active in the rebellion against the Sultan of Oman five years ago, which was put down when the Shah of Iran sent troops to patrol Oman's borders.

There are also questionable links between radical European and U.S. groupings and the more militant factions of the trade unions that control Iran's oil workers. These groupings are clustered under the umbrellas of such institutions as the Washington-based Institute for Policy Studies, Amsterdam's Transnational Institute, and the London-based Bertrand Russell Peace Foundation. All these are institutional centers for the international radical-environmentalist movement, and all have a pedigree of terrorist connections. All, as well, supported the takeover of Iran last year by the antitechnology forces of the Ayatollah Khomeini.

—Judith Wyer

## Washington

# Carter Synfuels Program On Rocks

Since President Carter's July proposal to create an Emergency Mobilization Board and Energy Security Fund to speed through vast synthetic fuels projects, the project has been winding through the congressional maze, undergoing significant revisions along the way. In fact, Carter has admitted that his initial proposal has gone down the drain and that he will have to compromise if and when Congress passes any program.

More than six House and Senate committees are considering legislation to implement variations on the synfuels program, while environmentalists, protechnology forces, and free enterprise groups have voiced opposition on various grounds. Almost all the organizations testifying before Congress—including the General Accounting Office—have proposed a go-slow, conservative approach to synfuels.

One of the biggest political footballs is the carbon dioxide issue. The environmentalists have complained about alleged climatic effects from the increased levels of carbon dioxide expected from the synfuels program. In early July, the White House Council on Environmental Quality released a study showing that the use of synfuels increases the amount of carbon dioxide released into the atmosphere 2.3 times, compared to the level from burning a comparable amount of natural gas.

Senator Abe Ribicoff (D-Conn) released a statement July 27 saying that a massive coal and synthetics program could double carbon dioxide levels by 2010, which might effect global climate. The Department of Energy then

retaliated with its own report Aug. 8 claiming that such effects were being exaggerated.

Interestingly, the carbon dioxide question, which should receive competent scientific investigation, has not brought the environmentalist groups any closer to support for clean nuclear energy. Nor have the environmentalists or the synfuels supporters scientifically examined the damage to the economy of a synfuels program.

#### **Congressional Actions**

Some of the congressional activity in regard to synfuels includes:

**House Science and Technology Committee:** Ranking Republican member John Wydler (R-NY) released a statement Sept. 13 calling for a "limited" program in which federal funds, including those already authorized, do not exceed \$25 billion. Carter's original proposal was for an \$88 billion effort. In addition, rather than new agencies to implement the program, Wydler called for the DOE to take charge. The Carter program calls for the immediate commercialization of fundamentally untried technology for coal liquefaction. Wydler and his staff have recommended that after technical demonstration is made, a second pioneer plant should be built to prove economic feasibility.

**Senate Banking Committee:** The committee held hearings in July on the Moorhead amendment to the Defense Production Act, and in the second week in September marked up a remodeled bill that includes synfuels, solar energy, and alcohol production. The bill proposes \$3 billion for no more than 12 synfuels plants, six for oil shale processing and six for coal synthetics.

**Senate Budget Committee:** In hearings held throughout the month of September, the committee has heard testimony from three consulting firms urging them not to eliminate the demonstration-plant stage before commercialization. Cameron Engineers, ICF Inc., and Booz, Allen and Hamilton all called Carter's program "overambitious" and urged moderation.

**House Interior Committee:** This committee is not formulating a synfuels program but has passed out of committee a bill dealing with the proposed Emergency Mobilization Board. Under

the leadership of Congressman Morris Udall (D-Ariz), the committee eliminated a waiver requested by the administration to supersede local and state laws. Environmental supporter Udall will not compromise on environmental and other laws in order to "fast track" the synfuels program.

**House Commerce Committee:** The committee passed a bill Sept. 12 incorporating the Carter "fast track" to speed nonnuclear priority energy projects through the federal bureaucracy. The bill includes a waiver on state and local laws for such projects. Because of the substantial differences in the House Commerce and Interior bills, the House Rules Committee will now decide in what form the legislation will go to the full House.

**Senate Energy Committee:** The key Energy Committee voted Sept. 19 not to include the waiver provision in its legislation, but chairman Henry Jackson (D-WA) is trying to rework the Omnibus Energy Bill in accordance with the administration's proposals. Three bills will be consolidated and marked up for a vote in late September.

**Senate Environment and Public Works:** The committee objects to the "fast track" program of bypassing existing federal guidelines, laws, and procedures that may be passed by Senate committees and is also disputing the jurisdiction of the committees themselves.

—Marsha Freeman

## **Agnew, Panofsky Receive 1978 Fermi Award**

Dr. Harold M. Agnew, former director of Los Alamos Scientific Laboratory and current president of General Atomic Company, and Dr. Wolfgang K. H. Panofsky, director of the Stanford Linear Accelerator Center, are the 1978 recipients of the Enrico Fermi Award.

The award, established in 1954 when the Atomic Energy Commission presented a special award to Fermi, is the highest scientific award given by the Department of Energy. It is presented

in recognition of exceptional scientific and technical achievement in the development, use, or control of atomic energy.

Dr. Agnew was cited for his innovative contributions to nuclear physics and weaponry, his dynamic leadership of LASL, and his counsel to the U.S. government in national security.

Dr. Panofsky's citation notes his very important contributions to elementary particle physics, his leading role in advancing accelerator technology, his positive influence on younger scientists, and his scientific advice to the U.S. government.

Other less appropriate awards are as follows: James Schlesinger was given the National Security Medal upon his departure from the department, and John Deutch, sworn in Aug. 8 as DOE under secretary, received the DOE's Distinguished Service Medal.

## **House Temporarily Supports Breeder**

The Clinch River Breeder Reactor, whose long-term fate awaits resolution of the deadlock between the administration and Congress, will be given immediate continuing operating funds by a resolution prepared by the House.

Indecision in the Congress about what to do with the project has been fostered by the fear of some supporters that President Carter will once again veto the entire energy budget if it includes funding for the breeder. For that reason, the authorization bill that should cover the breeder does not include any funding for the breeder at all. However, the appropriations bill does include full funding for the program. In order to resolve this discrepancy temporarily, a continuing resolution for new programs and those not previously authorized will include Clinch River funding.

The continuing resolution also includes funding for abortion, salary increases, and a host of other programs, and, therefore, the probreeder congressmen are hoping that neither the Senate nor the administration will veto the resolution.

## Frieman Nominated For Energy Research Post

Dr. Edward Frieman, deputy director of the Princeton Plasma Physics Laboratory and professor of astrophysical sciences at Princeton University, has been nominated to succeed John Deutch as director of the DOE Office of Energy Research. Frieman, who has been involved with the fusion program for more than 20 years, may well be the person under whose leadership the DOE fusion program is placed, if the pending departmental reorganization puts magnetic fusion under energy research.

Frieman joined the controlled thermonuclear reaction research group at Princeton in 1952 under Project Matterhorn, which was declassified in 1958, and created the Plasma Physics Lab. In 1953, he was appointed the head of the theoretical division, and in 1964, was awarded a National Science Foundation postdoctoral fellowship. In the same year he became associate director of the laboratory.

He has served as a member of the board of directors of the Aeronautical Research Association at Princeton and the NSF Physics Advisory Panel, as a consultant to the DOE laser fusion division, and is a member of the board of editors of the American Physical Society.

In addition, Frieman has had experience in military-government advisory groups, including the NASA Nuclear Processes Advisory Committee and the Naval Research Advisory Committee. Reportedly, he became acquainted with Deutch during their common scientific advisory experience for the military.

### Fusion Options

Sources in the fusion community are unsure of the effect of either of the possible options being discussed for placement of the magnetic fusion program. If placed under an assistant

secretary for nuclear development, the program may become both a political and budgetary football in an already difficult political atmosphere.

Putting fusion research and development in the Office of Energy Research rather than in a program area, however, implies that it is not considered a commercially viable technology in the near term.

The opinion of many fusion scientists is that no matter where the program is placed, fusion development will result only from a statement of national purpose from outside the DOE.

### Militarizing the DOE

*Fusion* warned back in July that the DOE would increasingly bring in new people with military and military-related experience rather than energy or scientific credentials as a way of implementing a Malthusian energy austerity program. With the swearing-in of former Defense Department assistant secretary Charles Duncan as energy secretary, this militarization process has been accelerated.

At a press conference July 20 after his appointment, Duncan commented that his experience at the Department of Defense would help him in his new position. The DOD has its own energy research programs, he said and "further collaboration between the DOD and DOE on those efforts will be beneficial . . . There is already a lot of synergism between what is going on in Defense and what is going on in DOE. I think we need to facilitate those interchanges; we need to encourage that cooperation . . ."

According to sources within the DOE and the energy press in Washington, Duncan will fill key positions with underlings from the DOD. As DOE

becomes more and more an economic warfare and crisis management operation to control rather than develop energy, it is probable that the dwindling number of scientists at the DOE will find it more and more difficult to lead advanced technology programs, which are clearly not a priority in the new DOE administration.

Some of the probable appointments include:

**Joseph Nye** to replace Harry Bergold as assistant secretary for international affairs. As the Carter administration's key nonproliferation expert in the State Department, Nye earned the enmity of virtually every advanced and developing nation committed to the advancement of civilian nuclear power. He was a chief architect of the administration's programs to attempt to deny the transfer of nuclear power technology to the Third World. He is reported to be a personal friend of both Under Secretary John Deutch and Deputy Secretary John Sawhill.

**William Lewis** to replace Alvin Alm as assistant secretary for policy and evaluation. Lewis served with Duncan at the DOD as assistant secretary for program analysis and evaluation.

**John Shannon** to step in as head of the congressional liaison office. Shannon is a retired Army colonel who has been working in the DOD in recruitment programs.

**Deanne Siemer** as a special executive assistant to Duncan. She is now DOD general counsel.

**Ruth Davis** to replace George McIsaacs as assistant secretary for resource application. She is currently the DOD deputy undersecretary for research and advanced technology.

Another reported shoo-in is George Fumich, who will be brought in to head the newly created job of assistant secretary for coal and fossil fuels. Fumich, the brother-in-law of Senate majority leader Robert Byrd (D-W Va), is a lawyer and synfuel supporter who has the distinction of running for Congress in West Virginia and losing the district to the Republicans for the first time since Reconstruction.

—Marsha Freeman

# Hirsch Panel Calls for Fusion Plant by 1995

Rep. Mike McCormack (D-Wash), chairman of the House Subcommittee on Energy Research and Production, entered into the Congressional Record Sept. 13 the written report of the findings and recommendations of the Fusion Advisory Panel, reprinted here in full. The panel, chaired by Robert L. Hirsch, former head of the U.S. magnetic confinement program, is made up of distinguished fusion scientists and educators as well as business leaders.

The panel notes the tremendous progress in fusion research and strongly recommends that the United States plan and build a \$1 billion demonstration fusion plant by the year 1995. Such a program corresponds to the government's "Logic III" (out of five "Logics") timetable for fusion development developed under Hirsch, and is 15 years ahead of the Department of Energy's present fusion schedule.

The Fusion Energy Foundation is now collaborating with science and industry representatives to draw up federal legislation to move the fusion program forward with the urgency conveyed by McCormack and the Hirsch Panel. The December issue of Fusion will report on this legislative package and will begin a nationwide postcard campaign to Congress to build support for a brute-force U.S. fusion energy program.

## Rep. McCormack's Introduction

Mr. Speaker, the Subcommittee on Energy Research and Production has received a written report from its newly formed Fusion Advisory Panel, containing findings and recommendations concerning the fusion energy program....

The essence of the panel's findings is that:

First, the tokamak magnetic fusion research program has been highly successful in accomplishing its goals, on time and within costs;

Second, present experimental data indicate that a demonstration of an energy producing fusion reaction in the early 1980s is almost assured; and

Third, it is none-too-soon for the Department of Energy to plan a comprehensive strategy for bringing a tokamak fusion electric demonstration plant on line by 1995.

The panel also noted that while this ambitious plan would certainly require added funding in the short term, the cost to the country in the long run would most likely be less than that involved in following the Department of Energy's current program strategy.

It seems clear that we have no option except to press forward with development of fusion electric production as soon as possible, and that this effort should never be limited by budgetary considerations.

In light of these observations and the panel's recommendations, I have written to Dr. John Deutch, Acting Under Secretary of the Department of Energy, asking him to prepare a detailed program plan—including costs—to accomplish the above recommended goals. This letter to Dr.

Deutch was published in the July 26, 1979, *Congressional Record*.

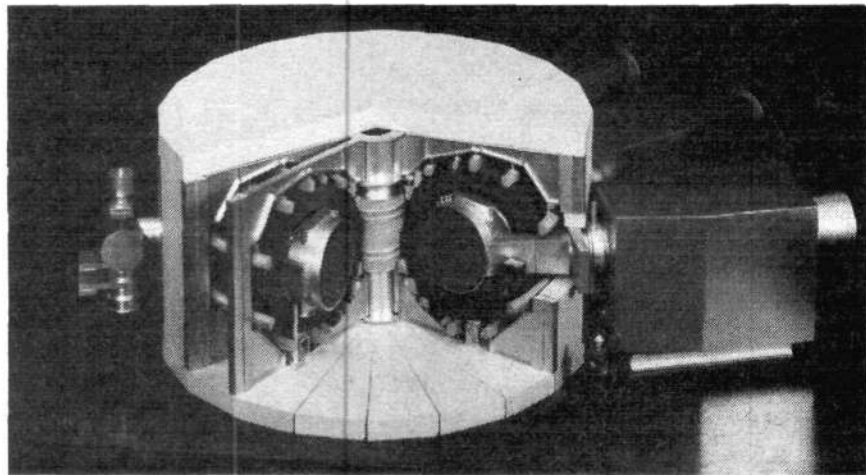
I urge the Members of the House to lend their support to an accelerated development program for this extremely promising energy technology.

A copy of the report of the Fusion Advisory Panel follows:

## The Hirsch Panel Report

The Fusion Advisory Panel of the Energy Research and Production Subcommittee of the House Science and Technology Committee met on July 10 and 11. At that time, the panel concentrated its attention on magnetic confinement fusion. Even though you and your colleagues received an oral report from the panel on July 11, it was deemed important to provide you with a short letter documenting the results of our efforts. The following is provided on behalf of the panel and represents the views of the overwhelming majority of our group.

On the basis of the information presented to us as well as the background that the panel members have in fusion and related technologies, we have come to several important conclusions. First and foremost is that the fusion program has to date achieved a very substantial and impressive measure of success. The magnetic confinement program has reached, and in many cases surpassed, the goals publicly set forth in past years. Magnetic fusion research has consistently been on schedule and very close to cost, even during recent inflationary times. On



A scale model of the TFTR tokamak at the Princeton Plasma Laboratory. Scheduled to begin operation in 1981, the TFTR is expected to reach breakeven energy conditions.



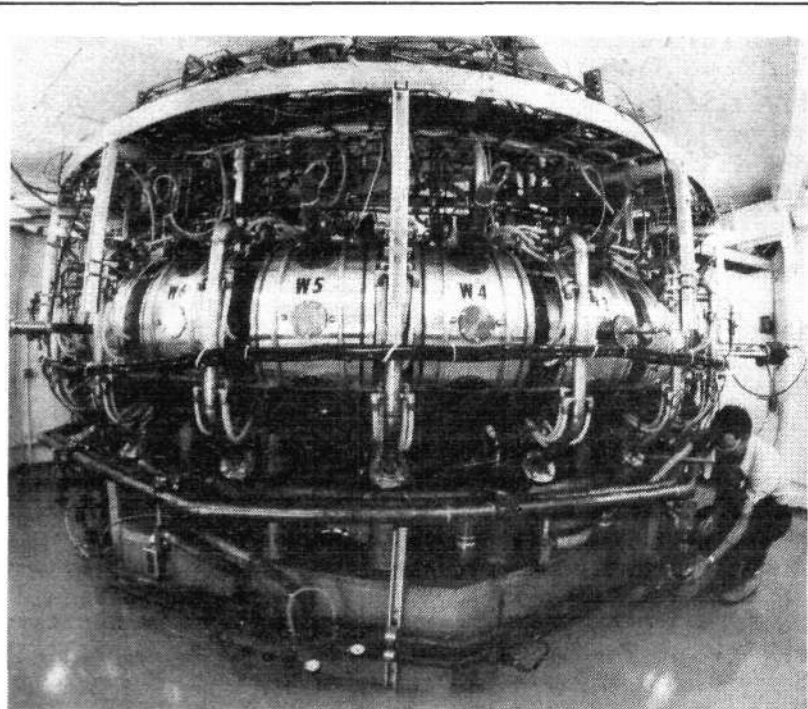
this basis, we see the program to be not only viable, but unusually meritorious and a source of national pride.

Second, as evidenced by recent results from the Princeton Large Torus, the Alcator, the Impurities Studies Experiment, and Doublet III, we believe that the magnetic fusion energy program is without a doubt ready to proceed much more aggressively than presently projected by the DOE. A key element in an expanded program would be a billion dollar class experimental fusion power system. In our view, this step must be formally initiated in the near term, not only because of the country's urgent need for energy for the future but because a delay would substantially reduce the effectiveness of the ongoing program. We wholeheartedly believe that electric power from fusion should be attainable before the turn of the century, and we believe the total programmatic cost for an accelerated program will be lower than for the present stretched out schedule.

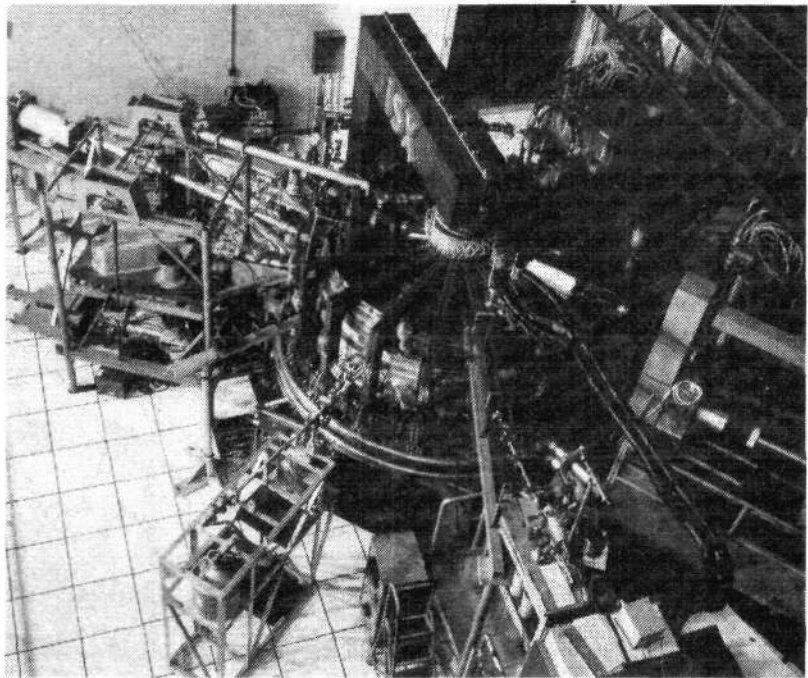
In view of these conclusions and based upon our deliberations, we recommend that the Subcommittee seriously investigate a more vigorous approach to practical fusion power. Specifically, we recommend that the Department of Energy be requested to prepare a program plan aimed at the goal of operating a demonstration fusion power plant by the year 1995. Such a plan should include a description of technical elements, costs, schedules, industrial involvement, etc. Once this plan is developed, a special hearing should be held to determine the credibility and desirability of such a program goal. We realize this to be an aggressive approach, but we believe that the recent successes in magnetic fusion research coupled with the energy needs of the nation justify an ambitious magnetic confinement fusion program.

My colleagues and I on the Fusion Advisory Panel hope that our efforts thus far have been useful to the Congress. We were impressed by the strong interest in fusion power evidenced by the large Congressional representation at the panel's sessions.

*Robert L. Hirsch*  
Chairman, Fusion Advisory Panel



ORNL



ORNL

### We're Sorry, Elmo

The Elmo Bumpy Torus tokamak at Oak Ridge National Laboratory (top) was mistakenly identified as the ISX-B tokamak (bottom), also at Oak Ridge, in the September issue of *Fusion*, pages 30-31. The EBT uses a rippled magnetic field, keeping the plasma from drifting into the walls of the torus through magnetic drift.

## Conferences

14th Intersociety Energy Conversion Engineering Conf., Aug. 5-10

# Putting a Hydrogen Economy on the Agenda

by Marsha Freeman

*At the 14th Intersociety Energy Conversion Engineering Conference held in Boston Aug. 5-10, scientists and engineers from the United States and Europe reported on the most up-to-date results from experimental and conceptual design work in hydrogen production, storage, transport, and end-use. This conference report emphasizes developments in production technology; a more comprehensive report covering the conference documents on storage and end-use technology will appear in a future issue of Fusion.*

Between now and the end of the century, the United States must make the transition from a fuel economy based on petroleum and natural gas to one that uses the most plentiful resource on earth—water—to fuel industry, homes, and transportation systems. With the commercial development of fusion and advanced nuclear technologies, hydrogen isotopes will become the primary fuel for production of electric power, replacing fossil fuels. Although, contrary to the Department of Energy statistics, it is not true that the world is immediately running out of these fossil fuels, such fuels are finite and must increasingly be used only as chemical feedstocks where, at this point, hydrocarbons have no substitute.

Hydrogen fuel from water is inexhaustible, easily available for all nations, nonpolluting, and totally "recyclable." That is, hydrogen can be produced from water by various methods of thermochemical and electrolytic decomposition; and when it is combusted as a fuel, combining with oxygen, the end-product is, again, water. Therefore, hydrogen is a closed-cycle fuel whose "waste-product" is the raw material for producing the fuel itself.

Research in hydrogen production technologies began in the mid-1950s by the National Aeronautics and Space Administration, out of their need to use liquid hydrogen fuel for rockets. NASA developed an impressive array of techniques for handling, liquifying, and storing the fuel, but until the maturation of concepts for advanced

nuclear possibilities were on the engineers' drawing boards in the late 1960s, there were no breakthroughs made on production.

### Hydrogen Production Key

The separation of hydrogen from oxygen in water is an endothermic and very energy-intensive process. The most cost-effective hydrogen process

## Hydrogen Production Technologies

### Currently Commercial

**re-formation of methane** produces nearly all of the 5 million tons of hydrogen produced today. Methane (natural gas) is reacted with steam in the presence of nickel catalysts at about 1,600 degrees Fahrenheit, producing carbon monoxide and hydrogen. The carbon monoxide is shift-converted with water, producing more hydrogen and carbon dioxide. Half of the hydrogen is produced from the methane, and half from the water.

**electrolysis of water** is used today to produce very pure hydrogen for special uses. Electricity is passed through water that is surrounded by an electrically conductive electrolyte, producing a chemical decomposition of the water. This method is expensive because of the relatively high cost of electric power. Researchers are trying to lower the cost by increasing efficiency in electrolysis through developing increased catalytic activity of the electrodes, including higher temperature electrolysis (above 200 degrees Fahrenheit) and by using solid polymer electrolytes.

### Techniques Under Development

**thermochemical cycles** are under development using high temperature and fusion reactors as the heat source. These cycles attempt to extract hydrogen chemically from water by the use of heat alone. The reactions with the highly corrosive chemical mediators typically take place at temperatures up to 1,500 degrees Fahrenheit, which are needed to regenerate the chemical. Hybrid cycles using both heat and electricity are also under development.

**high-temperature electrolysis** is under conceptual development for use with fusion reactors as the heat source. Using a temperature of up to about 2,700 degrees Fahrenheit, hydrogen is produced at an efficiency projected between 60 to 70 percent. The heat transferred by ceramic ducts from the reactor blanket is passed through a series of electrolyzers that drop the temperature of the water as each produces hydrogen. Hydrogen would be used as the fuel source for the reactor and would be electrolytically produced as a general fuel.

at this time is the steam re-forming of methane, or natural gas (see box). Approximately half of the hydrogen is supplied by the methane and half from the water. For applications in agricultural, electronics, and semiconductor manufacture, a purer form of hydrogen gas is required and electrolysis of water is the production technique.

#### Problems with Coal

The need to develop alternate production methods stems from the finitude of natural gas and the high cost of electric power relative to the energy content of the hydrogen fuel produced by electrolysis. Proposals have been made to use heavier fossil fuels such as petroleum and coal for hydrogen production. The problem is that the hydrogen content of coal, for example, is less than one-fourth that of natural gas, and 83% of hydrogen produced in processes that depend on the partial oxidation of coal (the reverse process is coal gasification to produce methane) is not from the coal but from the steam.

There are additional problems with the coal proposal involving the transporting and handling of the coal required for a commercial-sized hydrogen production plant, as well as the serious environmental considerations with high-pressure gasifiers capable of high throughputs of coal and ash.

The most productive lines of investigation, therefore, have been to

couple the heat of nuclear power plants with various kinds of cycles to liberate hydrogen directly from water.

#### High Temperature Reactors

Since the early 1970s a number of corporations have been investigating the linking of high-temperature nuclear reactors with thermochemical processes for hydrogen production. Impressive experimental work has been done by General Atomic and Westinghouse with technology support from Los Alamos Scientific Laboratory, the University of Kentucky, and Brookhaven and Argonne National Laboratories. In addition, the Euratom laboratories in Julich, West Germany and Ispra, Italy and Mitsubishi Heavy Industries in Tokyo are investigating thermochemical production.

The nuclear-integrated thermochemical cycles involve the use of chemical interactions to convert water to hydrogen and oxygen in closed cycles where a system of linked regenerative chemical reactions needs inputs of only water and heat. Hybrid cycles that use both thermal and electrical energy are also under experimental investigation.

General Atomic Company began thermochemical hydrogen production research in 1972 as a way to use the 850 degrees Celsius outlet heat from the high-temperature gas-cooled reactors (HTGR) they were developing. At close to atmospheric tempera-

ture, iodine reacts with sulfur dioxide and water to produce sulfuric acid and hydrogen iodides. At a slightly higher temperature of 120 degrees the iodides are broken down into free hydrogen and iodine.

The third step, requiring the most energy, is the decomposition of the highly corrosive sulfuric acid back to water, sulfur dioxide, and oxygen. This step takes place in a cracking furnace at about 850 degrees, and is necessary to regenerate the chemical reactant for the process. General Atomic estimates that the cycle can achieve an almost 50% efficiency, in terms of the amount of thermal energy input and the amount of energy released when the hydrogen product is combusted as fuel.

One of the major technological problems in the HTGR thermochemical process is the development of materials to withstand the corrosive nature of sulfuric acid at such high temperatures. To try to ameliorate this problem, various hybrid cycles involving both thermal and electrolytic energy input have been developed. Westinghouse has been doing research on a sulfur cycle hybrid process since 1973, with funding from the Department of Energy since 1976. The major reactions are the *thermal* decomposition of sulfuric acid into water, sulfur dioxide, and oxygen, and then the regeneration of sulfuric acid by *electrochemical* oxidation of the sulfuric dioxide, which releases hydrogen.

#### Working Models

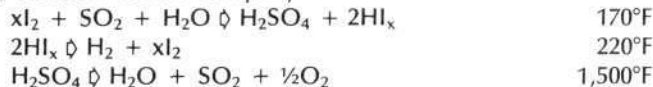
Westinghouse has a bench-scale model operating and plans a process development unit running by 1983 at performance levels appropriate for a commercial unit. This spring, the scientists at the Ispra Euratom Laboratory operated the world's first hybrid thermochemical system producing 100 pounds of hydrogen per hour.

Both the pure thermochemical and hybrid thermochemical technologies will probably be competitive with coal-based hydrogen production and be cheaper than conventional electrolytic technology (see box on costs). Although the thermal energy input from high temperature reactors will essentially be "free," since it would be comprised of the waste heat ef-

## Major Thermochemical Cycles For Hydrogen Production

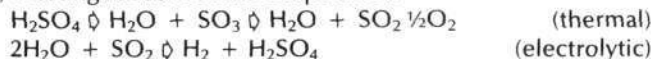
### Pure Thermochemical Cycles

#### (1) General Atomic Company

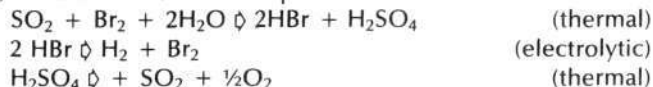


### Hybrid Thermochemical Cycles

#### (1) Westinghouse Electric Corporation



#### (2) Commission of the European Communities



fluent from the electricity generating cycle, the thermodynamic limitations in the chemical processes and the cost of expensive materials and chemicals indicate preliminarily that hydrogen produced from thermochemical processes will cost substantially more than natural gas or petroleum fuels.

#### **Fusion Hydrogen**

At approximately 2,500 degrees Celsius it is possible totally thermally to split water to produce hydrogen. Aside from the problem of developing materials to withstand temperatures of that magnitude, the only heat source that could economically provide that heat level is fusion. Even at temperatures lower than those required for total thermal splitting, temperatures beyond the range of the HTGR (1,200 degrees) are potentially more efficient and less expensive. The relationship between the thermal and electrical input required for direct splitting of water is linear—that is, the higher the temperature, the less expensive electrical input required.

In May 1977, the Department of Energy held a workshop to evaluate possible fusion processes for the production of hydrogen. The participants included Mel Bowman from Los Alamos; Bernard Eastlund, a developer of the fusion torch concept; James Powell and Meyer Steinberg from Brookhaven National Lab; Henry Gomberg from KMS Fusion; and other scientists in the fusion development field.

Five processes were evaluated, and the most promising was determined to be high-temperature electrolysis. Research in this area, reported on at the August Boston conference, has been done mainly at Brookhaven, with supporting work at Argonne National Lab. This work involves a thermal input at about 1,500 degrees and use of electric power produced in a conventional steam turbine cycle from the fusion reaction.

Projections are for 50 to 70 percent hydrogen production efficiencies by high-temperature electrolysis and 40 to 60 percent electric generation efficiencies using high-temperature lithium blankets, which breed the tritium needed for the fusion reaction. The conceptual design includes using

ceramic ducts to transfer the heat from the blanket to electrolyzers arranged in a temperature cascade.

The Brookhaven design includes a series of between nine and twelve electrolyzers at a maximum temperature of about 1,827 degrees. The maximum temperatures will be fixed by materials limitations, which, in turn, will set the limits for the optimum efficiency

in the production process. According to a very preliminary economic analysis done by the Brookhaven team, the cost of supplying a coal-based hydrogen plant with fuel balances the increased capital cost required for the fusion reactor.

From design studies that are quite tentative (since engineering demonstration fusion reactors have not yet

## **The Cost of Developing Advanced Hydrogen Technologies**

### **Thermochemical Cycles**

Most thermochemical cycles have been developed to make use of the waste heat from the high-temperature reactors that have been under development here and in Western Europe since the early 1970s. Therefore, the remaining development costs are for the thermochemical cycles themselves.

The major problem is the development of materials to withstand highly corrosive chemicals at high temperatures. Researchers in the field have estimated that a \$100 million effort would solve all of the remaining materials and component technology problems and make the technique ready for scale-up for commercial deployment.

A number of the organizations now developing thermochemical cycles already have small units operating and project the cost of hydrogen fuel to be competitive with production methods used today, in about the \$3 to \$6 per million BTU range. This is still significantly higher than the \$1 per million BTU cost for natural gas and \$2 per million BTU cost for oil, but will be necessary in integrated nuclear-industrial complexes for agricultural, petroleum refining, and some primary fuel uses.

### **High-Temperature Electrolysis**

Unlike the thermochemical processes, high-temperature electrolysis depends upon a heat source that is not yet commercially available—fusion energy. Scientists and engineers have estimated that if a full-scale high-temperature electrolysis hydrogen program were undertaken in parallel with an aggressive fusion program, an experimental production unit could be developed for use with a commercial demonstration fusion reactor in a decade.

The hydrogen production development cost, excluding the fusion reactor research and development, would be in the range of \$200 to \$500 million. It is estimated that a large-scale demonstration plant for hook-up with an experimental fusion power plant would cost about \$500,000. At this point, the fusion-hydrogen high temperature electrolysis work is not limited by technological problems (which researchers are confident can all be solved), but by the funding for both the reactor and hydrogen programs.

This process is projected to bring the cost of hydrogen fuel down to possibly a 60¢ per barrel equivalent of oil prices. This is because of the greatly increased thermodynamic efficiency of splitting water at such high temperatures, with the resulting minimal need for electrolytic splitting. The cost of electric power, in addition, will be cheaper per unit of capital cost and fuel cost with fusion compared to either conventional nuclear or fossil fuel power production.

been built), the Brookhaven team estimates that the cost of the hydrogen fuel from the proposed fusion design will be approximately half that of a comparable fission electrochemical system. In other words, the hydrogen produced from a fusion-hydrogen plant will be equivalent to an energy cost that corresponds to 45¢ to 60¢ per gallon of gasoline.

#### Will We Get There in Time?

With even less than a decade of experimental and design work in the nuclear/fusion hydrogen production field, there are significant results. It is demonstrably clear that if a serious effort were mounted in the critical remaining areas for both HTGR and fusion hydrogen technology, the transition to a hydrogen-based economy could begin on a large scale in the early 1990s. The present DOE funding situation, however, makes this goal impossible.

Although Westinghouse had a small high-temperature reactor development program in the mid-1970s, when the government pulled back on funding, so did Westinghouse. And General Atomic had nearly its entire HTGR budget eliminated in the 1980 DOE fiscal proposal. Furthermore, the crucial area of materials development for high-temperature and corrosion-resistant materials for thermochemical and electrolysis research is also fighting for minimal funding, with no coordinated government priority program in view.

The demoralization of scientists and engineers put into the position of fighting for every penny of research funding was painfully clear in the presentations at the energy conversion conference. Trying to find a way of "fitting" their research into the upside-down priorities of the DOE, scientists who were developing the integration of nuclear power production with chemical and industrial processes (nuplexes) are now scrambling to turn out proposals for "solar-driven" thermochemical and other hydrogen production processes—the only growing area of DOE-funded R&D.

In fiscal year 1979, the DOE-funded Energy Storage Systems program, a significant percentage of which is man-

aged through NASA by the Jet Propulsion Lab, was at a funding level of about \$6.3 million. The DOE's request for 1980 cut the budget to \$2.4 million. This work includes thermochemical cycles, materials development, transmission storage, hydrides, and other development technologies.

The basic problem to be solved for the transition of a hydrogen economy is the production of hydrogen fuel at costs comparable to the cost of today's fossil fuels. Research and development is also needed in techniques to store, transport, and use hydrogen, but many are already well known and could easily be engineered. Furthermore, the overall economics of the transition to a fusion-hydrogen economy has to be evaluated with the

aid of the LaRouche-Riemannian economic model described in the July issue of *Fusion*.

#### Commitment Required Now

At the point that fusion could be ready for commercial use near the turn of the century, the nation must be ready to switch over to hydrogen fuel produced with fusion reactors. This requires a commitment to do the research and development *now* so that this transition, especially in transport, is not disruptive, but the next step in the evolution of energy and resource systems that take us to the age of inexhaustible fuel for electric power.

*Marsha Freeman is director of industrial research for the Fusion Energy Foundation.*

Science and Technology for Development, Vienna

## UN Conference Pushes 'Appropriate Technology'

by Jonathan Tennenbaum

One billion people live in darkness; without electricity, little progress can be made to eliminate illiteracy or to train a skilled labor force in the Third World.

With this declaration, E.P. Velikhov, vice president of the Soviet Academy of Sciences and a leader of the Soviet fusion research program, put the issue of the advanced technological development of the underdeveloped countries on center stage at the United Nations Conference on Science and Technology for Development, UNCSTD, held in Vienna, Austria, Aug. 15-22.

Velikhov's remarks to the 4,000 participants highlighted an issue that was only marginally addressed in the course of the official conference sessions, but that was the subject of hot debate in private meetings and corridor consultations outside the main forum—the nuclear-powered industrialization of the Third World.

The high technology, pronuclear perspective was put forward con-

cretely by the Fusion Energy Foundation, which distributed a detailed policy statement at the conference calling for the development of nuplexes, agroindustrial cities centered around one or more nuclear plants.

#### Controlled Debate

The official sessions of the conference were, in fact, rigged. Tedious speeches and debates were directed to pitting the underdeveloped countries against the industrialized nations on the grounds of giving the "poor countries a greater voice in the control of technology transfer." Much of the proceedings echoed the environmentalists' cry that the West has "imposed" its technology on the developing sector without regard for "local customs."

Throughout the conferences, the British and U.S. delegations, the latter the largest in attendance, acted as enforcers of the International Monetary Fund and World Bank's policy of "appropriate technology"—a policy that means windmills, hand plows, and handicrafts, instead of nuclear power, mechanized farming, and industry for the Third World.



United Nations

Conference leaders (left to right): Guy Gresford, conference deputy secretary general; K.K.S. Dadzie, director general for development and international economic cooperation; Kurt Waldheim, UN secretary general; J.F. DaCosta, conference secretary general; Jean Gasarian, conference secretary.

In addition to the rigged agenda at the official UN conference, UN organizers supported a parallel "alternative conference" under the auspices of the UN Nongovernmental Organizations (NGO) Forum. There, those disgruntled with the UNCSTD sessions were subjected to the International Monetary Fund's more "radical" approach to Third World development, with discussion of "alternative lifestyles," "appropriate technology," and "appropriate psychology."

Among the organizations participating in the NGO forum were the Washington-based Institute for Policy Studies and its sister organization in Amsterdam, the Transnational Institute, both of which have fostered the terrorist wing of the environmentalist movement.

Velikhov's statement broke through the banal stupor imposed on the general session of UNCSTD. What the Third World needs, he said, is a crash electrification program on the order of what V.I. Lenin accomplished in Soviet Russia 50 years ago. Velikhov then challenged the French delegate, who—contrary to official French government policy—had said that nuclear energy would play only a minor role in such developing regions as black Africa.

No, Velikhov insisted, nuclear energy is decisive for the future of the Third World, and that means that the industrial nations, East and West, must undertake rapid worldwide expansion of fission power now, and accelerated

research and development into thermonuclear fusion energy. Fusion, Velikhov said, will be the main energy source of the future. Those in the advanced sector who try to sabotage the nuclear effort, he concluded, share a heavy responsibility for the future economic collapse and devastation of the Third World.

FEF representatives distributed 500 copies of a policy statement that called for using the European Monetary System as the basis of the new gold-backed world credit and monetary system to replace the IMF and the World Bank. That new system would provide hundreds of billions of dollars of credit to finance the transfer of high-technology capital goods to the developing sector making possible package deals for the construction of entire new industrial cities—nuplexes.

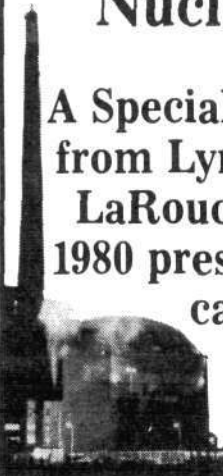
The FEF statement was illustrated by maps from the forthcoming book, *Blueprint for the Industrialization of Africa*, showing FEF proposals for a continental railway network for Africa. The proposal, which takes into account the need not just for construction of the network but for the nutritional and cultural requirements to raise the workforce's standard of living, will cost more than \$800 billion—far beyond anything the International Monetary Fund is able, or willing to spend.

*Jonathan Tennenbaum, a mathematician, is a European representative of the Fusion Energy Foundation.*

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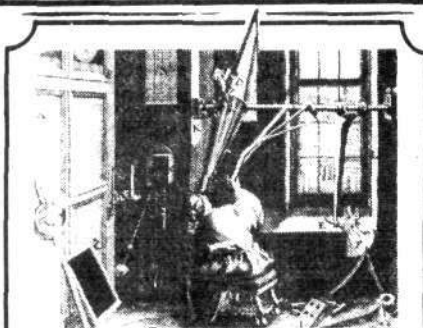
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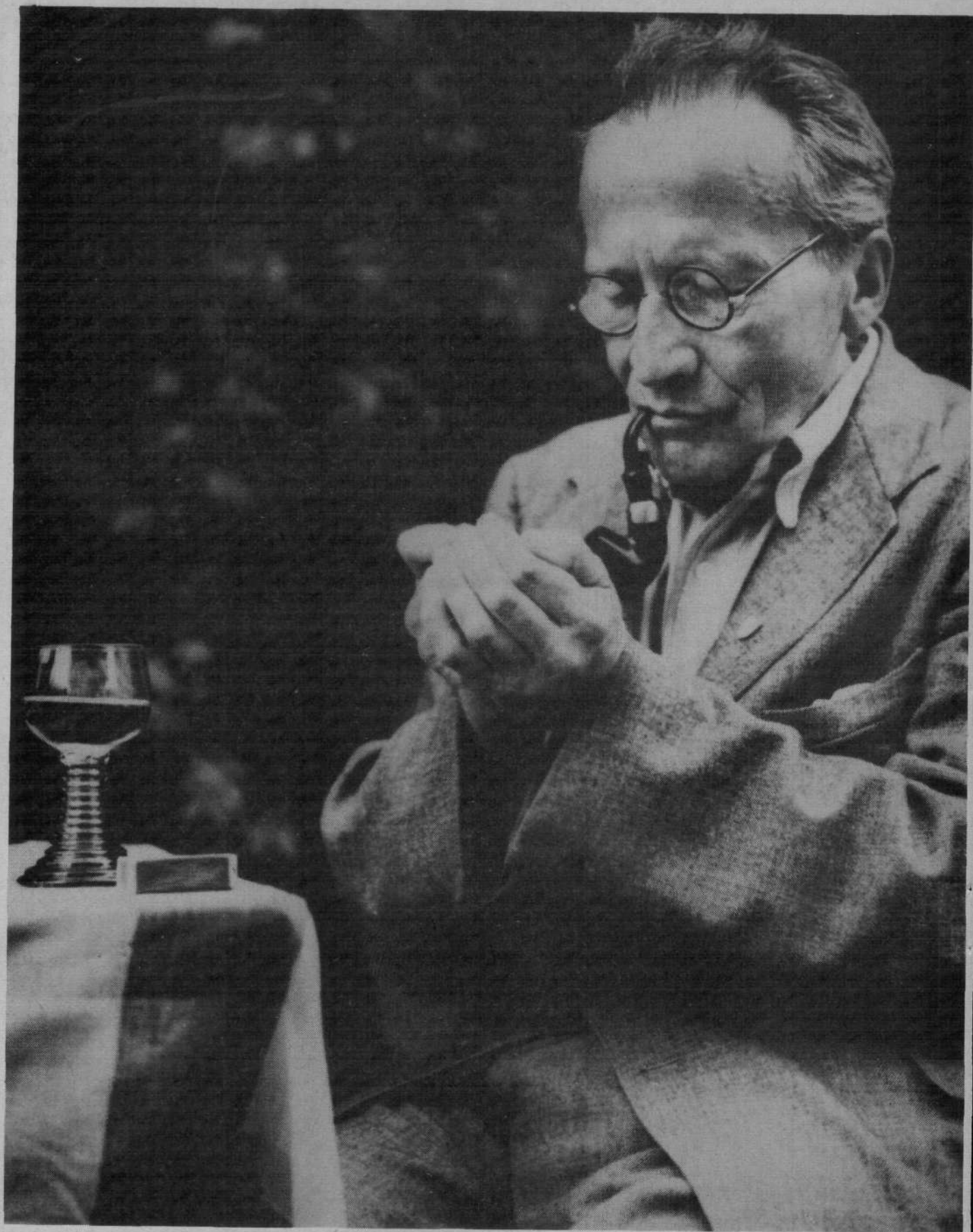
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# The Theoretical Impasse In Inertial Confinement Fusion

by Uwe Parpart

*Uwe Parpart is the director of research of the Fusion Energy Foundation. A graduate of the West German Naval Academy, he has taught mathematics, physics, and philosophy and was on the faculty of Swarthmore College for several years.*

\* \* \*

ALTHOUGH LEADING U.S. researchers in laser fusion remain outwardly confident that this country's principal experiments at the Lawrence Livermore and Los Alamos Laboratories are on target and will demonstrate scientific breakeven during the next three to four years, many of them will also readily admit that progress in the theoretical comprehension of some of the fundamental problems involved in laser fusion has been unsatisfactory and is out of step with laser engineering accomplishments.

In one sense, of course, this is a familiar situation and no cause for great alarm. We built perfectly good steam engines well before we had a full theoretical understanding of all the principles governing their behavior. How-

ever, unlike the steam engine case, questions surrounding the coupling of the laser energy into the target of fusionable material and the dynamics of the target pellet implosion are intimately connected with the most fundamental problems in microscopic physics—that is, nuclear and high-energy particle physics—and in astrophysics. Therefore, they will be resolved only in conjunction with significant progress in these domains.

The theoretical impasse in laser fusion thus means that what workers in the laser fusion and related inertial confinement fusion efforts define as "theory" is much too narrowly conceived. And this narrowness is further reinforced by the absurd degree of secrecy and catch-all security classification imposed upon the field.

On the other hand, an impasse can also serve as a point of inflection. It presents us with the unique opportunity of using the present difficulties as the take-off point for a new look at some of the basic physics problems not entirely untouched, but certainly not significantly advanced since the great quantum mechanics debates of the 1920s. The attainment of laser fusion would serve as an excellent focal point and most appropriate task orientation for such a broader theoretical effort.

In this article I will suggest several Ansätze (approaches) for such a program as well as develop further points already touched upon in my previous discussion of Bernhard Riemann's work on shock waves.<sup>1</sup> The article is also intended to serve as something of an introduction to Dr. Friedwardt Winterberg's article, "Reminiscences About the Origins of Inertial Confinement Fusion," in this issue.

*Erwin Schrödinger, the last theoretical physicist of note whose ideas on particle physics were in line with Riemann's continuum approach.*

Photo Pfaundler, Innsbruck, Austria



Winterberg's work is rooted in the approach to physics of the Göttingen hydrodynamicist school and his contributions to inertial confinement fusion—from his early suggestions on the use of ion beams to the initiation of the "impact fusion" approach are characterized by remarkable inventiveness and originality. Impact fusion, the bombardment of a target of fusible material with high velocity macroscopic particles, is now beginning to receive a good deal of attention not only among specialists working with large-scale particle accelerators but among fusion researchers in general.

It is an outstanding quality of Winterberg's papers that they never reflect an otherwise omnipresent self-imposed narrow professionalism, but explore a concept in all directions, unafraid of what some might call speculative suggestions and conclusions. This is the prerequisite attitude if we are going to realize the vast potential of inertial confinement fusion in the near term.

In a recent conversation the point was made to me by E.P. Velikhov, former head of the Soviet fusion program and now vice president of the Soviet Academy of Science, that although the first fusion reactors—in the form of

fusion-fission hybrids—will probably be based on the tokamak magnetic confinement principle, it will be as a result of mastering the principles of inertial confinement fusion that we will be able to progress to advanced fusion systems and achieve the kind of revolution in energy technology that has been accomplished in computer and information technology over the past 20 years. Specifically, Velikhov mentioned electronic-beam and fast liner methods of fusion. The Soviet program, while by no means deemphasizing magnetic confinement, therefore, is geared toward achieving early breakthroughs in inertial confinement to realize that larger goal.

As the Soviets realize, we need not just another energy system fundamentally equivalent to existing ones, but systems that can lead to the attainment of energy densities in energy production and use that exceed present densities of energy throughput by several orders of magnitude. The solution to the outstanding problems in inertial confinement fusion will make that possible. It is this unique conjuncture of opportunities—to propel us into a qualitatively new and more advanced energy future and simultaneously provide major new insights into the solution of

## Glossary

**Bose-Einstein statistics and distribution:** for an assembly of gaslike particles such as photons, pi mesons, and all nuclei having an even number of nucleons and all particles with integer spin (bosons), the quantum statistical mechanics of the interactions of the particles are those of a system of indistinguishable particles for which there is no restriction on the number of particles that may exist in the same state simultaneously. Such an assemblage is either noninteracting or weakly interacting; therefore, the distribution of energy in the assembly is quite different from that of the Maxwell-Boltzmann distribution for normal gases.

**Boltzmann or Maxwell-Boltzmann statistics and distribution:** the classical statistical mechanics of identical particles, such as gas molecules. The distribution of energies in an assembly of particles interacting according to the Boltzmann statistics is said to have a Maxwell-Boltzmann distribution when the assembly is in thermal equilibrium. The peak of the distribution identifies the temperature of the assembly.

**degeneracy temperature:** a temperature in comparison to which the gas temperature must be large if no noticeable gas degeneration is to occur.

**eigenvalue:** in quantum mechanical usage, eigenvalues correspond to quantum numbers and eigenvectors to stationary state wave functions that are solutions to the differential or matrix equations describing quantum behavior.

**equation of state:** a mathematical expression that defines the physical state of a homogeneous substance—gas, liquid, or solid—by relating volume to pressure and absolute temperature for a given mass of the material.

**electron wave packet:** the function of the spin orientation and position of one or more electrons, specifying the dynamical state of the electrons; the square modulus of the functions gives the probability per unit volume of finding an electron at a given position.

**Fermi-Dirac quantum statistics:** the statistics of an assembly of identical half-integer spin particles, such as electrons or individual nucleons. Such particles have wave functions antisymmetrical with respect to particle interchange, hence satisfying the Pauli exclusion principle, which states that no two particles can have all of their quantum numbers the same.

**Fermi gas:** an assembly of independent particles that obey Fermi-Dirac quantum statistics and, therefore, obey the Pauli exclusion principle. This concept is used in the free electron theory of metals and in one model of the behavior of nucleons in a nucleus.

**Hamilton-Jacobi equation:** a particular partial differential equation useful in studying certain systems of ordinary equations arising in the calculus of variations, dynamics, and optics.

**Hamiltonian analogy:** Hamiltonian mechanics permits optical and mechanical systems to be treated with the same method of approach. For example, Hamilton's variational principle includes both the principle of least action and

several of the principal unresolved issues in theoretical physics—that makes inertial confinement fusion the touchstone of scientific progress today.

As is well known and has been discussed in the open literature in detail since the early 1970s, fusion ignition by high-powered lasers without precompression of the fusionable material in the target pellet imposes prohibitive energy requirements and can be regarded as practically unrealizable.<sup>2</sup> On the other hand, isentropic\* or close-to-isentropic precompression of thick-shelled targets through a sequence of weak shocks delivered by a carefully tailored sequence of laser pulses has not yet led to fully satisfactory results.<sup>3</sup>

Thin-shelled targets subjected to strong shocks have been tried, but this approach is vitiated by the Rayleigh-Taylor instability.\* In the paper on Riemannian shock waves cited above, I suggested a third line of attack inspired by certain remarks in Riemann's 1859 paper "On the Propagation of Plane Air Waves of Finite Amplitude"<sup>4</sup> as well as by

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\*Words and phrases followed by asterisks are defined in the accompanying glossary.

work done by Hans Bethe et al. during World War II on the theory of shock waves for arbitrary equations of state\* and the pressure waves\* produced by underwater explosions.<sup>5</sup>

Since a decrease in entropy alone is an impermissible jump condition across a shock wave, it is entirely conceivable that isentropic compression results from the dynamics of strong shock/equation-of-state interactions shaped by the appropriate kind of target geometry. Conventional wisdom now has it that nothing of the sort will occur, since at the temperatures and densities we are dealing with, once a strong shock has been delivered into the target, the fusionable material has been transformed into a so-called Fermi gas\* whose behavior is well understood and does not conform to the circumstances envisaged in my suggestion.

#### *The Hypothesis*

In more detail, the opposing arguments run as follows: I have argued that we should investigate the experimental hypothesis that strong shocks change the equation of state of the fusionable material in such a way that a certain measure of decoupling of density and temperature and

Fermat's principle of least time, which was developed to determine the path of light.

**isentropic:** a process that occurs without change in entropy; for example, in isentropic compression, there is no transfer of heat and, hence, of entropy.

**jump conditions:** the conditions on both sides of the discontinuity formed by a shock wave and their relationship.

**LASNEX:** a computer code developed by Lawrence Livermore Laboratory as a modification of the computer simulation code NIXON, which is used in the design of H-bombs and for laser pellet microexplosions. It attempts to combine all known physical processes together with empirical experimental results in a consistent, calculable computer simulation of inertial confinement.

**mean free path:** the average distance a particle can travel without colliding with another particle.

**natural number sequence:** the sequence of the positive integers; that is, 1,2,3,4, . . . .

**Nernst's heat theorem:** (The Third Law of Thermodynamics): the theorem expressing that the rate of change of free energy of a homogeneous system with temperature and also the rate of change of enthalpy with temperature approaches zero as the temperature approaches absolute zero. It follows from this theorem that no such system can be cooled to absolute zero.

**positivist Copenhagen School:** the logical positivist interpretation of quantum mechanics promoted by Niels Bohr. According to his view, the uncertainty principle is a fun-

damental physical principle that demonstrates the impossibility of coherent causality on the atomic scale. Furthermore, the seemingly paradoxical properties of microscopic systems, such as so-called particle duality, are not resolved but are simply designated "complementary" aspects of the phenomenon.

**phase change:** the metamorphosis of a material or mixture from one physical state to another, such as gas to liquid, or solid to gas.

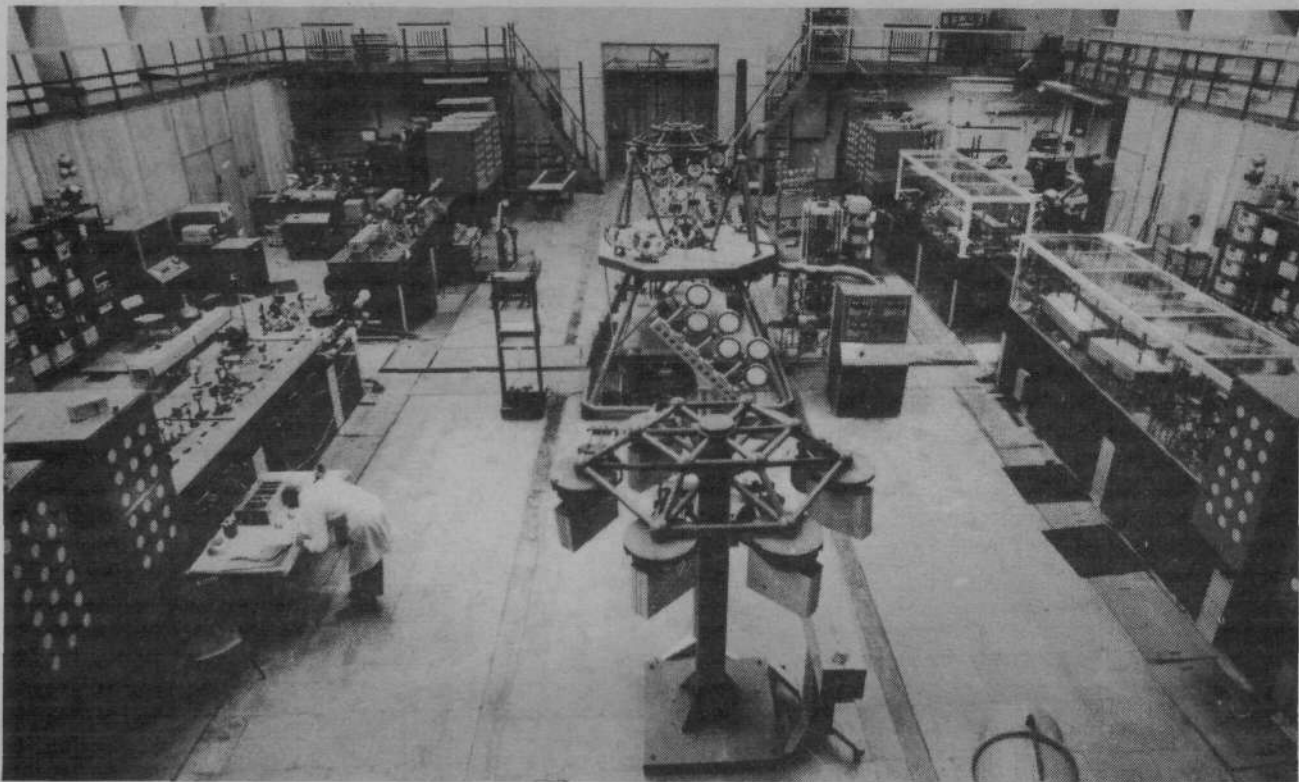
**pressure waves:** a wave in a fluid in which a compression is propagated; that is, a longitudinal wave, like a sound wave, as opposed to a transverse wave, like a water wave.

**quantum jumps:** a transition from one stationary state to another in a quantized system. The term jump indicates that the stationary states are not adjacent; for example, energy states, but represent discrete differences in quantum values between which the system jumps.

**quantization:** the restriction of an observable quantity, such as energy or angular momentum, associated with a physical system, such as an atom, molecule, or elementary particle, to a discrete set of values.

**soliton:** a physical structure observed in plasma physics and hydrodynamics that forms out of continuous media by discrete properties such as localized energy content and maintenance of its identity throughout interaction and collision with other solitons.

**scale length:** the basic unit of measure that cannot be subdivided.



The laser fusion laboratory at the Lebedev Institute in Moscow, 1978.

hence isentropic or close-to-isentropic compression might result. The mechanism I envisage that would lead to such a result is closely associated with a variety of phenomena observed when seemingly random small-scale fluid turbulence leads to the formation of relatively large-scale coherent and stable structures concentrating the energy of the system into solitons,\* vortices, and so forth. The very rapid onset of the formation of such structures, the extent to which their existence governs the fluid behavior both globally and locally, and the development of new types of interaction between these structures jointly are best summarized by thinking of the fluid as having undergone a phase change,\* where in the new phase the energy absorption characteristics and other relevant parameters no longer continuously connect with the previous state.

My hypothesis thus portrays a physical process—exemplified by inertial confinement fusion but certainly not exclusively so—that conforms to the crucial epistemological requirement that there must be identifiable and experimentally replicable processes in nature that

(1) demonstrate the discontinuous transition from given states to states exhibiting greater degrees of internal organization; and

(2) accomplish this transition through a kind of “tearing” of new structures (particles) and of laws governing their interaction out of and facilitated by the continuous modes (waves and so forth) modifying the previous state.

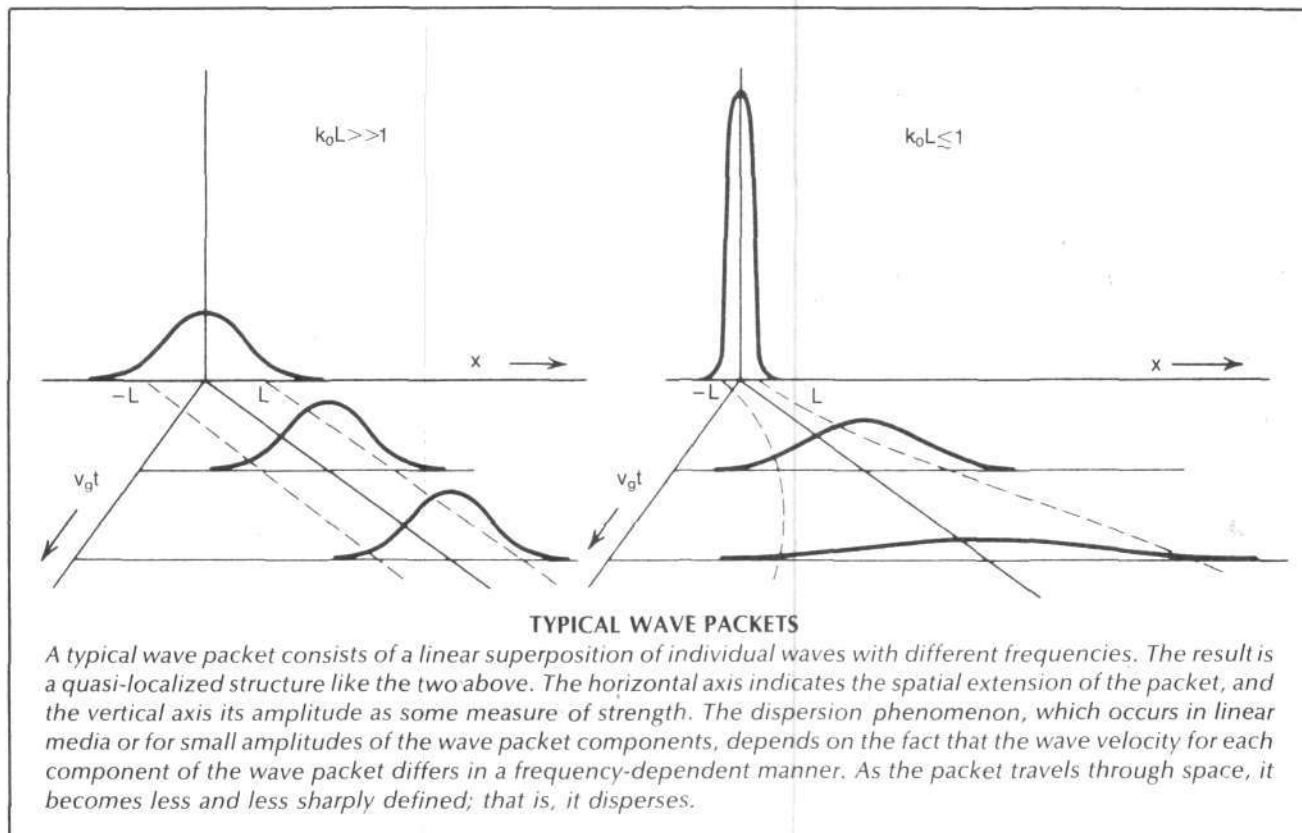
Such processes, first explicitly defined by Bernhard Riemann, are *negentropic* in the sense that they evolve new entities and modes of interaction capable, for example, of

greater and more efficient energy capture. They conform to the ordinary conservation laws in the sense that these laws define the *jump conditions\** for the discontinuities. Note that for laser fusion, negentropic phase sequences should be of interest not only for the identification of efficient isentropic compression schemes, but also to find better ways of coping with the Rayleigh-Taylor boundary layer instability. The existence and quantitative characterization of deterministic, coherent structures in turbulent boundary layer flow opens up the possibility of viewing such turbulence not merely as destructive; manipulation of and interference with these large-scale structures could make the turbulence controllable and even potentially beneficial.<sup>6</sup>

#### The Contrary Argument

The contrary argument asserts that as soon as a significant degree of compression of the fusible material is achieved, the accelerated matter is transformed into a highly interactive Fermi gas<sup>7</sup> adequately described by Fermi-Dirac quantum statistics.\* In particular, application of the Fermi statistical method yields definite values for the thermodynamic parameters of the gas, and the predicted values do not conform to the decoupling hypothesis presented above. The argument presumably can be buttressed further through arrays of detailed numerical values tracing the entirety of the compression process, generated by the LASNEX computer code.\*

With the arguments thus stated, it is clear that the disagreement involves no easily settled secondary matter of fact. LASNEX output is relevant only to the extent that we



can agree that the code takes into account and correctly models conditions of turbulence as demanded above. Basically, what is at issue in the analysis of pellet compression can, at least in first approximation, be defined as involving a crucial choice of scale length (or a limited range of scale lengths) deemed appropriate for the analysis.

The LASNEX code permits description of phenomena of macroscopic scales of length, or else it switches you into the micro realm employing there the homogenizing scale length assumptions of quantum statistics. In its time evolution the compression process must then be patched together from different pieces of analysis obtained by the generally divergent methods of description governing the different realms.

This approach, of course, must become hopelessly inadequate whenever the interaction of objects and events spanning widely differing scale lengths is to be examined—a circumstance characteristically satisfied precisely under the conditions of criticality and singularity defining the shock wave/phase transition hypothesis.

The fundamental point of method involved here, which a few changes in LASNEX subroutines cannot address, is made by Riemann toward the end of his 1854 paper "On the Hypotheses Upon Which Geometry Is Based":<sup>6</sup>

Upon the precision with which we pursue the phenomena [from the macroscopic realm] into the infinitely small essentially rests the comprehension of their causal connection . . . . If [the] independence of bodies from [their] location does not take place, then

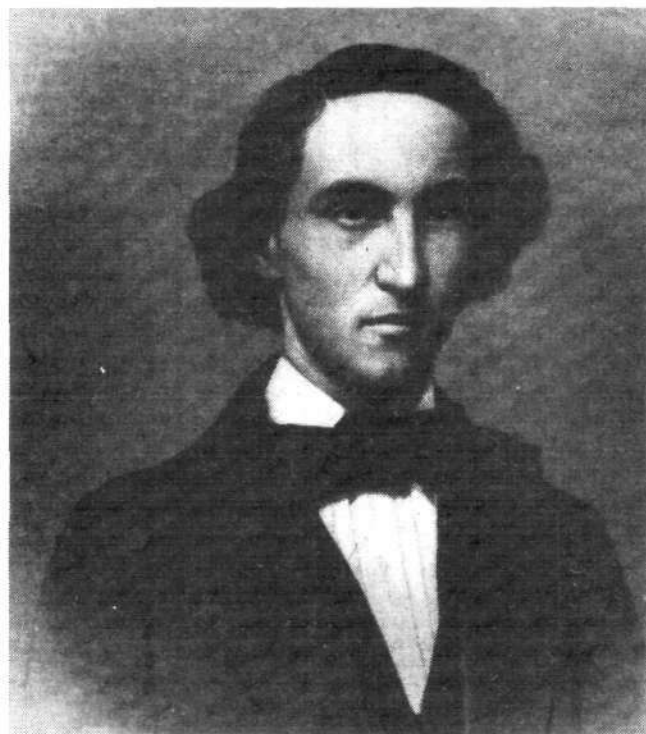
one cannot from the measure relations in the large draw conclusions about those in the infinitely small; at each point the measure of curvature [of space] can then have arbitrary values in three directions if only the total curvature of every measurable portion of space is not noticeably different from zero . . . . [And since] the empirical concepts upon which spatial measure relations are founded, [viz.] the concept of the rigid body and of the light ray, appear to lose their validity in the infinitely small, it is quite conceivable that in the infinitely small the measure relations of space do not conform to the presuppositions of [Euclidean] geometry, and this would have to be assumed in fact as soon as, on that basis, the [observed] phenomena could be explained in a simpler manner. The question of the validity of the presuppositions of [Euclidean] geometry in the infinitely small is connected with the question of what constitutes the inner reason and basis for the measure relations of space.

#### *Riemann's Advice*

So Riemann's counsel to us is quite unambiguous:

(1) Pursue the phenomena into the infinitely small; only then will the essence of causal connections be revealed—a difficult bit of advice to follow if your investigation is limited to certain preassigned scale lengths!

(2) As you are pursuing the phenomena make no a priori assumptions about specific metric relations, scales, modes of partition, and so forth, but be guided by the evolution of the physical process itself so that your "work is not



Burdny Library, Norwalk, Conn.

J. Willard Gibbs. Schrödinger provided a solution to the Gibbs paradox.

hindered by the limitations of the concepts, and progress in the comprehension of the overall connection of things is not hemmed by traditional prejudices."<sup>9</sup>

Riemann, of course, knew and emphasized time and again in all of his studies—ranging from the behavior of complex functions to the necessary development of shock waves in the propagation of waves of finite amplitude in compressible media—that it is precisely the evolution of infinities, of points at which a manifold spanned by a given set of parameters becomes singular, as well as the discernment of invariants defining causal connections across such singularities, that such a priori practices obscure and more often prevent entirely.

To have ignored—or be ignorant of—Riemann's advice in this matter is no special distinction of researchers in laser fusion. If anything, it is workers in this field who among contemporary physicists reflect at least indirectly the Riemannian mathematical physics tradition. A priori space and time categories, homogeneity and elementarity assumptions intrude into inertial confinement research and into plasma physics more generally as a result of the absolute hegemony of such epistemological primitivism in high-energy particle physics and much of quantum electrodynamics and the largely uncritical acceptance and utilization by fusion researchers of the allegedly well-established results in those domains. Erwin Schrödinger and, in a more limited sense, L.D. Landau were the last theoretical physicists of note whose ideas on particle physics were in line with Riemann's general ap-

proach. For them at least quantum jumps,\* natural number sequences\* defining electron behavior, or the applicability of Bose-Einstein\* and Fermi-Dirac rather than Boltzmann\* statistics to certain types of particles were phenomena to be explained rather than to be accepted as primitive data without further questions asked.

Laser fusion researchers, continually forced in their own work to bridge the gap between particle and macroscopic hydrodynamic descriptions of matter under extreme conditions, are uniquely situated to reopen the questions Schrödinger attempted to address and to launch a flanking attack on the wild proliferation of subatomic particles and bad epistemology now making a scandal out of particle physics.

### The Significance of Schrödinger's Approach

It is a little known fact, obscured somewhat by his own presentation in the groundbreaking 1926 papers on wave mechanics, that Schrödinger arrived at his ideas on "quantization\* as an eigenvalue\* problem" not so much by formal considerations involving the Hamilton-Jacobi differential equation\* or the Hamiltonian analogy between mechanics and optics,\* but as an immediate consequence of his study of certain difficulties in the theory of gases that arise when theorems such as Nernst's Heat Theorem\* are applied to gases under extreme conditions.

Schrödinger's subject matter, when he developed crucial aspects of his theory, was thus the same as that dealt with by laser fusion researchers studying the dynamics of the pellet compression process. His ideas on the theory of gases are laid down in four successive papers between 1924 and 1926, the last one of March 1926 titled "On Einstein's Gas Theory" being by far the most important. The type of difficulty in gas theory considered in these papers is exemplified by the so-called Gibbs paradox arising from the unrestricted application of the classical Boltzmann entropy formula

$$S = k \log W,$$

where  $S$  is the entropy of a given state of the system under consideration,  $k$  the Boltzmann constant, and  $W$  the number of dynamical microstates corresponding to the given thermodynamical state.

The paradox develops as follows: For a specific thermodynamical state given in terms of the energy  $U$  (or equivalently, the temperature  $T$ ), the volume  $V$ , and the particle number  $n$ , the classical theory yields an expression for the entropy

$$(1) S = nk \log V + \frac{3nk}{2 \log T} + nk \log \left( \frac{2\pi mk}{h^2} \right)^{3/2} + \frac{3}{2} nk$$

(where  $m$  = particle mass and  $h$  = Planck's constant).

Gibbs now pointed out that if two equal volumes of different nonreacting gases are joined together, formula (1) above gives the empirically observed entropy increase. But, he observed, if two volumes of the same gas are combined, the entropy not merely doubles as expected, but

wrongly increases by the added amount of  $2nk \log 2$ . This is easily verified by substituting  $2n$  and  $2V$  for  $n$  and  $V$  in (1).

It was, of course, widely recognized that subtraction of the term  $k \log n!$  [ $= nk (\log n-1)$ ] by Stirling's formula in the form  $\log n! = n (\log n-1)$  from (1) would lead to an entropy formula

$$(2) S = nk \log \frac{V}{n} + \frac{3nk}{2 \log T} + nk \log \left( \frac{2\pi mk}{h^2} \right)^{3/2} + \frac{5}{2}nk$$

yielding correct results. However, finding a convincing theoretical justification for the elimination of  $k \log n!$  from (1) was quite another matter. In the first of his four gas theory papers,<sup>10</sup> Schrödinger attempted such a justification by proposing that in the theory of gas degeneration the characteristic length,  $l$ , in the expression

$$T_c = \frac{h^2}{8m l^2 k}$$

(where  $m$  = molecular mass)

for the degeneracy temperature\* be chosen to be of the order of magnitude of the mean free path.\* Crucially,  $l$  enters into the entropy formula by determining the size of the cells in phase space all points (representing dynamical states) of which are regarded as equal.

From the standpoint here, what is most important about this mean-free-path approach is that from the outset Schrödinger makes it clear that he is looking for a physical reason, a physically efficient cause for the elimination of  $k \log n!$  rather than treating the whole matter as a mere bookkeeping problem. This is stated explicitly at the beginning of the March 1926 paper in which Schrödinger comments on Einstein's proposal that the difficulties in the theory of gases might be eliminated if an entirely new type of statistics, the so-called Bose(-Einstein) statistics, were applied to the motions of the gas molecules.<sup>11</sup> Although accepting the correctness of Einstein's point, Schrödinger writes:

Our natural sentiment rightfully balks at the idea of regarding this new [type of statistics] as something primary admitting of no further explanation. Rather, there appears veiled in it the assumption of a certain dependency upon one another or of an interaction of the gas molecules, which, however, in this form can only be analysed with [great] difficulty.

The basic idea (*Grundgedanke*) of his own analysis of the sought-after dependency and interaction is then introduced:

We must take seriously the de Broglie-Einstein undulation theory of the moving corpuscle according to which the latter is nothing other than a kind of "foam crest" [*Schaumkamm*] upon the wave radiation constituting the fundamental world-principle.

In the specific gas theoretic application of this idea, the gas is treated as a single system of linear oscillators much like a volume of radiation in equilibrium. (Two examples are a black body and a rigid body.) The frequency spectrum of the system (or gaseous body) that replaces the energy distribution of the classical molecular model is obtained through quantization of the standing waves of constant phase possible in volume  $V$ . Since in this single-system treatment of the gas fully individually distinguishable molecules no longer exist (although a certain amount of "granular" structure is maintained through the one-parameter frequency characterization of the gas), the  $k \log n!$  term in the definition of the entropy drops out quite naturally. This is because the number  $n!$  referred to the permutations of the dynamical states of the  $n$  molecules in volume  $V$ , while now we are counting only the dynamical states themselves.

Summarizing matters at the end of the article, Schrödinger states that if experimental facts make it necessary that the Bose-Einstein form of statistics be applied to a certain class of objects:

We must conclude that this class of objects consists not of genuine individuals, but of energetic excitation-states. Bose's statistics then appear only as a transitory state and can be replaced by "natural" statistics applied to another class of objects.

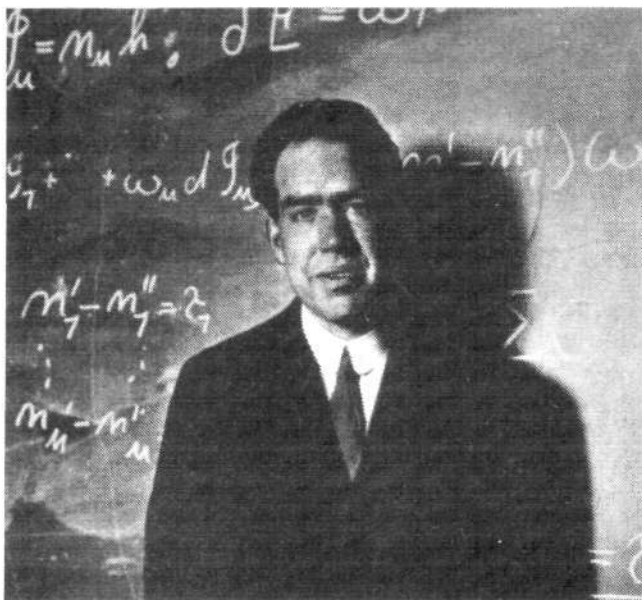
#### *Understanding Determinate Nature*

The reason I have quoted extensively from this 1926 Schrödinger paper on gas theory is that today—and this is no compliment to contemporary physics—more than 50 years later, it is still by far the clearest, most precise presentation by any theoretical physicist of the *determinate*—or



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H.A. Lorentz. Lorentz's private correspondence with Schrödinger on wave mechanics provides evidence that Schrödinger had suggested that particles were identical to certain kinds of shock waves.



Brown Brothers

Niels Bohr, head of Copenhagen's Institute for Theoretical Physics. His so-called positivist school bullied and isolated Schrödinger, contributing to Schrödinger's abandonment of attempts to extend his theory along the lines of Riemannian physics.

relative, or "ephemeral" in Plato's sense—character of particulate matter, the space it occupies, and the form of its interactions. Difficulties with the entropy definition demonstrate that in most interesting cases gases cannot be viewed as made up of independent individual molecules together with "Newtonian" interactions corresponding to Boltzmann-type statistics. Rather, the gas in a certain thermodynamical macrostate must be taken as a single collective phenomenon determining the type of individuality and modes of interaction characteristic of that state. The evolution of these modes under given boundary conditions, and including in particular the development of singularities, then determines the transition to successive macrostates.

It must be stressed again that the definition of the "cell"-size, which plays such a uniquely important role in statistical thermodynamics, is to be included among the determinate rather than the a priori given parameters.

Schrödinger's understanding of the determinate nature of particularity as I have presented and documented it so far, also guided him toward the development of his wave-mechanical theory of the electron, shortly after or possibly simultaneously with the completion of his work on gas theory. In fact, in the very first paragraph of his first paper on wave mechanics in the *Annalen der Physik*, the epistemological concern is very much in evidence:<sup>12</sup>

In this paper I wish . . . to show that the customary quantum conditions can be replaced by another postulate, in which the notion of "whole numbers" merely as such, is not introduced. Rather when integral-

ness does appear, it arises in the same natural way as it does in the case of the node-numbers of a vibrating string. The new conception . . . strikes, I believe, very deeply at the true nature of the quantum rules [emphasis added].

Still, I believe that despite its obvious groundbreaking significance, the presentation of the electron theory in the 1926 wave-mechanics papers is truncated and does not do justice to the full scope of Schrödinger's "Riemannian" approach. At the time, under the full onslaught of the positivist Copenhagen School,\* isolated, and with little collaborative support even from those who in principle agreed with his continuum theory of quantization, Schrödinger himself soon abandoned most attempts at extending his theory to a full-fledged causal account satisfying the criteria of Riemannian "negentropic" physics as defined above. (These attempts, as I shall show, were clearly in evidence in the last gas theory paper and in private correspondence with Lorentz.)

Or, in Plato's terms, he remained and was forced to remain satisfied with the account of the necessary or errant causes without ascending to the full knowledge of the divine cause that supersedes them and explains their meaning.

#### The Evidence

The evidence for my view on what Schrödinger might have achieved if it were not for the intellectual thuggery of Niels Bohr and his Copenhagen crew is as follows:

First, he was familiar with Riemann's works, in particular his work on shock waves, and he postulated the necessarily nonlinear character of the continuous medium with respect to which the electron is to be defined.

Second, he identified a kind of mechanism, involving quasi-periodic motions that could give sufficient stability to his electron wave-packets\* and that today we know to be precisely the type giving rise to highly stable solitons, and so forth.

Third, he at all times regarded the  $\Psi$ -function account of the electron as incomplete, an attitude that in the long run makes sense only if one has had at least a glimpse of an overreaching process that might explain that incompleteness and associated uncertainty.

These are the details:

In his summary of the main results of the last gas theory paper, Schrödinger notes that while the frequency spectrum of the "gaseous body" is obtained through quantization of the standing waves compatible with the volume  $V$ , the spectrum is not quite what one might expect, because the dispersion of the waves must be taken into account.<sup>13</sup> And it is precisely because of this dispersion, he notes at an earlier point, that:

The universal radiation as whose "signals" or perhaps singularities corpuscles are to be defined, is something essentially more complicated than, say, the wave-radiation of the Maxwell theory; and not only because it shows dispersion at all, but specifically because the dispersion law of the phase velocity for

a wave group additionally depends upon what kind of singularity the group of waves in question generates through their superposition. *In this one is reminded of the behavior of "waves of finite amplitude"* [emphasis added] . . .

So there is the explicit reference to Riemann's analysis of the propagation properties of waves of finite amplitude, the identification of corpuscle-singularities with Riemannian compression shocks, and, most important, the assertion of the *determination of the dispersion law by the kind of singularity generated*.

Schrödinger's tentative suggestion here that particles might be identifiable with certain kinds of shock waves is paralleled by contemporary attempts at identifying particles with solitons—coherent, highly stable types of structures that have dispersion as one of the principal processes bringing them into existence. Moreover, he assigns to them the exact manifold-connecting causal role demanded by Riemannian analysis.

Should there be any doubt about the legitimacy of this interpretation of Schrödinger's meaning, consider the following portions of his private correspondence with H.A. Lorentz on wave-mechanics concerned specifically with the stability of electrons interpreted as coherent wave packets. Lorentz had written that he had gathered from Schrödinger's paper that particulars were regarded as comparable to wave packets propagating with the group velocity.

However, a wave packet can never stay together in the long run and remain limited to a small space. The smallest dispersion of the mean will pull it apart in the direction of propagation, and, aside from any dispersion, it will widen more and more in the transverse direction ("diffraction"). Because of this inevitable smearing out, a wave packet appears to me little suited to represent things to which we want to ascribe a somewhat permanent individual existence.

Schrödinger's very interesting reply consists of two parts. He first acknowledges that he, too, has been quite concerned about the "sticking together" of the wave packets, but:

I am very happy that now at least I can point to a simple *example*, where, contrary to all reasonable expectation, it *nonetheless happens*. I hope that in any case this is so for all those cases in which ordinary mechanics speaks of *quasi-periodic* motions.

This is a most important comment, because quasi-periodic motions again are precisely motions in which a small, nonlinear disturbance is superimposed upon a larger periodic motion and whose extremely surprising coherent modes and unexpectedly rapid returns to periodicity were discovered when these kinds of motion became analyzable on a large scale with the advent of electronic computers.

The classic paper on this subject from which most recent studies of coherence and nonlinearity derive is the 1955 Fermi-Pasta-Ulam paper.<sup>14</sup> In it the authors had attempted to state a simple problem in mathematical physics that nonetheless could not be solved with pencil and paper because it required very lengthy computations. Here is Ulam's description of the problem:

The question was to find out how this nonlinearity [a small nonlinear term added to the usual equation of a vibrating string] after very many periods of vibrations would gradually alter the well-known periodic behavior of back and forth oscillations in one mode; how other modes of the string would become more important; and how, we thought, the entire motion would ultimately thermalize, imitating perhaps the behavior of fluids which are initially laminar and become more and more turbulent and convert their macroscopic motion into heat.

But nothing of the sort occurred: "The results were entirely different qualitatively from what even Fermi, with his great knowledge of wave motions, had expected," Ulam wrote. It was assumed that the shape would finally become "a mess" both in the form of the string and in the way the energy was distributed among higher and higher modes (tones). It did not. The string played only several low notes "and perhaps even more amazingly, after what would have been several hundred ordinary up and down vibrations it came back almost exactly to its original sinusoidal shape. I know that Fermi considered this to be, as he said, 'a minor discovery.'"<sup>15</sup>

#### *The Right Track*

Of course, in 1926, Schrödinger could not have been expected to carry through in detail this kind of analysis of nonlinear vibrations. But there is no question in my mind that he was on the right track, and there certainly was no need to waste 30 or even 50 years before, hesitatingly, some of his 1926 ideas are beginning to be reapplied to the analysis of particles and their interactions.<sup>16</sup>

Louis de Broglie, who developed some of the fundamental concepts upon which Schrödinger's wave mechanics as well as the last gas theory paper were based—unlike, I think, Schrödinger in his later work—at no point made any compromises with the Copenhagen School. I was told by his present principal collaborator, Georges Lochak, that de Broglie considered the post-1926 developments in quantum mechanics "a virtual coup d'état in theoretical physics," and continued to work in almost complete isolation on problems in wave mechanics.

Lochak also directed my attention to de Broglie's 1956 work *Une tentative d'interprétation causale et non linéaire de la mécanique ondulatoire*, where in chapter 8 de Broglie mentions "ondes solitaires" (solitons) in a discussion of corpuscle-singularities of wave groups.<sup>17</sup>

This is mentioned here to indicate that after 1926, an entirely different course of development in particle physics was possible than the course that led to today's quark-gluon trivia. Joint consideration of macroscopic vibration



and turbulence phenomena and of microscopic particle structure from the same standpoint of coherent structure born of nonlinearity in the context of investigations of compression and gas and fluid degeneration in laser fusion could reopen the Riemannian path in particle physics blocked and buried since the mid-1920s.

The second part of Schrödinger's response to Lorentz on electron stability is as telling and worthy of follow-up as his first. It reads:

Even once we take this [the stability of wave packets] as affirmed and agreed upon, there still always remains the difficulty of the entirely free electron in totally field-free space. Would you consider it a very serious objection to the theory if it turned out that in totally field-free space the electron cannot exist? Or perhaps that in general even "free" electrons in the ordinary sense do not retain their individuality permanently? That to speak of single electrons in a cathode ray bundle perhaps only has the meaning: the bundle possesses a certain "granular" structure . . . and neither the pure wave description nor the pure corpuscle description are exactly on the mark, but something in between which we have not as yet adequately attained?

Particles conceived as plasmoids of some sort, "free" only in a restricted sense, their behavior "uncertain" on a particle by particle basis, but not as elements of a collective higher-order structure—these were clearly the kind of questions on Schrödinger's mind, and if he had pursued them from the strictly Riemannian standpoint there is no question that some of the apparent "mysteries" surrounding particle physics till this day would have been resolved several decades ago.

I suspect that one of the problems that tripped up Schrödinger and ultimately wore down his resistance to Copenhagen mysticism—at least to the extent that his work lost its positive direction—was that his own knowledge of Riemannian geometry was insufficient and, as can be easily documented by checking the footnotes to his wave mechanical papers, that he relied strongly on Hermann Weyl's "linearity in the small" interpretation of the Riemannian manifold. This is a fatal epistemological flaw and destroys the sole basis in physical geometry that can lead to the much-sought-for unified field theory.

#### Notes

1. "Riemann Declassified—His Method and Program for the Natural Sciences," *Fusion* March-April 1979, pp. 24-37.
2. See, for example, Keith Bruckner, *IEEE Trans. Plasma Sci.*, 1:13 (1973).
3. John Nuckolls et al., "Laser Compression of Matter to Super-High Densities," *Nature*, 239:139 (1972).
4. "Über die Fortpflanzung ebener Luftwellen von endlicher Schwingungswerte," in *Gesammelte Mathematische Werke*, ed. H. Weber (1876), pp. 145-164. This has been translated by the author and will be published in the *International Journal of Fusion Energy*, Vol. 2, No. 3, 1979.
5. Hans Bethe et al., "The Pressure Wave Produced by an Underwater Explosion, I, II," National Defense Research Committee, Division B, Report Nos. 252, 281 (1942).
6. See "Dynamic Stabilization of the Rayleigh-Taylor Instability on Laser-Imploded Shells," by Jay P. Boris published as NRL Memorandum Report 3427, December 1976, which presents one approach to dynamic stabilization

of the Rayleigh-Taylor instability published in the open literature. A second unpublished approach was developed by the late Harry Sahlin of Lawrence Livermore Laboratory while he was working on LASNEX simulations of Soviet scientist L. Rudakov's conical target design.

The Boris approach to dynamic stabilization is based on varying the input of the laser energy incident on a fusion target. Boris projects that if this variation is carried out at the proper frequency or frequencies it will resonantly dissipate the growth of the most dangerous Rayleigh-Taylor instability mode. Scientists from Livermore point out that while Boris's work is quite interesting, there is nothing stopping the modulation of laser energy input from resonantly enhancing other Rayleigh-Taylor modes at the same time it is stabilizing some modes.

Sahlin's approach is much more interesting. It is based on the target medium itself modulating the input energy. Sahlin noticed while carrying out unpublished studies utilizing the Livermore LASNEX computer code that multilayered Rudakov-type conical targets lead to a situation where the layers of the target communicate with one another through acoustic waves during implosion. According to Sahlin, this communication not only stabilizes the Rayleigh-Taylor instability, but also allows for the stable reflection of the compression shock many times. And as a result, the fusion fuel is much more effectively compressed and heated.

7. For a description of this method of analysis, see Ya. B. Zel'dovich and Yu. P. Raizer, *The Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, Vol. 1, (New York, 1966).
8. "On the Hypotheses Upon Which Geometry Is Based," Riemann's Habilitation Paper at Göttingen University can be found in German in his *Collected Works, Gesammelte Mathematische Werke*, ed. H. Weber, pp. 254-269.
9. "Hypotheses"
10. *Physik. Zeitschr.* 25 (1924), pp. 41-45.
11. Albert Einstein, *Berliner Berichte* 1924, p. 261; 1925, p. 3.
12. *Ann. d. Physik*, 79 (1926), pp. 361-376.
13. Following the ideas of de Broglie, the frequency spectrum is computed from the point of view that a molecule of velocity  $v = \beta c$  and rest mass  $m$  is simply a "signal" or the "foam crest" of a wave system whose frequency  $\nu$  is near the value

$$\nu = mc^2/h \sqrt{1-\beta^2}$$

and for whose phase velocity  $u$  a dispersion law holds, which is given by the formula for  $\nu$  in conjunction with

$$u = c/\beta = c^2/v.$$

To demonstrate according to de Broglie,  $\nu$  then plays the role of the signal velocity. The problem then consists of counting the number of vibrations of volume  $V$  for a wave motion that is subject to this dispersion law.

14. E. Fermi, J.R. Pasta, and S.M. Ulam, "Studies of Nonlinear Problems," Los Alamos Scientific Laboratory Report, LA-1940, (1955).
15. S.M. Ulam, *Adventures of a Mathematician* (New York, 1976), pp. 226-227.
16. The natural extension of an avoidance of these fundamental lines of inquiry is the present-day perturbative many-body theories—of which the Bose-Einstein case of Schrödinger's earlier paper was the first. In these theories—which now constitute the main line of theoretical inquiry in plasma physics, fluid mechanics, solid state physics, field theory and elementary particle theory—the total interactions of a system are summed up out of the pairwise interactions between the modes (or particles in the system), their triples of interaction, etc. Each increasingly complex combination of "particle interaction" forms a term in the additive series describing the whole system; the hope being that the series converges (that is, only the pairwise interactions are important so that the first term is much larger than the rest of the series, and so on).

Unfortunately these theories all have been recently found to be plagued with almost identical problems of proving the convergence of this series. Although researchers had hoped since the 1920s that a formal proof of the sometimes numerical result of convergence could be rigorously proved, it has been shown in the last several years for almost all of these cases that the series does not converge; that higher-order terms are infinite; and that this problem is due to long-range effects (in space or time).

The downfall of these theories is strikingly similar to what Schrödinger foreshadowed: These particles thought to make up many-body systems are not individually identifiable; they act like the "foam-crest" of some underlying continuum phenomena.

17. De Broglie's work, *A Draft of a Causal and Nonlinear Interpretation of Wave Mechanics*, was published in French by Gauthier-Villars in Paris.

Dr. Friedwardt Winterberg



## Some Reminiscences About the Origins of Inertial Confinement

by Dr. Friedwardt Winterberg

*Friedwardt Winterberg is professor of physics at the Desert Research Institute of the University of Nevada System in Reno. In the early 1960s, Winterberg made the first proposals for impact fusion and light ion and electron-beam fusion, as well as a method for generating an intense light ion beam using a magnetically insulated diode. This year Winterberg was awarded the Hermann Oberth gold medal for his pioneering work in thermonuclear propulsion. The award, present annually by the Hermann Oberth-Wernher von Braun International Foundation for Space Flight, is considered the most distinguished scientific award in astronautics.*

\* \* \*

AN ARTICLE in the February 1979 *Fusion* by Dr. Steven Bardwell and Charles B. Stevens discloses for the first time that Soviet researchers give great scientific credit for the physical principles of inertial confinement fusion to the German hydrodynamic school of Ludwig Prandtl.<sup>1</sup> In particular, the article states that Adolf Busemann's work laid the groundwork for the U.S. and Soviet hydrogen bomb programs.<sup>2</sup>

#### Author's Note

I dedicate this article to the memory of Harry Sahlin, who died in May 1979. His personal idealism and dedication for the achievement of inertial confinement fusion will be remembered by all his friends.

These Soviet remarks can be considered quite sensational, because for the first time they shed some light on the Soviet H-bomb design, and the U.S. design is probably not too different.

This report on the Soviet views brought back into my memory the early ideas we had in postwar Germany about inertial confinement fusion. These ideas arose from the work of three German scientists whose work was done during World War II—G. Guderley, Busemann, and Walter Trinks. The work by Guderley and Busemann was theoretical. Trinks was already working both theoretically and experimentally on the possibility of releasing thermonuclear energy by the use of high explosives. Prior to 1945, I did not participate in these early studies, and I can relay only what others have told me, but I can give a first-hand report about the theoretical efforts after the war.

#### Initial Ideas

The idea of thermonuclear fusion goes back to a paper published in 1928 by two young physicists, R. Atkinson, an Englishman, and F. Houtermans, a German, who tried to explain why the sun and stars keep shining for billions of years.<sup>3</sup> They suggested that in the stellar interiors, which have temperatures of about 50 million degrees Celsius and pressures of many billion atmospheres, a nuclear fire is taking place that slowly converts hydrogen into helium. At these temperatures the ions have energies of several keV; therefore, it was clear that for nuclear reactions to be

possible at such low energies, Gamow's wave mechanical tunnel effect\* would have to play an important role.

Even though this early study did not correctly identify the particular thermonuclear reactions considered nowadays as the right ones, its principal idea is still valid. At that time, however, nobody thought it would ever be possible to realize such thermonuclear reactions on earth; the temperatures and pressures appeared to be beyond reach.

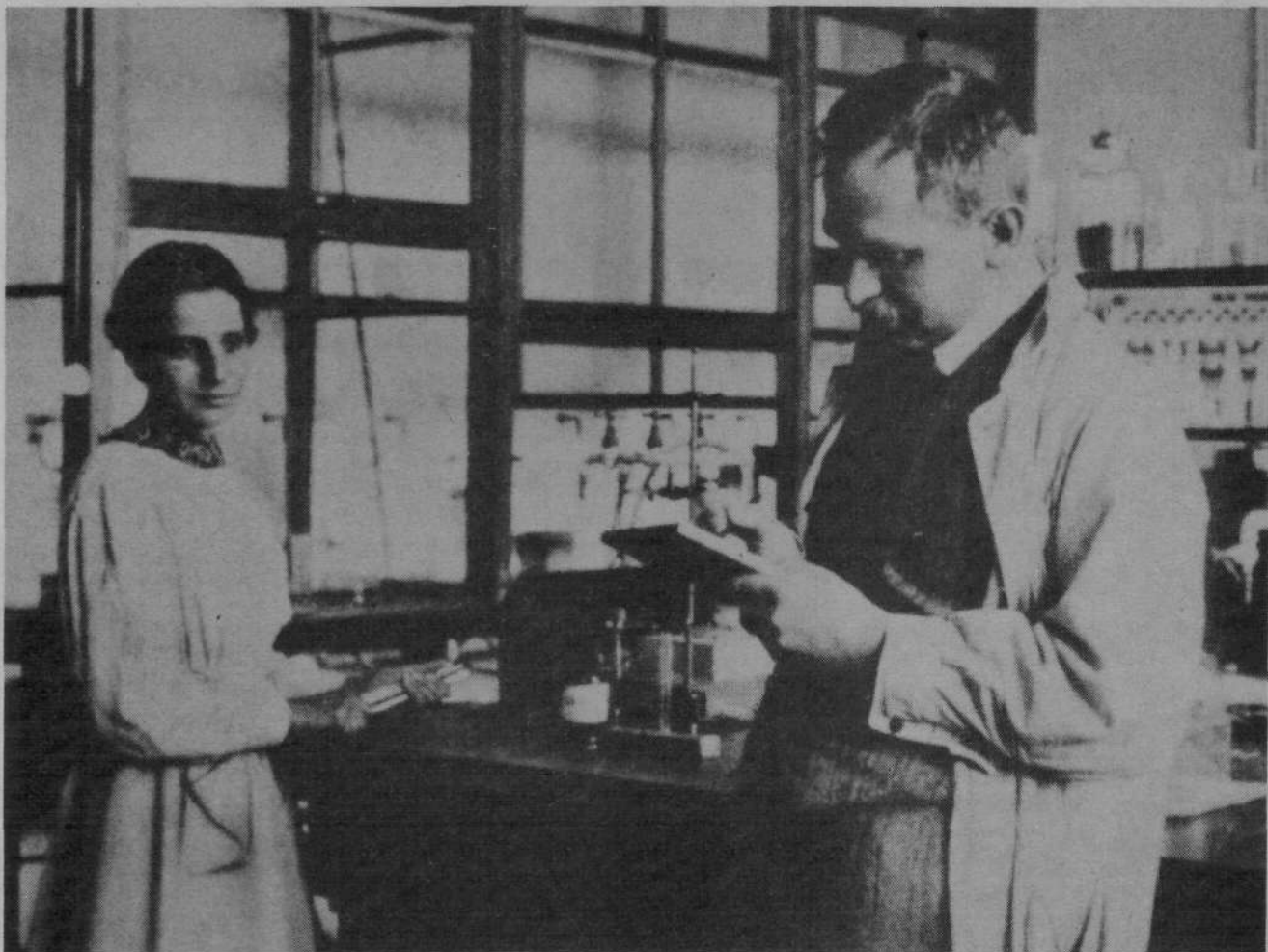
This negative outlook dramatically changed overnight with the discovery of nuclear fission by Otto Hahn and Fritz Strassmann in 1938. This discovery, of course, led to the atomic bomb. The temperatures and pressures that were theoretically expected to occur in an exploding fission bomb turned out to be just high enough to reach the lowest ignition temperatures for thermonuclear reactions. However, because an atomic bomb does not work below a critical mass, this approach could lead only to a bigger explosion and, therefore, seemed unsuitable for commercial energy production.

Parallel to these developments, some other important

ideas came up in the totally unrelated field of supersonic fluid dynamics and shock wave physics. Problems of this kind were extensively studied by the school of Prandtl in Göttingen, and there were two important papers published—one by Guderley<sup>4</sup> and the other by Busemann.<sup>5</sup>

Guderley had recognized that the temperature and pressure in a convergent spherical symmetric shock wave would rise as  $r^{-0.8}$ , where  $r$  is the distance of shock wave\* from the center of convergence.\* Guderley's solution thus predicted for a convergent spherical shock wave the attainment of very high temperatures and pressures. The question arose, therefore, whether this effect could reach the ignition temperatures for thermonuclear reactions. The suggestion was to start a convergent spherical shock wave from some initial radius using a chemical explosive. However, since the  $r^{-0.8}$  dependence in the temperature rise would ultimately stop if the distance of the shock wave from the center of convergence became smaller than the mean free path\* (at thermonuclear temperatures this path can be rather large), it was clear that this approach would require starting the convergent shock wave from a quite large initial radius.

\*Expressions followed by an asterisk appear in the glossary.



*Otto Hahn and Lise Meitner, pioneers in work on the splitting of the atom.*

Brown Brothers

Because of this shortcoming, Trinks proposed a new approach in 1942 which he also tried out experimentally. Trinks enclosed deuterium gas inside a hollow silver sphere. The silver sphere was surrounded by a layer of high explosive, which was surrounded by a tamp, and the high explosive was simultaneously ignited at many positions on the sphere. By the confining action of the outer tamp the silver sphere was spherically symmetrically imploded.

It was clear that because of the high initial pressure, the silver would behave like a liquid. During the implosion the radius of the silver sphere would shrink and its thickness fatten. This fattening would be accompanied by a rapid acceleration of the inner surface of the hollow sphere toward the center of convergence. As a result, the deuterium gas trapped within the silver sphere was adiabatically compressed to high densities and temperatures, approaching those existing in the center of stars.

Trinks's method promised the attainment of much higher temperatures than those possible with the Guderley solution if both experiments started from the same initial radius. However, a price was paid; the configuration by Trinks was subject to Rayleigh-Taylor instabilities.\* Trinks had shown

that with a hollow sphere having an initial diameter of 1 meter it should be possible to reach a final temperature of  $4 \times 10^6$  degrees Kelvin at a pressure of  $2.5 \times 10^8$  atmospheres. The final inner radius of the shell was computed to be 3.5 millimeters, a quite realistic value.

Experiments conducted by Trinks around 1942 were looking for neutron-activated silver from neutrons set free in thermonuclear deuterium-deuterium reactions but none was found. The probable reason was that the size of the spheres actually used in his experiments was much too small.

At the end of the war, the work by Trinks and other German explosive experts was confiscated by Dr. Samuel Goudsmit, an editor of *Physical Review* who was working in the Alsos Mission for the U.S. government. Then it was classified for several years by the U.S. Atomic Energy Commission as "Secret Restricted Data"!

### Postwar Research

After the war, experimental thermonuclear research was forbidden in Germany and Austria. However, this fact did not deter physicists in these countries from thinking. One

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## Glossary

**adiabatic compression:** a mode of compression in which the temperature and pressure of the compressed medium will increase as a result of the compression, but no additional heat energy is transferred.

**center of convergence:** the focus of a "mirror" used to concentrate a set of shock waves.

**closed chain reaction:** a set of nuclear reactions in which there are no net neutrons produced; the neutrons produced in one reaction are "consumed" in the other.

**cyclotron radiation:** radiation given off by electrons in intense magnetic fields.

**Gamov's wave mechanical tunnel effect:** a theoretical result in quantum mechanics that predicts that certain nuclear reactions can occur at much lower energies than conventional theories predict.

**isentropic:** a process that occurs without change in entropy; for example, in isentropic compression there is no transfer of heat and, hence, of entropy.

**large amplitude Riemannian wave:** a one-dimensional (that is, going only in one direction) shock wave.

**Mach number:** the ratio of the speed of the shock wave to the speed of sound in the gas; the higher the Mach number, the stronger the shock wave.

**mean free path:** the average distance a particle can travel without colliding with another particle.

**neutron multiplier:** an ingredient in a nuclear cycle that produces more neutrons than it consumes.

**particle beam:** beams of electrons, protons, or heavy subatomic particles used for heating and compressing fusion targets.

**prolate ellipsoid configuration:** a technique for focusing shock waves that uses an approximately elliptical surface to reflect the shock waves to a point.

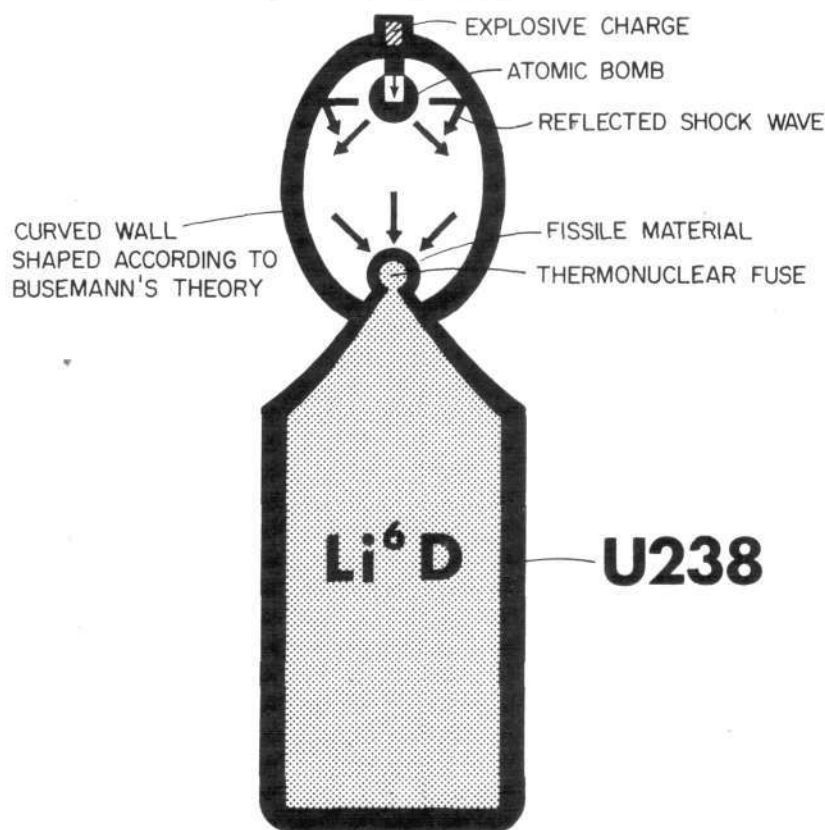
**Rayleigh-Taylor instability:** the tendency for a thin shell to ripple when it is compressed (for example, the "instability" that occurs when a balloon is compressed).

**shock wave:** the final state of a strong pressure wave that propagates in a compressible medium like a gas; this pressure wave will develop an extremely sharp leading edge, giving it almost explosive properties. A sonic boom is a shock wave.

**supersonic:** any velocity greater than the velocity of sound in that medium; the Mach number for a supersonic velocity is greater than 1.

**z-pinch:** a plasma containment device that uses strong axial currents to confine a plasma or fusion fuel.

# H - BOMB



© F. WINTERBERG  
(Design of author around 1952)

Figure 1

## THE WINTERBERG H-BOMB DESIGN

This simplified diagram describes five stages involved in bomb design: (1) Assembly and detonation of a "gun-type" fission device. (2) Formation of a shock wave from the fission bomb explosion and its shaping through reflection in a "whispering-gallery-type" chamber. The ellipsoidal shape of this chamber leads to a focusing of the reflected shock waves onto the second foci point of the ellipsoid, where the thermonuclear fuse is located. (3) The focused shock implodes and ignites the thermonuclear fuse, which consists of an outer layer of fissile material and an inner layer of fusion fuel. The outer layer of fissile material acts both as a tamp to permit more efficient implosion of the fusion fuel and as an aid to thermonuclear ignition. (4) The ignition of intense fusion reactions in the fuse leads to the formation of a thermonuclear burn wave and a copious amount of neutrons. (5) These neutrons then induce fissioning in the uranium-238 tamp, which further multiplies the total energy output of the device.

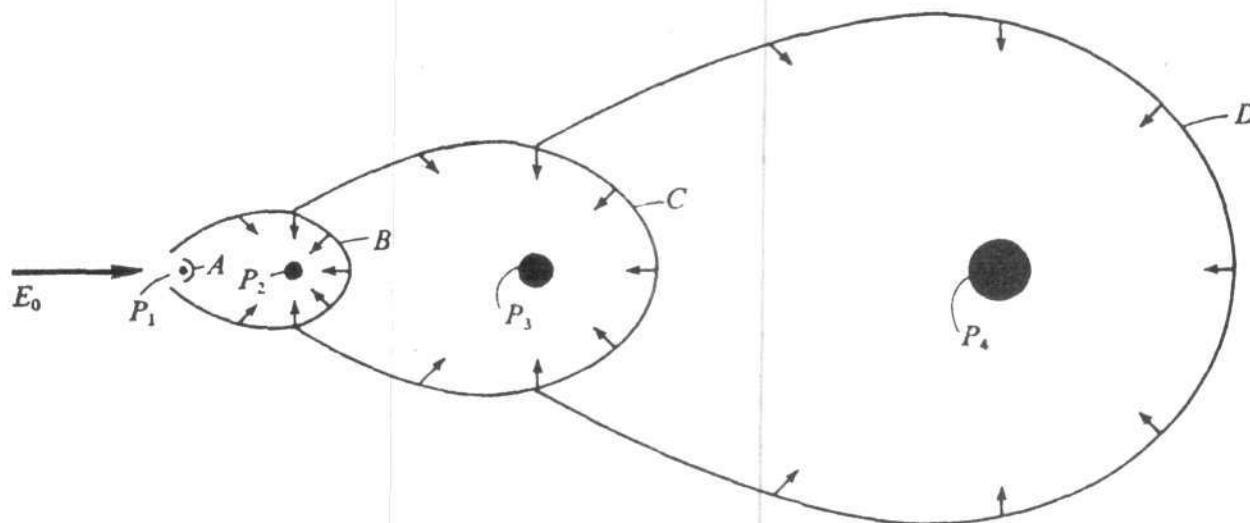
of these scientists who did think was Professor Hans Thirring, an eminent Austrian physicist. In 1946, Thirring published a book on the history of the atomic bomb that contained a chapter about the theoretical possibility of igniting a thermonuclear explosion by a fission bomb. He called it the superbomb and estimated that its explosive power could be easily 1,000 times larger than the explosive power of an atomic bomb. As possible explosives Thirring suggested both deuterium and lithium hydride. In particular, he proposed Li<sup>7</sup>H, but we know today that this does not work because the cross-section for the thermonuclear reactions between Li<sup>7</sup> and H is much too small. Nevertheless, Thirring's ideas stimulated further thinking. I was still in high school when I read Thirring's book, parts of which were published in the *Bulletin of Atomic Scientists* several years later.

Around 1948, I read an article about the superbomb in the U.S. Information Center in Stuttgart. The article was written by a reporter who had interviewed several scientists

for their opinion. From these interviews he learned that simply by bringing a thermonuclear explosive in contact with an exploding fission bomb, the thermonuclear explosive would be blown aside by the large radiation pressure of the fission explosion long before the thermonuclear material could catch fire.

The problem of igniting a thermonuclear fire, therefore, could be aptly described as similar to the problem a person has lighting a cigarette in a storm. Long before the cigarette can catch fire, the wind will have blown out his match. However, he may know that he can overcome this problem by forming a curved shield with his hand around both cigarette and match. This suggests that one might solve the problem of thermonuclear ignition by a similar trick, except that the "wind" would come from an exploding fission bomb and is supersonic,\* unlike the subsonic wind of a storm.

In course of his search, the reporter had also interviewed a famous physicist—I think it was Ernest Lawrence—who



**Figure 2**

**PROLATE ELLIPSOIDAL FOCUSING OF SHOCK WAVES**

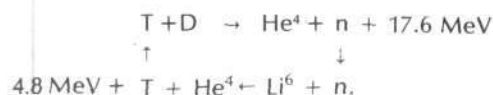
In a 1976 article in the *Journal of Plasma Physics*, Winterberg showed the above use of focused shock waves in the prolate ellipsoidal configuration. Each ellipsoid focuses the energy from the shock waves produced by the preceding microexplosion (shown as  $P_1$ ,  $P_2$ , and so forth). The shock waves emanate from these points and are reflected on toward the next fusion pellet in the direction shown by the arrows.

It is a unique property of the prolate ellipsoid that it can focus these waves to a point. In Winterberg's application, a small amount of initial energy,  $E_0$ , is used to ignite a small pellet,  $P_1$ , whose explosion is focused (using the ellipsoid B) onto the next pellet,  $P_2$ . The energy from the explosion of  $P_2$  is then focused (using C) onto  $P_3$ . Each step in this process greatly amplifies the energy and then uses the ellipsoid to concentrate that energy for the next step of amplification.

apparently was unaware about the technique everyone uses to light a cigarette in a storm. Therefore, the physicist believed that the only answer to the problem was tritium, and he showed the reporter a tiny bottle of  $T_2O$ , which he had kept in his closet. (The story with the  $T_2O$  bottle in Lawrence's closet is interesting in itself because it would not conform to presently acceptable safety standards regarding radioactive materials.) Lawrence's idea, of course, was the deuterium-tritium bomb. However, tritium is radioactive with a half-life of 12.3 years, and since it must be generated in nuclear reactors by neutron bombardment of lithium, it would be necessary to continuously reproduce the decayed tritium. The larger the DT superbomb capability, the larger the tritium factory would have to be. A further impediment for a weapon based on a DT explosive would have been the need to liquify a mixture of DT, which can be done only with a large refrigeration system.

In 1950, an interesting paper appeared in an obscure German Physical Society magazine by a Dr. Ulrich Jetter,<sup>6</sup>

an otherwise little known physicist. Titled "The Superbomb," the paper contained an entirely new suggestion that changed the outlook overnight. This was probably the same idea independently arrived at by Edward Teller in the United States and Andrei Sakharov in the Soviet Union. Jetter suggested that it might not be necessary at all to breed tritium in a reactor since the production of tritium could take place during a thermonuclear explosion itself. The idea was to use  $Li^6D$  directly as the explosive with a sufficient number of neutrons acting as a catalyst for the conversion of  $Li^6$  and D into  $He^4$  under the closed chain reaction:<sup>\*</sup>



One important consequence of this emerged immediately. Since  $Li^6D$  is a salt and solid at room temperature,



American Institute of Physics, Niels Bohr Library

Where the Riemannian hydrodynamicist tradition flourished: The physics division at Göttingen University, 1907. Ludwig Prandtl is at the far left, row one.

there would be no need for an expensive refrigeration system. The initial neutrons required to set off the reaction could be provided by the fission explosion. However, since some neutrons would always be lost, the thermonuclear reaction would have to be coupled to a neutron multiplier.\* For this purpose, ordinary uranium offered itself and could be simultaneously used as a tamp.

Samples taken from the fallout of the 1954 H-bomb tests showed large quantities of U-238 fission products, confirming, in fact, that the United States chose such a concept. Soviet tests showed the same. The first thermonuclear test in 1952 known as the Mike test did not produce a fission fallout. The explosion had a yield of 20 megatons, and since it seemed unlikely that the necessary quantities of tritium could be easily produced for such a large yield, this had to be a pure deuterium explosion.

At the time, many people did not think that a thermonuclear detonation in pure deuterium would be possible. However, calculations show that a detonation in pure deuterium, in fact, is possible because the *DD* reaction produces tritium and  $\text{He}^3$ , both of which react strongly with deuterium. This two-stage thermonuclear combustion in deuterium makes possible a detonation as violent as that of *DT*. However, in contrast to a *DT* detonation, the ignition temperature here is several 100 keV—roughly 10 times higher than for the *DT* reaction. Therefore, it is much more difficult to ignite a thermonuclear detonation in pure deu-

terium. One way out, of course, would be to use some tritium first to ignite a *DT* detonation. This would raise the temperature that would then ignite a *DD* detonation.

Around 1952, I came up with some ideas about how an H-bomb might actually work. To overcome the above-mentioned difficulty of having the thermonuclear material blown away by the radiation pressure of the exploding atomic bomb, I thought it might be possible to solve this problem by putting several atomic bombs at the corner of a polyhedron with the thermonuclear fuse positioned in the center. The minimum number of atomic bombs required would be four, occupying the corners of a tetrahedron.

This, of course, was a configuration that would approach Guderley's spherical convergent shock wave in the limiting case of an infinite number of atomic bombs placed on the surface of a sphere. Furthermore, since the Guderley solution predicted an  $r^{-0.8}$  temperature rise, a 20-fold increase in temperature from  $5 \times 10^7$  degrees Kelvin, the temperature of an exploding fission bomb, to  $10^9$  degrees Kelvin  $\approx$  100 keV could be reached by a convergent shock wave beginning at a radius of 1 meter down to  $\sim$  1 centimeter. Therefore, if a deuterium fuse were put in the center of convergence, it would become possible to have a deuterium deflagration going into an adjacent deuterium horn.

Since the use of many atomic bombs seemed impractical, I thought the same effect might perhaps be possible with just one bomb, using the generalization of a prolate ellips-

oid configuration\* for large-amplitude Riemannian waves.\* For small-amplitude acoustic waves,\* a disturbance originating in one focus of a prolate ellipsoid is refocused into the second focus. The so-called whispering galleries make use of this effect. The same effect still occurs for large-amplitude Riemannian waves but with an important difference: the wall shape differs from a mathematical ellipsoid and depends on the Mach number.\*

The exact theory of how the wall has to be shaped is found in Busemann's classical paper cited above. In a superficial sense, then, the theory tells us how to "curve our hand," if the match is an atomic bomb and the cigarette the thermonuclear explosive. Busemann's theory has a forerunner in a 1908 theory by Prandtl and Meyer describing isentropic\* supersonic flow along a curved wall.

In 1952, I suggested how one could incorporate this effect into an H-bomb design using the explosive proposed by Jetter. (This concept is shown in Figure 1). When the United States exploded a large thermonuclear device in 1954, I was at the Max Planck Institute for Physics in Göttingen. The experiments quite naturally attracted our interest and curiosity about how the Americans did it. Most physicists then knew of the possibility of using Li<sup>6</sup>D as an explosive. Not known, of course, was the confinement and ignition concept. During an institute tea I mentioned to Werner Heisenberg that I believed this could be done by the shock wave ellipsoid configuration. After thinking for a moment, Heisenberg replied, "Yes, I can quite well imagine that this is the way it is being done." But he added with a smile, "it is better not to think about these horrible things."

### Atoms for Peace

These ideas were borne out of a purely intellectual curiosity and really did not excite me very much. At that time, the other highly hypothetical alternative possibility for igniting a thermonuclear microexplosion was infinitely more interesting, because if it could be done it would open the prospect for an unlimited clean source of useful energy.

From 1956 on, I was in Hamburg to help set up a nuclear research reactor under President Eisenhower's Atoms for Peace program. It was there that I met Dr. Diebner, under whom Trinks had worked during the war. Together with Professor Bagge, we began to think how we could possibly ignite a thermonuclear miniexplosion using chemical high explosives. Our idea was to use Guderley's solution in conjunction with a superfast z-pinch\* or exploding wire.

About a year later, Dr. von Weizsäcker called for a meeting of specialists in Göttingen where the major approaches to controlled fusion would be discussed. The purpose of the meeting was to identify the research areas that in his opinion deserved funding. Before I went to the meeting Diebner warned me, "If Weizsäcker learns that we want to make fusion in little bangs, he will immediately be against it."

The way the meeting went, all approaches—other than the one proposed by Göttingen—were presented and shot down one after the other with the exception of ours.

The approach proposed by Göttingen was similar to the stellarator concept. At that time the optimism for magnetic confinement fusion was very great and everyone believed that DD fusion would be possible with it. With chemically driven shock waves, DD fusion was certainly out of reach. (Today, of course, we know that DD fusion is also out of reach for magnetic fusion, but this was not known until the Soviet scientist Trubnikov showed in 1958 at the Geneva Conference on the Peaceful Uses of Atomic Energy that the reason for this is cyclotron radiation.\*)

Therefore, the only criticism Dr. von Weizsäcker raised against the convergent shock wave approach was that it could work only with DT and then only in form of a minibomb. When I replied that we should not fail to think about this possibility, Dr. von Weizsäcker interrupted me and said, "That is where I stop thinking."

After this remark, nobody dared say anything more, and the minibomb was "dropped" in favor of magnetic fusion.

During the same meeting I also discussed the imploding shell approach by Trinks, but nobody gave it much credence. Because of this setback we were condemned to continue to work only theoretically. At one time the Krupp Company showed some interest through Dr. Dieter Pfirsich, then working at Krupp and today one of Europe's most eminent plasma physicists.

Because it appeared very difficult to start a uniform implosion with a shell made up of high explosives that were simultaneously ignited at many points, I reconsidered the old idea of using a shock wave focusing ellipsoidal cavity. The idea was to put the chemical explosive into one focus and the exploding wire into the other focus, but no experiments were ever done.

Around 1958, I began thinking about using particle beams\* for microexplosion ignition, including the possibility of beams composed of microparticles. But this is an entirely different story, eventually involving many other scientists. This was also at the time that laser fusion began.

Looking back, the principal difference in our early thinking compared to the large-scale U.S. weapons research program was the quest for controlled thermonuclear fusion by inertial confinement. This quest has not yet been achieved, which, of course, shows that it is by orders of magnitude more difficult than the fission-triggered H-bomb first demonstrated by Teller and Sakharov.

### Notes

1. "12th European Laser Conference: Soviets Propose International Laser Facility," *Fusion*, Feb. 1979, pp.11-14.
2. Busemann, now 78, is professor emeritus at the University of Colorado. He holds many distinguished honors from various countries and is a member of the U.S. Academy of Engineering, an honor that has not been given to many German scientists who came to the United States after 1945. In a letter written to me, Busemann says that when the Allied forces came to Germany, they showed great interest in his papers, some of which at that time were not published.
3. R. Atkinson and F. Houtermans. 1928. *Zeitschrift f. Physik* 54: 656.
4. G. Guderley. 1942. *Luftfahrtforschung* 19: 302.
5. A. Busemann. 1942. *Luftfahrtforschung* 19: 137.
6. See for example, D. Irving, *The German Atomic Bomb* (New York: Simon and Schuster, 1967), p. 216; also "Habilitation Paper," University of Göttingen, 1947; and German Patent No. 977825, Aug. 13, 1952.
7. U. Jetter. 1950. *Physikalische Blätter* 6: 199; and ORNL-tr. 842.





# The Fallacy Of Scalar Elementarity

by Lyndon H. LaRouche, Jr.

*Lyndon H. LaRouche, Jr., well-known internationally as an economist, is a 1980 presidential candidate and is running in the New Hampshire Democratic Party primary. This article was initially presented at the Fusion Energy Foundation's June conference in Paris on the industrialization of Africa as a supplement to LaRouche's main presentation, "The Myth About Equilibrium Economics." The text of the LaRouche speech, as well as a summary of the questions and answers will appear in a forthcoming book of conference papers titled Blueprint for the Industrialization of Africa.*

\* \* \*

THE PRINCIPAL MENTAL blockage against comprehending Bernhard Riemann's 1854 Habilitation theses "On the Hypotheses Upon Which Geometry Is Based," is the widespread prejudice that insists that the quantification of physics must be ultimately premised on scalar-metric comparisons of relations among so-called elementary particularities.<sup>1</sup> The same mental blockage, the same axiomatic folly, must tend to prevent some specialists from comprehending competently the deeper implications of my contributions to economic science.

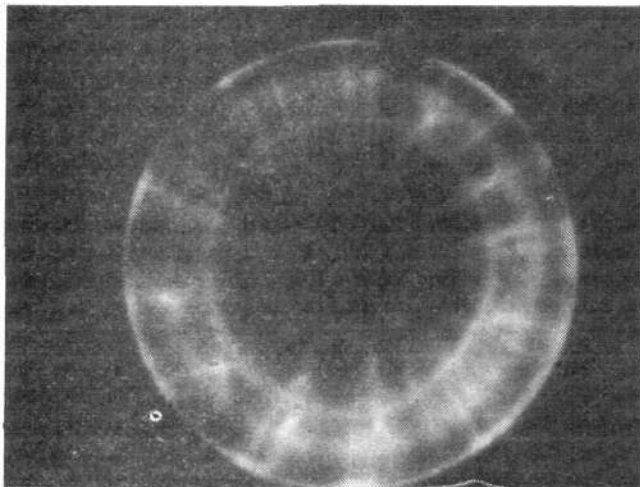
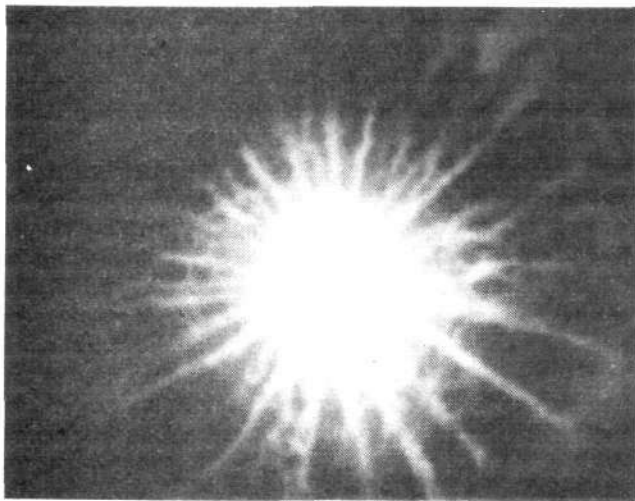
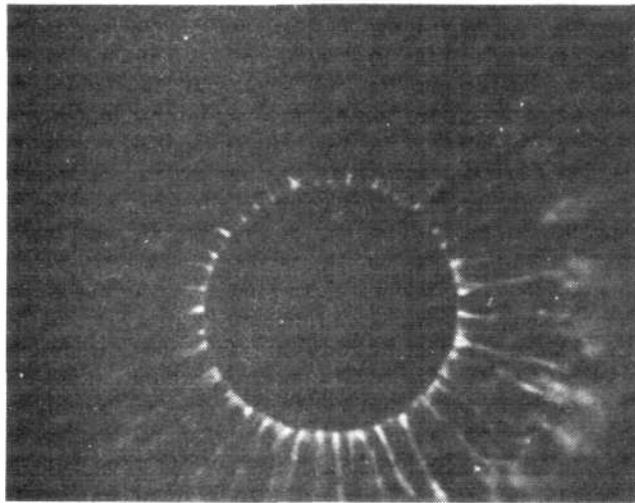
*The formation of these highly ordered plasma vortex filaments, photographed in a plasma focus device, cannot be explained by conventional theories.*

Photograph courtesy of Dr. Winston Bostick

This cited prejudice, sometimes identified as reductionism, appeals for its authority to the most naive sort of popular prejudice. It not only asserts that the universe must be an aggregation of discrete building-blocks; it also asserts that the intrinsic character of such self-evident, "elementary" particularities must be of the simplest conceivable quality. It asserts, furthermore, that the comparison of the relations among such elementary particles must be of the simplest quality—that is, scalar.

In the crude British materialism of the late 17th through mid-19th centuries, the image of the universe was broadly Newtonian. One started with a priori notions of visible space and of time and measured action in such space-time geometries by the standard of homogeneous, scalar extension in both a priori space and a priori time. Mass was included within space-time as another scalar, whose a priori relationship in space was action-at-a-distance. To the extent that the British faction considered itself obliged to take notice of Lagrange, it degraded Lagrange from a representative of the "hydrodynamicist" currents of Continental Science to an heir of Newton, and it treated rotation merely as an added, a priori scalarity.

Admittedly, this British "materialist" viewpoint underwent some painful adjustments during the 17th century. As the Edinburgh-Cambridge faction associated with Charles Babbage noted with public alarm, beginning the 1820s and 1830s, the level of science achieved in the United States (for example, Joseph Henry, et al.), France, Germany, and Russia not only had far outdistanced British science, but only a handful of British specialists were competent even to teach



Photographs courtesy of Dr. Winston Bostick

*"The central feature of the physics of Riemann is a preoccupation with those cases of continuous action, ostensibly according to a characteristic of action,  $n$ , in which there is a discontinuity. . . that brings the results of continuing causal action into a domain of characteristic  $n + 1$ . . . ."*

the new qualities of mathematical physics being developed among the continental heirs of Descartes, Leibniz, and Carnot. This clash between the Edinburgh-Cambridge and Oxford factions within Britain led to such work as the famous project associated principally with the Cambridge faction's James Clerk Maxwell. Maxwell was the leader among those British specialists who syncretized, Delphically, key aspects of the accomplishments of a plagiarized Continental Science, without tolerating any influence counter to the reductionist methodological tradition of Locke, Newton, Boyle, et al.<sup>2</sup>

Although Maxwell and his successors generalized British reductionist physics into a form more appropriate to describe the accomplishments of Continental Science, there was no other quality of methodological improvement over the reductionism of Newton. The same a priori assumptions embedded in Newtonian schemas were merely extended into the case for a more generalized number of degrees of freedom, to achieve a mere, Delphic descriptive power with respect to modern experimental inquiry and procedures of instruction.

### A Crucial Flaw

A related flaw afflicted the Einstein-Weyl program. Although both Einstein and Hermann Weyl were gifted persons, Albert Einstein's importance, relative to some among his leading scientific contemporaries, not only was exaggerated but this exaggeration tended to assist lack of proper regard for other important currents of scientific thought during the first decades of this century. More specifically, although Einstein's program was described as Riemannian, that program was poor and defective from the standpoint represented in its most concentrated expression in Riemann's cited 1854 theses on underlying hypotheses. Einstein's universe was determined by a scalar principle of fundamental action. Therein lies the crucial flaw and limitation of the Einstein-Weyl program.

As long as we tolerate the embedding of reductionist notions of elementarity and scalarity of relativistic space, we have obliged ourselves to continue—in one disguise or another—to look at the universe mathematically as an aggregation of particles undergoing action-at-distance. Although we may superimpose additional assumptions positing the existence of a physical-spatial field, these additional assumptions improve the power of physics by means of introducing an insoluble contradiction among the totality of the axiomatic assumptions so aggregated.

Those additional assumptions concerning the efficiency of some form of "unified field" are a considerable improvement in physics. Such assumptions bring mathematical physics toward greater agreement with the experimental evidence bearing upon the actual constitution of our universe. Unfortunately, the fact that such assumptions are irreconcilable with particularate elementarity and scalarity has been largely avoided, if not exactly overlooked. We move in the proper directions, but most among us so far refuse to cut ourselves free from the anchor of inherited reductionist errors.

The direction of a true solution to such contradictions is

the crux of Riemann's cited 1854 theses. I refer now to portions of *The Theory of the European Monetary Fund*.<sup>3</sup>

In that, cited location, with the aid of Dante Alighieri's *Commedia* and other pedagogical devices, we communicate the sensuous reality of a multiply connected Riemannian manifold. Each subsumed domain of such a manifold is characterized in and for itself by a *characteristic* analogous to the notion of invariance. The successive domains are then ordered, using the denotations of  $n, n+1, n+2 \dots$  to identify as transfinities such characteristics of action within the respective domains. Treating causally connected emergence of such mutually efficient domains as the primary focus of our inquiry, we investigate the ordering of the series  $n, n+1, n+2 \dots$ . The transinvariant corresponding to such an ordering we may denote by the capital letter  $N$ , with the added specification that the characteristic action associated with  $N$  is the passing-over from a given domain of reference,  $n$ , to a successor domain,  $n+1$ .

What is "elementary" in such a manifold? *It is the characteristic action represented by a going-over from  $n$  to  $n+1$ .*

This means that that same characteristic of  $N$  is also embedded, over and above  $n$  as such, within the action occurring in  $n$ 's subsumed domain. In other words, the assumption of simple, particularate elementarity is proven to be an absurdity in any universe within which the successive emergence of biosphere and man from "inorganic" planetary existence occurs.

That, in first approximation, is the conception embedded in Riemann's cited 1854 theses.

### The Problem of Knowledge

Once we have gone so far as that, we are immediately confronted with the need to treat the problem of human knowledge more rigorously.

The proof of man's knowledge of the universe is man's demonstrated willful mastery of the universe. This is not a question of whether some individuals are enabled to exist from year to year. It is not a matter of individual experience or small-group experience. Can man expand his population in such a way that the reflected per capita power of the average individual member of that population over nature also advances? Those kinds of advances in knowledge that enable such a result supply the basis for proof of what is to be considered valid scientific knowledge.

This proof is not associated merely with particular bits of knowledge. The proof is associated with advances from one "level" of knowledge to a more-perfected form of knowledge. It is the advancement of new knowledge over old knowledge that represents the datum of our inquiry. We must abstract the *advancement* as such from the particular knowledges within whose succession that advancement is immediately situated for abstraction.

If we identify the characteristics of the "Purgatory" succession of cantos in the *Commedia* as  $n+1$ , and the succession characteristic of the "Paradise" cantos as  $n+2$ , we have the following. The advancement represented by the succession of cantos in the "Purgatory" is the ordering principle, the characteristic corresponding to  $n+1$ . Similarly, the succession of cantos in the "Paradise" is the

characteristic corresponding to  $n+2$ . It is the characteristic that orders the succession of the three domains, "Inferno," "Purgatory," "Paradise"— $n, n+1, n+2$ —that is  $N$ .

In respect to the succession of cantos, we adduce  $n+1$  or  $n+2$  from the characteristic subsuming all advances from  $c(n)$  to  $c(n+1)$ . That yields either  $n+1$  or  $n+2$ . The transition from  $n$ , to  $n+1$ , to  $n+2$ , defines characteristic  $N$ . Characteristic  $N$  is thus proven to be embedded also within the unit of action leading from each  $c(n)$  to  $c(n+1)$ .

In other words, Riemann's physics is coherent with Plato's case for the "hypothesis of the higher hypothesis."<sup>4</sup> With respect to the physics, the actual ontology of the universe as a whole is that implied by the implications of the "hypothesis of the higher hypothesis."

We focus now on the provable connection between the hypothesis of the higher hypothesis, as a matter of the internal characteristics of human knowledge, to the actual ontology of that universe that human activity is willfully mastering.

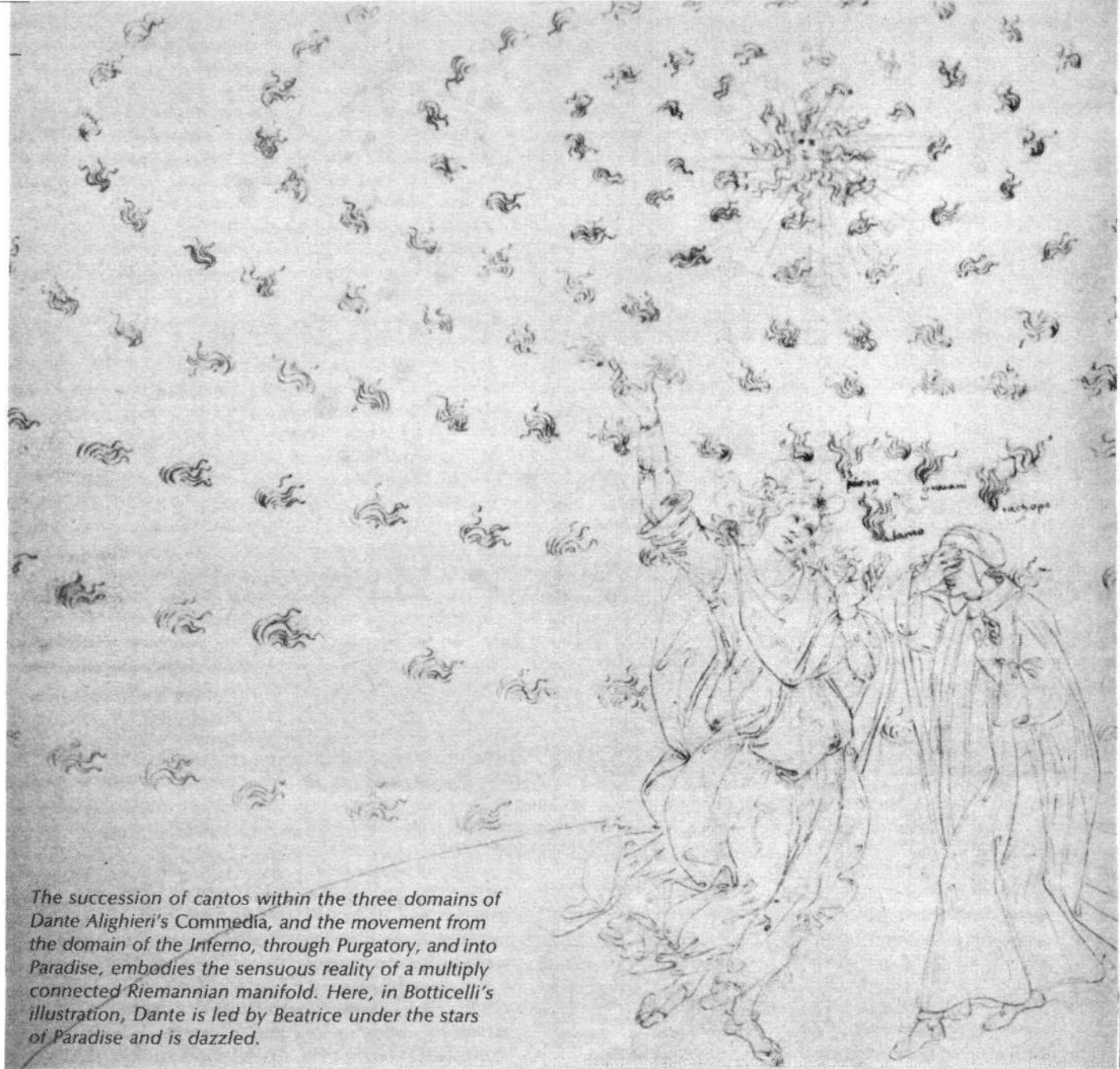
In general, the proof is this. As we show in other published locations and as we identify the proof in *The Theory of the European Monetary Fund*, two interconnected considerations prove that no fixed level of human knowledge satisfies the requirement for continued human existence.

First, assuming a fixed population corresponding to a fixed mode of production, the relative finiteness of the man-altered primary resources defined by such a technology means that the continued existence of man in such a fixed form is not possible. Only advances in technology, by cheapening the cost of exploitation and maintenance of old forms of resources and by defining new, added ranges of resources, can enable even a culture of a fixed population-scale to survive.

Second, the possible population-density for any quality of per capita existence is immediately a function of the level of technology. Furthermore, in the final analysis, the absolute size of the human population is determined by extant technology of productive and related practice. Finally, in the same vein, man's progress from lower to higher levels of culture occurs through elimination or simply depletion of those conditions that represent primary resources for lower levels of culture and smaller scales of the human population. It is not possible to return from a higher to lower level of culture. Rather, any course of action to such an effect must produce new forms of genocidal famine, epidemic, and probably also sylvatic and other devolutions of the environment and a plunge of such a society into bestialized savagery.

Therefore, the ostensibly fixed level of knowledge corresponding to any one moment in human culture does not represent a continuous mastery of nature. Therefore, no fixed form of existent knowledge can embody or adequately reflect the actual lawful ordering of the universe.

Human mastery of the universe's lawful ordering is embodied, uniquely, in those creative-mental processes that subsume successive revolutions in scientific knowledge and technology. Man's knowledge of the universe is located uniquely in those modes of creation of hypothesis that provably generate successful, successive scientific rev-



*The succession of cantos within the three domains of Dante Alighieri's *Commedia*, and the movement from the domain of the *Inferno*, through *Purgatory*, and into *Paradise*, embodies the sensuous reality of a multiply connected Riemannian manifold. Here, in Botticelli's illustration, Dante is led by Beatrice under the stars of *Paradise* and is dazzled.*

olutions—not any momentary state of formal scientific knowledge, as prejudice defines existing, mathematical physics or an equivalent today.

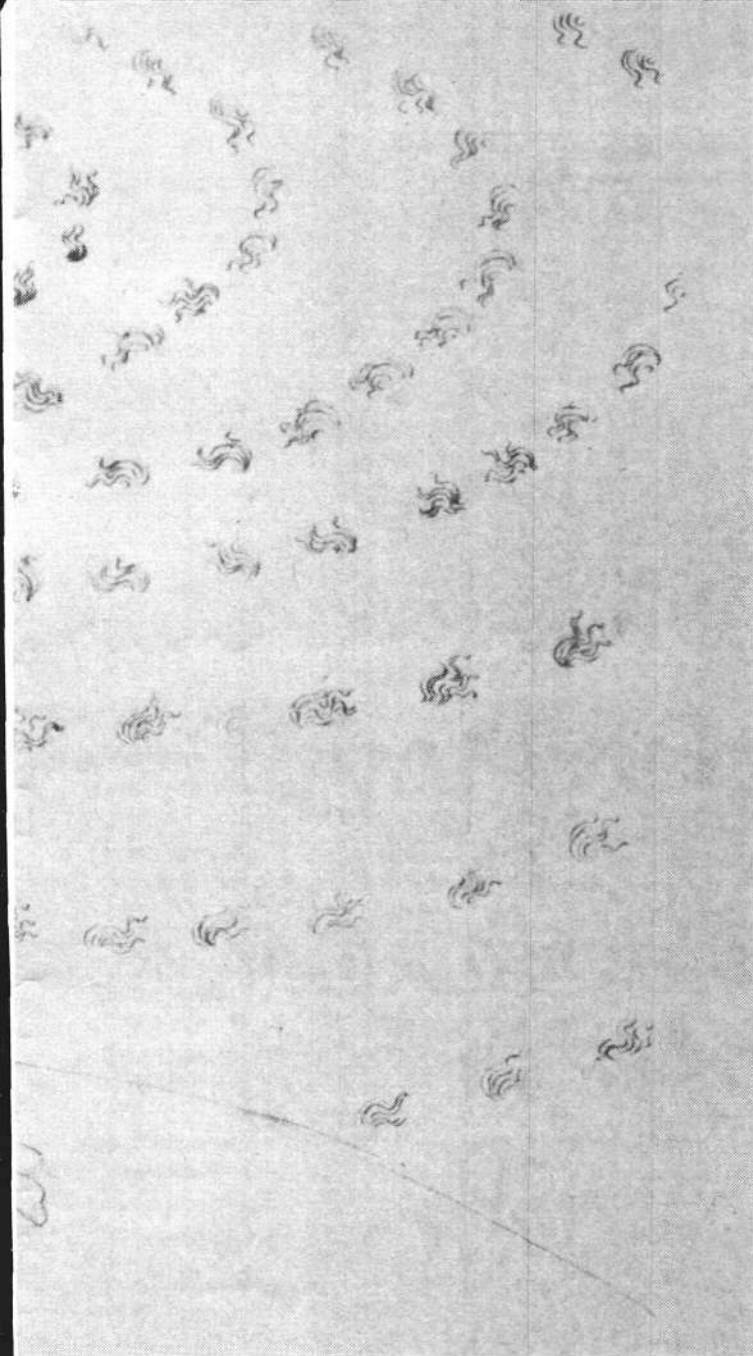
#### **Successive Scientific Revolutions** -

Therefore, the lawful ordering of the universe is not in correspondence with what we regard generally as the existing internal (mathematical-logical-ontological) organization of present-day schoolboy physics. Human knowledge efficiently, continuously maintains willful mastery of the lawful ordering of the universe only through successive scientific and technological revolutions. We must abstract, therefore, a continuously revolutionary principle of hypothesis-generation from successful branches of human cultural development. That principle of self-improving generation of higher hypotheses is the activity of the

human mind that is uniquely proven to be in continuously efficient correspondence with the lawful ordering of the universe. The ontology of our universe can only be that ontology that is in agreement with the adduced principles of self-improving generation of higher hypotheses.

That is nothing but an updated restatement of Plato's proof: the proof that the fundamental lawful organization and ontology of our universe is Riemannian—not that of Newton, Maxwell, et al.

The central feature of the physics of Riemann is a preoccupation with those cases of continuous action, ostensibly according to a characteristic of action  $n$ , in which there occurs a discontinuity—from the standpoint of characteristic  $n+1$ . That, for example, is the driving insight behind Riemann's treatment of shock waves as well as the problem that confronts us today in assessing



the appearance of so-called anomalies within intensified, controlled plasmas. Karl Weierstrass's treatment of the determination of discontinuities and the treatment of discontinuities within the framework of Georg Cantor's notion of transfinities are complementary aspects of the same line of inquiry.

The most direct approach to solving the essential questions subsumed by this is obtained not in experimental physics as such, but within the framework of economic science of the condition to which my work has advanced that science.

That is grounded, as I have elaborated the matter elsewhere, by successive corrections of a simple sort of thermodynamic analysis of economics along the lines of our foregoing outline of the problem of defining human knowledge.

The fact that the investigation begins with counting of calories does not imply we have succumbed to the reductionist assumptions, in which energy is a quantum susceptible of elementary definition in scalar terms. Our procedure, our method is the same that we apply to Dante's *Commedia*, in *The Theory of the European Monetary Fund*, and other locations. Although, like the reductionists, we begin with crude empirical measurements of actions on the macroscale of everyday or analogous experience and experiment, we proceed in a direction exactly opposite to that of the reductionists.

Contrary to Goethe's friend, G.W.F. Hegel, we cannot and must not order societies in a *post hoc ergo propter hoc* sort of time-series of assumed causal action. Human history is studded with cultural sewers, with degenerated cultures such as Ptolemaic Egypt and the late Roman Republic and Roman Empire, that are hideous retrogressions. Contrary to Hegel, chattel-slavery was never a necessary characteristic of the human condition.

Nonetheless, beginning with reconstruction of the characteristic modes of existence of our ancient ancestors, working forward from the Pleistocene, we can construct a time-series for those moments of human development in which progress did occur. By successful, we mean a culture whose advances in mode of production and life permitted an expansion of population within that culture, under correlated conditions of a rise in the per capita power over nature and conditions of life in that culture.

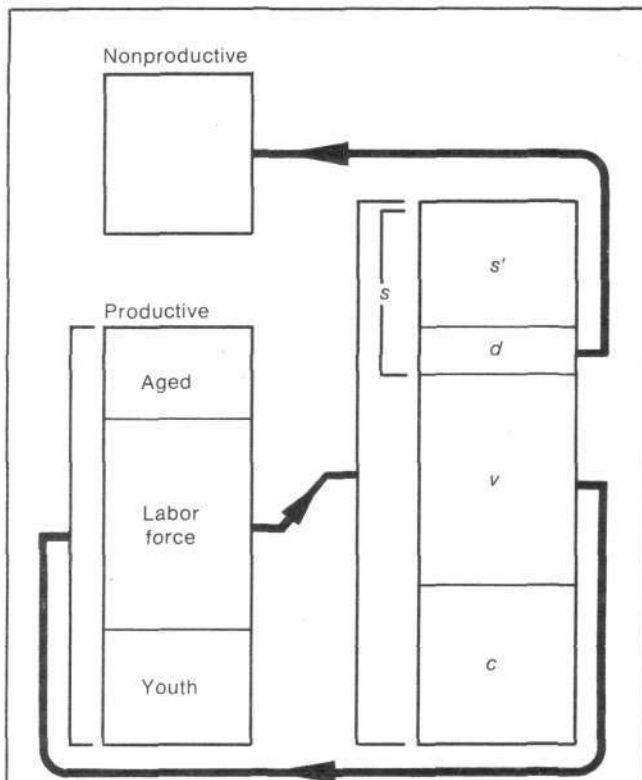
The first characteristic of such progress is an increase in the per capita ratio of useful calories of energy. Animal husbandry, for example, increases per capita control over calories of animal life, and hence of vegetable life. Development of agriculture increases per capita calories at a society's disposal. Tools increase the number of calories of the biosphere and other resources controlled per calorie of human activity.

However, it is not merely the number of calories per capita throughput which is decisive. If the value of the expression  $s'/(c+v)$  approaches zero, even though the per capita caloric values of  $c$  and  $v$  rise, the society is doomed to a Malthusian crisis and collapse.<sup>5</sup> The continued development of society requires, as we show elsewhere, that the social rate of profit  $s'/(c+v)$  must rise as the combined per capita caloric throughput of  $c$  and  $v$  rise.

The advancement of a society demands a higher level of per capita culture, which means higher per capita caloric values for  $v$ . The combined effect of marginal resources and advances in technology requires a higher rate of rise of magnitude of  $c$  than of  $v$ . So a constant rate of expansion of the culture requires that the magnitude of allocable "free energy"—over and above maintaining the society on an existing scale, in an existing technological mode—not only must rise per capita, but must rise per capita in respect to the doubly rising, per capita combined caloric values of throughput for  $(c+v)$ , the latter for the energy density condition of  $(v)$  proportional to  $(c+v)$ .

This is not the end of the proposition.

The advances in technology are the results of inventions,



This bar diagram is a pedagogical device for examining the negentropic content of the economy as a whole. The categories are as follows:

$v$  = variable capital, the portion of the total product (output) produced through a given production-consumption cycle representing the cost of reproducing the productive labor force at the same cultural-material level.

$c$  = constant capital, the portion of total product representing the cost of replacement of plant, equipment, and raw materials at current level and quality of production.

$s$  = surplus product, the portion of total product exceeding the quantity  $c+v$ .

$d$  = nonproductive consumption, the portion of total product representing the cost of reproducing nonproductive labor in the private and public sectors at current level.

inventions that are in aggregate advances in technology and hence in the qualities of scientific knowledge subsuming qualities of technological advance. These advances are realized through free energy ( $s'$ ), and have the categorical effect of raising the caloric throughput per capita of  $v$  while increasing the ratio  $c/v$ , and also either maintaining a constant or rising value for resulting social values of  $s'/(v+c)$ . In general, therefore, a rising social value of  $s'/(v+c)$  under conditions of rising energy-density of  $v$  is the precondition for the continuous, successful existence of a culture.

The constraints are rising values for  $s'/(c+v)$ , under the condition that  $c/v$  is rising, and that the per capita caloric

throughput consumed as  $v$  is rising. This condition, satisfying those constraints, is a condition approximating—in first approximation—what we term *negentropy*.

### Negentropy

This must be qualified further. To the extent that there is continuous progress in a culture satisfying the requirement of *negentropy*, creative-mental innovations in one moment are *mediated* through development of the technology of production and conditions of life. This gives empirical reality to the discoveries that are represented and alters the material experience of the society in such a fashion as to provide the conditions favoring further advances in technological discoveries and in scientific knowledge.

Thus, a general line of advancement in scientific knowledge mediates its self-development through technological progress in an expanding society.

This absolutely distinguishes man from the beasts. Man willfully evolves both his knowledge and conditions of life to higher levels of negentropy. It is this creative-mental power of mankind which is the source of wealth-creating powers, and thus the source of all wealth. The source of the negentropy of cultural development is the negentropy springing from the self-development of man's willful mastery of the universe.

Since man continuously masters the universe in this negentropic way, and in no other way, man's knowledge is in efficient correspondence with the lawful ordering in the universe only when that knowledge is in correspondence with the indicated appreciation of the negentropic functions associated with  $s'/(c+v)$ . It is such self-developing, self-subsisting negentropic transformations to higher "free energy" ratios for  $s'/(c+v)$  that corresponds to the unit of elementary action we must define.

It follows that the universe as a whole is a primary reality as a whole—not an aggregation of elementary particularities. For reasons we have summarily outlined here, any other ontological conception of the universe must necessarily be arbitrary and absurd, since this is the only conception that corresponds to the actuality of human experience. This universe is not only a primary elementarity with respect to itself; it is a self-subsisting being, creatively elaborating itself in a negentropic way—as Plato insisted, and as Riemannian physics requires.

Consequently, from the standpoint of contemporary physics, the most elementary unit of action to be encountered in the efficient mastery of physical processes can not be anything but a unit of action defined in respect to self-subsisting, self-developing—self-reflexive—*negentropy* as the fundamental unit of action of reference. Correspondingly, those experimental expressions that correspond to the most elementary feature of action in physical processes must be nonsimple and must consequently defy scalar metrics for their interpretation.

These conclusions are rigorously necessary and are rigorously proven, on condition that we define science as man's coherent knowledge of his continuing successful mastery of the lawful ordering of the universe for present and future human existence.

As Friedrich Schiller correctly understood Immanuel Kant's key error, Kant misdefined *duty* as a state of self-imposed wretchedness of spirit, a condition of unhappiness, self-denial, of "unfreedom." Although Kant was sensible, in an undefined way, of the reality and universalizing efficiency of creative powers, Kant despaired of a knowable form for such efficiency within the domain of the understanding of mortal man. Kant's understanding could not escape the mechanistic misconception of necessity. Kant could not understand that there is no proper conflict between Necessity and Freedom. Freedom, contrary to Kant's view of unhappy service to duty, is not violation of law, but the initiation and realization of those creative discoveries that correspond to man's continuous willful mastery of—and thus atonement with—the lawful ordering of our universe. Scientific discovery is the exemplar of the realization of true Freedom by the individual.

Schiller's refutation of the Kantian paradoxes was brilliant on this point, but not otherwise an original conception. Philo Judaeus of Alexandria had refuted the Aristotelian school on the same grounds nearly two millennia earlier.

In the Aristotelian schema, God, by creating a world of permanent laws and, presumably, conservation of a scalar notion of energy, made himself impotent in face of such a predetermined lawful ordering within his creation. Hence, either God is dead or as good as dead, or the material universe must be brought to an end so that God might once again become efficient. Thus, the folly of Aristotle was clear to Philo Judaeus.

In the full scope of the Aristotelian system and tradition, there are included those two, contradictory elements otherwise associated with Manichean cultism. The Horus of the Ptolemaic version of the Isis-cult is both Apollo and Dionysius, both the Son of God and Satan. So, Toynbee is an exemplary Manichean, an exemplary Isis-cultist, and also a true Aristotelian. However, in ordinary discussions of Aristotelianism during modern times, we emphasize the "apollonian," as opposed to the irrationalist-existentialist aspects. We are speaking of the kind of Aristotelianism that requires a "Big Bang" dogma respecting the origins of the universe, the same "Big Bang"—or "equilibrium economics"—theology rightly denounced as folly by Philo Judaeus.

Admittedly, we have turned abruptly to an aspect of the matter that most observers would tend to associate with theology, rather than science. This is no extravagance, no digression on the writer's part. The British doctrines of a "pulsating" or Toynbeean universe and the alternative "Big Bang" account are not judgments that originate in astrophysical evidence, but in the overtly or shamefacedly theological prejudices British astronomers bring to the interpretation of the evidence.

Therefore, without calling attention to the Isis-priestly robes worn under the agnostic or atheistic smock of today's anglophile scientists, we cannot bring to light the true source of the controversies that continue to beset science to this date.

It is provable, and conclusively so, as we have outlined

the case, as Ibn Sina, Cardinal Nicholas of Cusa, and Plato have shown, that the universe as a whole is properly viewed by man as a self-subsisting, intelligent, creative being. If one calls that being God, then one defines oneself as different from the mere beasts exactly to the extent one, oneself, acts and develops as a mortal being in such an image of God. To master the lawful ordering of the universe is to perfect one's knowledge and practice in atonement with the lawful ordering of the universe. One's creative powers oblige one to conduct one's mortal life not merely in imitation of divine, creative powers, but as a conscious instrument of the continuing, creative development of that universe—a universe that is self-subsisting, creative being.

Furthermore, insofar as one is merely mortal, one is ephemeral. Yet, as one is creative in conformity with the universalist principles of perfection, one also divine. The mortal and the divine are thus *consubstantial*.

One may interpret this as theology or as science. So far in this account, the two are the same. There is no possibility of a competent science that is not consistent with such a theology. Perhaps for those whose self-estimation and development locates them yet in the condition Dante Alighieri associates with "Inferno" and "Purgatory," where they cannot comprehend science, theology in the ordinary sense is their access to truth, to the divine. So, I ally myself ecumenically with the Neoplatonic Judaism of Philo, with Apostolic Christianity, and with the Neoplatonic theology of the Koran.

From the standpoint of Neoplatonic ecumenicism, that is as far as science as science is obliged to intrude upon essentials of theological matters.

For me and my collaborators, the creative potentialities of mankind, the potentialities we exemplify in our image of successive, successful revolutions in scientific knowledge and practice, are the exemplification of the divine. We are the instruments and servants of that self-subsisting, creative being that is our universe as a whole, in which service it is our duty, the meaning of our ephemeral, mortal lives, that we perfect the human species, that the species may advance to the fullness of its task as the instrument for mediating the greater creative development of our universe as a whole. So, we must live; to that end we must know, must discover, and must so guide our informed practice.

To that end, our task is clearly defined by the circumstances of the world today.

### The Human Condition

What is the human condition?

Approximately three-quarters of the human population live in regions of the world we euphemistically call the developing sector. In a very large part, they are condemned to live proximate to the condition of beasts, so very often in a worse condition than a farmer of the industrialized nations would tolerate for his cows, his swine. In the industrialized nations, we count ourselves fortunate if a bare majority of our adult populations have reached midway through the upward course of Dante's Purgatory. Accompanying the economic and moral stag-



*"Human mastery of the universe's lawful ordering is embodied, uniquely, in those creative-mental processes that subsume successive revolutions in scientific knowledge and technology. . . ." Left: Milling wheat by traditional method; Right: A top view of the PDX tokamak at Princeton Plasma Physics Laboratory.*



United Nations

nation and decay we have tolerated, notably during the past two decades, ever-larger portions of our populations, especially our youth, are being plunged into dionysian cults or some other reflection of Dante's *Inferno*.

We are at the verge of war. We are informed by some that it is a war whose radioactive cesium might conceivably eliminate both human life and higher animal life during its course and early aftermath. We tolerate "International Monetary Fund conditionalities" and analogous policies. Through the realization of such policies, we tolerate the engendering of the spread of famine and epidemic and murderous social chaos among especially the most vulnerable of the so-called developing nations. Not only have the leading perpetrators of these policies estimated that such policies mean reducing the human population in the order of three-quarters during two decades. It is probable that such a process of large-scale and intensive devolution of entire continents might unleash new combinations of epidemics and sylvatic, whose consequences could be as certain a destruction of our species through biological catastrophe as through the most pessimistically estimated consequences of general nuclear warfare.

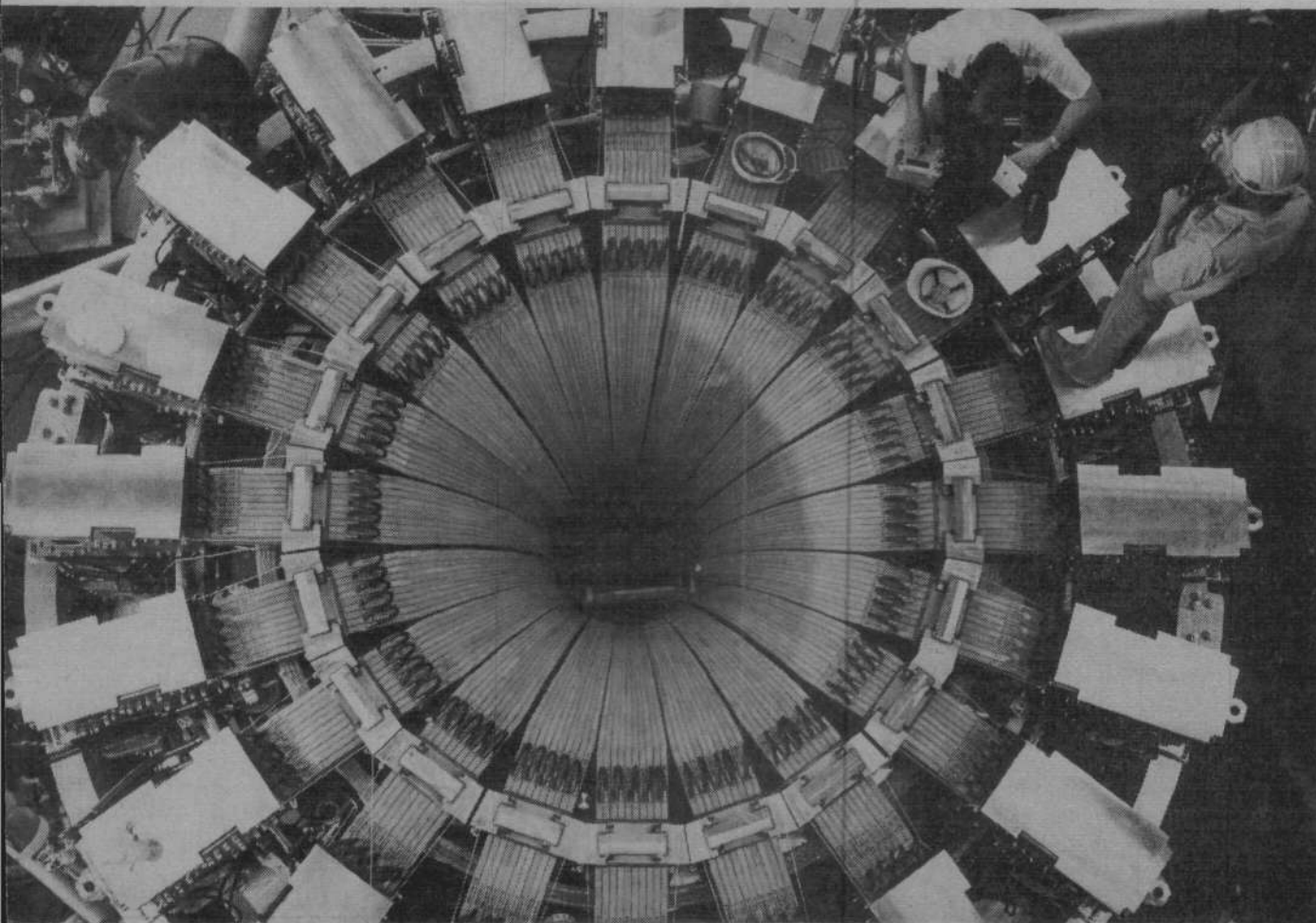
Yet, nearly all of those persons facing such threatened destruction, each person living in such depraved forms of assorted moral and material conditions, are precious hu-

man beings. In each such mind there is the potential of the divine.

Our task, as the servants and instruments of that creative being that is our universe, is not such miserable degradation as I am obliged, to my regret, to have so accurately summarized. Our business is to bring this planet into order, as a garden for mankind's existence, and then to begin our broader duties in the solar system and the universe more generally.

That true task before us is not some ineffable dream of a distant time to come. It is an order in human affairs that could be brought within sight of new generations a quarter of a century to 50 years hence. To bring such a state into being by such a future point is our task. We must rise above continuing to tolerate the cultist refuse associated with British ideologies and their like. We who accept our responsibilities as creative instruments of creation, must proceed from the kind of knowledge agreeable to the work of the coming century and use that knowledge today to make such a coming century a possibility.

Science and morality are, properly conceived, one and the same matter. We must bring to an end the influence of that British materialist doctrine, misnamed "science," that is suited variously only to the baboonlike existence



PPPL

outlined by Thomas Hobbes, the tamed baboons of John Locke's doctrine, or the chattering, or the imbecilic apemen of Jean-Jacques Rousseau's neurotic fantasies. We must cease to equate "scientific objectivity" with an absence of morality.

This is not to propose the superimposition of some arbitrary directive exogenously upon scientific inquiry. The most seminal single influence in the development of modern science was the 15th century Cardinal Nicholas of Cusa. In this matter, one ought not to merely extract certain influential, isolated conceptions from Cusa, but rather examine his methodology—the true source of his influence on Kepler, Gilbert, Descartes, Leibniz. We stand today on the continent of Europe, whose scientific heritage runs through Descartes and Leibniz, through the hydrodynamic school of Euler, the Bernouillis, Lazare Carnot and his heirs, and great Göttingen. Bernhard Riemann, the greatest 19th century representative of Continental Science, like Leibniz before him, was able to succeed in his scientific contributions because his creative-mental powers were governed by those Platonic/Neoplatonic conceptions with which I have associated myself here.

A moral science and a fruitful science are one and the same thing.

#### Notes

1. Bernhard Riemann's 1854 Habilitation Paper, which qualified him as an instructor at Göttingen University, can be found in the 1876 edition of his *Collected Works (Gesammelte Mathematische Werke)*, ed. H. Weber, pp. 254-269. The Fusion Energy Foundation expects to publish a new English translation of this foundational treatise in the near future.
2. The term Delphi is used here to indicate a deliberately misleading effort. The Delphi Technique was developed by the Rand Corporation as part of a postwar project to control scientific work, especially work on the frontiers of science. For a full description of the Rand project, see "The Delphi Technique: Writing Off Scientific Discovery" by Mary Gilbertson in *Fusion* (May 1979), pp. 40-47.
3. *The Theory of the European Monetary Fund*, written by LaRouche, was published in Oct. 1978 as a supplement to the *Executive Intelligence Review*.
4. For a discussion of the "hypothesis of the higher hypothesis," see the author's "A Theory of Development for African Labor," *Fusion* (June 1979), especially pp. 54-56.
5. The terminology used here— $s$ ,  $v$ , and  $c$ —is discussed in the author's "Theory of the European Monetary Fund." It can also be found in "Economics Becomes a Science," by Steven Bardwell and Uwe Parpart in *Fusion* (July 1979), pp. 32-50.

In brief,  $v$ =variable capital, the portion of the total product produced through a given production-consumption cycle representing the cost of reproducing the productive labor force at the same cultural-material level;  $c$ =constant capital, the portion of total product representing the cost of replacement of plant, equipment, and raw materials at current level and quality of production;  $s$ =surplus product, the portion of total product exceeding the quantity  $(c+v)$ ; and  $s'$ =absolute surplus, the portion of total product available for reinvestment after deducting from the surplus product the cost of reproduction of nonreproductive labor in the private and public sectors at current levels.

The expression  $s'/(c+v)$  equals the rate of surplus production.



# How Technology

by David Diehl, Jr.

*David Diehl, with other members of his family, owns and runs a 5,000-acre grain farm in Dansville, Mich. A past president of the Michigan Corn Growers Association, Diehl is one of the best known farmers in the state. On Aug. 3, he spoke at a Southfield, Mich. forum on the energy crisis sponsored by the Fusion Energy Foundation and the Independent Voters League of Michigan. This is an edited version of Diehl's speech to the audience of 250.*

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WHAT IS A FARMER? He's a plumber. He's a carpenter. He's a welder. He's an electrician, a machinist, a mechanic, a financier, and a statesman. One of the advantages to being a farmer is that you have to become conversant in many different areas. Most of them are technological. Many of them may be over your head. But it's a fun game to be in.

Farmers in this country comprise a relatively small proportion of the population. The Department of Agriculture's definition puts it at around 4 percent. Twenty percent of that group produces somewhere between 80 and 90 percent of all the food and fiber in this country. To a large degree, the productive capacity of U.S. agriculture stays in the hands of 1 percent of the population.

Farmers are a very small segment of the population; yet because of us, somewhere around 40 percent of the population derives its livelihood directly. I'm talking about the people that build agricultural machinery, that produce the fertilizer and the transportation systems that are needed. I'm talking about the grocer down the street and the truck-drivers that have to deliver the products to the grocery stores and the processors that produce the food as you know it in the grocery store.

American agriculture uses more steel than the automotive industry. It uses more rubber than the automotive industry. On my farm, I wear out—in replacement parts—enough steel every year to produce 1,000 automobiles.

# Made the American Farmer

The value of farms in this country exceeds that of all the stock listed on the New York Stock Exchange and the American Stock Exchange. That makes us sound like we're a pretty wealthy group of people. Let me counter that with the statement that in my operation, which is considered a well-run farm, that wealth is jointly owned among a couple of banks and production credit associations. A very small portion of it actually remains in family hands.

## The American Farmer

America's farmers are a unique group of human beings. Fierce independence is almost a prerequisite for being a farmer. Most farmers, because of the type of work they do, tend to have very strong moral or religious beliefs. For many years, farmers have been sort of a low man on the social totem pole. The typical impression of a farmer has been a man in overalls and a straw hat with a weed sticking out of the corner of his mouth. He usually had dirty hands and dirty feet, and normally a very distinct odor.

All of this happens to be necessary to the job. If you happen to be in a livestock operation, if you work around animals, it's pretty hard not to acquire the smell. My family's operation happens to be a grain farm. Every once on a while we goof and some of the stuff gets a little rotten. We have to clean it up, and there is nothing—I mean absolutely nothing—that stinks worse than rotten soybeans.

However, in a given day, you could well find a farmer getting dirty shoveling manure or cleaning up around the soybeans and half an hour later sitting across the desk in a suit and tie negotiating a million-dollar loan with a friendly banker.

Farmers in this country started out as a basically self-sufficient lot. They had to be. They didn't have access to implement dealers as we know them today. If they used a plow point, chances are they had to make it themselves. As we improved our transportation network and our educational system, as we developed the modern communications system we have today, farmers came closer to their city cousins. One-hundred years ago a young farmer may

have never seen a city. Today, by the time he gets out of high school he has been in at least one and probably two or three of our leading urban centers. He's been exposed to what happens in the outside world. He has the same opportunities of education and has acquired many of the same attitudes that city dwellers have.

The big thing that made this possible is cheap, abundant energy. The farmer got out of the field and out from behind the horse when he had the gasoline engine and the gasoline to run it. The farmer got into town when he had the car that made that 20-mile trip possible. He made it only occasionally with a horse; but when he had a car he could make it every week.

When he got the telephone, he could call his neighbors and find out what was going on. The radio brought the world into his living room. All of a sudden America's farmer realized that there were a lot more things available than what he had—and he wanted them. So he went to work and got them.

Cheap energy brought electricity into his home. This meant that he no longer had to rely on a windmill. When the wind didn't blow, he no longer had to pump water by hand for 20 thirsty animals. He could milk his cows with an electric milking machine. A lot of the labor and drudgery was gone.

## Energy and Agriculture

These changes mean something else as well. Today we are at the point where if somebody shuts off the flow of diesel fuel, gasoline, natural gas, or electricity to America's farms, our food production is gone. In Michigan, for example, a farm fuel shortage could hurt us very badly. For every day after the 10th of May the corn planting is delayed, for whatever reason, it costs us one bushel to the acre. Ten days without fuel could lose us 10 bushels to the acre. When it comes time to harvest the crop, after the 15th of October we lose a bushel to the acre of what we've already grown if we don't have it in the barn.

Concerned? Yes, we're very concerned. To the point of

**ENERGY USE PER HECTARE IN RICE PRODUCTION  
IN VARIOUS COUNTRIES\***

| Country | Installed horse-power per hectare farm machines and draft animals only | Energy for farm operations (million Btu's per hectare)† | Energy for irrigation and nitrogen fertilizers manufacture (million Btu's per hectare) | Total energy input per hectare (million Btu's) | Rice yield kilograms per hectare | Energy Intensity (million Btu's per ton of rice) |
|---------|--|---|--|--|----------------------------------|--|
| India   | 0.7  | 20  | 6.5  | 26.5   | 1,400                            | 19   |
| China   | 0.7  | 20  | 12   | 32   | 3,000                            | 10.7   |
| Taiwan  | 0.5  | 10  | 22   | 32   | 4,000                            | 8  |
| Japan   | 1.6  | 10  | 25   | 35   | 5,600                            | 6.2  |
| USA     | 1.5  | 7   | 25   | 32   | 5,100                            | 6.3  |

\*Total grain production depends not only on seed variety, soil quality, etc., but also on the mix of grains grown. Therefore, comparing a single grain gives a better comparison of the energy intensity of various farming methods.

†Energy used to perform various tillage, planting, and harvesting activities.

Source: Arjun Makhijani, *Energy and Agriculture in the Third World*, Cambridge, Mass: Ballinger Publisher Company, 1975, p. 17.

*U.S. agricultural production is more energy-efficient overall because it uses intensive methods of mechanization and chemical inputs. As the table shows, increased irrigation and fertilizer energy per hectare and reduced manual labor lead to dramatic increases in rice production. Most important, such increased productivity requires the qualitative development of the most important natural resource—the human mind. And as the graph shows, the small farm model uses more—not less—fuel.*

asking for 100 percent allocations? No. If we've got a problem right now, we'll take our share of it along with everyone else. What concerns me is that it isn't necessary. There are solutions and we ought to be working for them.

One solution people are talking about is gasohol. There are some real moral, political, and economic issues on this question. I've seen enough to be convinced that we can produce alcohol pretty effectively cost-wise. But are we willing to sacrifice food for liquid fuel when that fuel may not be necessary? I'd lay even money right now that within the next two or three years we'll have an alcohol plant on our farm. I can take the corn stalks out of the field—basically waste material—and convert them to alcohol to run my own machinery. This means that I won't be dependent on diesel fuel and gasoline, as I am now.

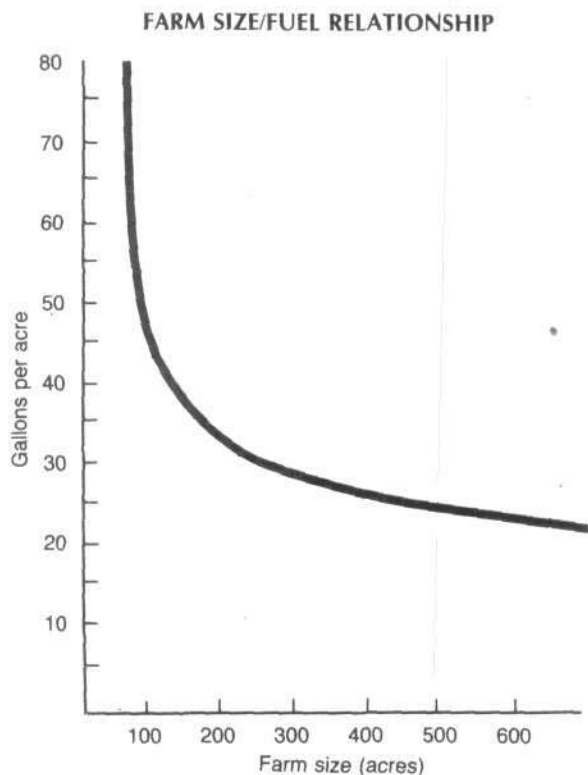
But the economics don't work to bring that form of alcohol to Detroit. Corn stalks are a bulky item and expensive to transport. We need to look for other solutions, and there are other solutions to be found.

One of the things I look to is cheap electricity. Since Three Mile Island, the nuclear potential for electricity production has been stepped on pretty hard. That bothers me because I can see down the road to the potential of fusion energy, and with that, an extremely cheap electricity supply. This could bring the opportunity to convert salt water into fresh water at a reasonable price, an opportunity to irrigate major portions of the globe and produce good quality food at a reasonable price.

One of things American farmers take pride in is the fact that we are capable of putting on the American table a diet that is rivaled nowhere in the world. We've got some problems doing this, however. An example: Michigan has a fairly healthy fruit industry. DDT, which was widely used by fruit growers, was banned several years ago. This happened although there is not one documented case of human injury or death from DDT anywhere in the world. The chemicals that we've been using to replace DDT seriously injure or kill at least one person in Michigan every year. I have a hard time with the moral judgment of possibly killing a few birds as opposed to very probably killing several human beings. If I had my choice about using some of these chemicals, I'd be tickled to death to do away with them. If U.S. farmers have a better option, they'll use it.

Government has a tremendous effect on agriculture. One of the areas important to me as a grain farmer is the export potential of the industry. Without these exports, American agriculture would be dead. With the proper government support, exports could go to a level undreamed of now. We can produce food more cheaply than anywhere else in the world, and that's not going to change. We can produce agricultural technology at a tremendous rate. Let's help some of the other people do some of the things they don't know how to do yet.

One of the unique things about U.S. agriculture is the historical role of the cooperative extension service. The



role of the extension service has been to disseminate technology back to the farmer, and it has been extremely effective. In cooperation with agricultural universities and the agricultural research service of the federal government, information developed at the academic level is applied very rapidly at the farm level. In fact, today techniques being tested at the federal and state level are being simultaneously applied on farms. There are a couple of instances in our operation where we applied a technology before it had been recommended by the university because we could see without question that it would work well in our operation.

It's almost impossible for farmers to put together a research and development program like that of General Motors or General Electric. So we need the kind of research that is being done in our colleges and universities with the support of the federal government. And I'm sorry to say that this work has been rather dramatically cut back in the past five years.

Farming has a tendency to be a dangerous occupation. In general, the accidents that happen are brought on by carelessness. The federal government has tried to set up standards that protect us from ourselves. I have a couple of examples of the sorts of things that have happened as a result. A few years back we bought a new tractor. Six months later we bought a second, identical model. The second cab cost us \$2,000 more. Why? Because the federal government had come out with the roll-over protection

standard for tractors. In our case, we had that system on both tractors. But the second cab had a little sticker, about two inches by one inch, saying that the cab met federal standards. The reason this sticker cost us \$2,000 is that the manufacturer had to assume more liability under federal standards.

The other example involves the combine, a big, expensive, complicated piece of harvesting machinery. When used in the proper manner, the combine is an extremely safe piece of machinery. But quite a few accidents have happened on combines because farmers have not used good judgment operating them. The Occupational Safety and Health Administration came in and tried to set standards for this machine. A bright young attorney on OSHA's staff who had never been on a farm, had never seen a combine, had never even seen a picture of a combine, drew up regulations for it. This I find a little bit disgusting, because the way the standard was set, there was no physical way to get the crop into the machine so that the combine could do its job. It cost a coalition of U.S. farm organizations hundreds of thousands of dollars in legal fees to get these standards changed.

#### The Family Farm in America

One of the other issues in agriculture in recent years is the buying of land by foreign individuals. On this issue I can speak from first-hand experience. We sold 200 of our 5,000 acres plus. The reason we sold it was purely economic. It cost us \$100 an acre to own that land, whether we did a thing with it or not. We can lease the land back on a 30-year option for \$50 an acre. Your math doesn't have to be any better than mine to see that the sale means quite a few dollars in my pocket. Although the same thing is happening in quite a few places in the United States, the percentage of land being sold to foreigners is quite small. The largest buyer of American farmland is still the American farmer.

One other area of concern for many people—but not to me—is the takeover of agriculture by corporate operations. First of all, you've got to separate corporate farms from family operations that have become incorporated for tax and liability reasons. I'll be amazed if in a couple of years Diehl Fields isn't a corporate farm. But it will still be a family operation.

A second point is that statistics show that fewer farms are being sold today to actual corporations than at any other time in our history. I can tell you why: corporations can't make money out of farming. The farmer puts in long hours, and he has to. It's pretty hard for a corporation to find someone willing to work a 130 hour week and do it for six weeks in a row. There isn't enough money in agriculture to pay somebody to do this kind of a job, unless it's the farmer who has his family, his money, and his farm on the line.

This is one of the reasons that the family farm will remain viable in this country. Farmers are pretty special people. In fact, farmers are great. If you ever have a chance to go out and visit a modern farming operation, you'll find that most farmers will welcome you. You're welcome to come to Diehl Fields in Dansville.

# Major Advance Announced In Particle Research

Erwin M. Friedlander and Richard M. Weiner demonstrate in a recent article published in *Physical Review Letters* (July 2, 1979, p. 15) that subatomic matter undergoes a phase change under the impetus of highly energetic particle collisions. Their analysis has important implications on the macrocosmic scale as well as for countering the quark theory.

Friedlander and Weiner used the so-called hydrodynamical model, developed by the Soviet physicist Lev Landau in 1953, to analyze data from head-on collisions of highly energetic protons from the intersecting storage rings at the Super Proton Synchrotron of the Center for European Nuclear Research, CERN, at Geneva. The intersecting storage rings at CERN allow experimenters to achieve collisional energies previously only observed in cosmic ray events, which are so infrequent as to make the collection of accurate data extremely difficult and time consuming.

According to the Landau theory, the colliding particles act like a liquid. There is an initial phase of rapid compression of the nuclear matter, caused by the shock waves generated during the first instants of the collision. This is followed by the slow emission of new entities, *pi mesons*, for example, generated from the undifferentiated fluid during the passage of the shock waves. Then, as the material starts to expand, most of the newly created particles are rapidly emitted.

### Phase Change

During the entire period of the collision, the matter can be described using thermodynamic parameters—such as temperature and the speed of sound—that are familiar from the treatment of bulk fluids. However, Friedlander and Weiner noticed that the most recent data, representing events involving higher momentum

components transverse to the initial direction of motion of the colliding protons, did not follow the pattern established from the earlier data.

In order to reconcile the experimental results with the theory, it was necessary to postulate that the nuclear matter underwent a phase transition in which the velocity of sound jumped by almost a factor of 1.5.

If one was to compare this situation to gas dynamics, the result would be similar to a gas composed of strongly interacting molecules suddenly acting as if it were composed of weakly interacting molecules. In the case Friedlander and Weiner considered, the apparent laws governing the behavior of the system seem themselves to be changed by the lawful evolution of the system.

The importance of this discovery can in no way be discounted. In fact, there is a striking similarity to Riemann's approach to the propagation of shock waves and the implications to be drawn from that work for achieving fusion by inertial confinement. (See "Riemann Declassified" in the March-April 1979 issue of *Fusion*.)

### Macrocosmic Scale

On the macrocosmic scale, significant evidence has been gathered in recent years to show that star formation may occur in a manner similar to elementary particle formation in the hydrodynamic model. (See, for example, *Scientific American*, Aug. 1979, p. 138.) Shock waves emanating from a supernova event can compress an interstellar gas cloud to create the centers of attraction around which the cloud can collapse into stars.

In a recent interview, Friedlander pointed out that the macrocosmic implications of this work are of even greater consequence when applied to the evolution of the universe as a whole. If, in fact, the kind of phase

change observed in the present work is a universal characteristic of matter regardless of the scale of the phenomenon, then it might be possible to avoid the absurd conclusions derived from a linear extrapolation of present conditions into the remote past.

The recent results likewise indicate the necessity for a Riemannian hydrodynamical theory of nuclear matter, as opposed to the ad hoc quark theory.

—Dr. John Schoonover

## AEC Study Shows: No Mutations from Low-Level Radiation

A 75-generation, 21-year study of the long-term effects of low-level radiation on mice has concluded that the extreme concern about low levels of radiation in the environment is unwarranted. The experiment, started by the Atomic Energy Commission in 1958, was conducted by Jake Spalding at the "Mouse House" at the Los Alamos Scientific Laboratory in New Mexico.

The mice were irradiated at the age of 26 days with 200 rads of X-ray radiation, 2,000 times the dosage received in the average tooth X-ray. By the 75th generation, Spalding found a 33 percent increase in the number of progeny in the irradiated group of mice. During that time, there were only two mutations: There was one hairless mouse in the 31st generation of the nonirradiated control group and one spastic mouse in the 23rd generation of the irradiated group.

Challenging Spalding's experiment on the basis that inbreeding prevented deleterious mutations from being observed, Dr. Earl L. Green, former director of Jackson Laboratory in Bar Harbor, Maine, ran a similar experiment without any inbreeding. After 20 generations of mice without any mutations, Green concluded, "We were not able to find evidence to support what we believe is true—that radiation produces mutations."

# Feeding the Irrational Fear

## *The Nuclear Catastrophe*

Bett Pohnka and Barbara C. Griffin, Port Washington, N.Y.: Ashley Books, Inc., 1977, 295 pp. (no price listed).

## *The Accident*

Hans Heinrich Ziemann, New York: St. Martins Press, 1979, 327 pp., \$10.95.

A number of years ago psychological profile studies of the American population revealed that one of the greatest irrational fears of the average citizen was to be victimized by incurable cancer. Since the early 1950s, the anti-technology movement, led by such propagandists as Barry Commoner and his mentor, Margaret Mead, has fed these fears by creating allegedly scientific arguments that prove that advanced technology and industry cause cancer and other incurable diseases.

Both *The Nuclear Catastrophe* and *The Accident* exemplify the pure fiction end of this fear campaign. In both books, the authors have taken an assortment of fictional occurrences, based on alleged scientific fact, and stitched them together into a Frankenstein's monster to terrify the credulous.

In *The Nuclear Catastrophe*, published two years ago but widely publicized after Three Mile Island, the authors open their story with the bomb-like explosion of an atomic power station on the outskirts of Los Angeles. This actually impossible event, they allege, is based in scientific fact on a 1950s incident in a tiny and primitive research reactor in Idaho. The remainder of their volume is devoted to endless grisly descriptions of the physical and psychological effects of high doses of radiation on the Los Angeles population, using the World War II Hiroshima bombing as the model.

*The Accident*, a novel released in West Germany, treats its readers to a scenario involving a crazed terrorist

who plans and executes the sabotage of a nuclear power plant, designed to be West Germany's largest, on the day of its inauguration. This tortured story line includes fictional descriptions of the terrorist's step-by-step scientific planning, a rundown of the safety defects already present in the brand new plant, and the official mishaps that lead to the accident. "The accident," of course, is the "meltdown" of the reactor's radioactive core, which leads to an atomic explosion, mass evacuation, and even the firebombing of the nearby city of Darmstadt to divert an oncoming radioactive cloud. Readers are spared no details of the effects of "radiation sickness."

Both these volumes, examples of the anti-technology forces' cynical attempts to manipulate the U.S. population against advanced nuclear energy technologies, are not only bad fiction but also a pack of lies.

—Stuart Pettingell

## Books Received

**The Partnership: A History of the Apollo-Soyuz Test Project.** Edward Clinton Ezell and Linda Neuman Ezell. Washington, D.C.: NASA, 1978 (NASA-SP-4209). 544 pp., \$8.30.

**Beyond the Age of Waste: A Report to the Club of Rome.** D. Gabor et al. New York: Pergamon Press, 1978. 229 pp., \$25.

**Science, Technology and Economic Growth in Developing Countries.** ed. G. E. Skorov. New York: Pergamon Press, 1978. 210 pp., \$18.

**The Wired Society.** James Martin. Fort Lee, N.J.: Prentice-Hall, Inc., 1978. 289 pp., \$12.95.

**Metals Joining Manual.** M. M. Schwartz. New York: McGraw Hill Book Company, 1979. 548 pp., \$22.50.

**Technological and Social Change: A Transdisciplinary Model.** Jacob Fried and Paul Molnar. Princeton, N.J.: Petrocelli Books, Inc., 1978. 167 pp., \$15.

## St Louis Conference on Energy, Transportation

"Energy, Transportation, Inland Waterways—Critical Choices for the 1980s" was the topic of a day-long Fusion Energy Foundation conference on the St. Louis campus of Washington University Sept. 22 that drew 100 participants.

Calvin Larson, FEF director of agricultural engineering, led the morning panel with a description of the 1964 Parsons Engineering firm plan to transform America's waterways by building a new river system that would run parallel to the Mississippi River basin through the Great Plains states. The system was designed to eliminate the region's chronic water shortages, Larson said, to boost agricultural productivity, and to increase the use of barge transport for bulk shipments of commodities for export. The major block standing in the way of this and similar proposals, Larson explained, has been the refusal of Congress to appropriate funds for feasibility studies.

Guy Jester, former colonel in the Army Corps of Engineers for the St. Louis district, followed Larson with a discussion of the water project funding problems. "Private corporations cannot make long-term capital investments of the scale needed," he said. "We need projects that can have 50- to 100-year payoffs. The federal government must become involved in this."

Jester, who was speaking for the Association to Improve the Mississippi River, also detailed the battle to upgrade and enlarge the Alton lock and dam 26, the link between the Illinois and Mississippi Rivers through which tens of millions of tons of U.S. agricultural products pass each year.

Other speakers at the conference included 1980 presidential candidate Lyndon H. LaRouche, Jr., Frank Spinner, the president of the Tower Grove Bank, St. Louis 11th ward Republican committeeman Conway Briscoe, FEF executive director Dr. Morris Levitt,

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FEF Midwest director Mel Klenetsky, and Thomas Pierce, chairman of the Washington University Students for LaRouche Committee.

A full report of the major speeches at the conference will appear in the December issue of *Fusion*.

## Winterberg Reviews Impact Fusion

"We could demonstrate workable fusion systems in the very near future; we need nothing more than the will to do it," said Dr. Friedwardt Winterberg at the first of a fall series of FEF seminars Sept. 14.

Winterberg, a pioneer in fusion research who now works at the Nevada Desert Research Center, explained how fusion energy will provide humanity with the means to harness the resources of the solar system and then the entire Milky Way galaxy.

The main focus of Winterberg's talk was a discussion of the impact fusion approach, which consists of accelerating a projectile or projectiles weighing between .1 to 1 gram to extremely high velocities of 70 to 200 kilometers per second (160,000 to 450,000 miles per hour) and directing this projectile onto a fusion target. The gigantic velocity of the projectile is converted into a shock wave when it impacts onto the fusion target. This shock wave then compresses and heats the fusion fuel to ignition conditions.

The advantages of impact fusion over alternative laser, electron, and ion beam systems is its intrinsically higher efficiency, its higher driver efficiencies, its lack of repetition rate problems, and its simplified target design.

Winterberg was the first scientist to propose the impact approach to inertial confinement fusion about 15 years ago. Originally the idea was rejected by the U.S. scientific community, but today the national laboratories have become interested in the unique idea because of difficulties arising in the laser pellet approach to fusion.

Since Winterberg first suggested the idea, the technological feasibility of building the type of accelerator needed for high velocity projectiles has greatly improved. Recent scientific papers and a few preliminary experiments by Euratom indicate that there do not appear to be any insuperable scientific or technological problems to building such an accelerator. As Winterberg emphasized, "We need only have the will."

The December issue of *Fusion* will feature the impact fusion approach.

## Board Member Honored

The Fusion Energy Foundation is pleased to announce that advisory board member R. Tom Sawyer has recently been named an honorary member of the Gas Turbine Society of Japan. Sawyer, a founding member of the

American Nuclear Society, was instrumental in the development of the gas turbine.

## Levitt in Maine For Pronuclear Tour

Maine's press corps turned out in force Sept. 13 in Augusta to hear FEF director Dr. Morris Levitt report on the environmentalist plans for violence at the Seabrook, N.H. nuclear plant.

Levitt's press conference capped a two-day swing through the state, which was highlighted by a Fusion Energy Foundation fundraising dinner in Brunswick, an interview with the Brunswick *Times-Record*, and a talk show discussion on radio FAU in Augusta.

## TMI Sabotage Aired on Pittsburgh Radio Show

Did the nation's press corps act responsibly in shaping its coverage of last March's incident at the Three Mile Island nuclear plant?

This question came to the fore Sept. 3 when FEF executive director Morris Levitt outlined the findings of The Independent Commission of Inquiry on Three Mile Island to a Pittsburgh radio audience. Levitt was interviewed for two hours on radio KDKA's John Signa talk show and told listeners that the commission, which the FEF initiated, had determined that the incident at the Three Mile Island plant was caused by sabotage.

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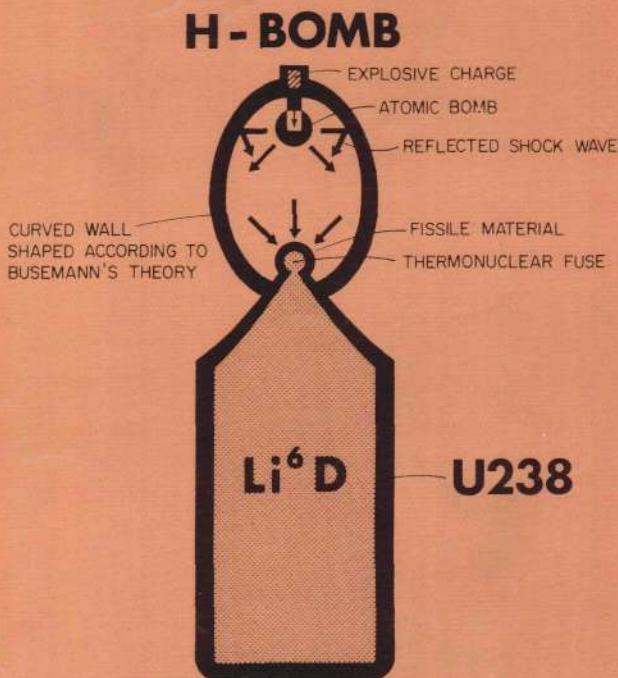


## Advancing Inertial Confinement Fusion

The development of the H-bomb was a spinoff of the theoretical work of a number of leading hydrodynamicists centered at the University of Göttingen in Germany. Most of them approached hydrodynamic problems from the standpoint of shock waves as developed by Bernhard Riemann and Erwin Schrödinger. As this issue's feature articles by Uwe Parpart and Dr. Friedwardt Winterberg demonstrate, the successful H-bomb design provided a stunning verification of their theories, but classification policies have since been used to prevent further scientific progress in inertial confinement fusion research.

Behind the immediate issue of freeing up inertial fusion research lies a more fundamental issue. Phenomena such as shock waves show that neither the quality of physical action nor particles themselves are scalar elementarities. The article by Lyndon LaRouche provides the conceptual basis for a Riemannian physics that can describe the physical universe as it really is—a self-developing progression of multiply connected manifolds.

The cover: Above, a fusion pellet being irradiated by a carbon dioxide laser at the Los Alamos Scientific Laboratory in New Mexico. At left, a design of how the H-bomb works that was developed independently by Dr. Friedwardt Winterberg around 1952 (more details inside). The front cover photograph is the fifth Solvay conference of physics in Brussels, 1927. Erwin Schrödinger, a key figure in our lead feature, is the third from left in the top row. Other physicists depicted include W. Pauli, W. Heisenberg, L. Brillouin, P.A.M. Dirac, L.V. deBroglie, M. Born, N. Bohr, and A. Einstein.



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(Design of author around 1952)

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