FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION
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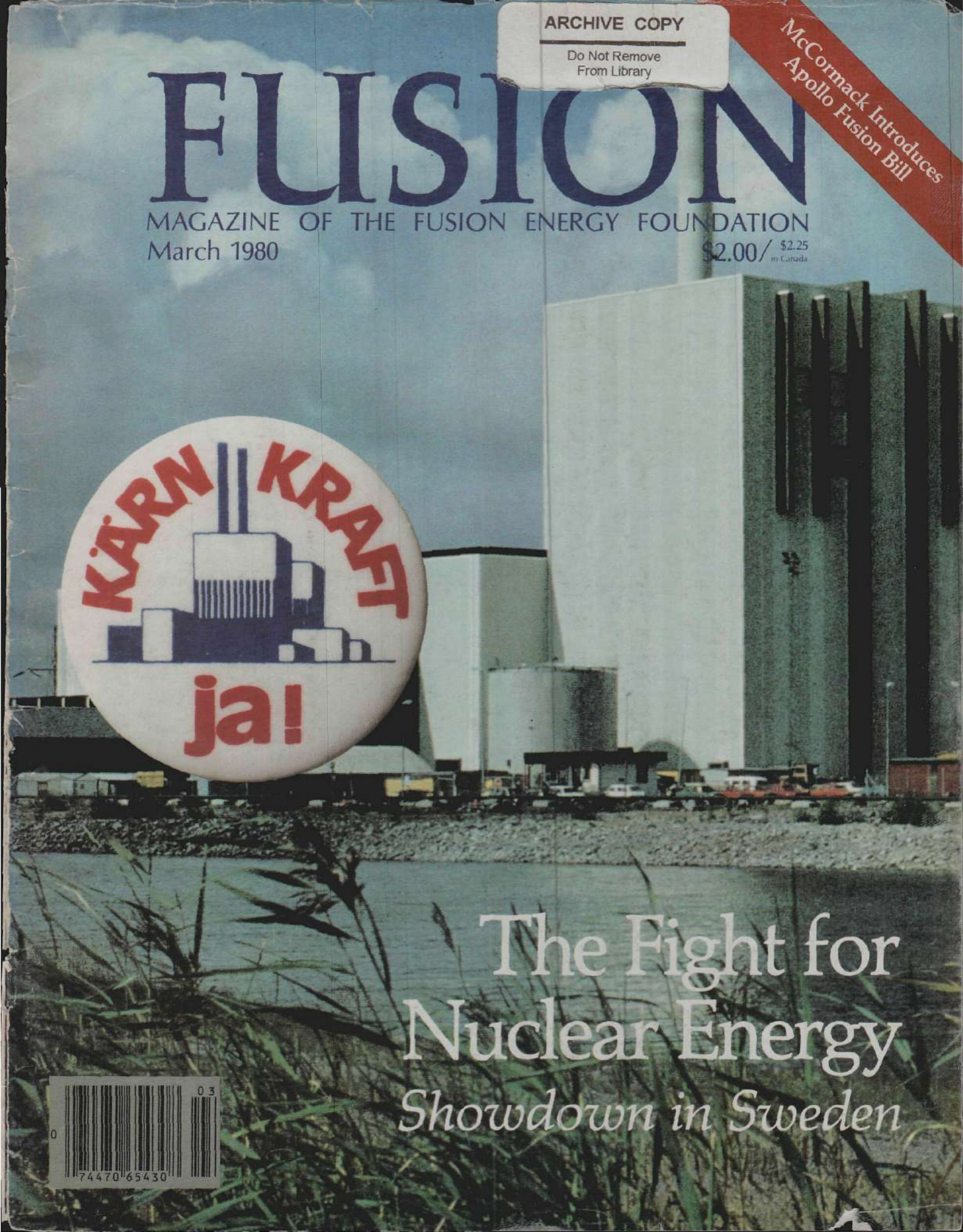
McCormack Introduces Apollo Fusion Bill



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Magnetohydrodynamics—
Doubling Energy Efficiency by Direct Conversion
by Marsha Freeman

Argonne National Laboratory

FUSION

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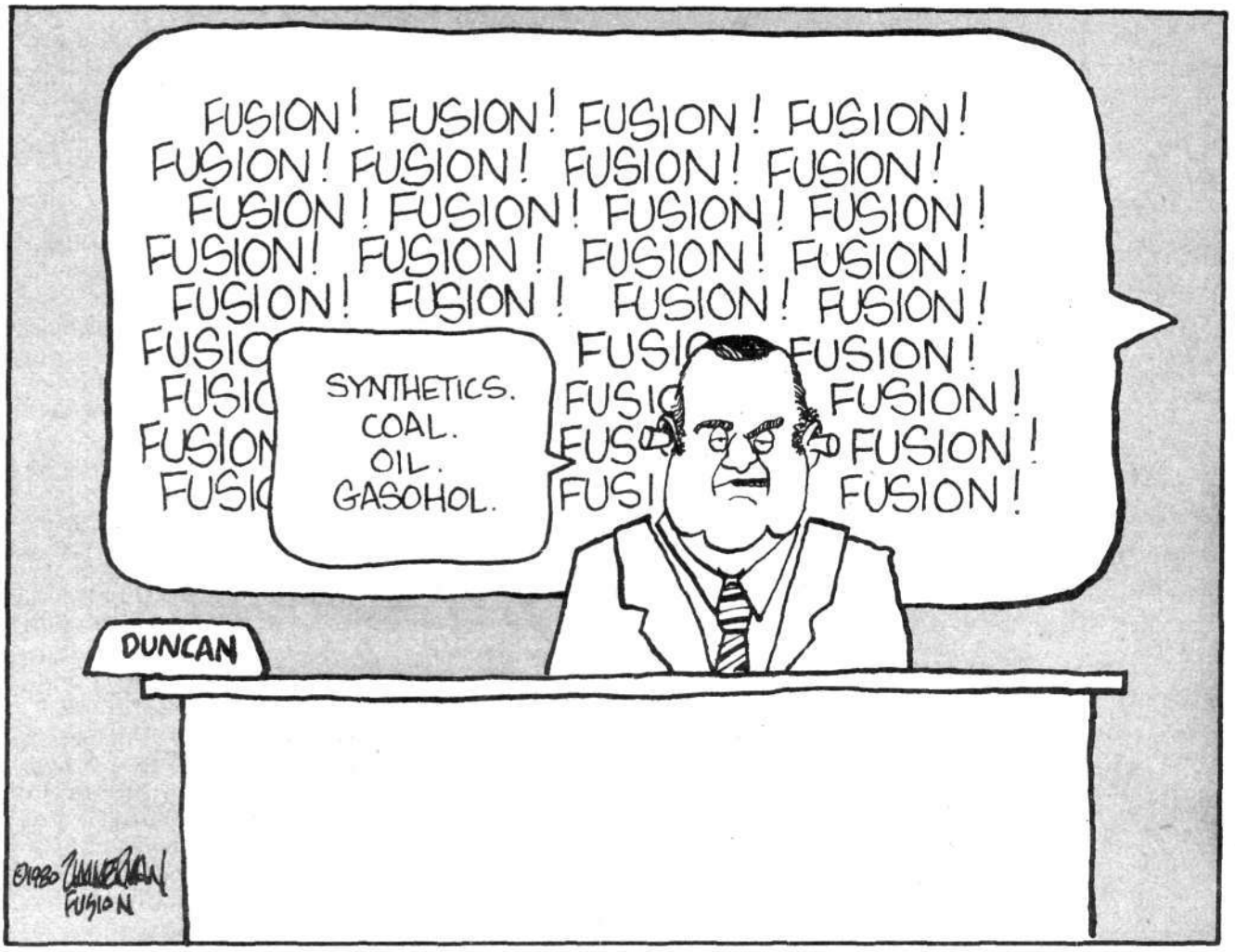


The McCormack Bill And the Energy War

Now that Congressman Mike McCormack has introduced his bill, HR 6308, calling for an Apollo-style program to build a demonstration commercial fusion plant by the year 2000—if not much sooner—the United States has a crucial opportunity at last to begin to reverse the Carter administraiion's war on energy production.

There is no doubt that the McCormack legislation is the right bill at the right time. Congressman McCormack has pinpointed the important issues facing the nation in the bill itself as well as in the congressional hearings and the press conference he organized to motivate the bill. The most important issue is that of national peace and security. As McCormack put it in Section 2 of his bill:

The early development and export of fusion energy systems consistent with the established preeminence of the United States in the field of high technology products, will improve the economic posture of the United States and ultimately reduce the pressures for international strife by providing access to energy abundance for all nations.

The testimony from leading scientists, lab directors, and industrial managers at McCormack's committee hearings and press conference made it clear that the main obstacle to commercializing fusion in this century is a lack of funding, not any basic problems with science or technology. And, as the McCormack proposal stresses, developed fusion power will not just be a domestic energy source but a vital ingredient among America's high technology exports.

A Predictable 'Deaf Ear'

Predictably, the Carter administration in the person of Energy Secretary Charles Duncan has already promised to turn a "deaf ear" to the McCormack proposal. We say predictably, because ever since President Carter called the energy situation the "moral equivalent of war," his administration has been waging all-out war on energy production.

It is not simply that the nation's energy supplies have become less reliable because of concerted DOE policy. Even more indicative of the administration's real policy intentions has been the DOE attempts to gut the research budget for every single technology that could have produced more energy more safely, more efficiently, more cheaply, and more productively.

Taken as a whole, the DOE record is truly astonishing. To name just a few items: Instead of closing the nuclear fuel cycle and implementing any of the sound nuclear waste storage options, the administration has scuttled spent-fuel reprocessing, killed the Clinch River breeder project, and stonewalled on setting up waste storage facilities. For good measure it has recently recommended even the elimination of breeder design studies along with the cutting out of the high temperature gas-cooled reactor and the gas-cooled breeder.

And, of course, MHD, which could be used for cleaner, twice as efficient coal combustion, has had its budget kept flat, while the administration cranks up the grossly inefficient solar program.

With this track record, it should not be surprising that the administration's fusion policy is to keep the magnetic confinement budget flat, preventing fusion engineering tests until the mid-1980s and recommending the gutting of the advanced laser fusion program.

But then again, this is the same administration that boasts numerous veterans of the New York Council on Foreign Relation's *1980s Project*. The *1980s Project* forthrightly called for destroying the world's oil supply infrastructure and getting rid of nuclear power—all in the course of putting the world economy through what the *1980s Project* calls "controlled disintegration" and International Monetary Fund financial dictatorship.

Congress's Duty

For this reason, the fight for the McCormack bill is inseparable from the fight to restore the nation's economy as the principal means of war avoidance. This time Congress must do its duty. Congress—which has made so many noble noises on behalf of energy production and capitulated so many times to "lesser evil" versions of administration energy policy—cannot be allowed to punt on this one.

Congressman McCormack has called for 200 cosponsors for his fusion bill. *Fusion* readers who have already armed him with thousands of postcards supporting the fusion acceleration effort can now help in mobilizing their congressmen, senators, and local representatives to create the visible support required.

The Fusion Energy Foundation, of course, will be in the middle of the national fight for fusion. As this issue goes to press, we are mobilizing all our forces nationwide to get out the facts on the McCormack bill. You can help to win the fight by letting us know what you are doing to organize in your area and by sending in your contributions now to the FEF.

LAROUCHE SUPPORTED

To the Editor:

... I personally do not believe that a scientist should commit himself in this way [joining Scientists for LaRouche] to any candidate. I also would refuse to join such a group even for the president because though I like the president as a person I think that his present energy policy leaves much to be desired. Any such commitment would also greatly reduce my own credibility to speak on the issues because it could be always said that my opinion is actually not my own but rather the opinion of the candidate.

However, after learning more about Mr. LaRouche's position on the energy question in the January 1980 issue of *Fusion*, there is little doubt that of all the different candidates his proposed program is the most scientifically founded. The next best position I could find was that of Governor Connally. Totally unrealistic is the position of Governor Brown. These observations, of course, may change as the positions of the candidates may change.

In regard to Mr. LaRouche's position I have little doubt that any really scientifically informed person, who is able to put aside prejudicial bias created from negative publicity Mr. LaRouche has received in the media, would share my observations. My observations, of course, shall not imply an endorsement of other stands on the issues by Mr. LaRouche or any other presidential candidate.

Dr. Friedwardt Winterberg
Reno, Nevada

(Dr. Winterberg, professor of physics at the Desert Research Institute of the University of Nevada System in Reno, is the recipient of the 1979 Hermann Oberth gold medal for his pioneering work in thermonuclear propulsion)

Continued on page 4

Letters

Continued from page 3

LEIBNIZ, PAPIN, AND THE STEAM ENGINE

We have received many enthusiastic comments from U.S. and European readers on the article by Philip Valenti, "Leibniz, Papin, and the Steam Engine: A Case Study in British Sabotage," which appeared in the December issue. Many readers have asked whether the Newcomen Society of Britain has responded to Valenti's charges. Author Valenti reports that he has not yet heard from the British Newcomen Society, but, with permission, he has made available to Fusion *readers a letter from Mr. Charles Penrose, Jr., president of the Newcomen Society in North America. Valenti had written Penrose asking for a response to his charge that the Newcomen Society was "founded entirely on a political and scientific hoax." Excerpts from Mr. Penrose's reply appear here. More letters on the steam engine will appear in the next issue.*

* * *

Your speculations and deductions concerning matters which took place in Britain over two centuries ago vis-a-vis the invention, development and application of steam power are most interesting. Whether Thomas Newcomen was, in fact, directly influenced by the prior work of Leibniz and Papin would appear to be a fascinating question and one not readily answered. It is certainly granted that Leibniz and Papin did important pioneering work in conceptualizing the development of a working steam engine. History certainly bears this fact out.

Thomas Newcomen was not of the Establishment and was not a member of the Royal Society. He, from what we know, was a modest man of humble origin born in Dartmouth, England, the town in which he died. He was a member of the Methodist Church in that small city and a man of undisputed ingenuity who did, in fact, construct an atmospheric steam engine in the year 1712. All of this is known to you and to historians.

Also well known is the fact that Newcomen-type engines were constructed and utilized in the ensuing 75 years in England, in France, and in America. I believe it is correct to say that Newcomen can be construed, in fact, as "the Father of the Industrial Revolution" in light of his engine's success. I would not dispute identifying Messrs. Leibniz and Papin as "the Grandfathers of the Industrial Revolution" in view of their well known and, insofar as I know, undisputed relationship and service to the theory of steam power.

A liberty is taken to send a copy of this letter to Ian McNeil, Executive Secretary, the Newcomen Society for the Study of the History of Engineering and Technology in London inasmuch as a copy of your letter to me was sent to him and to others. We would be grateful to you for copies of responses you may get from the distinguished members of the scientific community furnished, through your courtesy, with a copy of your letter to me. I suspect that many of these can comment and I hope they do so much more ably than I upon the content of your article.

Charles Penrose, Jr.
President, The Newcomen Society
in North America

ANOTHER NEWTONIAN DELAY

To the Editor:

I enjoyed Valenti's article about Denis Papin. It may interest you to know that a declaration by Newton stating that dispersion is always proportional to refraction did much to delay development of the achromatic refracting telescope for some 55 years also. Newton turned out to be wrong, but his reputation lent credence to the statement which discouraged experimental challenge. We are a clever but imbecile species. . . .

Taking the Headline Out of a Fusion Article

Many readers received the February issue minus part of a headline on page 52. The headline should have read as above: "National Science Foundation: Taking the Science Out of Education."

The printer tells us that on the late-night shift after 30,000 copies of *Fusion* had been printed, one of the pressmen was so taken by the illustration on page 52 that he masked out the headline with tape and made a print of the illustration for himself. The trouble is that he did not remove the tape before running several thousand issues through the press without the headline and without the signature of the illustrator, Christopher Sloan.

Our apologies to readers who received these misprinted issues, as well as to the author and illustrator.

Throughout the 17th and into the early 18th century, the only practical telescopes were refractors made with single element objective lenses using materials and methods based on spectacle lens technology. Two major problems in such lenses as applied to telescopes consist of spherical aberration and vivid color phenomena (the latter due to the dispersive property glass shares with other transparent substances), and as a result, images formed by these simple lenses yield low contrast and won't focus sharply.

The only recourse the early constructors had was to make the focal length of the objective as long as possible. Experience showed that chromatic error and spherical aberration diminished relative to image size with increasing focal length, so views of objects would become more distinct. Consequently, refractors got longer and longer as observers sought better performance from them, and unwieldly assemblies 60 and 70 feet long became commonplace.

Chromatic aberration continued to defy analysis by conventional 17th century thinking until Isaac Newton grasped the reality of white light as the sum of the perceived colors of the spectrum via experiments with prisms in 1666. This insight enabled him to distinguish between spherical and chromatic aberration in lenses, but subsequent attempts to express them quantitatively led to his erroneous conclusion that refraction is always accompanied by a like amount of dispersion in all transparent media. If this is true, the achromatic lens would prove impossible, as he stated in 1671.

Newton thereupon transferred his attention to the development of the reflecting telescope which has no chromatism, and meaningful advances in lens objectives languished until Chester Moor Hall combined two elements of crown and flint glasses to achieve an achromatic telescope objective, in 1733. . . .

Paul G. Shenkel
Optical Techniques, Inc.
Newtown, Pa.

GRASPING AT STRAWS

To the Editor:

To totally disregard and dismiss the real potential for biomass as a long-range fuel supply is irresponsible. . . . The conclusion that biomass as a fuel is only workable at the expense of food production ("The Gasohol Fraud" Sept. 1978) is an outright lie. No biomass researcher or responsible energy journalist has ever proposed this scenario. There

Continued on page 6

The Lightning Rod

My dear friends,

At one time I enjoyed a modest prosperity and a bit of fame, not wholly displeasing to me, though an acquaintance desirous of keeping my head in proportion to the rest of my parts has informed me that on a recent "multiple-choice" American history test given to his high school class, 20 percent of the students identified me as Secretary of the Treasury to Calvin Coolidge.

Be that as it may, my celebrity has been sufficient to keep my name on a number of lists, as authorized to receive commercial messages from those wishing to notify me by post of opportunities for purchase. In this manner I have several magazine subscriptions, a multitude of kitchen utensils, and a television set, the latter bringing with it the opportunity to receive a great many more commercial messages.

All this troubles me not at all, for I have ever found peddlers a valuable source of news and information, and naturally want to avail myself of the latest *modern conveniences*. Yet, lately, a disturbing note has crept into many of the messages I receive in this fashion. It seems my benefactors are constantly warning me not to buy the very things they are offering to sell.

Item: A shiny new motor car glides across the televison screen into a filling station. The personable young miss at the wheel exchanges a few words with the pump attendant. Just when I am expecting to hear him utter a hearty "fill 'er up?" the young lady puts her vehicle in gear and drives off. The company's musical jingle exhorts me to "save a gallon" by avoiding the purchase of their gasoline.

Item: An electrical power company invites me to view an exhibition of their latest inventions at a lofty skyscraper in the heart of Manhattan. I experience a warm proprietary glow, and dash off to see the marvelous new things that can be done to make and use electricity. It turns out, though, that the power company is mainly interested in showing me that I need less of it. In fact, when I arrive at the building, the moving staircase is boarded up, and a large sign informs me that it has been shut down as "part of our energy-saving project."

Item: A stern, grim-jawed gentleman is speaking from behind the Great Seal of the President of the United States. He tells me that the Russians are running short of oil and may plan to seize the oil fields in certain Middle Eastern countries if they cannot supply their needs. Therefore, he continues, we will not sell the Russians the drilling equipment they require to extract oil on their own territory.

According to the logic of such messages, that which allows men and nations to be what they are is too valuable for them to possess. And since there is so little of it, the best one can do is organize a discussion of how and what requirements will be eliminated.

That strikes me as a very dangerous philosophy. If America persists in telling itself we are going out of business, I am afraid we will find ourselves sponsoring the biggest Going-Out-of-Business Sale in history, after which there will be nothing left to "save."

Yr. obt. svt.

Letters

Continued from page 5

are known land resources estimated between 100 and 400 million acres that could be dedicated to biomass with no impact on either food or timber/pulp production. Using 40 or 50 million of these acres could produce 4 to 5 quads of energy.

If biomass can be grown on the oceans (and studies have shown it can) the potential energy may be unlimited. To disregard this potential is narrow-minded. . . .

Joseph E. Leone
General Electric Company
Philadelphia, Pa.

The Editor Replies

If we approach the energy problem the way Mr. Leone suggests, even if we grow biomass on the entire island of Japan or the state of Oregon, it would supply the world with less than 2 percent of current U.S. annual energy production.

We recommend that Mr. Leone read a little publicized but authoritative pamphlet published by the U.S. Department of Agriculture's Economics, Statistics, and Cooperatives Service, Agricultural Economic Report No. 425, "Growing Energy: Land for Biomass Farms" by Kathryn A. Zeimetz. Zeimetz documents that contrary to the myth that biomass crops for energy conversion can be grown anywhere, biomass requires "high quality land to maximize energy gain and minimize environmental hazards." This is the quality of land required for current food production.

Aside from requiring an army of workers to collect and tend to such an operation, a biomass solution would mean that approximately 8.7 million acres of trees would be needed to produce just 1.25 percent of U.S. annual energy production. These figures are from a study by the Mitre Corporation, cited by Zeitmetz.

An added problem of extreme practical importance is that biomass has low efficiencies of conversion, lower than crude oil or natural gas. The energy value per ton is approximately one-third that of crude oil that contains 38 million Btu's per ton; dried plant matter contains at best 13 million Btu's per ton. And if bio-

mass is not dried, then energy levels fall off to those of inefficient oilshale or tar sands, at about 4 million Btu's per ton. At this rate, to provide 10 percent or 8 quadrillion Btu's of 1980 U.S. energy consumption would require 70 million acres of biomass.

Even more important, devoting farmland to biomass would mean a reduction of land now devoted to food and fiber crops, as the Zeimetz study notes and as the Carter administration gasohol policy is intended to do.

Yes, of course, biomass can be grown on the oceans and even in space; but how is it to be collected and converted and how much of it will be needed for an economy that is expanding and increasing its energy use? Why not leave biomass for its most productive use—in our stomachs—and concentrate on developing safe, clean, economical, and far more energy-efficient forms of energy like nuclear fission and fusion.

Cynthia Parsons

DOPE RIGHTS?

To the Editor

. . . I would suggest that you relax on the dope issue. You must be aware of the wealth of information on victimless crime. You should not be concerned with the "rightness" or "wrongness" of drug use, per se, but rather with the logistics and gain and loss factors involved in attempting to legislate morality. It simply doesn't work, except in totalitarian societies. In a free society, this sort of legislation actually encourages those elements who work outside of the law. They find a commodity which is artificially expensive because of its illegality and *create* a market, where there was none before. The accompanying rise in violent crime is unavoidable. Remember Prohibition? Remember when illegal drugs became big business?

Imagine what could be done with the more than *90 billion* federal, state, and local tax dollars spent last year in the battle to curtail cocaine traffic alone! I don't have the figures on marijuana, heroin, and other drugs, but they must be staggering. Think about the potential revenue on these same commodities, which are now entering the country in ever-increasing amounts, totally tax free.

If you are interested in seeing violent crime diminished by about half; if you would like to see tax dollars freed for worthwhile causes, try decriminalizing drugs, along with prostitution and other victimless crimes. Think of the energy we could buy.

We all have the inalienable right to destroy ourselves in whatever way we see fit, providing we do not forcefully take anyone else with us. That is, after all, our basis for argument against the antienergy establishment and their desire to live in the dark.

Andrew M. Hanlen
Los Angeles, Calif.

The Editor Replies

The drug abuse problem in the United States is now of such epidemic proportions that threatens the survival of our country. Between 30 and 40 million Americans are regular users of marijuana, the great majority of them under 20 years of age. The research of Dr. Robert Heath, reported in an article by Dr. Gabriel Nahas in the September issue of *Fusion* ("The Biological Effects of Marijuana"), indicates that these 30 to 40 million very likely have brain damage in the area of the limbic system, a brain area associated with attention span, short-term memory, and emotional control.

This is a catastrophe for the millions of individuals involved, but even more so for the nation. Virtually an entire generation has been lost to drugs and to the related decadence of rock music, antiscience environmentalism and other forms of the counterculture. This has significantly weakened the will of the American population to defend the idea of Progress, upon which our nation was founded.

Drug abuse, then, is not a private matter, but a public concern of the highest importance. From that standpoint, the individual emphatically does not have the right to destroy himself.

As for exactly what is spent on stopping drug traffic (and it was only $5.5 billion on the federal level during the entire 1969-1978 period in the United States), how today's biggest drug pushers come right out of organized crime and Prohibition, and why most efforts to date have not stopped the top-level "respectable" pushers, we recommend reading the bestseller *Dope, Incorporated.*

Ned Rosinsky, MD

Calendar

March

9-13
25th Annual International Gas Turbine Conf. and Exhibit and 22nd Annual Fluids Engineering Conf.
New Orleans, Louisiana

10-12
27th International Scientific Congress on Electronics and 20th International Scientific Meeting on Space.
Rassegna Internazionale Elettronica Nucleare ed Aerospaziale
Rome

17
Energy Debate
Dr. Morris Levitt vs. Stuart Diamond
Lynchburg, Va.
Lynchburg College
The Burton Student Center, 8:00 P.M.

24-26
7th Energy Technology Conf. and Exposition
American Gas Association, Inc., Gas Research Institute, EPRI, National Coal Asso.
Washington, D.C.

24-28
American Physical Society
Spring Meeting
New York City

25-28
Meeting on Nuclear Reactors
German Nuclear Society, Deutsches Atomforum e.V.
West Berlin

March 30-April 1
4th International Petrochemical Conf.
National Petroleum Refiners Asso.
San Antonio, Texas

31
Energy Debate
Dr. Morris Levitt vs. Stuart Diamond
Utica, N.Y.
Utica College
The Strebet Auditorium — 8:00 P.M.

April

8-10
The Three Mile Island Nuclear Accident: Technical, Social, and Economic Implications
New York Academy of Sciences
New York City

Mike McCormack

News Briefs

FUSION BILL HAS 100 COSPONSORS

The "Apollo-style" fusion energy development bill introduced into Congress Jan. 22 by Representative Mike McCormack had more than 100 congressional cosponsors by Feb. 1, according to an aide to the congressman. The bill recommends $20 billion for fusion research, with the year 2000 as a target date for the production of a commercial-demonstration fusion reactor. The bill's chances of passage in the House are now considered excellent, according to Washington sources.

The immediate goal of fusion supporters is to find sponsors for companion legislation in the Senate.

For a full report on the McCormack fusion bill, see the Washington news section, this issue.

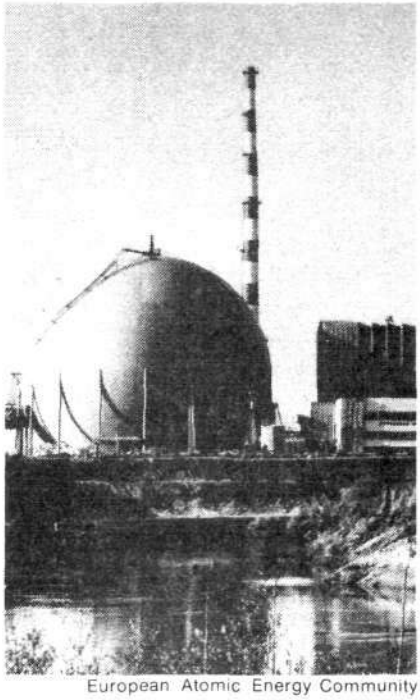
DOE UNDERSECRETARY DEUTCH RESIGNS

Dr. John Deutch, Department of Energy undersecretary, submitted his resignation to President Carter in late January and said he will return to teach at Massachusetts Institute of Technology. Before entering DOE in 1977, Deutch headed the chemistry department at MIT.

Deutch made a speedy rise to the number 3 position in the department under former energy secretary James Schlesinger. In October 1977, he was made head of the Office of Energy Research, where he reviewed the fusion and magnetohydrodynamic programs, downgrading their importance and their recommended funding level. His tenure at the office added "10 to 20 years to the timetable of each program," noted one unhappy energy specialist. Deutch then became acting assistant secretary for energy technology, and soon thereafter undersecretary.

During the Vietnam War, Deutch was a scientific advisor to defense secretary Robert McNamara. He also served at the Rand Corporation, where he first became a colleague of James Schlesinger. Deutch headed President Carter's panel on nuclear waste disposal, whose year-long study failed to recommend a policy on the matter.

There are rumors in Washington that Deutch may become the president's election campaign advisor on scientific questions.



European Atomic Energy Community

The SENN nuclear power plant near Naples, Italy.

FRENCH TO SEEK CHANGES IN U.S. NUCLEAR POLICY

French Industry Minister André Giraud will visit Washington in early February to ask for changes in the Carter administration's energy policy. Interviewed shortly after French President Giscard d'Estaing had reiterated France's commitment to accelerated nuclear energy development, Giraud was asked by the *International Herald Tribune* Jan. 29 to comment on his U.S. visit: "We Europeans are committed to the development of nuclear energy and we think that the USA's stalling on this issue is wrong. It's got to be stopped. The United States must adopt a crash nuclear program."

ITALY REAFFIRMS NUCLEAR POLICY

A panel of government-appointed experts issued a report in mid-January on the safety status of Italian nuclear plants, giving an "all clear" to the government to continue its nuclear construction program. As a follow-up to the report, the same panel plus several representatives of the nuclear industry participated in a National Conference on Nuclear Safety in Venice Jan. 26. The events mark a policy turnaround in Italy, where nuclear construction has been blocked for two years by environmentalist lobbying.

Budget and Planning Minister Nino Andreatta, who authored the national energy plan, told the Milan daily *Corriere della Sera*, "There is nothing more useful for solving the anguishing problem of hunger in the world than to start the construction of nuclear plants immediately."

RESHUFFLE IN SOVIET SCIENCE HIERARCHY

V. Kirillin was forced out of his post as chairman of the Soviet State Committee on Science and Technology in January, and a great deal is being read into the move in Western capitals. Kirillin was replaced by Academician G. Marchuk. Kirillin is a systems analyst who was associated with the Club of Rome zero-growth organization in Western Europe and who advocated moderate or limited growth within the Soviet Union itself. By contrast, Marchuk has been the head of the research program in Novosibirsk, a high-technology city-building project in Siberia (pop. 1,000,000), and advocates the most rapid possible Soviet economic development.

Passed over in Marchuk's appointment was Jermen Gvishiani, Kirillin's deputy, known in the West through the International Institute of Applied Systems Analysis, which he jointly heads with former U.S. national security advisor McGeorge Bundy. The larger implication is that the Soviet faction in favor of advanced science for both economic and military reasons is moving to downplay the role of the slow-growth-oriented systems analysis.

CONGRESS AGREES ON WINDFALL OIL TAX

A House-Senate conference committee Jan. 22 announced agreement on a windfall profits tax that will place a $227 billion tax on oil production during the next 10 years. As many oilmen have pointed out, the excise tax is not on profits, but on production at the wellhead, and the real windfall is to the U.S. Treasury. As this issue goes to press, there is still discussion about what to do with the proceeds of this largest single tax package in U.S. legislative history, but little mention of putting the money back into energy production.

John Miller, the president of the Independent Petroleum Association of America commented that the tax would create a regulatory nightmare for producers, while Maurice Granville, chairman of the board of Texaco, said the tax "gives the U.S. consumer the worst of both worlds – higher prices and less energy."

EARTHQUAKE DAMAGE AT LAWRENCE LIVERMORE

An earthquake in Livermore, California Jan. 24 caused a total of $10 million damage at Lawrence Livermore Laboratory—$3.5 million in nonstructural repairs and the rest for architectural upgrades such as tying down library shelves and light fixtures to minimize repairs in any future earthquakes. A spokesman for the laboratory said that the Shiva laser was not seriously damaged. Although bolts were loosened in the laser bay and sheared off in the target chamber, the frame for the huge laser was not bent. As of this writing, staff members were inspecting the optical components.

After the earthquake the national media beamed out headlines of a Livermore "radiation leak," although the actual leak of a tritium solution not only was contained in an impermeable asphalt container but also had a level of radiation half that allowed by the Department of Energy to be dumped into the lab's normal sewer line. The leaking container holds five one-hundredths of a microcurie of tritium per cubic centimeter, a solution that is used in fusion research.

LOUSEWORT LAURELS TO STERNGLASS—AGAIN

The March lousewort laurels award goes to Dr. Ernest Sternglass, making him our first two-time winner. This time he wins for his recent pronouncements at the Three Mile Island nuclear plant on the unknown dangers of krypton gas—an inert gas whose properties have been well known for years. Krypton could become "concentrated and dangerous," Sternglass said. The professor of environmental science at Pittsburgh University was called in by environmentalists in the TMI area in order to protest the plans of Metropolitan Edison to release krypton-85 from the crippled TMI plant at levels below those normally allowed by government regulations. As one TMI engineer put it, it's like prohibiting soda pop because when you open up the bottle the carbon dioxide might hit your face in concentrated form and kill you.

Sternglass is notorious in the engineering and physics community for his wild statistical analyses that purport to show the dangers of nuclear fission.

Viewpoint

by Senator John Melcher

We Need a Broad-Scale MHD Program

This month Fusion *inaugurates a new column—Viewpoint—that will present the views of elected officials and business, science, and community leaders on topics of interest to* Fusion *readers. Senator Melcher, a Montana Democrat, is a strong supporter of the nation's MHD program.*

MHD is a crucial technology to increase the efficiency of our electric-generating system. It can increase the efficiency of burning coal to make electric power by more than 50 percent. Conservation will save some energy, but we are still showing an electric load growth of 4-5 percent per year and in the Northwest the demand for power is even greater.

We will need increased power even for conservation, and if we did ever get into solar power, we would need energy for all of the materials, like copper and aluminum piping, that solar energy would require.

The administration will submit its request for a $17.5 million supplemental budget increase for fiscal year 1980 on Feb. 1. This will include money for the testing of components and money for the Soviet cooperation program. This is the first solid evidence that the administration will carry out what it said last month—a speed-up of the program. In the fiscal year 1981 budget, we expect an authorization of more than $100 million and a firm commitment to the next stage of the program—an engineering test facility—in 1984-85.

I'm not sure even that's fast enough.

One aspect of the program not addressed by the DOE, even in its accelerated program plan, which I suggested to Undersecretary John Deutch at the MHD budget hearings last year, is that the DOE program should be broadened to use in industrial plants, such as aluminum-making plants. There are many industrial processes where you need excessive amounts of heat, in addition to electricity.

I know that Reynolds, which has its own MHD program, approached Deutch with such a proposal in late 1978. Deutch said that it was too early in the program to do such work.

Congress has the responsibility and should insist that industrial MHD use become part of the DOE program. The research effort should be broadened to include industrial uses that require both power and heat.

If that were done, the program would advance more rapidly. I'm mystified as to why that isn't done now. Researchers at Reynolds have told me that it's easier to pursue MHD's industrial uses than MHD's role in generating electricity. The technology could demonstrate its effectiveness most easily that way.

The Senate has taken the lead in pushing the MHD program in terms of dollars. The reluctance has come from the House side to go as fast as we'd like to go. When I think of all the money we spend through the DOE, it's ironic that for the most promising technology, we've had a hard time getting the program we know we need.

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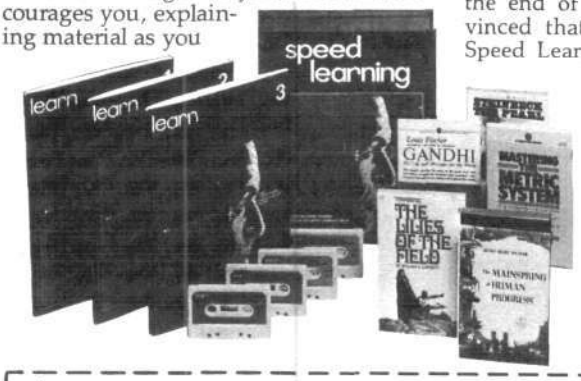

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The Fight for Nuclear Energy: Showdown in Sweden

On March 23, Swedish voters will go to the polls to cast their ballots in a referendum on nuclear energy that has been widely covered in the international press. The referendum gives them three alternative positions on the nuclear question, none of which *is a "yes" vote for the accelerated development of the nuclear energy industry of Sweden, now one of the most advanced and prosperous nuclear industries in the world.*

The Forbundet Kärnkraft och Utveckling, the Swedish Association for Nuclear Power Development, calls the referendum nonsense. The association, known throughout Sweden as the FKU, has been at the head of the fight to ensure that the referendum does not close down the 12 nuclear plants already operating or on the drawing board. But, more than that, with a broad labor, industry, and political party membership, the FKU is building the institutional force to implement a Swedish national policy for advanced fission power development at home and massive exports of nuclear technologies to the Third World.

This exclusive report by FKU members Clifford Gaddy and Kerstin Gaddy and Fusion's *energy editor William Engdahl reviews Swedish political history on the energy question up to the present, demonstrating that it was only by importing an environmentalist movement into Sweden and grafting it onto the party structures from the top down that the antinuclear interests were able to force the upcoming referendum on the Swedish population.*

The Sweden nuclear story initiates "Nuclear Report" as a regular Fusion *feature.*

Creating Environmentalism From the Top Down

The March 23 referendum on nuclear power in Sweden is being billed as the culmination of a lengthy evolutionary process of environmentalist thinking. Over the course of the past decade or so, as naive opinion would have it, the concern of the Swedish population has been raised step by step from such problems as fluoride in drinking water and additives in food to a final "yes" or "no" decision on the critical issue of nuclear power.

In fact, nothing could be further from the truth than the view that the March referendum is the ultimate democratic act in a native Swedish drama of participatory politics. The reality of the Swedish antinuclear debate is that from the very outset it was orchestrated from outside Sweden by such international institutions as the United Nations, the Club of Rome, and the Friends of the Earth. These organizations developed Sweden as a laboratory, a model in which environmentalism could be institutionalized as government policy—with the ultimate aim of reexporting that model to the United States and other leading industrialized nations.

The key role Sweden could play for the environmentalist movement worldwide became apparent more than a decade ago. Although the ideology of environmentalism had been launched, primarily in the United States, in the mid-1960s, the ideas could attract no mass following, much less influence government policy in a major way. From the standpoint of the world environmentalist movement, it became obvious that the approach had to be reversed. Rather than attempt to build a grassroots movement first, what was required was a situation in which an existing government could be persuaded to directly adopt environmentalism as official policy. The corresponding ideology could then be imposed upon the population from the top down.

No country was better suited for that approach than Sweden.

Palme the Environmentalist

Sweden is a country in which the national government has near-total control of the instruments of public opinion—the TV and radio networks, for instance, are 100 percent state-controlled. Even more important, Sweden's prime minister at the beginning of the 1970s, the left Social Democrat Olof Palme, was highly sympathetic to the environmentalist program.

Palme had established his liberal profile in the 1960s on the basis of his support for liberalization of pornography and drug laws as well as his highly vocal opposition to U.S. involvement in Vietnam. As the decade of the 1970s began, Palme made it clear that he had chosen a new cause to espouse—the implementation of the "postindustrial society." This

was the idea that industrialized societies had reached the limits of their development and were now destined to evolve only in a nonmaterialist, "qualitative" mode.

The year 1969 was a major turning point in this process. One of Palme's first acts on becoming prime minister in 1969 was to establish an official government think tank for planning Sweden's transformation into the zero-growth post-industrial society he himself had already outlined. The new agency, the Secretariat for Future Studies (SFS), developed rapidly into the equivalent of a propaganda ministry for environmentalism in Sweden, much like the White House Council on Environmental Quality in the United States. The Secretariat unleashed a flood of information materials and trained a staff of journalists who were later to serve on the major daily newspapers of Sweden as "energy editors."

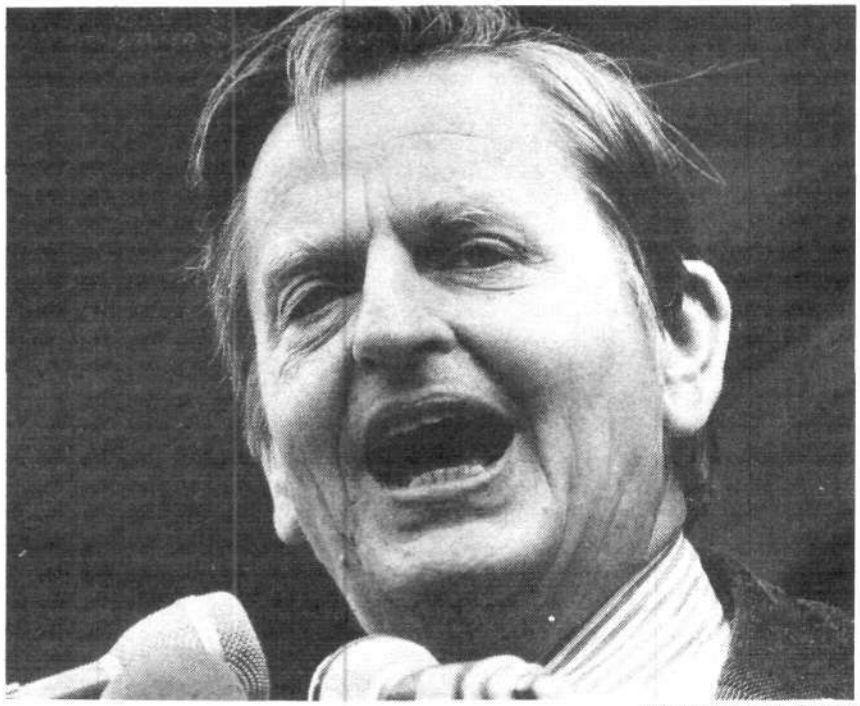
The creation of the Secretariat, the journalist training programs, and the domestic public relations campaigns for environmentalism, however, turned out to be only the preliminaries for the much more important project of using Sweden to launch a worldwide environmentalism program under the auspices of the United Nations.

Enter the United Nations

Shortly after coming to power, Palme had offered to make Sweden the host nation for a UN conference on environmental problems. That conference, the United Nations Conference on the Human Environment, brought thousands of government officials and nongovernmental activists into Stockholm for several weeks in the summer of 1972.

In addition to officially establishing the image of Sweden as the model of an environmentally oriented society, the 1972 UN conference also provided the context for the most important political shift inside Sweden since the war.

The secretary-general of the UN conference was the former World Bank official, Maurice F. Strong of Canada. In addition to his ties to Canadian and British government and financial circles, Strong was also a member of the advisory board of the Friends of the Earth, the leading political intelligence organization of the world environmentalist movement.



Pressens Bild AB, Sweden

United Nations

Importing Environmentalism. Above: Olof Palme; below Maurice Strong (center) at a press conference during the June 1972 UN Conference on Human Environment in Stockholm.

Set up internationally in 1969 with $200,000 in seed money provided by Atlantic Richfield oil company's Robert O. Anderson from his post as chairman of the Aspen Institute, the California-based Friends of the Earth organization established its Swedish branch immediately after Palme's accession to the post of prime minister. Before, during, and after the 1972 UN conference, the Friends of the Earth—financed then by UN funds—worked on completing the scenario for the full environmentalist takeover of Sweden by converting Sweden's second-largest political party, the Center Party, into the mass-based environmen-

talist movement that until then had been lacking despite Palme's measures.

Up to the time of the environmentalist onslaught, Sweden's Center Party traditionally functioned as the constituency-based political machine of farmers. Far from being peasants on small plots, Swedish farmers in the 1950s and 1960s had begun to approach the educational, technological, and income levels of American farmers. They were dependent on cheap energy and modern technology, and their party, the Center Party, quite logically was a solid supporter of nuclear power.

This all changed in the summer of 1975. With the mediation of the Friends of the Earth and allied U.S.-based groups such as the Union of Concerned Scientists, a special session of seminars was set up to inform leading Center Party politicians of new U.S. findings on "the dangers of nuclear power." The principal speaker at that summer session was Nobel Prize-winner Hannes Alfven, a Swede who had been residing in California for several years.

Another imported seminar leader was S. David Freeman, now head of the Tennessee Valley Authority and then an official of the Ford Foundation. Freeman was personally invited by Palme to lead a series of sessions on energy for a select group of parliament members, including the leader of the Center Party, Thorbjörn Fälldin, and future energy minister Olof Johansson. With Palme's support, Freeman convinced the parliament to adopt a long-range energy program that reduced Sweden's planned nuclear plants from 25 to 13 and called for zero-energy growth by 1990.

Interestingly, Freeman then took his Swedish success back to the United States where he used it to outline an energy policy for the new Carter administration in 1976 as White House energy advisor. This policy then became the basis for energy secretary James Schlesinger's "National Energy Program."

Fälldin, a sheep farmer from northern Sweden, emerged from the various seminars as an ardent opponent of nuclear energy. Later he described his experience as a "Damascus Road" conversion from his previous pronuclear stance.

With the capture of Center Party leader Fälldin, the transformation of the party into a full-fledged environmentalist party was underway. In the 1976 general elections, the party's rabidly antinuclear program attracted an extra margin of electoral support of some 5 to 7 percent. This showing was then used to lend credibility to the myth that an environmentalist platform was a guaranteed vote-getter for any party in modern Sweden.

In fact, however, the Center Party's initial successes were reversed as its old traditionalist base became disenchanted with the party's new image and switched to the Conservative Party. The Center Party proved to be the biggest loser of all in the 1979 elections. By then, however, the scenario had been played out to the end: The Swedish nuclear program was pronounced to be a mere "parenthesis" in Swedish history and the national referendum had already been scheduled to allow the voters to determine how quickly it was to be phased out.

Bo Schilling/Pressens Bild AB, Sweden

Thorbjörn Fälldin: A Damascus Road conversion.

The March 23 Referendum

The confusion in Sweden on the energy issue can best be seen by the three different alternatives voters will have on the ballot March 23. Rather than vote simply "yes" or "no," voters must select among the following:

Alternative 1: that the production of the 12 reactors that are now in operation or under construction should be completed. This alternative is backed by the Moderate Party (the conservatives) under party leader and Minister of Economics Gosta Bohman.

Alternative 2: that the 12 reactors should be completed and that the entire energy sector should be owned by the state. This alternative is backed by the Social Democratic Party under former prime minister Olof Palme and the Liberal Party under Foreign Minister Ola Ullsten.

Alternative 3: that the six Swedish nuclear reactors now producing electricity should be closed down within 10 years and that the other six reactors that are about ready to be started up should be dismantled. This alternative is supported by the Center Party under Prime Minister Thorbjörn Fälldin and by the Left Party Communists under Lars Werner.

New Alignments

The party line-up on the referendum shows that the energy issue has made the old division of "left" and "right" politics a thing of the past. The prime minister in the new socialist government is collaborating with the communists, and Olof Palme's social democrats are working together with the liberals.

Even more striking, however, is the fact that all the "alternatives" agree that nuclear power should not be developed any further. The energy programs of all the above-mentioned parties that make up the Swedish Riksdag (parliament) state that nuclear energy should be used only until "soft" and "renewable" energy sources like wind and solar power have been developed. Nothing is said about mining Swedish uranium, which accounts for about 80 percent of Europe's uranium supply. And nothing is said about developing the next generation of nuclear power—that is, breeders and high temperature reactors.

All the parties agree that nuclear power should be simply a "parenthesis" in national technological development to be ended as quickly as possible.

How the Referendum Was Born

In 1976, Sweden's Social Democratic Party under Olof Palme lost the national election, and for the first time in 44 years the three-party opposition formed a non-Social-Democrat government under Prime Minister Thorbjörn Fälldin. That government fell after two years on the issue of nuclear power.

During the election campaign, Fälldin had promised that his government would end the use of nuclear power, but his two coalition partners would not go along with this policy. In a final attempt to keep his government together, Fälldin proposed in 1978 that the nation decide the nuclear question in a referendum. The Riksdag, however, would not go along with any such proposal. Therefore, Fälldin's government fell in fall 1978 and the Liberal Party under Ola Ullsten formed a minority government with the help of Olof Palme's Social Democrats.

The demand for a referendum could not have succeeded without the Social Democratic Party, which has about 40 percent of the Swedish electorate in the palm of its hand. And it was not until the Three Mile Island incident that Olof Palme could get his reluctant party to accept the idea of a referendum.

The day after the Harrisburg incident, March 29, 1979, Palme called a press conference, where he said that his fellow party member Pierre Vinde, working out of the United Nations in New York City, had given him first-hand reports of the "extremely dangerous" situation at the Three Mile Island plant. Palme told the press that nuclear power had proved to be much more dangerous than anybody thought. Therefore, he proposed that Swedish nuclear reactors that were ready to be started up should not be put into use until the nuclear power question was put before the population in a referendum. Palme immediately got the Center Party to agree to this policy and the parliament majority in favor of a referendum became a fact.

At the time of new parliamentary elections in fall 1979, Palme had hoped that he could regain power if he kept the nuclear question out of the election campaign. But Fälldin again formed a three-party coalition government, this time hoping to keep it together with the nuclear issue out of the government decisions.

Above: 'Nuclear power is safer than sex', FKU organizers at an Uppsala pro-nuclear rally; below: FKU founder John Hardwick.

Today the Swedish government is functioning virtually as a caretaker government, with all important decisions postponed until after the nuclear referendum.

Since the previous liberal minority government also was of a caretaker sort, it can be said that Sweden has been without a government policy for almost two years because of the nuclear question. The economy of the country therefore has been standing still, with no one daring to make new investments.

The Role of the FKU

The only organization that has demanded a real "yes" in the nuclear power referendum is the Association for Nuclear Power and Development, known by its initials in Swedish as the FKU. The FKU was initiated in 1976 by John Hardwick, a member of the European Labor Party and one of its parliamentary candidates in 1979. Under Hardwick's leadership, the organization has formed a broad alliance between industry and labor backing a program of rapid expansion for Sweden's nuclear industry.

FKU

Last spring, the FKU made national banner headlines in the major Swedish dailies, when 20 trade union leaders from all over the country in collaboration with the FKU presented a resolution against the energy policy of Olof Palme and the Social Democratic Party. Representing a wide cross-section of the Social Democratic labor leadership, the resolution demanded that the Social Democratic Party adopt the nuclear energy expansion program of the FKU as the only way to secure jobs and better living standards.

About six months ago, when the battle over the referendum began to heat up, the FKU brought out the first issue of its national magazine on energy policy, *Energi*. The first run of the four-color glossy magazine was only 2,000 copies, but it caught on so quickly that it soon published 45,000 copies. The coming issue of *Energi* will run 60,000 copies, with advertisers representing every sector of high-technology Swedish industry.

The feature article in the current issue outlines the energy policy of the FKU under the headline "Nuclear Sweden."

The FKU program emphasizes the need for continuous scientific, industrial, and technological development. Specifying that Sweden should build as many nuclear power plants as the country needs for its own industrial development—about 50 by the year 2000—the program also demands Swedish export of additional nuclear power plants. Furthermore, the program urges that Sweden mine its uranium reserves and develop the entire nuclear fuel cycle inside Sweden, including enrichment and reprocessing plants. It also demands that Sweden develop breeder reactors and high temperature reactors in collaboration with continental Europe.

The FKU program has attracted many young people, especially scientifically minded youth in the Moderate Party youth group. At the same time, groups within the labor unions and leaders in industry have looked at the FKU program—the only "yes" alternative—as the only realistic alternative if Sweden is to continue to exist as a highly developed industrialized country. Support for the FKU ideas is reflected in the fact that the FKU now has more than 2,500 members and that its magazine, *Energi*, is growing very rapidly.

An Advanced Nuclear Industry

The most remarkable aspect of the Swedish nuclear story is that the country known best for its antinuclear campaigns, a tiny nation of little more than 8 million people, has assembled one of the world's most advanced and highly developed nuclear industries.

The Swedish nuclear story begins almost immediately after World War II. At that time, the Swedish government, on the urging of Danish physicist Niels Bohr, planned to adopt Bohr's conception of a joint U.S.-Soviet nuclear research program to be based in neutral Sweden. England's Prime Minister Winston Churchill directly intervened to prevent this by orchestrating the Cold War. Nevertheless, in 1947, the state research company AB Atomenergi was formed. In 1954, after president Eisenhower launched Atoms for Peace, the first Swedish-made nuclear reactor was begun.

In 1963, the first Swedish power reactor began operations. The reactor, Agesta, was built in a suburb of Stockholm and initially encountered opposition from residents who feared radioactive effluents in a nearby lake. However, when the reactor was shut down in 1974, residents protested its replacement by an oil-fired plant and demanded that the clean nuclear reactor be continued. This gives an indication of the actual sentiment in favor of nuclear power in Sweden.

Today Sweden stands as the world leader in terms of percentage of total electric power generated from nuclear sources with slightly over 25 percent. By comparison, the United States, which has 70 reactors, generates 13 percent of its power from nuclear plants.

After the Swedish industry and the government decided in the late 1960s to concentrate on commercial light water reactor design rather than an earlier heavy water British-type reactor, a centralized commercial reactor industry was formed. In 1968, the ASEA electrical group, referred to as the "General Electric of Sweden" and dominated by the Wallenberg family, secured 50 percent state participation in an authority, ASEA-ATOM.

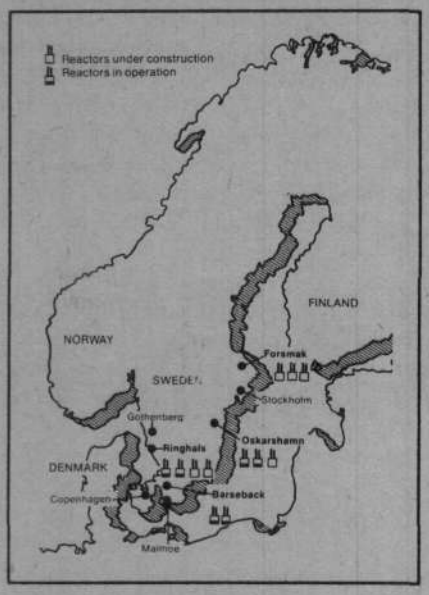
The creation of ASEA-ATOM meant government underwriting for the development of a full-scale indigenous nuclear industry. This centralization of the industry under one corporate group with government support, a dirigist approach, gave the far smaller Swedish nuclear industry an edge that the U.S. industry lacked, because of its decentralized division among system supply, system contractors, engineers, and constructors. The organization of the Swedish nuclear industry has ensured uniformity of design and maximal integration of safety reducdancy systesm. It has also ensured the best posture for capturing the appropriate share of the important export market.

Once this government backing was secured, Swedish industry launched a domestic program that called for a total of 25 reactors by 1985. With this program, Sweden undertook the world's most ambitious commitment to nuclear energy development. By the early 1970s, the stage was set for a major nuclear-led industrial boom in Sweden to fuel a rapidly expanding world export market.

The Potential for Development

Sweden has no indigenous fossil fuel resources, so it was entirely lawful that Swedish industry embarked on such an aggressive nuclear program. The large domestic nuclear base would be the launching pad for a vigorous export drive. With abundant cheap power to fuel a major export-vectored boom, the Swedish nuclear industry was preparing to take advantage of the worldwide network of ASEA in Latin America, Africa, the Middle East, and northern and Eastern Europe. The nation's first export package of two 660 megawatt-electric power reactors—Teollisuuden Voima Oy I and II—went to neighboring Finland.

Sweden was also fortunate to be sitting on one of the world's largest deposits of uranium ore. There are an estimated 300,000 tons of uranium ore in the Ranstad region of Sweden and there is a strong probability based on geologic formations that there is far more in the



Above, a map showing the location of Sweden's existing and planned nuclear facilities. At left, a nuclear reactor pressure vessel, constructed on a floating factory floor, ready for delivery.
ASEA-Atom

north. This is 20 percent or more of total world uranium reserves and fully 80 percent of Europe's reserves. With such industrial and raw material resources, Sweden was primed to play a key role in world nuclear technology transfer.

Taking this a step further, the FKU (Association for Nuclear Energy and Development) has elaborated a proposal to revive the combined shipbuilding capacity of Malmoe and Copenhagen, which can be viewed as an Orestad industrial superregion. This region contains the most dense high-technology shipbuilding in all of Europe. Yet, today it is becoming a ghost town under conditions of forced collapse of world trade.

A spokesman for one of the major shipyards in Sweden that has been shut down for lack of shipbuilding orders has proposed that his yards be converted into a facility to build floating nuclear power plants. The conversion could take place overnight, he said.

This conception—pioneered by Westinghouse Offshore Power Systems in Jacksonville, Florida—but abandoned because of environmental and financial harrassment—is being pursued aggressively in the Soviet Union and Japan.

The floating shipyard assembly on barges of nuclear plants would allow assembly-line mass production of such plants to be delivered to sites along the entire Baltic and the Middle East. This floating nuclear concept is the key to rapid industrialization of the developing sector.

In the context of such a development perspective, integrated with the emerging Franco-German led European Monetary System and coordinated with the economic cooperation and development treaties between Western Europe and the Soviet Union, Swedish uranium resources could be enriched in French and Soviet enrichment facilities to fuel a blossoming European—and developing sector—nuclear industry.

Environmentalist Destruction

The catch lies in the fact that the vast development potential of the Swedish nuclear industry has been all but destroyed at this point. In the first place, the uranium potential of Sweden still lies fallow. The Ranstad ores have been kept underdeveloped for alleged ecological reasons. The actual reason is the attempt by the worldwide uranium cartel, referred to by those knowledgeable as the London Uranium Cartel or the Uranium Institute, to hold back uranium development and force world prices skyward by monopolization. Rio Tinto Zinc of London—with vast uranium holdings in Canada, Australia, and South Africa—is the key party behind this. Development of the Ranstad reserves at this point would break open the price side of world nuclear development and encourage a great many more nations to expand their nuclear commitment.

Second, the high quality specialty steel industry has collapsed as projected orders for building nuclear components fell through. Likewise, the construction industry has been in a deepening recession and five of the six shipyards in Gothenburg have been closed down by the government for "lack of orders."

Like the Carter administration's push for conservation, the Palme maneuvering to scale down Sweden's nuclear reactor program from 25 reactors to 13 is all the more remarkable in light of the dramatic impact on Europe, and Sweden in particular, of the 1974 oil price escalation. Once the government had made a commitment to an economic collapse scenario, it was only a matter of time before the various components of Sweden's enormous industrial capacity began falling into bankruptcy. This self-feeding spiral can still be reversed. But a dramatic effort to turn it around must come soon.

Special Report

The UN Project on Futures

Promoting 'One World or None'

It is the widely held view among relatively uninformed U.S. citizens that the United Nations Organization is, at most, a diplomatic talk-shop, perhaps useful during crises but predominantly harmless in terms of real influence on world affairs. Admittedly, in the past, this view tended to conform to the facts. However, at present there are powerful forces in the world, known for their antagonism to science and technological progress—what they term "unbridled growth"—who have set afoot a movement to turn the UN into a supranational government in fact.

The principal instrument of this movement—a "One World" conspiracy—is a massive and cancerous growth in the United Nations bureaucracy, which has long exercised a blatant form of "intellectual colonialism" over every Third World nation and significantly manipulates the policies and perceptions of leading powers including the United States. This cancerous growth is centered around the entities of UNITAR (United Nations Institute for Training and Research), UNESCO (United Nations Economic, Scientific, and Cultural Organization), UNCTAD (United Nations Conference on Trade and Development), the FAO (Food and Agricultural Organization), and the WHO (World Health Organization).

Dr. Ervin Laszlo

The key to the nature and purposes of this bureaucracy is a man named Dr. Ervin Laszlo, a representative of the zero-growth Club of Rome who is soon to be appointed to the Secretariat of the United Nations. Laszlo is the project director of the Project on Futures of UNITAR, the UN organization generally considered to be the overall "think tank" for all United Nations projects.

UNITAR's Project on Futures, which includes in its leadership others such as low-technology advocate Jan Tinbergen and economist Robert Triffin, was the main determining influence on the *1980s Project* studies of the New York Council on Foreign Relations. These studies include about half of the officials in the Carter administration and, not unexpectedly, now form the central programmatic basis for the policies of the Carter administration. In brief, *1980s Project* materials recommend a new world order based on environmentalism, to be achieved through "controlled disintegration" of the world's industrial economies, and a reduction of the world's population by more than half through the year 2000. (A report on the *1980s Project* appeared in the October 1979 *Fusion*.)

This is also the approach of the Club of Rome—for which Laszlo has been a program author for more than 20 years—which launched the international zero-growth movement.

As the governments of the European nations, Japan, the Soviet bloc, and many developing nations have stated, and the Fusion Energy Foundation has documented (see the research section, this issue), merely to avoid mass-scale misery and death by starvation and disease throughout the Third World in the coming decades requires the realization of the fastest possible rates of industrial, techonological and scientific growth in the United States and other advanced nations. This will permit rapid-pace industrialization of the entire so-called developing sector, based on nuclear en-

United Nations Photo by Ray Witlen

Thinking small: This hand-powered sugar cane mill in an Indian village is typical of the small-scale UN agricultural projects.

ergy, the "nuplex city" concept, large-scale advanced-technology transfer, and the introduction of advanced science in the social practice of the Third World.

In contrast, Ervin Laszlo proposes a slowdown to no-growth economic activity of the advanced nations, "redistribution" of a fixed pie of wealth worldwide, and, at all costs, an end to the dissemination of advanced scientific practice in the developing sector.

To ensure this return to a "small is better" world, Laszlo proposes to destroy the sovereignty of national governments.

One might dismiss Laszlo as an eccentric, were it not for the fact that Laszlo's UNITAR not only does the "thinking" for a sprawling UNO bureaucracy, but also interfaces and works closely with the Council on Foreign Relations (and through it, the Carter executive branch); British intelligence networks in New York, London, and Oxford-Cambridge; the Dutch royal family, the Belgian royal family; the Hapsburg family's "Pan-European movement" networks; and the international activities of the Societas Jesu, the Jesuit Order. Thus Laszlo and his colleagues at the UNO have enormous leverage and channels of influence with which to impose their genocidal programs.

The institutionalized outlook of UNITAR, and therefore, the entire UNO, is summarized in two books. The first, published in 1975, is titled *Restructuring the International Order*, and was developed under the supervision of Jan Tinbergen, a Laszlo associate who has been a political intelligence operative of the British Cecil family since 1930. This book forthrightly promotes the racist notion of "culturally relative scientific values," in order to argue against promoting advanced science in the Third World. In other words, the Western nations should not spread advanced technology out of respect for the "indigenous ideas of science" that exist among various primitive cultures. The book also slyly recommends certain "indigenous ideas" that the same UNO agencies should promote.

The second book is Ervin Laszlo's own, a 1977 publication titled *Goals for Mankind*, which characterizes science as the main tool that "imperialism uses for the continued subjugation of the developing sector." Laszlo argues for a redirection of world research and development efforts in order to develop labor-intensive farming techniques; improve use of indigenous water resources using labor-intensive methods; evolve local cottage-industries; invent birth control techniques that are safe and inexpensive; and develop small-scale energy technologies based on wind, water, organic waste, and so forth.

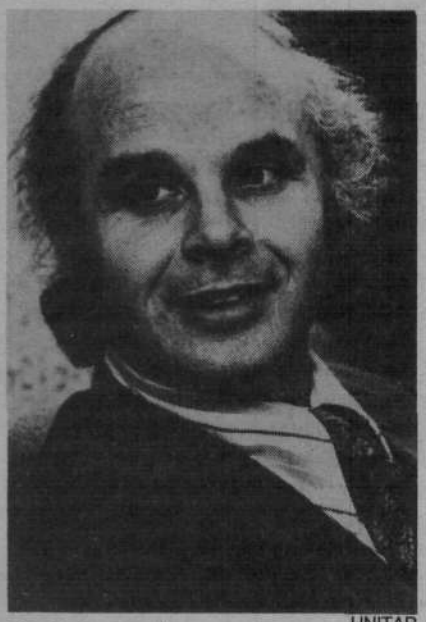
To this mockery of economic development, Laszlo gives the name "economic development."

UNITAR and "Omega Point"

UNITAR was founded one year after Pope Paul's celebrated 1964 encyclical, *Populorum Progressio*, in order to combat the far-reaching economic development program the pope there advanced. Together with the Justitia et Pax commission within the Vatican itself, UNITAR constitutes the command-and-control center for the so-called radical left-wing of the Jesuits and similar forces that organize internationally to prevent the building of a high-technology, high-science civilization in the Third World.

Justitia et Pax is currently headed by a Jesuit in this spirit; UNITAR is headed by men like Laszlo, who, although not Jesuits, openly proclaim their life's work to be the realization of the "Omega Point" vision of Father Teilhard de Chardin, S.J.—a permanent end to scientific-technological progress by means of establishing a "one world" government.

In 1975, UNITAR, in particular, put into circulation the term New International Economic Order to describe the "Omega Point" vision. The key to the New International Economic Order is the rule of supranational institutions over a world divided into competing "regional orders." In Europe, for example, this view has long been propounded by Count Otto von Hapsburg's Pan-European



UNITAR

Dr. Ervin Laszlo

Ervin Laszlo's Antiscience Program

In his 1977 book *Goals for Mankind*, Ervin Laszlo called for redirecting international research and development efforts exclusively for the following tasks:

1. Develop labor-intensive farming techniques to produce foodstuffs acceptable to indigenous cultures.
2. Improve the use of indigenous water resources with labor-intensive low capital-cost methods.
3. Evolve local cottage industries by improving on traditional techniques of tanning, weaving, carpetmaking, pottery, ceramics, carpentry and food processing, and finding novel uses for local products.
4. Inventing birth control techniques and devices that are safe, inexpensive, simple to use and acceptable to the local cultures.
5. Develop small-scale energy technologies that use nonpolluting and renewable sources (windmills, watermills, organic waste conversion, solar panels) for cooking, hot water and space heating. [pp. 246–47, Signet edition].

Union in the form of a "Europe of the Regions"—not sovereign states—in which Hapsburg dreams of becoming emperor.

The same plan was worked out at the October 1979 Belgrade meeting of the International Monetary Fund, where participants coupled proposals to end the reserve role of the dollar with proposals to massively reduce international lending by agencies other than the IMF. "IMF authority to set economic policy for the United States and Western Europe [should] be increased," the meeting concluded. Key to this, in turn, was the creation of regional currency zones, in which each currency zone survives by competing with the other, thereby eliminating formally and in practice the economic sovereignty of nations.

(Admitting that Otto von Hapsburg is a little man with more moustache than brains, this "regionalization" aspect of the UNITAR's New International Economic Order will be recognized by most readers as, essentially, a return to the order of the medieval world. That is not accidental. UNITAR's membership is dominated by the Club of Rome, a group dominated by the West European "black nobility"—the Hapsburgs, the Cecils, the Pallavicinis, and the Belgian and Dutch monarchies.)

UNITAR's specific role in this "one world" plan is, to put it bluntly, the brainwashing of governments. UNITAR coordinates research, documentation and draft-preparation of policies intended to be initiated by various UN forums. Literally, there is not a single UN study, document, or resolution whose policy-content has not been either totally or significantly shaped by the general outlook inserted therein by UNITAR and related agencies.

The UNITAR Octopus

The related coordinating agencies that do the research, profiling, and intelligence-gathering in every Third World nation, and others besides, include:

- The Center for Economic and Social Studies of the Third World (CEESTEM), Mexico City;
- The Center for Research on the New International Economic Order, Oxford, England;
- The Norman Paterson School of International Affairs, Carleton University, Ottawa, Canada;
- The Institute of World Economics, Budapest, Hungary;
- The Chr. Michelsen Institute of Science and Intellectual Freedom, Bergen, Norway;
- The Indian Institute of Management, Bangalore, India; and
- The International Institute of Administrative Sciences, Brussels, Belgium.

Exemplary of the combined operations of this octopus is a massive intelligence-gathering and brainwashing project now underway, involving 90 research groups around the world, under the supervision of UNITAR/CEESTEM, with Oxford University remaining in the background. This involves the gathering of every type of economic, political, military, social, and cultural intelligence from throughout the world, as well as compiling, codifying, computer storage, processing, and evaluation.

The objective of the project, to quote from UNITAR literature, is: "Identification of the main types of obstacles blocking the establishment of the new international economic order (NIEO); suggestion of appropriate strategies on national, regional, and world levels for overcoming the most critical obstacles; recommendation of the elements of a new Programme of Action for adoption by the General Assembly in 1980...."

On the basis of the UNITAR project's results, scores of new zero-growth and antiindustrial policy proposals and recommendations, couched, of course, in humanitarian "redistribution of wealth" terminology by seasoned linguisticians, will be introduced at every trade negotiation, raw materials forum, development forum, scientific colloquium—at UNCTAD, FAO, UNESCO, World Bank, and every other international meeting that will occur in 1980.

To reenforce this massive plan to control the environment of every international meeting, UNITAR runs "training seminars" for diplomats and others. The purpose of such training is to strengthen certain code phrases such as "interdependence," "humanitarianism," "global perspective," "human needs," "world solidarity," "structural changes," "planetary dimension," and other buzz-words that add up to an indispensable nice-sounding jargon to cover the medieval policy proposals with which UNITAR floods every international negotiating forum.

None of this cosmetic verbiage nor the policies behind it are in the U.S. interest. While maintaining U.S. representation at the United Nations for various diplomatic purposes, the government should strictly uphold U.S. national sovereignty and interests completely outside the orbit of the UN's profeudal institutions.

This special report was written by Vin Berg, based on extensive documentary material compiled by Criton Zoakos, contributing editor for the Executive Intelligence Review.

'One World or None'

The Christian Science Monitor *published an editorial Jan. 16 from* The Bulletin of Atomic Scientists. *We excerpt:*

> . . . This brings us directly to what may be the most pressing and divisive issue of the next decade—nuclear power. The connections between the peaceful atom and nuclear proliferation . . . [create] divisions within the community of concerned citizens.
>
> "There is a certain tendency . . . among citizens in the industrialized world to overlook the special problems and points of view of the two-thirds of humankind that we usually term underdeveloped . . . We must strive diligently to see scientific and technical problems of developing countries through the eyes of their scientists, to try to evaluate "solutions" in terms of their needs and aspirations.
>
> In the end we must return to a slogan that was popular in the days of the *Bulletin*'s founding, but which, perhaps through overuse, has since gone out of style: One World or None.

McCormack Bill Seeks $20 Billion For Commercial Fusion by 2000

Congressman Mike McCormack (D-Wash.) introduced a bill into Congress Jan. 22 for an Apollo-style program to develop a commercial fusion reactor before the end of the century. As of this writing, the bill, HR 6308, has 45 cosponsors in the House, including most members of the Science and Technology Committee, Majority Leader Jim Wright (Tex.), Minority Leader John Rhodes (Ariz.), and Illinois Democrat Dan Rostenkowski. (The text of the bill appears on page 23.)

McCormack has sent a letter to all congressmen requesting their support for the $20 billion fusion bill, and telegrams to industrial leaders and the national laboratories urging support for the bill have gone out from Dr. Robert L. Hirsch, chairman of the Fusion Advisory Panel to the House Science and Technology Committee's Subcommittee on Energy Research and Production. McCormack, who chairs the subcommittee, would like at least 200 cosponsors for the bill.

The bill will "make it the policy of the U.S. government to build the first electric generating fusion power plant before the year 2000," McCormack announced to 300 engineers attending a conference on nuclear safety in Washington, D.C. Jan. 17. "We must move into the engineering phase with fusion and not wait for somebody else to do it. We must expand our entire nuclear implementation policy," he stressed, making it absolutely clear that the nation must also rapidly expand nuclear energy.

Mankind's Most Important Energy Event

Many of the nation's leading fusion scientists joined McCormack at a background briefing for the press Jan. 18. There McCormack called the decision to go ahead with a crash fusion program "the single most important energy event in the history of mankind. Once we develop fusion we will be in a position to produce enough energy for all time, for all mankind. This is not hyperbole, but fact."

"Why now?" McCormack asked the dozen press representatives at the briefing. "Extraordinary success in the research programs in magnetic fusion labs in the last 18 months tells us we are ready to move out of the research phase and into the engineering phase. The next machine, the Tokamak Fusion Test Reactor at the Princeton Plasma Physics Laboratory, will reach scientific breakeven. We are convinced we are ready to build machines to actually run on fusion reactions . . . . You can't drive research to demand answers from nature, but you can drive the engineering once you have the answers."

The McCormack bill deals only with magnetic confinement because his committee has no oversight for inertial confinement.

Scientific Support

In addition to the thousands of postcards he has received from *Fusion* readers in support of a crash program to develop fusion, McCormack has the backing of

Photograph by Gustavo Rincon, courtesy of IEEE

Congressman Mike McCormack speaking at a January conference on nuclear safety sponsored by the Institute of Electrical and Electronics Engineers and the Nuclear Regulatory Commission.

some of the most prominent fusion scientists in the nation.

At the press briefing, Dr. Stephen O. Dean, president of Fusion Power Associates and formerly the deputy head of the U.S. magnetic confinement fusion effort, outlined the changes in the current DOE program that would be required to institute an "Apollo management" program.

In order to move the timetable for commercial demonstration from the year 2015 to 1995, design and construction of the next-step Engineering Test Facility must begin immediately—in the 1981 budget year, Dean said. In addition, the construction time for both the test facility and commercial demonstration plant must be reduced from eight to six years.

Dr. Robert Hirsch, vice president of Exxon Research and Engineering and former head of the fusion program, described the conclusions of the panel of experts he led in a review of the fusion program for McCormack's subcommittee. Hirsch stated that years ago such an accelerated program would have entailed "too high a risk," but that now the only limiting factor on the speed of progress is funding.

"It boils down to the country now making a decision, taking the option . . . . We have the scientific confidence to go ahead *now*," he stated emphatically.

Hirsch was followed by Dr. Mel Gottlieb, director of the Princeton Plasma Physics Laboratory. When questioned if it would first be necessary to get unanimous agreement from the scientific community on this ambitious plan, Gottlieb replied: "If you wait for absolute unanimity in the scientific community your end point is infinity. Scientists in the program have to make judgments."

The Princeton Large Torus, PLT, and the Polodial Divertor Experiment, PDX, both at Princeton, produced results better than anticipated, permitting scientists to "extrapolate the data to build a reactor," Gottlieb stated. "We'll build reactors before we understand every detail—if you needed to understand the physics to get water out of the faucet, you wouldn't have any plumbing."

Gottlieb also pointed out that the Engineering Test Facility, ETF, will be the first "serious attack at engineering data and that this information will apply to tokamaks, mirror machines, and other magnetic fusion devices." What the reactor of "the future will be really doesn't affect the ETF," he explained. The technology and engineering data will be necessary for whatever design-conception is eventually proven the best.

The briefing also included important input from Dr. Lee Berry, the director of the Oak Ridge National Laboratory's magnetic fusion program, and Dr. Ron Davidson, director of the fusion program at the Massachusetts Institute of Technology. The briefing took place in the House Science and Technology Committee hearing room, decorated with photographs from the NASA Apollo program of the 1960s.

We Must Go Nuclear

Could the accelerated fusion program be seen as a "subsidy to an ailing nuclear industry," or in competition with nuclear fission for budget allocation, a reporter asked. McCormack replied that fission and fusion must be seen as parallel technologies. "Even if we could build one fusion reactor per week in the year 2000, it would take 50 years to replace our year-2000 energy system. Light water reactors and breeders will fill the gap. They are parallel technologies, like gas and oil were, or like coal and nuclear are today."

At a nuclear safety conference sponsored by the Institute for Electrical and Electronics Engineers and the Nuclear Regulatory Commission Jan. 17, McCormack made clear that the government's present policy on nuclear power would have serious consequences, both domestically and around the world. Any "timid approach to energy development" will lead to declining U.S. standards of living or dependence on foreign oil, he stated. "A now-weakened United States has led to an international power vacuum. . . . Fission is the cheapest form of energy production. . . . We have to get as many nuclear plants on line as fast as possible throughout the world.

"We must take the offensive on nuclear energy," the congressman continued. "We must recognize publicly that the United States and the world must rely on nuclear power for at least 50 years. Nuclear power as an energy source of 'last resort' was never realistic and now is irresponsible. We must announce as U.S. energy policy that we shall expand nuclear production as rapidly as possible. We must ensure our allies that we will follow through and do so. . . ."

Stating his own program for energy development, McCormack said, "We must have 500 gigawatts of nuclear energy by the year 2000, which is not over ambitious. This must include 25 to 30 fast breeder reactor plants and 25 to 30 high temperature gas-cooled reactors. They must be of a standardized design."

One engineer then asked McCormack whom he would consider supporting for president in 1980. "I would like to support a candidate from my own party who has a program for energy and economic development. I will support the candidate that has a program the closest to my own," McCormack said.

Getting Industry into Fusion

The McCormack bill would authorize approximately $20 billion to achieve a demonstration fusion reactor before the year 2000. In the next 20 years, this program will lay the basis for high-technology industry's development of the

New Fusion Negotiations with Japan

Dr. Franklin Coffman, director for development and technology in the DOE Fusion Office, will go to Tokyo Feb. 15 to propose new cooperation between the U.S. and Japanese fusion programs in technology development. The new U.S. proposal is to concentrate cooperation in the areas of superconducting magnet and fusion materials development. The Japanese have a large effort in superconducting and cryogenic technology.

Fusion is the first priority in the overall energy and scientific cooperation agreements the United States signed with Japan last year. So far, there have been exchanges of information on the bumpy torus programs at Oak Ridge National Laboratory and Nagoya University, and Japan has funded an upgrade of General Atomic's Doublet III tokamak experiment in San Diego.

advanced materials and other new industries that mass production of fusion power plants will require.

A number of the participants at the press briefing expressed the concern that without a vigorous national policy for fusion development, the private sector would not have the resources to create new industries for commercial fusion.

Why should the taxpayer have to finance such a project, one reporter asked. Couldn't private industry build the device?

Stephen Dean, whose Fusion Power Associates is an industry-based group made up of several high-technology companies interested in developing the industries for fusion, responded that industry had shown a willingness to put its own money into fusion. For example, when the DOE asked for proposals to build a more advanced Elmo Bumpy Torus fusion reactor, four corporate consortia spent about $800,000 each for studies. Dean suggested that tax incentives in conjunction with an Apollo-style management program could encourage industry to invest in the long term.

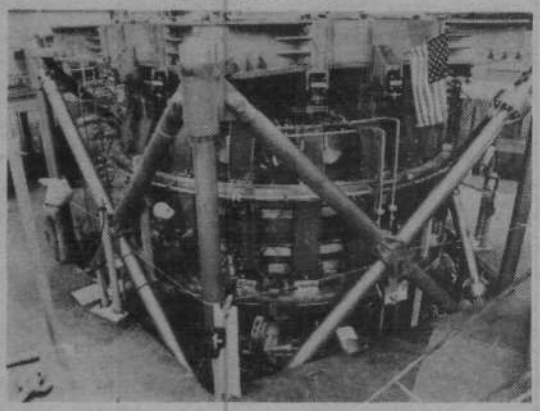
Hirsch echoed the Advisory Panel's concern. "Commercial fusion means that industry has to get involved at an early date. There should be major industrial participation in the ETF," for example. The only way this could be done, all concurred, is if industry is assured that there is a long-term authorization of a full commercialization program from the government.

Spinoffs

This reporter asked whether the congressman or the industrial and scientific representatives present were planning to educate industry on the revitalization of advanced industrial technology that would accompany a new "Apollo" project. Oak Ridge director Berry replied that there had already been important industrial technology spinoffs from the fusion program, particularly in the field of superconducting magnets. According to Dr. Hirsch, there is no study he knows of on the industrial impact of fusion research spinoffs. It is nevertheless clear that the process of getting from fusion research to on-line utility systems will involve a renaissance in scientific manpower training and industrial innovation.

—Marsha Freeman

HR 6308



The Fusion Energy Research, Development and Demonstration Act of 1980

This is the complete text of the Apollo fusion bill, HR 6308.

A full report on the hearings held by the McCormack Subcommittee on Energy Use and Production and a review of the U.S. fusion program in 1979 appear in the February issue of Fusion.

A bill to provide for an accelerated program of research and development of magnetic fusion energy technologies leading to the construction and successful operation of a magnetic fusion demonstration plant in the United States before the end of the 20th century to be carried out by the Department of Energy.

Section 1. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

That this act may be cited as the "Fusion Energy Research, Development, and Demonstration Act of 1980."

Findings and Policy

Section 2. (a) The Congress hereby finds that:

(1) the United States of America continues to be dependent on imported oil, and is faced with a finite and diminishing resource base of native fossil fuels;

(2) the current imbalance between supply and demand for fuels and energy in the United States is likely to grow each year for many years, aggravating an energy crisis and threatening the economic strength and national security of the nation;

(3) the energy crisis can only be solved by firm and decisive action by the federal government to conserve energy consumption in every realistic manner and to develop as quickly as possible a diversified and pluralistic national energy production capability;

(4) it is the proper and appropriate role of the federal government to undertake research, development, and demonstration programs in fusion energy technologies;

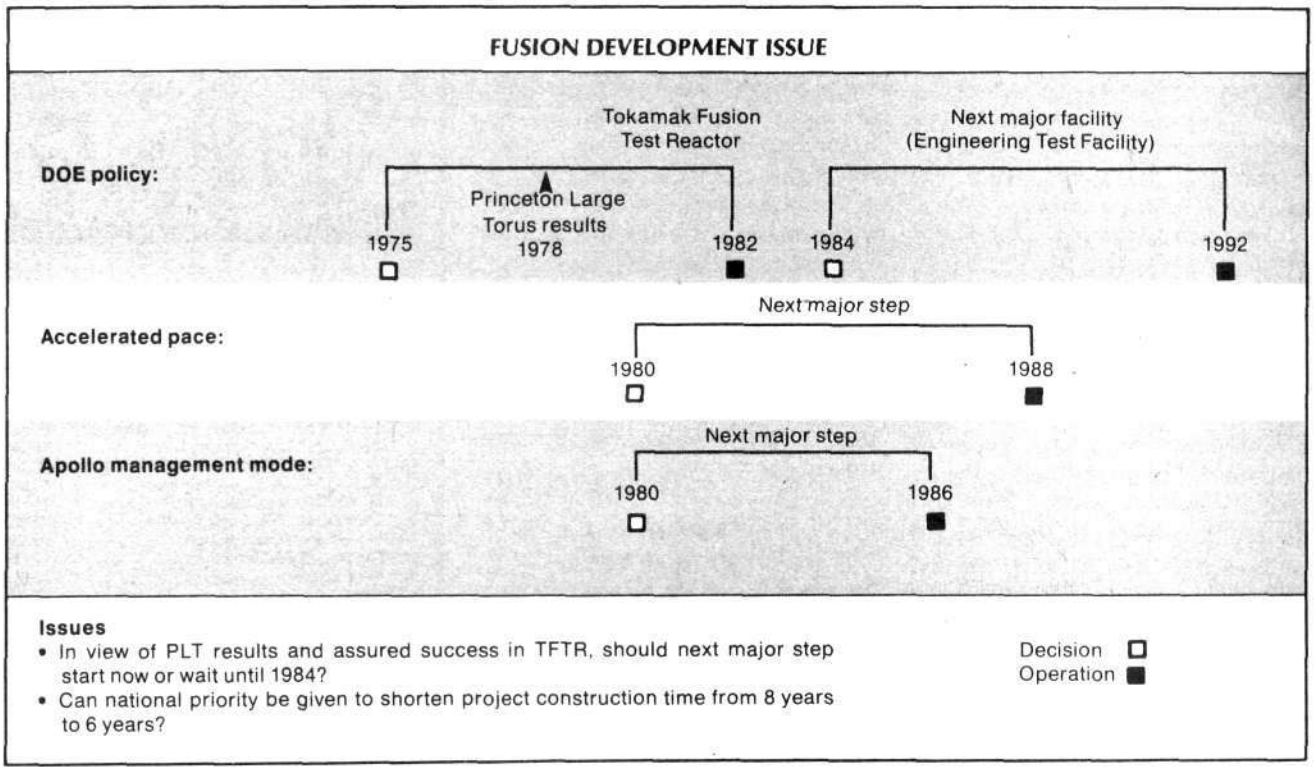
(5) fusion is the process by which the sun makes its energy, and every nation of our world possesses in the oceans and waters of our planet an easily accessible and inexhaustible supply of fuel for fusion energy which cannot be embargoed, is inexpensively recoverable, and is usable with minimal environmental impact;

(6) the early demonstration of the feasibility of using magnetic fusion energy systems for the generation of electricity and the production of heat, hydrogen, and other synthetic fuels will initiate a new era of energy abundance for all mankind forever;
(7) the widespread use of fusion energy systems to supplement and eventually replace conventional methods for the generation of electricity will help provide energy independence for all nations of the world;
(8) the spectacular successes encountered in magnetic fusion energy research since mid-1978 provide fusion scientists throughout the world with the confidence that the time has come to move aggressively into the engineering phase of fusion development; and that the conditions required for scientific breakeven can be obtained in devices now under construction;
(9) the early development and export of fusion energy systems, consistent with the established preeminence of the United States in the field of high technology products, will improve the economic posture of the United States, and ultimately reduce the pressures for international strife by providing access to energy abundance for all nations;
(10) innovation and creativity in the development of fusion energy components and systems can be fostered through continued research of alternate concepts which show promising potential; and
(11) it is contemplated that the programs established by this act will require the expenditure of approximately $20 billion during the next 20 years.

(b) It is therefore declared to be the policy of the United States and the purpose of this act to establish an aggressive research, development, and demonstration program involving magnetic fusion energy systems. Further, it is declared to be the policy of the United States and the purpose of this act that the objectives of this research, development, and demonstration program are:
(1) to proceed immediately with all work necessary to construct and operate a Fusion Engineering Test Facility by calendar year 1986;
(2) to follow the operation of the Fusion Engineering Test Facility with all steps necessary to construct and successfully operate a magnetic fusion demonstration facility before the end of this century.
(3) to maintain, and where appropriate expand, the base programs for fusion energy research, and the development and testing of appropriate alternative confinement technologies;
(4) to maintain a strong research and development program in advanced fusion fuels; and
(5) to take appropriate measures to ensure the maintenance of an uninterrupted source of scientific and engineering talent from the nation's colleges and universities in support of the magnetic fusion energy effort.

Definitions

SECTION 3. For purposes of this act:
(1) a "fusion energy system" is a system of components which uses magnetic fields and appropriate monitoring and



This is one of the figures presented by Dr. Stephen O. Dean at the McCormack press briefing on fusion to make the case for an Apollo-style fusion program. The answers to the two issues raised are, of course, that the next major step in the fusion program should start now, not in 1984 as the DOE now plans, and that we can indeed give national priority to shortening the project construction time of the next major facility.

control systems to contain a hot, highly ionized gas (called a plasma) for the purpose of creating a controlled environment in which a fusion reaction can proceed and which may include additional components such as energy storage and conversion devices and systems to generate electricity or produce hydrogen and other synthetic fuels;

(2) the term "magnetic fusion energy system" may be used interchangeably with the term "fusion energy system";

(3) "fusion" refers to the process whereby two very light nuclei (e.g. deuterium and tritium) are forced together, forming a compound nucleus, which subsequently separates into constituents which are different from the original colliding nuclei, with an accompanying energy release;

(4) the term "Fusion Engineering Test Facility" (FETF) refers to a fusion energy system designed to achieve net energy production; and may involve any or all of the generic engineering systems necessary for the construction of a demonstration plant;

(5) the term "Fusion Demonstration Plant" (FDP) refers to a full-scale prototype production plant designed to demonstrate the safety, reliability, duty factors, and maintenance standards of a fusion energy system, including the generation of electricity or the production of synthetic fuels;

(6) the term "advanced fusion fuels" refers to fuels which will undergo a fusion reaction, other than that involving deuterium with tritium;

(7) "scientific breakeven" refers to the condition existing when sufficient fusion reactions are occurring to produce as much power as is consumed in creating the conditions for the fusion reactions to occur;

(8) "facility" means any building complex, or other device constructively employing fusion systems; and

(9) "secretary" means the secretary of energy.

Research, Development, And Demonstration of Magnetic Fusion Energy Systems

SECTION 4. (a) The secretary is directed to establish immediately and carry forth such research, development, and demonstration programs, projects, or activities as may be necessary to meet the objectives of this act as set forth in section 2(b). As a part of any such program, project, or activity, the secretary shall:

(1) conduct and promote the coordination and acceleration of research, development, and demonstration programs relating to magnetic fusion energy systems and components thereof;

(2) seek support from and encourage cooperative efforts with the U.S. private sector—and with other governments in carrying out the purposes of this act;

(3) study the potential of using fusion energy systems for the production of hydrogen and other synthetic fuels and for other nonelectric applications; and

(4) investigate the potential of using fusion power for the electrification of all or part of domestic ground transportation systems.

Dissemination of Information And Other Activities to Educate The Public on the Use of Fusion Energy Technologies

SECTION 5. The secretary shall take all possible steps to assure that full and complete information with respect to the potential benefits of fusion energy and the status and progress of fusion research, development, and demonstration is made available to federal, state, and local authorities, relevant segments of the economy, the scientific and technical community, and the public at large, both during and after the close of the programs under this act, with the objective of promoting and facilitating to the maximum extent feasible the early and widespread knowledge of the practical uses of fusion energy throughout the United States.

Authorization of Appropriations

SECTION 6. There is hereby authorized to be appropriated to the secretary, for the fiscal year ending September 30, 1981, $500 million inclusive of any funds otherwise authorized to the secretary for the purpose of research, development, and demonstration of magnetic fusion energy technologies, and for each succeeding fiscal year such sums as may hereafter be provided in annual authorization acts.

'Last Resorts' And 'Deaf Ears'

The top DOE leadership has now put it on record: the DOE will not commit the nation to developing the cheapest, safest forms of energy for the future—fission and fusion energy.

Speaking to 300 engineers at a conference on nuclear safety in Washington, D.C. Jan. 15, DOE Undersecretary John Deutch repeated President Carter's policy that nuclear will be the energy source of last resort.

"There is no question that nuclear energy confronts us with a different set of issues than other energy sources and that we'd like to minimize the use of nuclear energy through conservation and the use of coal," Deutch stated matter-of-factly.

One of the engineers in the audience then asked Deutch why the administration was satisfied to apply "self-denial" to force things to go the way they want them to go. "It seems to me that the DOE projections for only 150 nuclear plants is a self-fulfilling prophecy. The administration has made nuclear energy a last resort and now no new plants are being built," the engineer said.

Deutch then pinned the blame on the private sector: "The reality of the situation is that the government can't affect the policies of the utilities. They decide what kinds of plants they will build," he said.

When this reporter followed up the engineer's questions with a reminder that in the late 1950s the executive branch decided to promote energy and scientific development and it launched the Atoms for Peace program and the National Aeronautics and Space Administration program, Deutch responded, "Would you want Admiral Rickover or NASA to run our power plants?"

The same day, another top DOE official, Ruth Davis, Assistant Secretary for Resource Applications, stunned the conference participants by proclaiming that nuclear power is "not a mature technology. It could be charitably called an emerging technology. . . ."

Ruth Davis DOE

The most audacious remarks, however, belong to Energy Secretary Charles Duncan. Asked in a Jan. 18 interview with the *Energy Daily* what his major concerns in energy were, Duncan said the administration will turn a "deaf ear" on the fusion community's entreaties to speed up the fusion program and begin construction of an Engineering Test Facility.

Charles Duncan DOE

Ducan then reaffirmed the president's stand on nondevelopment of the fast breeder reactor and fuel reprocessing.

Four Officials Confirmed

The DOE filled a number of high-level positions during January, including three assistant secretary posts and the director of energy research position in the reorganized structure.

Dr. Edward Frieman of the Princeton Plasma Physics Laboratory has been confirmed in the energy research post and will have departmental jurisdiction over the magnetic fusion program. It was announced that Frieman, who has been in fusion research for many years, will conduct another review of the fusion program, a task viewed by many in the fusion community and Congress as an administration stalling tactic to delay a decision on implementing an Apollo-style fusion program.

Frieman is also scheduled to visit China to discuss high-energy physics cooperation with the Chinese, in the wake of Defense Secretary Harold Brown's recent trip concerning military cooperation.

Dr. George "Woody" Cunningham will rejoin the DOE as assistant secretary for nuclear energy. Cunningham had served as director of nuclear energy programs in the DOE Office of Energy Technology under the former DOE structure.

Replacing Harry Bergold as assistant secretary for international affairs is Leslie Goldman who had served as principal deputy in that office prior to his appointment. Goldman, who participated in the development and enactment of the first major energy legislation after the oil crisis of 1973-74, served as the director of Illinois Senator Adlai Stevenson's State Projects Office.

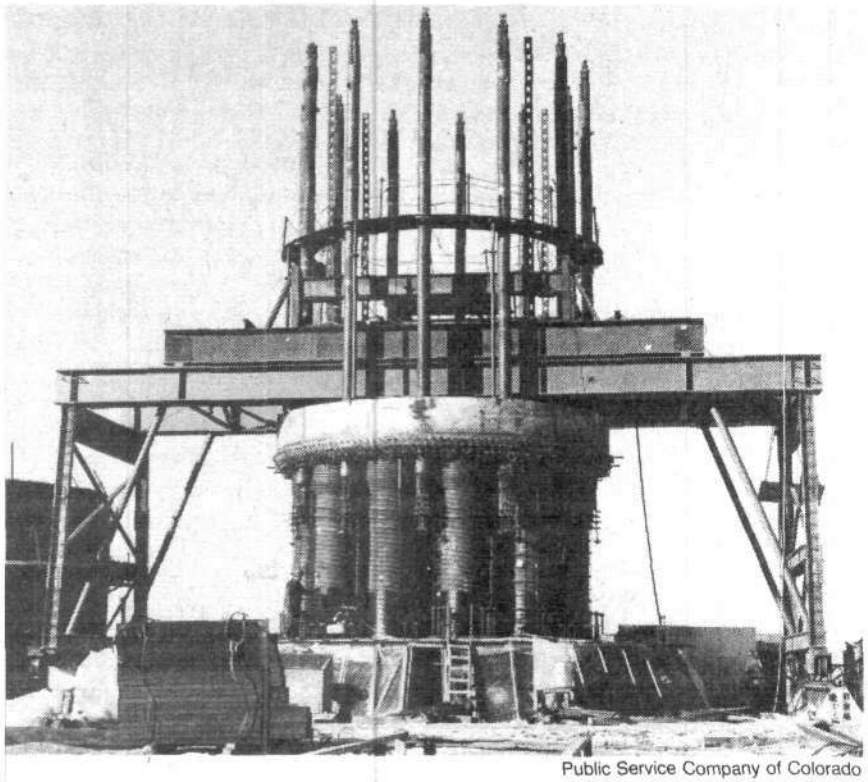
The new assistant secretary for conservation and solar energy will be Dr. Thomas E. Stelson, vice president for research and professor of civil engineering at Georgia Institute of Technology in Atlanta.

—Marsha Freeman

An Interview with Jon Gilbertson

Destroying U.S. Advanced Nuclear Technology

During the month of January, the Carter administration sent the fiscal year 1981 energy development budget to Congress with $250 million in cuts recommended for the U.S. advanced nuclear technology program. The cuts would eliminate the high temperature gas-cooled reactor as well as most of the nuclear breeder program. In this interview, Fusion Energy Foundation director of nuclear engineering Jon Gilbertson assesses the damage the proposed cuts would inflict on the nuclear program and the nation's economic future. Gilbertson, who has worked in the nuclear industry for more than 15 years, is one of the nation's leading experts on nuclear safety.



Public Service Company of Colorado

The nation's first—and only—high temperature gas-cooled reactor, shown here under construction at Fort St. Vrain, Colo.

Question: What is the status of the high temperature gas-cooled reactor and the gas-cooled breeder?

At a January meeting, representatives of the Carter administration, the General Accounting Office, and the Department of Energy agreed upon a compromise 1981 budget request for energy development that completely eliminates funds for the high temperature gas-cooled reactor and the gas-cooled fast breeder programs. The total budget cut involved is about $50 million.

If the cut is approved by Congress, it will destroy the nation's advanced nuclear technology program, since private industry is not able to fund the HTGR and fast breeder development alone. Essentially, this cuts the "insides" out of the near-term to mid-term U.S. energy development program, a program the nation has been committed to for more than two decades.

Question: Why are these reactors so critical to the U. S. energy development program?

The HTGR is not simply another nuclear power plant that produces cheap electricity; it is the only nuclear reactor that produces temperatures high enough to be used in generating process heat for a wide variety of industrial and agricultural processes (up to 1,400 degrees Fahrenheit). This type of versatile system, called a *nuplex* or an *integrated agroindustrial complex*, is the key to more efficient and much less expensive production processes both for the advanced economies and the developing nations.

Although there is a small-scale (300-megawatts electric) high-temperature gas-cooled reactor operating at Fort St. Vrain, Colorado, the HTGR is best viewed as the next-generation fission power system. In other words, more advanced and more economical HTGR systems will gradually replace the currently operating class of light water reactors. Phased in with the HTGR at a later point will be its future fuel factory, the gas-cooled fast breeder, which is an economical power producer in its own right.

Question: Can you say more about the economics of the nuplex system?

A decrease in the costs of industrial and agricultural production historically has been associated with an increase of productivity using a combination of automation and the application of an increasing quantity and quality of energy. This concept can best be understood by

visualizing advances in production as a process of increasing the energy density and energy throughput. In other words, the more energy that is generated by a given volume of fuel, the cheaper that energy is; and if this energy is applied efficiently to an industrial or agricultural process, the combined effect is to considerably reduce the cost of the end product.

Question: And how does the HTGR fit in?

These economical agroindustrial complexes can be built around any type of nuclear-fueled or fossil-fueled power plant, but by far the most economical, efficient, and productive complex will use the HTGR. The reason is that the higher temperatures of the HTGR make it the only reactor that can be used in the production of steel, a broad range of chemicals, fertilizers, gas from coal (most economically), synthetic fuels (methane and hydrogen), and so on.

By the way, designs for agroindustrial complexes were completed for India, Puerto Rico, the United States, and other areas in the late 1960s and early 1970s. Ironically, although these complexes were proven economical development models, the plans were scrapped as the world economy went into a decline.

Question: Are there other advantages to the HTGR?

In combination with the gas-cooled fast breeder reactor, the HTGR is the most economical and efficient system for initiating the thorium fuel cycle. Thorium is the only material in the earth's crust, in addition to uranium, that can be used as a nuclear fuel. Thus, cutting the HTGR development budget ensures that the nations will not develop and install the capability to convert thorium to fissionable uranium-233 and begin to tap the world's vast supply of this fuel.

From the beginning, the HTGR and the gas-cooled fast breeder system were designed, developed, and built based on the thorium cycle and this system has long been recognized as the best way to exploit this energy resource.

Question: What about the rest of the fast breeder reactor program?

The U.S. breeder program has just received a bad blow. The Carter administration and the Office of Management and Budget jointly recommended cutting $200 million from the Department of Energy request of $520 million for fiscal year 1981. That cut includes the Clinch River Breeder funding—all of it—as well as most funds for the alternative studies agreed to last year in the so-called McClure compromise. That compromise was part of Congress's attempt to restore cuts that Carter had tried to make in fiscal year 1979. So, the new recommendations represent another attempt by Carter to do what he keeps saying he wants to do—shut down the U.S. breeder program.

Question: You obviously consider the Carter administration antinuclear. Carter does oppose the breeder, but he hasn't cut out nuclear energy altogether. Doesn't the administration want to keep other aspects of the U.S. nuclear program going?

Superficially, President Carter conveys—at least to some groups—the image of being pronuclear by permitting a few light water reactors to be built, but his actions convey the opposite. The fact is, you cannot have a viable nuclear power program without "closing" the nuclear fuel cycle. And you cannot close the fuel cycle without having the fast breeder reactor, fuel reprocessing, and permanent long-term waste disposal. Carter refuses to allow their development; and, as he knows, this means that the required growth of nuclear energy use in the United States will not occur for lack of fuel.

Moreover, since the Carter administration came into office in 1977, the president has stopped construction of the only commercial fuel reprocessing plant, the Barnwell, South Carolina plant. He has delayed an already long overdue decision on locating a high-level radioactive waste depository until 1985, leaving this issue unresolved and creating a field-day for the environmentalists to shout about "dangerous wastes."

Finally, Carter has committed himself to do everything in his power to stop the U.S. breeder program.

Thus, as you can see from his actions, Carter is doing the opposite of what he actually promised our allies he would do—develop all aspects of nuclear technology—at last year's Tokyo economic summit. He knows he's not doing what he promised them, and America's allies have concluded that Carter is a liar.

Question: Is the breeder reactor actually necessary?

The United States must have nuclear power in order to sustain economic growth, and we must have the breeder to fuel our nuclear program. That is taken as a matter of course in other countries—France, West Germany, Japan, the Soviet Union of course, and even in developing nations like India. Most of these programs are much further along than in the United States, although less than 10 years ago, the United States led the world in breeder technology. These countries are also committed to, and are in various stages of, implementing fuel reprocessing and long-term waste disposal programs. These programs, too, are absolutely necessary to any nuclear development program.

Question: Given the current state of the U.S. breeder program, what do you believe can and ought to be done?

The Clinch River Breeder Reactor demonstration plant must be completed on a crash basis and put into operation immediately. Hopefully, this can be done no later than immediately after the 1981 inauguration of the next president. Since most of the major breeder components are already completed or nearly complete, this should take no longer than three to four years to accomplish; there are several immediate benefits to be realized.

First, this demonstration plant can generate valuable operating data and experience that can be used in the design and construction of the larger commercial-size breeder reactors. When it was conceived and designed years ago, the plant was meant to demonstrate the commercial viability and safety of the breeder as well as to provide operating experience on the key components, such as steam generators, heat exchangers, pumps, and so forth, in a liquid sodium environment. Because of the extensive delays in the U.S. program, much of this has already been demonstrated in breeder reactors in France, England, and the Soviet Union. So thanks to them, we're not as far behind as we would otherwise be. Still, it is extremely impor-

tant, in fact, essential, to have the actual operating experience of running a demonstration plant, to work out the many small problems that are bound to develop. So, Clinch River must be built, and built fast.

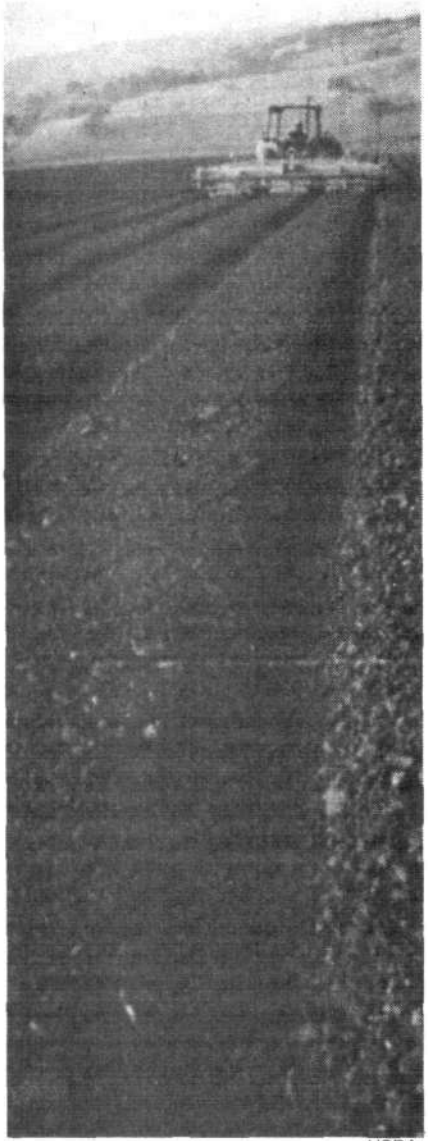
There are several other things that must accompany this. As we complete Clinch River, the U.S. must commit itself to launching a design and construction program for at least three commercial-size liquid metal cooled breeder reactors. The design of these reactors can also rest on experience already gained overseas, particularly the French program, and to the extent possible, the programs in England and the Soviet Union. Joint exchange agreements can be worked out, or government-assisted licensing arrangements can be made between foreign companies and the U.S. reactor manufacturers.

That is the most efficient route to go: Ensure the most rapid influx of existing breeder technology and know-how into the U.S. as the basis for our own commercial plant designs. On that basis, the initial design phase should be completed within a period of two years, at which time all three liquid metal cooled breeder plants should be committed to construction.

Question: Why three?

The point of having at least three plants is to involve all the U.S. reactor manufacturers fully in the program from the outset, as well as to incorporate different ideas and design variations into the program at the level of operating experience. The breeder is a new technology. The optimal variant isn't necessarily known. The entire U.S. industry must share in the experience of breeder construction and operation.

And just as our overall nuclear program doesn't really exist without the development of the breeder, so a commitment to the breeder automatically entails a full commitment to fuel reprocessing and radioactive waste disposal. You can't have one without the other. Without a nuclear program that includes them, you can't have economic growth.



USDA

A no-win grain deal

Carter Embargo Has Multibillion Price Tag

The Carter administration's decision to respond to the Soviet Union's actions in Afghanistan by curtailing technology transfers and imposing a grain embargo will cost the nation billions of dollars.

Washington sources report that scheduled meetings to negotiate joint work on magnetohydrodynamics have been canceled—to the disadvantage of the U.S. program. For example, the Soviets were planning to test an MHD channel made by Westinghouse for which there are no testing facilities available in the United States. The delivery of the channel has been postponed by the Carter administration.

Other high technology deals that were interrupted include spare parts for the Kama River truck plant and oil-drilling equipment.

As for the fusion program, Department of Energy spokesmen said that they were "not at liberty to say" what will happen to the joint U.S.-Soviet fusion meetings planned for the spring.

So far, the Agriculture Department has not even decided whether it will reimburse the cost of the 17 million tons of grain paid to farm-producers, or cover the grain companies' sales price to the Soviet Union. This decision can make the difference between $2 and $4 billion in government expenditures—the administration has put the cost at $2.5 billion.

Actually, the overall cost could be seven times that amount. One must add $2.5 billion in lost export revenues to the contract payoff and another $2 billion to finance a 1980 cropland diversion program, bringing the total real cost to $7 billion. But that's only the beginning.

Millions of tons of grain, in storage or not, have an enormous depressing effect on market prices. It is open to question whether markets and prices can be stabilized at a high enough level to

THE GOVERNMENT PRICE-TAG

Purchase of embargoed contracts	$ 3 billion
Expenditures for cropland-diversion and price-support	$10 billion
CCC appropriations for export credits to market portion of embargoed grain	$ 1 billion
Outlays and tax credits for gasohol	$ 1 billion
Total	**$15 billion**

prevent bankruptcy among farm producers. Producers will have to attempt to make up for the low prices by increased production. This will necessitate a huge government outlay for price-support, or alternatively, a set-aside program; otherwise, increased production will have a further depressing effect on prices. In 1979, price-support outlays were $5 billion; this year, they could rise to $10 billion.

Two other cost factors to consider are increased Commodity Credit Corporation export-credit lines to market the embargoed grain—slashed to $800 million by Carter (experts now concur this will have to be raised to $1.5 billion for 1980-81) and the president's preposterous gasohol program, which the administration hopes will absorb 5 million tons of grain this year.

A massive subsidy program granting tax credits of 44 cents per gallon to producers, gasohol will require a federal outlay of $8.5 to $12 billion over 10 years—or $1 billion per year when lost revenues are taken into account.

This brings the embargo grain bill to about $15 billion . . . before considering the intangible cost. What will be the magnitude of cash-flow crisis in the farm sector? This will require loans from the Farmers Home Administration. Even less readily calculable, what will be the impact on agribusiness suppliers, seed, fertilizer, chemical and equipment producers, dealerships and so forth. As David Diehl, former president of the Michigan Corngrowers Association pointed out, "There will be a ripple effect . . . on a whole series of agricultural-supporting industries."

New OSHA Rules Directed Against Industry

Secretary of Labor F. Ray Marshall and Occupational Safety and Health Administration director Eula Bingham announced new rules in mid-January for exposure to various chemicals on the job. Allegedly designed to protect industrial workers from contracting cancer at the workplace, the rules give Bingham

the power to declare any chemicals used in industry unsafe.

OSHA is empowered to give the offending industry the following choices: obtaining a substitute for the chemical, even at a prohibitive cost; lowering worker exposure to OSHA-determined levels, again cost and available technologies notwithstanding; or shutting down.

OSHA has compiled a list of 2,500 dangerous chemicals.

Does Industry Cause Cancer?

Bingham and OSHA proceed from the assumption that cancer is the disease of an industrial society and that any industrial use of a chemical renders it carcinogenic. Yet, Department of Health, Education, and Welfare studies have documented that there has been *no increase in cancer in the United States since 1900*, once increased population and lengthened life span are accounted for.

The OSHA report released in mid-January also implies that carcinogenic substances in the workplace cause 50 to 90 percent of all cancers. However, current studies demonstrate that at most only from 1 to 5 percent of cancers are industrially related.

Nowhere in this antiindustrial viewpoint is there room for the idea that continued scientific and industrial progress is the basis for solving the problem of carcinogenesis.

Furthermore, the new OSHA rules are based on studies of animals, the results of which are then extrapolated to humans. This writer and other experts have shown that it is unsound scientific practice to extrapolate from animal experiments to human beings. (See "There Is No Cancer Epidemic" in the Aug. 1978 issue of *Fusion*.)

First, the doses used in animal experiments are so large that almost all substances can induce tumors, even such beneficial and desirable materials as penicillin or the common U.S. nickel. To imply that massive doses in experimental studies and low levels in industrial exposures have the same biological effects is like saying that being hit by a 2-ton bale of cotton and a cotton dish cloth are equivalent.

Second, the tests that supposedly demonstrate human danger involve using animals that have been deliberately bred to be highly susceptible to cancer formation. To use immunologically deficient animals as the basis for stating effects on the biologically far more advanced human species is absurd.

Ironically, the environmentalist "cancer at the workplace" campaign has worked against finding a scientific solution to those cancers that are caused by hazardous chemicals: The basic scientific research budget has been cut down, while funding for the environmentally oriented research projects has increased, thus hindering the kind of basic research that will eventually solve the problem of cancer.

—Dr. Richard Pollak

Agnew Hits Lack of Weapons Back-Up

Nuclear weapons production facilities in the United States have no back-up facilities, according to Dr. Harold M. Agnew, the head of General Atomic Corp. and a member of President Carter's advisory committee on arms control.

Agnew, who is known internationally for his nuclear expertise, said in a Jan. 4 speech in San Diego: "There was a time in this country when every weapons facility had a backup. There were always two . . . . But now, there's one place for fabricating plutonium, and one place for fabricating uranium, and there's one place for putting things together. . . . In the past we've always had two plants, and that's all been cut back, little by little."

Agnew, who had harsh words for the Carter administration, said that the president's opposition to nuclear energy use and development was based on the fact that Carter is either misinformed or uninformed about technological aspects. Carter's opposition to nuclear energy "is political, certainly not technological," he stated, and he forecast no change in the White House's opinion.

"If we have another four years of this antinuclear environment surrounding the president, I'm not sure . . ." he broke off, visibly angry, according to reports in the *San Diego Union*. He then referred to the fact that his own firm, General Atomic, is owned by Royal Dutch Petroleum and Gulf Oil. "If the government program goes down they are going to wonder what the hell they are in this business for . . . . They don't make energy, so they don't understand it. They are in the business and have the expertise of getting something out of the ground, a raw material, and improving it and selling it."

Dr. Agnew also cited recent news stories concerning Soviet emphasis on nuclear development.

Euthanasia Test Case in Massachusetts

A 78-year-old Massachusetts resident was declared incompetent by a Massachusetts probate court and prohibited from receiving kidney dialysis treatment in what has now become a national test case for euthanasia. Earle N. Spring, a resident of the Holyoke Geriatric Center in Springfield, Mass., by court order was taken off dialysis treatment Jan. 18. Without dialysis treatments, after a few days Spring would have died.

Spring, who is slightly senile, had told several interviewers and nurses at the Geriatric Center that he did not wish to die.

Opponents of euthanasia were able to temporarily stay the probate court order in the Massachusetts Supreme Court and clear the way for Mr. Spring to resume dialysis treatments Jan. 23, but the stay is only temporary. In a telegram to President Carter, Fusion Energy Foundation executive director Dr. Morris Levitt stated: "Mr. Spring's legal murder would make a mockery of all scientific research and advancement to which I and my associates are dedicated. Do not allow cynicism and horror to be bred among researchers in all fields by the forced death of those whose lives can be preserved by our work."

Supporters of Democratic presidential contender Lyndon H. LaRouche, Jr., who mounted a campaign to save Spring's life, are now conducting a nationwide search for potential plaintiffs—especially senior citizens—for a class action suit on behalf of Earle Spring.

New Nuclear Report, Old Nuclear Policy

To preserve global harmony and avert disruptions of world energy supplies, nations must come to an agreement that will place all aspects of their civilian nuclear energy programs under the control and supervision of supranational agencies.

This is the substance of a report issued by the International Consultative Group on Nuclear Energy, a group cosponsored by the London-based Royal Institute for International Affairs and the U.S.-based Rockefeller Foundation. The sponsors jointly released the study group's findings at a Washington, D.C. press conference Jan. 17.

Much of the report is devoted to painting a dire picture of the future, should its recommendations not be followed. "As the balance between supply and demand becomes more delicate, we must expect increasingly fierce international competition for the energy sources which are available. . . . One result is that the world's energy system will be increasingly vulnerable to error, accident, or deliberate disruption."

Any "uncoordinated" development of nuclear power, the report continues, will produce "political instability" and other problems, whose solution requires that nations "compromise" and arrive at a "new bargain of confidence"—relinquishing their sovereignty on nuclear matters.

The Consultative Group purports to advocate nuclear energy and to assume that it will be developed. The group also says that it "studied" world energy problems afresh in order to produce its recommendations.

Curiously, however, these recommendations are only a reformulation of the old Bernard Baruch Plan of the postwar period. Baruch had proposed that supranational agencies be the vehicle to contain advanced nations' nuclear development and to prevent its introduction altogether in the so-called developing sector. Interestingly, the principal, determining influence on Baruch's plan was the Royal Institute for International Affairs. It is evident that for all its studies, preliminary reports, and the like, the Consultative Group has simply rehashed a policy whose essential features were formulated by its sponsoring agency some 35 years ago.

In other ways, too, the new report is simply a rerun of an old scheme. The RIIA, also called "Chatham House," is not only a think-tank, but the headquarters of the British Secret Intelligence Service. The dominant faction at RIIA is associated with the British Cecil family (for example, Lord Harlech, et al.), which is also among the powers behind a project to transform the United Nations into a "One World" government (see Special Report, this issue).

This "one world" policy views industrial development, including any project to generalize the benefits of nuclear development, as inimical to the medieval outlook associated with people like the various lords Cecil. At the same time, the "One-Worlders" view the sovereign nation-state as a hateful vehicle for industrial progress.

Through such connections, the Consultative Group's odd-ball emphasis on "supranational control" over civilian nuclear technology comes into proper perspective.

The Jan. 17 report was very carefully formulated linguistically. The actual objectives of the group's program are never stated more tangibly than by such buzzwords as "bargain of confidence" and "global harmony." For example: "One way in which confidence in both international supply and peaceful purposes might be further reinforced is by developing arrangements to conduct 'sensitive' processes or hold 'sensitive' materials not only under safeguards but also under multinational auspices. . . ."

Japan's Maglev Train Reaches 313 Mph

The magnetically levitated train now being tested at Japan National Railways' Miyazaki testing grounds reached a record speed of 313 miles per hour in early January, according to *Engineering News Record*. The car, which weighs more than 10 tons and is 45 feet long, is propelled by the interaction of magnetic fields on board the vehicle and in the roadbed guideway.

No Friction

A linear induction motor on board produces magnetic fields as does the electrically active guideway, and the vehicle "floats" above the track. There is no friction and the only limit to the speed is the air resistance. Superconducting magnets are used in the onboard motor system and the Miyazaki testing center is developing cryogenic technology for future commercial trains.

Japan National Railways plans to put "maglev" trains into service around 1990, running at about 300 mph. The new trains are expected to produce one-hour service between Tokyo and Osaka. The advanced Bullet train now in use takes three hours for the same trip.

The three-phase program, begun 17 years ago, is now in the final stage. In the second phase, starting this year, the railroad plans to convert the guideway to a more advanced design and to test a new 10-passenger car.

In the third development plan, the railway company will build a 25-mile test track in the corridor between Tokyo and Osaka. Eventually the guideway will be extended to those cities for regular service.

The program so far has cost $67 million and is expected to cost another $417 million. The United States stopped its maglev program in 1975.

Old nuclear policy: Bernard P. Baruch

At the Washington press briefing, however, Britain's Ian Smart, representing the RIIA, was much more to the point: "If individual countries do go ahead and develop nuclear power," he stated, "this uncoordinated use will exacerbate international problems . . . lead to acrimonious relations . . . be an abrasive factor in a wider set of international relations. . . ."

—Vin Berg and Marsha Freeman

Brazil-Iraq Sign Oil, Nuclear Contract

Brazil and Iraq have announced changes in their 1972 contractual agreement on joint oil exploitation, guaranteeing Brazil 160,000 barrels per day for 13 years at official prices.

Under the new agreement Iraq will purchase nuclear technology, arms, a complete tank factory, oil technology, and other goods and services from Brazil.

The original agreement called for the Brazilian state company, Braspetro, to invest more than $1 billion in development of the Maijnoon field it discovered in Iraq. In return, Brazil was to receive a percentage of that oil at bargain prices. In its new form, the agreement stipulates that for at least several months Iraq will raise shipments of oil to Brazil from the current 440,000 barrels to the 803,000 barrels-per-day level and that Brazil will pay at the official price for Iraqi crude.

EBT Experiment Gets Go-Ahead

The recent review of the Elmo Bumpy Torus toroidal mirror magnetic confinement system has given the green light to the EBT, according to sources in the fusion community.

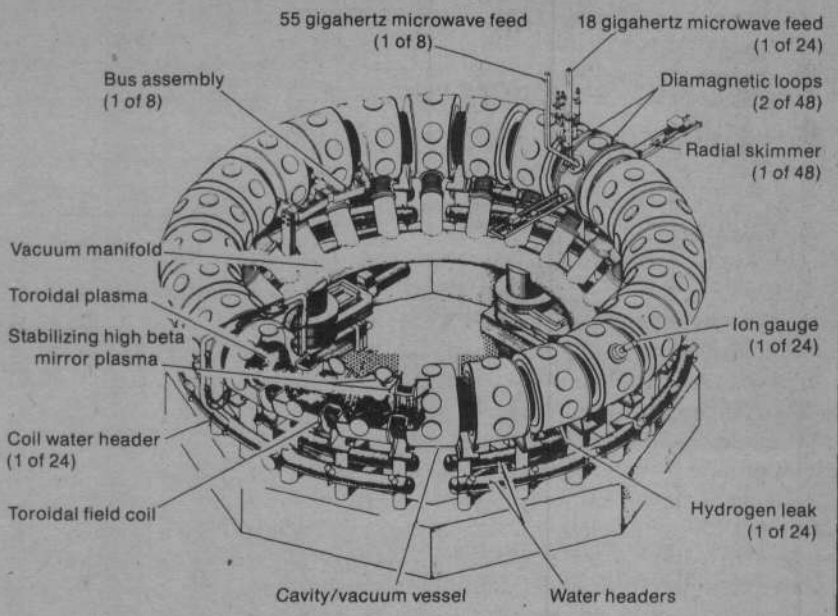
Reportedly, the distinguished scientific review panel appointed by the Department of Energy, will recommend not only the go-ahead for a $70 million proof-of-principle EBT experiment, but also a $14 million upgrade to be included in the plans for the EBT construction. The projected schedule for the completion of the EBT proof-of-principle experiment is 1985.

The Elmo Bumpy Torus, developed at Oak Ridge National Laboratory, is a toroidal magnetic system made up of a number of connected magnetic mirrors. In mirror confinement, the plasma is trapped in a region of low magnetic field intensity between two regions of intense magnetic field strength. The two strong "ends" of the magnetic field configuration tend to reflect plasma particles (ions and electrons) back into the region of low intensity (see figure).

In the EBT, a number of these mirror configurations are connected together to form a torus. Some plasma does escape out the ends of a simple mirror—this is why simple mirrors are called open systems—but since the EBT forms a closed torus, no plasma escapes from the overall device.

The ratio of the strength of end magnetic fields to the central magnetic field is called the mirror aspect ratio. The upgrade proposed for the EBT would increase the magnetic field strength so that higher mirror aspect ratios can be used. This higher aspect ratio will change the basic EBT plasma properties so that higher frequency microwave heaters can be used—90 megahertz, compared with 60 megahertz. The proof-of-principle project is expected to obtain density-confinement time products greater than 1 trillion nuclei per cubic centimeter per second.

The EBT holds great promise as a potential magnetic fusion reactor because the device would operate continuously (instead of in a pulsed mode like a tokamak). Also, the EBT would have a thin donut shape, which is much easier to build and is more amenable to modular construction.



ELMO BUMPY TORUS

Schematic of the current Elmo Bumpy Torus device at Oak Ridge National Laboratory

AIF Releases Fusion Report

The Atomic Industrial Forum released copies of its report, "Fusion Energy at the Crossroads: Role of the Private Sector," Jan. 18 at the background briefing for the press on fusion sponsored by Congressman Mike McCormack.

The five-page report, dated December 31, 1979, was compiled from a series of interviews with industrial and scientific experts and includes the conclusions of the AIF committee on fusion.

"Bringing the benefits of fusion energy to bear on the nation's energy problems can most effectively be realized through establishment of a national goal aimed at the construction and operation of a fusion energy facility producing net power before the turn of the century," the report states. The AIF fusion subcommittee on industrial participation is headed by Dr. Zalmon Shapiro, director of the Westinghouse fusion program.

Foster: Double Inertial Fusion Budget

Dr. John S. Foster, Jr., the vice president for science and technology of the TRW Company and chairman of the official Department of Energy Fusion Review Panel, has called for doubling the inertial confinement fusion research budget in 1981. In a speech at the American Association for the Advancement of Science symposium in San Francisco Jan. 8, Foster reviewed the specific recommendations and conclusions that the DOE Fusion Panel had made. "DOE must seek and gain congressional approval for an increased funding level—at least $250 mil-

Continued on page 70

Phaedrus Tandem Mirror Reports Good Initial Results

The relatively small tandem mirror experiment at the University of Wisconsin, the Phaedrus, has reported good initial results from its first series of experiments with a fully completed machine. The results, chiefly related to radio-frequency heating of the magnetically confined plasma, have great import for mirror confinement in general and tandem mirror confinement in particular.

The tandem mirror was developed in the mid-1970s and represents the high degree of synthesis and sophistication that magnetic fusion research has achieved. The tandem concept consists of a long cylindrical plasma with a simple solenoidal magnetic field and two mirrors, one at each end to prevent the plasma from flowing out the cylinder. Initial results on the large neutral-beam-heated tandem mirror experiment at the Lawrence Livermore Laboratory, the TMX, achieved the hottest, dense plasma yet.

In the meantime, the small Phaedrus tandem mirror experiment at the University of Wisconsin has obtained very interesting results with radio frequency heating experiments. The Phaedrus is designed as a small physics experiment for testing concepts in rf heating and low energy neutral beam refueling and confinement in the tandem approach. The experiment has been completed in stages with the first end-cell mirror being completed in Sept. 1978. The second end cell was completed in Nov. 1979.

The Phaedrus experiment has obtained up to 90 percent deposition into the end-cell plasma of 150 kilowatts at 3 megahertz radio frequency, according to DOE scientists. Maximum ion heating occurs off the mid-plane of the mirror where the radio frequency is equal to the ion cyclotron frequency (the frequency at which ions spiral along magnetic field lines). At 45 kilowatts of input radio frequency power, the ion temperature doubles to a value of about 400 electron volts—4.4 million degrees Celsius.

Plasma electrons are heated indirectly from an initial temperature of 10 eV to 14 eV. No degradation in the confinement parameter, the density-confinement time, was observed. This favorable result can be contrasted to rapid loss of plasma in previous mirror experiments in which internally generated radio frequency radiation (that generated by the plasma) was observed. The Phaedrus results bode well for the future of the tandem configuration and mirror research in general.

Tandem Mirror Upgrade To Be Reviewed

The Mirror Fusion Test Facility tandem upgrade, MFTF-B, is scheduled for DOE review in the near future. The upgraded device would add a second large mirror to the MFTF now under construction at Lawrence Livermore Laboratory in California. This addition, which would transform the MFTF into a large tandem mirror device, could operate in the mid-1980s and provide a scientific demonstration of the tandem approach.

It is expected that the review will be completed with favorable findings and that the review committee will recommend full funding at the $120 million level for MFTF-B.

John S. Luce Dies

Dr. John S. Luce of Lawrence Livermore Laboratory, a pioneer in U.S. fusion research, died Jan. 8 at the age of 70.

Luce, along with his coworker Dr. Harry Sahlin, who died less than a year ago, were among the most forward-looking scientists in the area of nonlinear plasma physics phenomena and their revolutionary implications. Because of this, their work has direct application to the most fundamental questions of modern mathematical physics.

Luce began his scientific career at the University of California at Berkeley, working under E. O. Lawrence, the inventor of the cyclotron. During World War II, Luce was the leader at Berkeley of the development of the Calutron uranium electromagnetic separation device that was based on the cyclotron. This was one of two methods for separating uranium isotopes developed in the Manhattan Project.

In 1942, Luce went to Oak Ridge National Laboratory, where he led the crash effort to put the electromagnetic isotope separation process on an industrial basis—a program that borrowed more than 11,000 tons of silver from the U.S. Treasury. Since copper was in short supply as a result of the war effort, silver was used to supply the magnet windings on the Calutrons at Oak Ridge. The Calutron became essential at the final stages of the Manhattan Project for production of pure uranium-235 for the uranium bomb.

Using the experience on particle accelerators in his work on the Calutron, Luce helped initiate the controlled fusion program at Oak Ridge after the war. Although the specific device he worked on in the early 1950s, the DCX, did not succeed, the accelerator technology developed for the DCX eventually became very important to the development of neutral-beam heating technology used in the 1970s on tokamaks.

In the 1960s, Luce worked at Aerojet Nucleonics developing the plasma focus on an Air Force contract. He next went to Lawrence Livermore to do further work on the plasma focus with Harry Sahlin, Dr. Winston Bostick, and others. Their work on collective acceleration processes in electron beam machines produced many new ideas for using the plasma focus to generate electron beams and for use in inertial confinement.

—Charles B. Stevens

Plato's Timaeus &

A galaxy in Centaurus.

Association of Universities for Research in Astronomy, Inc., the Ceno Tololo Inter-American Observatory

Modern Physics

by Dr. Steven Bardwell

EDITOR'S NOTE

Dr. Steven Bardwell, director of plasma physics for the Fusion Energy Foundation, has been part of a small group of scientists and political historians that recently completed a new, groundbreaking translation of Plato's *Timaeus*. The translation project developed out of historical studies probing the impasse in modern physics, specifically the question of why creative currents in physics had died out with Riemann.

This article is adapted from Bardwell's introduction to the new translation of the *Timaeus*, which is scheduled to be published in book form by the New Benjamin Franklin Publishing House. The translation, without notes, also appears in *The Campaigner* magazine in February 1980.

* * *

OF ALL PLATO'S DIALOGUES, the *Timaeus* has had by far the greatest influence on scientific thought.

Its pervasive influence among philosophical thinkers during the last 2,000 years is obvious if only because it was the sole dialogue available in Europe for almost 1,000 years and was the basis for much of the scientific and philosophical work of Neoplatonics like Augustine, Plotinus, and Porphyry as well as Roger Bacon and his successors.[1]

Furthermore, the *Timaeus* has been the seminal influence for all the major revolutions in scientific thought in the last 2,000 years. The first generalized development of scientific progress occurred in the Islamic Renaissance some 1,100 years after the height of the Platonic Academy. The leader of this scientific upsurge in medicine, mathematics, and optics was Ibn Sina (Avicenna), who is directly indebted to Plato and the Platonic method as it was transmitted through Plotinus and Porphyry. Some 600 years later came the next concentrated burst of scientific development—the European Renaissance, whose intellectual leadership beginning with Plethon, Ficino, Pico and continuing through Nicolas Cusanus and Bruno was based on a rediscovery of Plato. It is this lineage that informs the physics of Copernicus, Kepler, and Galileo.

Modern physics is, perhaps, even more explicitly indebted to the *Timaeus* for its method and spirit. The father of the last three centuries of European physics (as distinguished from the British or the Royal school of physics) is Leibniz. Leibniz's works on physics, such as the *Monadology* or his correspondence with Newton's protégé, Clarke—with all due respect for their originality—read like glosses on the *Timaeus*. The method described by Leibniz and consciously adopted by his successors, from the Bernoulli brothers through Gauss, Euler, and the Ecole school, was the basis for the tremendous advances made by Continental physics and mathematics for the next 150 years.

The vitality and depth of the Platonic method transmitted by Leibniz are absolutely clear in the philosophical writings of the towering figure of 19th century Continental mathematical physics, Bernhard Riemann. Similarly, Georg Cantor repeatedly notes his indebtedness to Leibniz and Plato. The tradition continues at least through the 1930s, with evidence provided in Werner Heisenberg's autobiographical essays noting that his concepts of symmetry in mathematical physics come from a careful reading of the *Timaeus*.[2] Similarly, in an essay called "Science and Western Thought," Wolfgang Pauli develops the thesis that one of the most important issues in 20th century science was posed in a rigorous form by Plato in the *Timaeus*—the question of the interdependence of matter and geometry.[3]

I am not speaking here simply of "indebtedness" or of "sources" for the scientific contributions these men made. It is a question of their rigorous and complete adoption of a *method*, a conceptual framework for scientific thought that Plato developed in an almost complete form in the *Timaeus*. The simple fact is that historically scientific progress has been generated by scientists who were armed with a conscious mastery of Plato's method—and, conversely, without a mastery of that method, scientific progress will stop.

The Problem of Translation

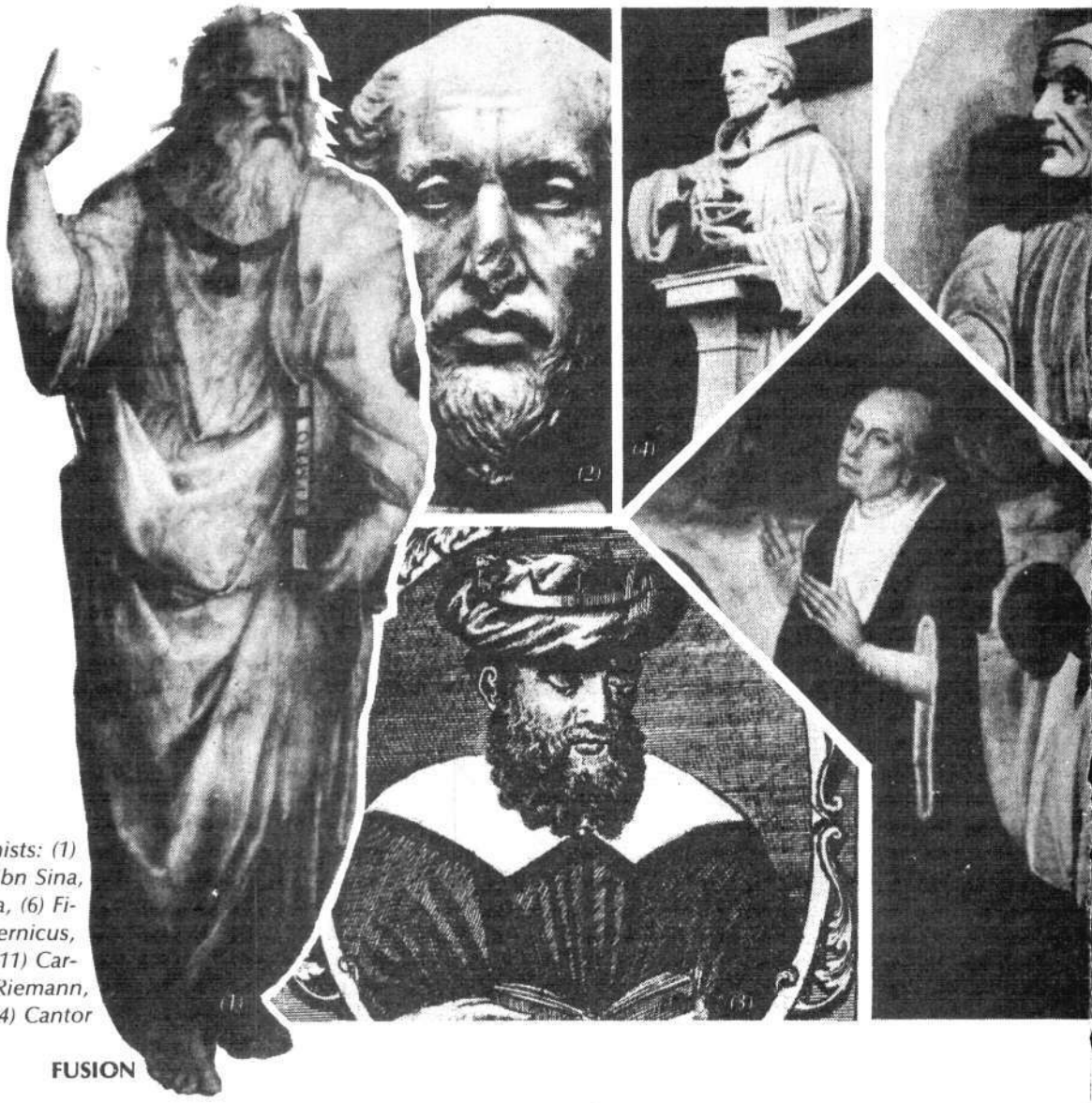
The *Timaeus* addresses the most difficult problems of present-day physics. The dialogue is not merely a philosophical discussion *about* science; it is a body of scientific results of the highest importance. As Pauli outlines in his essay, any scientific paper of this sort necessarily takes a factional position in the epistemological fight between a Platonic standpoint and an Aristotelian standpoint. The combination of the difficult sci-

entific work presented in the dialogue and its strong factional position has forced the translators of the *Timaeus* into two, sometimes overlapping, groups.

First, most translators start with, at best, a poor understanding of mathematics and physics. Since Plato is discussing physics and its methodology from a very advanced standpoint, a translator who is not involved in these scientific issues cannot adequately understand them. This problem is most pronounced in the case of determining an accurate rendering of the technical terms used in the dialogue. Without a grounding in the frontier questions of physical and mathematical science today and a background in the Platonic attack on those problems, as exemplified most consciously by Bernhard Riemann and Georg Cantor, it is simply impossible to find proper English equivalents for the concepts described in the *Timaeus*.[4] Second, there are a significant number of translators and commentators who have understood at least the factional importance of Plato's ideas—most important their anti-Newtonian and antiempiricist implications. These translators have not hesitated to distort and mistranslate the dialogue.

The seriousness of this factional battle cannot be overestimated. It not only pervades academia today, but also has shaped critical turning points in history over and over again. Ultimately, the crux of the issue is the fact that control of knowledge is power, and control over the method of generating new knowledge is absolute power. The *Timaeus* is an essential milestone on the road to the conscious control over man's ability to create new knowledge. Therefore, the hegemonic school of British empiricism has had a tremendous stake in obscuring Plato's method. The well-known bitterness of the Leibniz-Newton debate throughout the 18th and 19th centuries was not then, nor is it today, an academic affair. At issue is the progress of science and humanity.

The new translation of the *Timaeus* in which I have participated attempts to remedy both problems by bringing to bear the most advanced Platonic science and a clear understanding of the importance of Plato's method for modern science. The *Timaeus* is a work of the highest scientific rigor. The translator cannot afford to dismiss any passage as "obscure," "archaic," or "quaint, but now proven wrong" without the most careful



Plato and the Neoplatonists: (1) Plato, (2) Plotinus, (3) Ibn Sina, (4) Roger Bacon, (5) Cusa, (6) Ficino, (7) Bruno, (8) Copernicus, (9) Kepler, (10) Galileo, (11) Carnot, (12) Leibniz, (13) Riemann, (14) Cantor

consideration. In fact, exactly the passages that many commentators dismiss in these ways contain the most critical parts of Plato's work.[5]

Plato, as I shall show, had a clearer understanding of how science is done and taught than all but the most extraordinary scientists of the last 2,000 years, and the *Timaeus* must be translated with this in mind. By making the dialogue accessible to layman and scientist alike, the pedagogical task of Plato's Academy will be continued and science will be able to progress.

Central Ideas of the Timaeus

There are several critical concepts in the *Timaeus* that I shall review here. I shall also discuss in some detail a current frontier problem in physics in order to show the necessity of a Platonic approach to its solution.

Chronos—relativistic time. Plato's concept of time pervades the *Timaeus*. It is a recurring theme with counterpoint at every turning point in the dialogue.

Plato's concept of time is not that of some steady, unchanging backdrop to events in the universe. The Newtonian absolute time of everyday experience and of comon sense—which is also the usual implication of time in current scientific usage—is most emphatically not what Plato means by *chronos*. Plato describes an idea of time that is relativistic in the same sense that Riemann describes the geometry of space as relative: its metric is determined by the processes occurring "in it."

The assessment of Plato's concept of time made by most modern commentators is that the *Timaeus* anticipates the "relativity" of time to the observer or the interaction of time and its measurement. When Plato says

> Therefore, as a result of these reasons and considerations of God concerning the birth of time, in order for time to be born, the sun, moon, and the five stars which are known as the planets were created for the purpose of determining and preserving the metric of time [38e]

most translators and commentators make a dutiful bow to the logical positivist and thoroughly Aristotelian idea that it is the subjective *measurability* of time that gives it meaning.

This is not what Plato is saying, nor is it what he was understood to be saying by Platonic scientists like Leibniz or philosophers like Augustine.[6] The existence of time is not a subjective question of measurement but rather an objective question of *metric*. The distinction is critical. As Plato says again and again: time was created; it did not always exist. It is a property only of created and evolving entities and has neither permanent nor unchanging qualities. He makes this clear in the passage that precedes the paragraph quoted above:

> For we say that "it was," "it is," and "it will be," when only the "is" represents the precise term when referring to eternity. On the contrary, "was" and "will be," should be used only with respect to the notion of becoming, which takes place within time, because these are movements, while the eternally invariant, which remains unchanging and unmoving, cannot become either older or younger throughout the course of time, nor did it ever become so, nor is it becoming so now and neither will it be so in the future, given that absolutely nothing which the act of becoming bestows to the changing realm of the senses belongs to eternity, since these are forms of time which imitate eternity and revolve according to a metric [37e-38a].

Time exists only where objects change. As Riemann stresses, the metric for such change is "internally" defined and cannot be said to exist apart from that change. This means that qualitatively different modes of evolution generate different time metrics and that time exists as a determined quality of evolving systems. This quality will be shown below in the context of a current problem in physics that is unsolvable unless one applies this concept of time. From the standpoint of the translation, it must be stressed that Plato is discussing an objective property of the universe, not a Viennese phantasm.

Without this distinction between measure and metric, Plato's contrast of the quality of time as *kai arithmon* (literally, according to number) is inexplicable. Indeed, most translations make the above passage on time incomprehensible on precisely this point. The phrase refers to a metric in the Riemannian sense. Plato goes on to develop the concept of metric in the dialogue as an essential embodiment of order and physical law that does not occur "in" time but is a property of evolution and hence of time itself.

At one point in the dialogue, Plato stands back and condenses the argument he has constructed on the centrality of the problem of time and evolution:

> . . . There exist three distinct things, being, space and becoming, even before the creation of the universe. And the nurse of becoming, being moistened and inflamed and receiving the appearances of earth and air and experiencing whatever other affections go with them, manifested herself to be manifold [52d] . . . .

The three concepts Plato lists here subsume the most difficult points in the dialogue; it is "becoming" that immediately demands an accounting of the idea of time. As he says, properly speaking, created things do not exist; they may have been and perhaps they will be, but they are not. The temporal, evolutionary qualities of physical objects (what Plato frequently refers to as "otherness") are what these objects are. Without a mastery of this concept of time, the dialogue and, as I shall show, the solution to the fundamental paradoxes of modern physics are unattainable.[7]

chôra—matter/space, "manifold." Plato's thesis about the critical role of time in understanding the physical universe should not be mistaken for a formal or mystical description of perpetual (simple) change. Rather, the universe is changing in a specific and determinable direction; it is progressing.

As the first step toward understanding this directed evolution, Plato develops the concept of a medium "in" which this evolution occurs, *chôra*. Again, an accurate English rendering requires the use of one of several technical terms from mathematical physics, either a Riemannian manifold, or analogously, phase space. Each of these terms designates space, but space conditioned and qualified by the metric and dynamical laws of the systems that define that geometry.

The crux of the argument that Leibniz and Riemann make about the real quality of physical space is that it is not specifiable in an *a priori* way; rather, it is codetermined by the "laws of physics" going on "in" that space. Riemann derived this idea from Leibniz, and Leibniz took it from Plato.

The central problem Plato addresses in his discussion of the manifold of the universe is how to connect this manifold to evolution in time. He develops a concept of space (manifold) that is diametrically opposed, as Pauli notes, to the Aristotelian and Newtonian concept of absolute space—a rigid lattice that eternally bounds the universe. Plato describes a coevolving property of becoming, which he poetically describes as the "nurse of becoming."

Contained within this concept of space are two contrasting aspects. The first is the property of temporal change in the universe as a self-differentiating, self-organizing process that results in a hierarchy of successively more complex states. In earlier parts of the dialogue, Plato describes this process as the "soul" of the universe:

> According to the language of simile, we ought to say that this world was created by the providence of God as a living organism truly possessing soul and mind [30b].

In latter parts of the dialogue, the geometric and arithmetic properties of this self-differentiation are developed in detail. Neither of these attributes of an evolving geometry can be understood, however, on the basis of the conventional idea of space. The space Plato describes is an equal partner in the process of the development of the world—a phase space.

Plato specifies a contrasting aspect that *chôra* brings to the evolution of the universe—*anankê*. This term traditionally is translated as "necessity," but the description of its role in the evolution of the universe is puzzling:

> Because the birth of this world came forth as the mixed result of the coming together of reason and necessity, reason rules over necesssity by persuading her to drive

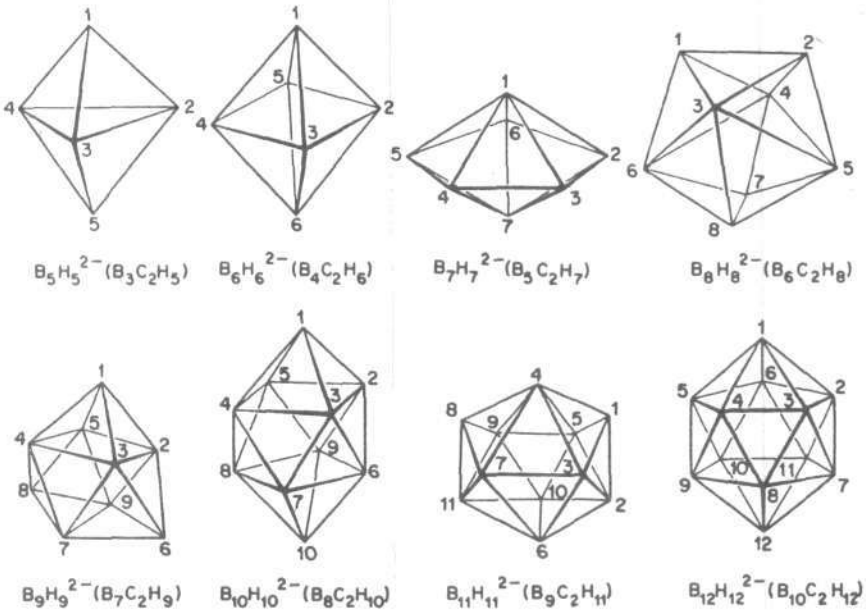
the greater part of the ephemerals toward what is best; and our universe was initially put together when necessity was defeated by rational persuasion in this fashion and by these principles [48a].

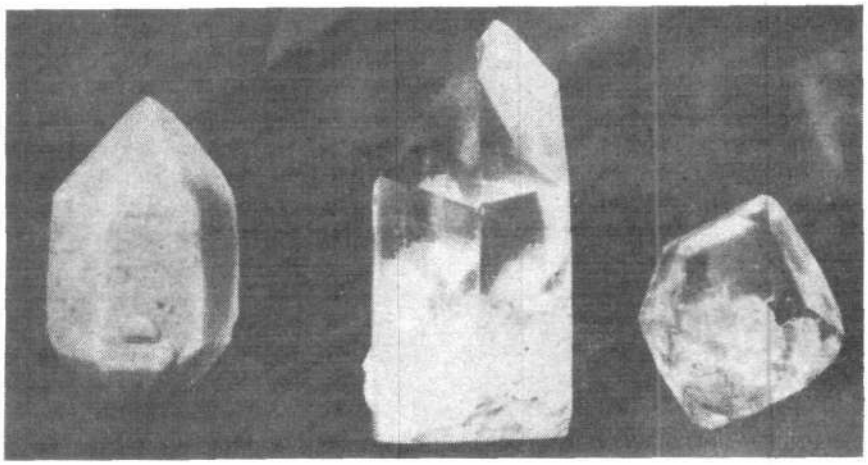
Why does Plato call the indeterminate part of change necessity? In what sense is necessity opposed to reason? This is an insoluble paradox within an Aristotelian framework, sending most translators into paroxysms of unintelligibility. In reality, the problem rests on the common-sense assumption of a Newtonian geometry.

In any manifold, as classically described, equations of motion generate a set of conservation laws; or, equivalently, there are constraints on the possible motions of the system. It is possible to reformulate the laws of the motion for the system entirely in terms of the constraint or conservation laws. These laws, whether formulated in terms of equations of motion or their equivalent constraints and conservation laws, constitute the Aristotelian conception of natural law. The laws of nature are the laws of physics, according to Newton.

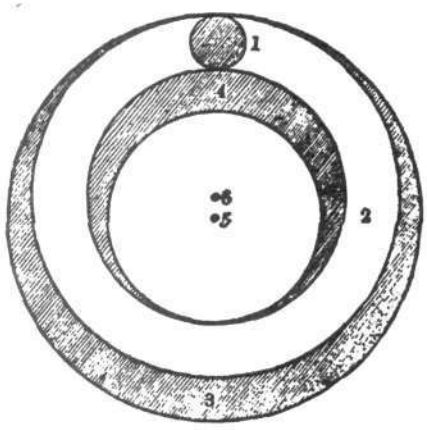
However, this is not the Platonic conception of the laws of nature. As Platonists like Leibniz make abundantly clear, the Platonic conception is of a severalfold *hierarchy* of natural law. On the lowest level there are the "laws of motion," fixed, mathematical laws describing motion within the confines of a single, fixed geometry. These laws are a property of a given phase space; and, indeed, when looked at from an advanced standpoint, as Plato does, this phase space *brings* these laws to the operation of the universe. The only sense in which Plato might connect necessity with space is exactly this sense: These laws bring the sort of iron necessity to evolution (constrained to one stage) that the Greek word connotes.

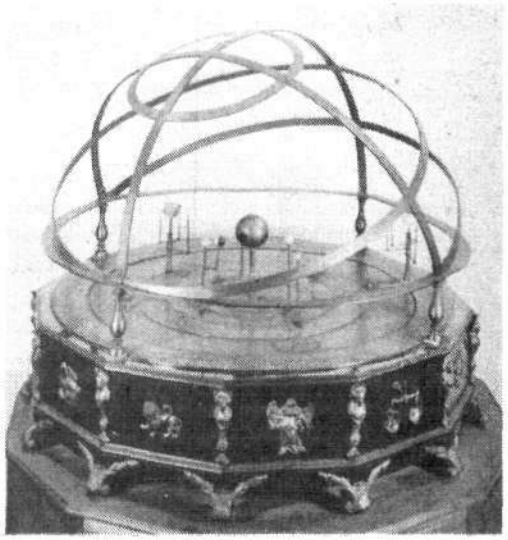
However, as Leibniz was at pains to point out, this is only the lowest level of lawfulness in the universe. These "laws of physics" are subsumed by a higher-order process of development that appears when one manifold is superseded by another. The laws of physics can, and do, change because of this higher-order causality. This is the force of Plato's statement that it was intelligence "persuading necessity" to do the best things that made the universe as it is. Thus, as defined by the





The illustration of boron compounds from a modern chemistry text shows geometric ordering of matter at the molecular level. The mathematical theory of complex electronic configurations typical of boron compounds is based on the symmetry properties of the equations of quantum mechanics first appreciated by Heisenberg. The photograph below shows three hexagonal quartz crystals





conventionally conceived laws of nature, necessity must be conditioned by some higher-order process.[8]

Aiônios—the invariant. Plato begins his discussion of physics with the distinction mentioned above between the "eternal" and the "created." The term Plato uses, *aiônios,* is usually translated as "eternal" or eternity. Plato maintains that the world as we know it is an image of this eternal entity:

> What is the difference between that which eternally exists and has no birth and that which is always coming into being and never exists? The first, being eternally invariant, is comprehended by mentation with the aid of reason; the second, which is ephemeral and never really exists, is imagined by opinion with the aid of unreasoning sense perception.
>
> Now, everything ephemeral that comes into being must of necessity come into being by some cause; because coming into being without a cause is impossible. Anything whatever, whose form and function its creator hones to perfection by looking up to the invariant and by utilizing the invariant as his exemplar, is by necessity beautiful. Anything that he creates by utilizing an ephemeral exemplar is not beautiful [27e-28a].

Plato describes a concept that has a precise equivalent in the theory of Riemannian manifolds and that must be considered the content of his *aiônios.* Riemann called the constant properties of a manifold *invariants* or *transinvariants,* properties that allow a lawful description of transitions between manifolds and, in this sense, supersede the "local" lawfulness of any one fixed manifold. An invariant is eternal in the same sense that Plato's *aiônios* is; more important, it provides the "model" for creating entities in any given manifold, in the same way Plato describes. These ephemerals are not entirely determined by the invariant, but the invariant causes their direction of ultimate evolution and the critical nondeterminist transitions from manifold to manifold.

For these reasons, the invariant is the correct translation of this term. It signifies a higher-order causality that is implied by the idea of phase space and its inherent limitedness. Note, however, that the invariant is eternal—in the sense that no time metric can apply to it—but it is not static.[9]

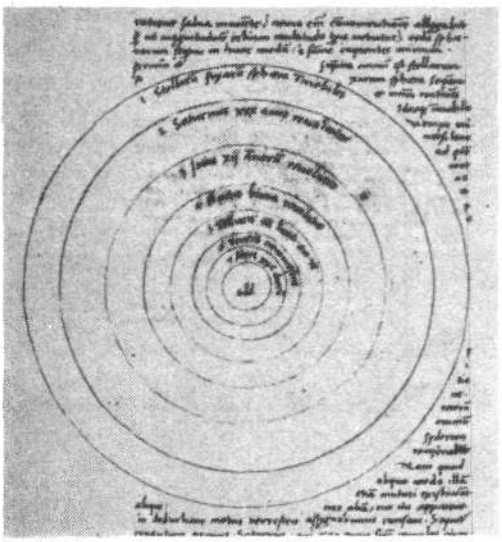
Plato gives content to the idea of the invariant by characterizing it as striving for the greatest good. Within the context of a single manifold, this invariant is made manifest by the self-differentiating and self-ordering tendency of evolution—an evolution that would be inexplicable without the existence of the invariant, since local time-evolution is ultimately constrained to be entropic.

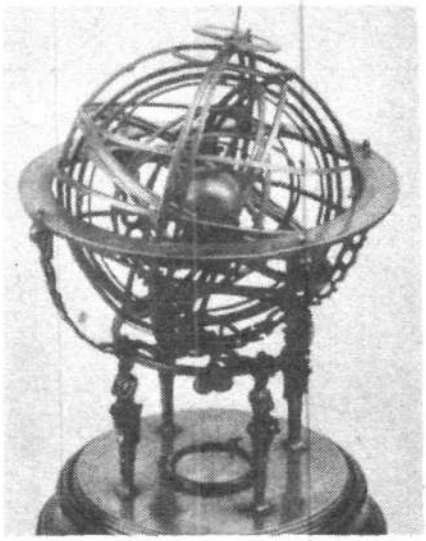
This result is now one of the foundations of modern physics: A system constrained to evolve according to a fixed set of laws (that is to say, a single Platonic manifold) must ultimately decay. Since this is not the case in reality, the "laws" must be changing and changing in a direction the global character of which can be known by an examination of the local changes in time that occur in any single manifold. Leibniz, in his correspondence with Clarke, attacks the usual Newtonian (that is, Aristotelian) conception on exactly this point and develops the Platonic counter:

> . . . The harmony which God has preestablished by the most beautiful and the most admirable of all his productions, whereby every simple substance is by its nature (if one may say so) a concentration and a living mirror of the whole universe according to its point of view. Which likewise is one of the most beautiful and most undeniable proofs of the existence of God, since none but God, viz. the universal cause, can produce such harmony of things.

Perhaps the greatest contribution of the *Timaeus* comes at this point. After laying out these essential conceptual tools that are still the *sine qua non* for scientific thinking, Plato poses the most difficult question for science, the real subject of science: What is the relationship between the invariant and created objects? How can these two orders of reality be related? How, in empirical detail, does the invariant order the physical, biological, and intellectual world we live in?

The task of science is not to catalogue or categorize facts as Aristotle prescribes; this is the death of science. The task of





The Timaeus has influenced man's view of the laws governing the universe through the centuries. Shown here are a variety of ancient astronomical devices. From left to right: An illustration of one of the many Arabic astronomical theories. A 16th century armillary sphere, whose concentric spheres were used to model the orbits of the planets for astronomical calculations. An azimuth quadrant from 16th century Germany; the orbits of the planets and many of their moons can be simulated with the device. A Copernican world system. A French armillary sphere, circa 1575.

science is rather to unravel the threads connecting the orders of existence in the universe (physical, biological, and mentative in the most obvious example) and then to understand these threads as the evidence of an overriding design and, indeed, a weaver.

In one of the most beautiful passages of the dialogue, the practical application of which will be evident below, Plato describes this interconnection and its implications in a discussion of the relationship between the ephemeral, changing aspects of the universe ("otherness") and the reflections in that universe of the invariant ("sameness"):

> The body of the universe was created visible but she, the soul who partakes of reason and harmony, was invisible, created the most perfect of ever-conceivable and existing creatures by the most perfect creator. And because of the fact that she is composed of the three portions of sameness, otherness, and existence, and because she has been apportioned and composed according to proportion, whenever the soul, while revolving about herself, touches any being that is either composite or indivisible, she proclaims with a resonance throughout her being that which has sameness with her and that which otherness; and she also proclaims where and how and when anything is in agreement with or is affected by either the ephemerals or eternally invariant [37d].

Contained in this poetry is the essential insight of Riemann's physics—the idea of a singularity as the physical manifestation of the transition from one manifold to another and as the carrier of the evidence of the higher-order invariant—resonating *kinoumené* as Plato calls it. The "propagation without voice or sound across the domain of the self-moving" is the proper subject of science.[10]

A Case Study from Plasma Physics

The *Timaeus*, properly understood, is a program for modern scientific research. There are a number of areas in physics where the critical nature of the insights from the *Timaeus* could be demonstrated. Here I discuss a partially solved problem in one of the most difficult areas of modern physics, plasma physics. This involves the study of electrically conducting gases, usually at very high temperatures, such as those in flames, neon lights, or stars. The problem I am using as a case study in scientific methodology is something of an exception that proves the contention that scientific research cannot progress without a mastery of Plato. The solution I discuss is little known and even less used within the mainstream of plasma physics because it presents almost insuperable conceptual difficulties for the average plasma physicist who is unacquainted with the ideas of the *Timaeus*. This is a case where the essential Platonic insights have been formulated in modern scientific language, yet remain inaccessible because of conceptual problems that were solved in the *Timaeus* 2,000 years ago.[11]

In the last eight years, physicists have developed a revolutionary new theory of the behavior of magnetized plasmas. Called the Grad-Hogan theory, after its codiscoverers from the Courant Institute of Mathematical Science, Harold Grad and John Hogan, the theory began with the practical problem of describing the behavior of the hot, ionized gas (a plasma) that is the fuel for nuclear fusion. The hydrogen fuel in fusion reactors is maintained at temperatures of millions of degrees and confined inside a force field generated by a magnetic field. Since the plasma is composed of charged particles rather than neutral atoms, its motion and evolution can be controlled using electric and magnetic fields. The specific fusion reactor that Grad and Hogan were studying and to which their theory was first applied is a tokamak, a donut-shaped magnetic bottle in the mainline research toward eventual commercial application of fusion energy.

In a purely theoretical context, Grad and Hogan faced the problem of describing the interaction of a magnetic field (generated partly by the tokamak and partly by the plasma itself) and the hot plasma. The fundamental equations that describe this problem, as far as is now known, have been available to physicists for more than 100 years, even before the discovery of the more general laws of the electromagnetic field (Maxwell's equations). In fact, these equations were first for-

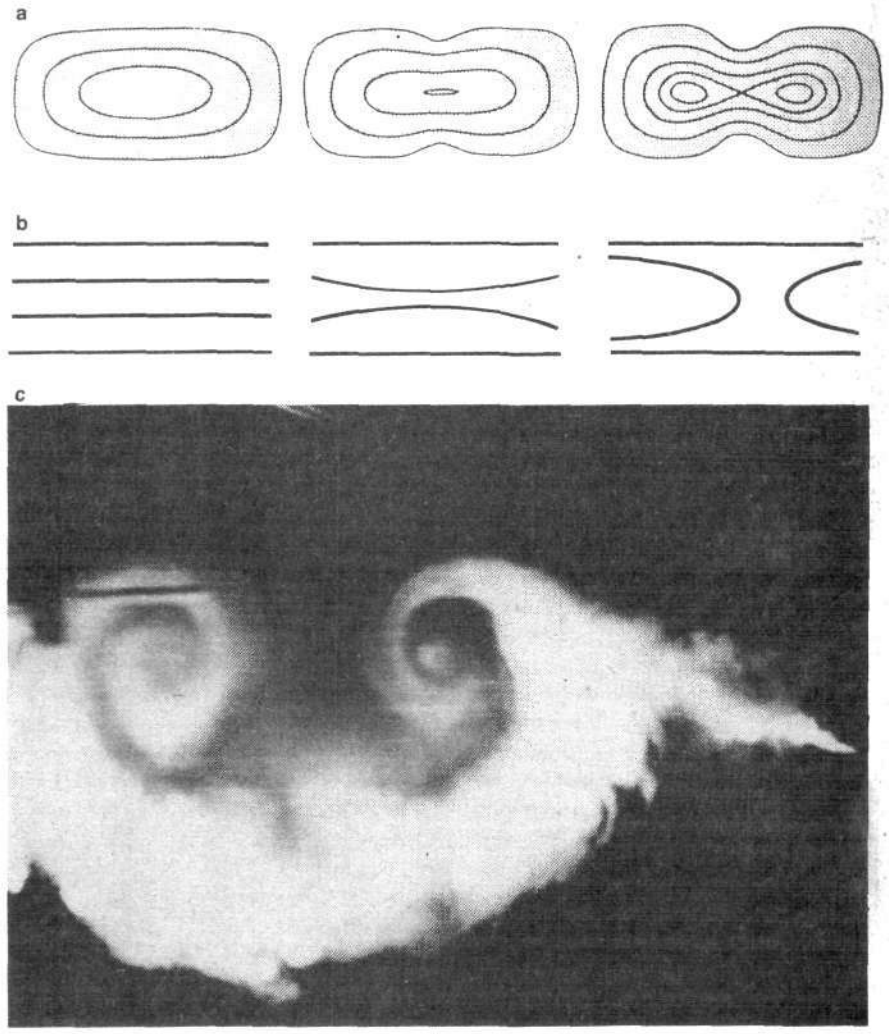
mulated for a problem that is mathematically very similar: the possible motions of a conventional (not electrically charged) fluid.

It turns out that there is a deep mathematical similarity between these two continuum systems. In a magnetized plasma, the magnetic field "ties" the plasma particles together in such a way that the plasma behaves like a continuous medium. In such a plasma, the flow is analogous to flow in a regular fluid, and both systems are governed by the same equations—with the important difference that in the regular fluid "vortex lines" replace the magnetic field lines. This means that for every physically realistic configuration of a magnetized plasma, there is an analogous state for a regular fluid if the magnetic field lines are replaced with "whirlpools" whose cores followed the magnetic field lines.

The classic result in this area of continuum mechanics, which applies to the regular fluid and to the magnetized plasma, was discovered in 1858 by Hermann von Helmholtz. Helmholtz studied the continuum equations in the case of an ideal fluid—a fluid in which there is no viscosity or resistance to flow, in the case of a regular fluid, or a fluid in which there is no resistance to electrical flow (infinite conductivity), in the case of a plasma. This assumption, which is an excellent approximation to real plasmas in fusion energy research and a somewhat rougher approximation for most fluids, means that there is no energy dissipation in the fluid because of the motion: The flow of the fluid does not run down by being turned into heat (through friction), but continues on indefinitely.

In a theorem bearing his name, Helmholtz showed that the topology of the flow (or magnetic field lines) in an ideal fluid cannot change. That is, the flow patterns (or magnetic field lines) can never break apart or reconnect, no matter what the fluid does. The lines can move closer to or farther from each other and they can get tangled up, but they can never touch one another. It is as if the flow lines (called stream lines) or magnetic field lines were physical objects—like threads—that may be swished about in the fluid as it flows but cannot be broken, reconnected, or untied by what the fluid does.

This theorem is one of the most far-reaching results in classical physics for a number of reasons. First, it strongly delineates the situations in which smooth flow—flow with no closed flow lines (and hence no vortices) is possible. The theorem states that vortex motion can exist only in an ideal fluid if it was there initially. Second, it shows that the seemingly



MAGNETIC FIELD LINE RECONNECTION

There are three usual ways that the magnetic field might change its topology. In (a), looked at from left to right, there is the formation of islands or loops where none existed before, a process called islation. When looked at from right to left, the opposite process is seen, the disappearance of these islands. The third way a magnetic field might change topology is shown in (b): the connection of two lines forming a so-called x-point. The singularity that the plasma creates occurs at the x-point. Vortices in the wake of an obstacle as smoke-tracers flow past it are shown in (c). The formation of vortices in this experiment demonstrate the fundamental significance of Helmholz's theorem: In a simply connected fluid, no vortices can form. That is, without something to disrupt the fluid flow, like the obstacle in this experiment, the flow would be smooth (given the additional assumption of zero viscosity).

self-evident aspects of a fluid, like its flow, are highly constrained by subtle geometric effects. Further, the theorem has the interesting implication that the microscopic processes responsible for dissipation (like the molecular collisions in a fluid that cause viscosity) ultimately determine the largest-scale qualitative features of the flow.

Helmholtz's theorem applies to magnetized plasmas in an analogous way. There the conclusion is that in an ideal plasma (one with no electrical resistance), the topology of the magnetic field lines cannot change. The prediction based on Helmholtz's theorem and the theorem's conventional interpretation were that the magnetic field in a collisionless plasma (for example, in a high-temperature tokamak) could not change its topology. Any "magnetic islands" (closed magnetized lines) that exist, cannot disappear; new islands cannot form; and magnetic lines cannot cross and rejoin.

Based on this classical theorem and its implications, plasma physicists have constructed theories and experiments and, more important, have used it as the guide for the formulation of new hypotheses and intuitive insights into the science. However, the theories so generated fail to predict correctly the operating characteristics of large magnetized plasmas like those in a tokamak.[12] This was more than just an embarrassment, because the actual machines consistently functioned better than theory predicted they should. The machines were able to confine the plasma longer than predicted, to heat it more efficiently than predicted, and to stabilize it more effectively than predicted.

The Grad-Hogan theory changed all this, although many plasma physicists have yet to realize it, for reasons I shall examine. Based on the analysis provided by their theory, Grad and Hogan recently published a paper on the long-term prospects for a tokamak fusion reactor and found that in almost every category past results had been too pessimistic.

Grad and Hogan showed that there was a strong theoretical basis for the construction of an economical fusion reactor using the tokamak design (a fact that some physicists had questioned) and that the key problem areas of stability, power density, and cost could be dealt with. It was only by using their more sophisticated analysis of the tokamak plasma that such conclusions could be proved.

The Conceptual Basis for the Grad-Hogan Theory

As Grad and Hogan point out in a number of papers, the most difficult question to answer about the equations that govern a magnetized plasma concerns time. In their most general form, the equations cannot be solved either analytically or by computer. Therefore, it is essential to begin with some physical insight into the actual behavior of the plasma in order to make any progress.

The first step is attempting to unravel the vastly different time scales that the equations contain. The same equations describe phenomena occurring with characteristic frequencies of millionths of a second along with those that occur on the order of seconds (the latter are of most technological interest). It is known experimentally that these two time scales are somewhat separated for the kind of plasma in a tokamak: There are very rapid phenomena and slow phenomena, without much in between. The first, even formal problem, is to derive from the general equations separate equations for the two time scales.

The conventional approach has been to make approximations that are based on the mathematical solvability of the result, not on its physical applicability. This is an unfortunate point noted by Grad and Hogan as well as by others; for if a rigorous, classical approach is taken, even the simplified equations cannot be understood.

Grad and his coworkers, however, started with a different approach to the question of time and its role in these equations. The difference in this attack is best illustrated by looking at the end result of its application—a disproof of Helmholtz's theorem. Grad found an example of an ideal plasma—one without resistivity—in which the reconnection of magnetic field lines could occur. As he said:

> These phenomena, exhibiting nonconservation of magnetic field line topology, are shown to occur in an ideal, nondissipative fluid, thereby violating beliefs, theorems, and calculations of over a century (including the mathematically equivalent questions involving vortex lines in an ideal fluid).

Now, in a footnote to an article proving his theorem, Helmholtz notes that the theorem is not applicable unless the plasma (or fluid) under consideration is *simply connected*; that is, has no holes in it; it must be contained in a volume that is completely filled with plasma. If the volume is multiply connected, then the topology of the fluid flow need not be conserved. (As an example, consider the wake of vortices that forms behind a barrier; the barrier creates a multiply connected fluid volume).

If the role of time in the equations governing the fluid or plamsa motion is taken to be the usual Newtonian and Aristotelian notion of a homogeneous background through which everything flows, then in a simply connected domain Helmholtz's theorem holds without exception. However, Grad and his coworkers discovered that these equations had an amazing property: By beginning with a different temporal process, the fluid (or plasma) can generate its own "holes"; it can change from a simply connected volume to a multiply connected one by virtue of its own evolution, and then go on to violate Helmholz's theorem.

Grad and Hogan formulated mathematically this alternate concept of the role time played in the equation, which they termed *adiabatic* processes, and discovered later that this concept of time not only upset one of the oldest intuitive foundations of continuum mechanics but also provided the crucial insight needed to understand the operation of a tokamak.

The central result of Grad and Hogan's argument is as follows: It is usually assumed, at least implicitly, that the physical quantities the equations contain can be chosen on the basis of, at most, mathematical convenience. The usual choice for a plasma, for example, involves the plasma flow velocity in some form. These dynamical variables, as they are called, the usual assumption goes, can then be solved for if the equations are correct.

Grad and Hogan, however, point out a usually overlooked

feature of this procedure: If one takes the usual choice of variables, like fluid velocity, then this assumption brings along with it a measurement of time. Since velocity flow is a dynamical variable, one's theory will have an equation for the time-dependence of the flow. But it turns out that this is impossible. Grad and Hogan found that a correct derivation, which did not begin with an arbitrary choice of variables, resulted in a set of equations for a new set of dynamical variables, not including the flow velocity, and that, in fact, the usual variables like flow velocity did not progress by the same "time" as the equations did.

This is a significant finding: It says that time is not given nor can it be assumed to be given somehow axiomatically or self-evidently; rather, time is created along with relevant physical processes the evolution of which is actually responsible for the qualities of temporal change in that system.

(At this point, most physicists have lost track of Grad's argument; yet, this is just where the *Timaeus* starts.)

Grad and Hogan took this result seriously and derived both the relevant time scales and variables from their physical system and mathematical model. The mathematical results were astounding.

In the first place, the equations that describe the actual physical dynamics of the plasma operate on a slow, adiabatic time scale that decouples the long-time motions of the plasma from the rapid fluctuations. This long-term behavior is determined by processes essentially independent from the fast, usually small-scale phenomena. Contrary to common sense, it is not the averaging or adding up of the rapid fluctuations that results in the long-term behavior of the plasma.

Second, the equations Grad and Hogan derived are of a form new in mathematics, so-called generalized differential equations that combine local microscopic effects with global ones in a unique way. A new technique had to be invented to solve these equations.

Third, the resulting equations had two variables describing the plasma that were unexpected from a conventional point of view. One was a function of the density of the plasma and the other was the *geometry* of the magnetic field—not the field itself, but a function of its shape, intensity, and distribution. The conventional variables like flow velocity, could be derived from the solutions to the equations for these variables, but the flow was not primary.

Fourth, in reality the evolution of the plasma seems to be a function of these variables (the density function and magnetic field geometry). The shape of the magnetic field, for example, *is not predetermined; it evolves with the plasma and must be* used to describe and predict that evolution.

Fifth, when the plasma's evolution was studied with these variables, it did several remarkable things. First, it created singularities in the flow—"holes" in terms of Helmholtz's theorem—that allowed the magnetic field topology to change. In the case of a tokamak this meant that the observed changes in magnetic field geometry could be explained for the first time. Second, they found that the past operation of tokamaks had been the result of effects generally ignored by previous theories (for example, atomic effects) and that when these effects were included, the previous so-called anomalous results could be explained. Further, Grad and Hogan showed that future machines could be built that took advantage of the most favorable processes in the plasma in order to generate economical energy.

The role of the Platonic concepts of time and space in understanding the significance of these results is apparent. Grad and Hogan describe almost exactly the relativistic idea of time that Plato developed in the *Timaeus* and they show the power of the idea in a concrete setting. In fact, they are able to classify the types of magnetic field geometry in some plasmas on the basis of the temporal properties "allowed" by the physical processes in the plasma within that geometry.

One reason Grad's papers have been so difficult for many scientists to understand is precisely his application of the Platonic idea that time is created by and has its metric imposed by the evolution going on within it; time is not set up beforehand.

In a similar way, the use of the concept of a manifold, as the self-creating geometry of a physical system—a concept that originated with Plato and is still misunderstood by most scientists—is the most striking result of Grad and Hogan's mathematical analysis. Their theory shows more clearly than any other example in plasma physics the applicability of Riemann's Platonic insight that geometry is a dynamic variable. Space is not an unchanging, fixed backdrop for the world, and a science based on that idea cannot explain the physical world, much less the biological or social world.

All this is clear enough from a reading of Grad and Hogan's work bearing the *Timaeus* in mind. The Platonic concepts of relativistic time and manifold are an important part of the Riemann-Leibniz heritage of the most successful mathematicians and physicists, even if the vast majority of scientists now find this work unapproachable.

The case of the transinvariant in the *Timaeus* is more problematic, however. Grad's work on the violations of Helmholtz's theroem deal only implicitly with this most fundamental Platonic result.

The Grad-Hogan theory is one of the most elegant applications of the approach to the study of singularities inspired by Riemann. Their theory is an important empirical specification of the properties of singularities in physical systems; it is the first global characterization of the process of magnetic field line reconnection. Furthermore, the deeper significance of these results has not escaped them. As Grad says:

> The significance of an example of [magnetic field line reconnection] is that it reverses cause and effect; instead *of the resistivity producing a certain rate of flow* across a separatrix [the singularity], the rate of flow is determined by external, global boundary conditions and other constraints, and the resistivity and thickness of the layer adjust to produce the required reconnection rate.

The importance of the Grad results, however, goes even further. By upsetting the conventional understanding of the applicability of Helmholtz's theorem, Grad implicitly proves a result that is damaging to an even more deeply entrenched dogma concerning the Second Law of Thermodynamics.

Grad's result on the conditions under which reconnection of magnetic field lines can occur, is part of a large body of

experimental and theoretical results dealing with the appearance of self-organizing phenomena in plasma physics. As Plato stresses, the basic direction of evolution is toward more highly differentiated and complex states; the world does not tend to run down as the Second Law of Thermodynamics predicts. Plasma physicists had been able to comfort themselves that the appearance of self-generated magnetic fields and magnetic islands, both clear instances of evolution intuitively opposed to the Second Law, could occur only in plasmas whose dissipative properties allowed this to happen; the increase in entropy brought on by the dissipation "accounted for" the otherwise anomalous self-ordering properties of the plasma. In the end, such physicists assured themselves, the universe is becoming more disordered, since Helmholtz's theorem affirms that this kind of magnetic field effect can occur only when there is dissipation.

Grad's result changes all this!

However, there is a more serious problem raised by the conclusion that must follow from the Platonic idea that the fundamental direction of evolution is towards states of greater order. This is a problem Plato provides an answer to, but which has as yet remained unasked even in the most advanced plasma physics work: It is impossible that the evolution of the universe be governed by a *single* manifold, especially if this manifold is characterized by self-ordering processes. At some point, if restricted to stay within that manifold, the potential for elaboration would have to be exhausted. No true infinity is possible *within* a given manifold.

If self-ordering processes are characteristic of the universe (and this is demonstrated dramatically by the experimental evidence in plasma physics), this *implies* that a higher-order process governs this locally self-ordering behavior—what Plato calls the invariant. Nonlinearity implies negentropy; this is the lesson from Plato that must inform science today.

Notes

1. See M. Klibansky, *The Continuity of the Platonic Tradition*, (Warburg Institute Studies) for a description of the manuscript tradition; also, C. Zoakos, "Avicenna and the Dawn of the Humanist Heritage," *The Campaigner*, July 1977.
2. W. Heisenberg, *Physics and Beyond*, New York: 1967.
3. W. Pauli, "Die Wissenschaft und das Abendlandische Denken," in *Europa—Erbe und Aufgabe, Internationaler Gelehrtenkongress Mains*, 1955, (Wiesbaden: F. Steiner Verlag, 1956), pp. 71–79.
4. G. Cantor, "Foundations of a Theory of Manifolds," English translation and introduction by Uwe Parpart, *The Campaigner*, Jan. 1976. The footnote in which Cantor summarizes the origin of his methodology is worth reproducing in full: "Plato's conception of the infinite is an entirely different one [from Aristotle's]. Similarly, I find points of contact for my conceptions in the philosophy of Nicolas Cusanus. I note the same thing with respect to Giordano Bruno, the successor of the man from Cusa."

   Later on, Cantor says:"The conviction concurs essentially both with the principles of the Platonic system and also with an essential feature of Spinoza's system. In relation to the former, I refer to Zeller (*Philosophy of the Greeks*): 'Only conceptual knowledge (according to Plato) will provide true insight. To the extent, however, that our notions are true—this premise Plato shares with others (Parmenides)—to the same extent their objects must be real and vice versa. What can be known is, what cannot be known is not, and to the same extent that something is, to that extent it is knowable.'

   "With respect to Spinoza, I need only call attention to proposition in *Ethics*, pars II, prop. VII: 'ordo et connexio idearum idem est ac orde et connexio rerum (The ordering and connection of ideas is the same as the ordering and connection of things).' "

   The same epistemological principle can also be demonstrated in the philosophy of Leibniz.
5. In reply to readers who may think that I have read into the dialogue modern concepts and scientific results, two things should be said.

   First, the historical impact of the *Timaeus* on thinkers like Cusa, Bruno, and Leibniz is a very powerful tool for assessing what Plato really meant. These thinkers, especially Leibniz, developed their scientific work with Plato's methodology and are hence reliable guides for the modern reader who is sincerely attempting to recreate Plato's thought. While it is out of place in this introduction to comment at length on Cusa, Bruno, or Leibniz, any of their works provides an invaluable roadmap to the *Timaeus* and should be used as an indicator of Plato's meaning in passages where he is elliptical.

   Second, and more to the point, Plato appears obscure and mystical only to those who have not come to grips with his scientific method. For the rest, both his followers and enemies, there is little to be read into the *Timaeus*.
6. See Leibniz, "The Correspondence with Clarke," Book 11 of the *Confessions* of St. Augustine, and Books 9 and 10 of Augustine's *City of God*.
7. Some of the most convincing evidence for this interpretation of the physics of the *Timaeus* can be found in Proclus's commentary on the *Timaeus* and in the *Enneads* of Plotinus. The sections in both dealing with time provide sharp insight both into what Plato meant and into how he was understood by the most advanced Platonic scientists following him.

   Proclus develops at length the central feature of Plato's idea of time as the means by which evolution is carried out; time exists because it is the faculty by which created things can come to approximate the "eternal" (see 240a, 244d, and 248c-d). He also has a very enlightening discussion of the phrase *kat' arithmon*. His description of the overall effect of time is beautiful: "When then, they say that time is the cause of corruption rather than of generation, and of oblivion rather than of preservation, and of all these ephemerally and not in essence, they very much resemble people asleep, who are unable to understand by reason what the benefits conferred by and through time on the soul and body are, and the benefits on all heaven through the whole of itself and on all created things."

   In a section of the *Enneads* [III, 7 (45)] Proclus makes the same distinctions. The second, third, and fourth paragraphs of this essay make the usual English translations of Plato's technical terms quite untenable.
8. Proclus alludes to what must have been the content of his commentary, now lost, on a manifold conception when he relates time and energy (246B). For a longer discussion of phase space, see the author's "Solving the Three-Body Problem," *Fusion*, March 1978, and Lyndon H. LaRouche, "Poetry must Begin to Supersede Mathematics in Physics," *Fusion*, Sept. 1978.
9. Proclus's commentary on the concept of the eternal is very interesting. He stresses that the eternal is not permanent, and in the process, he describes the concept of the invariant (241e–242a): "If therefore, these things are rightly asserted, eternity will not be one certain genus of being, as some think it is, such for instance as essence, or permanency, or sameness. For all these are parts of created things; and each of them has that to which it is, as it were, opposed. Thus, for instance, essence is opposed to nonexistence, motion to permanency, sameness to otherness. But to eternity, nothing is opposed. All these therefore, are similarly eternal, viz., sameness, otherness, permanency, motion. This, however, could not be the case if eternity was one of these."
10. See Plotinus, *Enneads*, "On Time and the Invariant," for a useful explication of the concepts of sameness (or better, self-identity) and otherness.
11. For an introduction to plasma physics for the layman, see the author's "Elementary Plasma Physics from an Advanced Standpoint," *Fusion*, Nov. 1978.
12. A review of the importance of the Grad-Hogan theory can be found in C. Stevens and S. Bardwell, "Coming Breakthroughs in Fusion Research," *Fusion*, Oct. 1978.

Evolution
A Riemannian Approach to Biology

by Carol Cleary

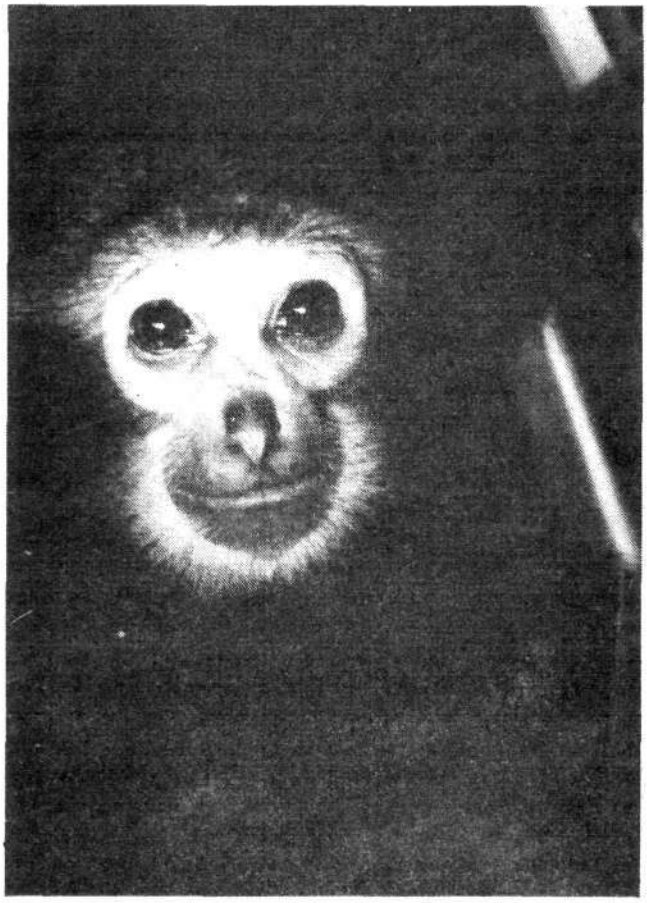
PART I
THE QUESTION OF EVOLUTION

THE RECENT PUBLICATION of chromosomal studies of the offspring of two different primate species threatens to trigger the final collapse of the shaky marriage between Darwinian theory and molecular biology. Chromosomal studies of the hybrid offspring—a cross between a gibbon, which has 22 chromosome pairs, and a siamong, which has 25—revealed considerable chromosome rearrangement. Although there is still much to be understood about the finely detailed higher-ordered chromosomal structure, this evidence of chromosomal rearrangement in the siamong-gibbon (called the siabon) is being used by a group of biologists as a living testimony to the fraudulent Darwinian approach to molecular biology (Myers 1979).

Proponents of the Darwinian view of evolution claim that gradual random change creates variation, and, because of the scarcity of resources available, only those rendered most fit by new variations are able to survive and procreate many offspring, creating new species; in other words, survival of the fittest.

After the acceptance of Darwin's theory, the development

* Terms followed by an asterisk can be found in the accompanying glossary.



Darwin disproved: The publication in July 1979 of chromosomal studies on a hybrid "siabon" ape created an uproar as biologists began to challenge the neo-Darwinian assumption that speciation generally occurs from a prolonged series of small random mutations that take place over a period of thousands or even millions of years. The primate siabon, raised at the Georgia State University Psychology Department's Primate Behavior Laboratory, is the offspring of a gibbon father with 22 chromosome pairs and a siamong mother with 25 chromosome pairs.
Sister Moore, Atlanta, Georgia

of molecular biology and Mendelian genetics* led to the viewpoint that inherited differences occur at the gene* level, the level at which a nucleic acid molecule apparently "codes" for one specific protein molecule. Thus, the marriage between molecular biology and Darwinian theory was consecrated on the basic tenet that changes on the gene level brought about by *random* point-mutations slowly create variations that, under the pressure of natural selection, cause evolution to occur.

During the postwar period, when most of the experimental work in the biological sciences was conducted on the molecular level in bacteria, the Darwinian view seemed very useful and productive for molecular-biological investigations. Extensive experimental work on bacterial organisms opened up many fruitful inquiries into some of the rudimentary features of living metabolism and led to tremendous technological progress in the realm of pharmaceutical treatment of medical problems. However, bacteria, a form of prokaryotes,* are primitive cells that lack the institutionalized internal differentiation of the more evolved cells, the eukaryotes* (see Figure 1). Most important, the prokaryotes lack the most exciting characteristic of living cells: a nonlinear capacity for further self-development and self-differentiation.

Attempts to extend comparative biochemistry beyond the case of bacterial cells to eukaryotes, and to true multicellular life, were largely unsuccessful in going beyond knowledge already gained from the metabolism of bacterial organisms. In some cases, rather interesting paradoxes were generated. For example, according to Darwinian molecular genetics, since the comparative biochemistry of most proteins in man and apes indicates that their genes should be 99 percent alike, there should be no significant genetic or other evolutionary differences between man and apes. For most zoologists and biologists, as for most laymen, this is a rather disquieting conclusion, to say the least.

An in-depth investigation conducted out of the University of Texas and the University of California in the early 1970s encountered the same type of paradox. Biochemist Allan C. Wilson at Berkeley and a small group of zoologists at the University of Texas attempted to verify experimentally that the leading edge of vertebrate evolution (fishes to amphibians to reptiles to mammals to placental mammals and higher primates) occurred through point-mutations of genes in a typical Darwinian fashion (Wilson 1974). They attempted to establish, through a broad statistical study of paleontological and biochemical evidence, that evolution proceeds by random small biochemical changes in the gene's coding for a structural or enzymatic protein—point-mutation. To conduct such a study, Wilson et al. measured the rate of evolutionary changes in a common protein in frogs (amphibians) and compared it with the rate of protein evolution in rapidly evolving placental mammals.

They found that the two groups had the same rate of protein evolution. This was the case despite the fact that by any simple biological measure, the placental mammals were rapidly evolv-

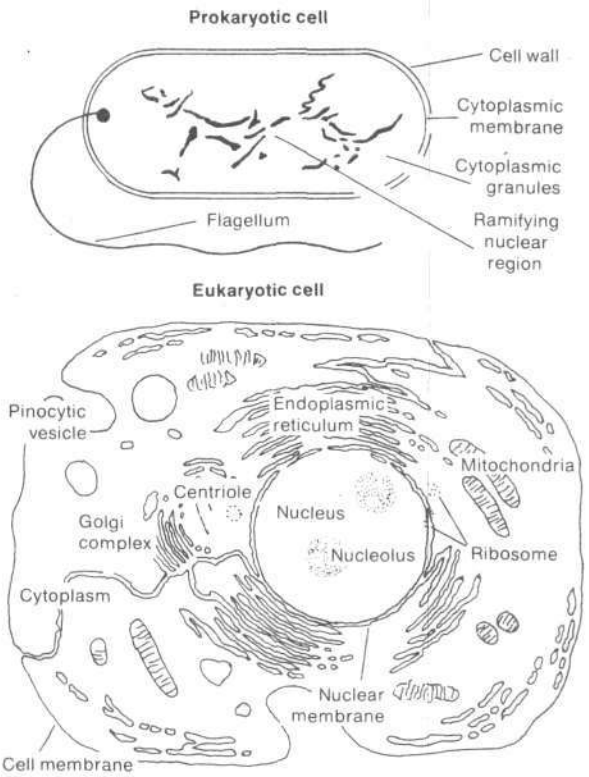


Figure 1
PROKARYOTIC AND EUKARYOTIC CELLS

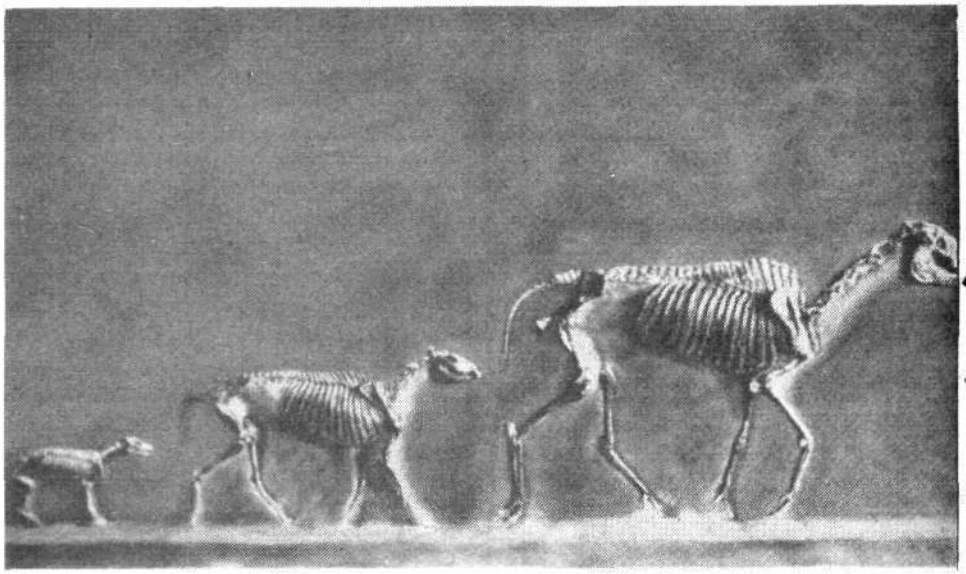
The eukaryotic cell shown is a generalized animal cell based on what is seen in electron micrographs. The mitochondria are the sites of the oxidative reactions that provide the cell with energy. The dots that line the endoplasmic reticulum are ribosomes, the sites of protein synthesis. In cell division, the pair of centrioles—one shown in longitudinal section (rods), the other in cross-section (circles)—part to form poles of the apparatus that separates two duplicate sets of chromosomes.

Shown in the prokaryotic cell are the cell wall, the cytoplasmic membrane, the cytoplasmic granules (which are primarily ribosomes), the ramifying nuclear region, and the flagellum.

Note that the organelles in the eukaryotic cell are membrane-bound, each providing its components—including the DNA-containing nucleus—with specific and unique conditions. This results in a highly internally differentiated condition where efficiencies of reactions are greatly increased.

The size differences between the eukaryotic and prokaryotic cells are very pronounced. For a 1-micron diameter bacterium and a 10-micron diameter animal cell, the volume differences are 1,000-fold. The energy throughput differences are even greater.

Source: *Modern Topics in Biochemistry*, New York: The Macmillan Co., 1966.



Various stages in the evolution of eohippus, *from a small dog-sized animal to the modern horse. Darwinian theory holds that this is a result of the survival of the fittest mutants in a world of limited resources. Actually it is a coherent manifestation of the changing constituents in the continuously expanding and self-differentiating biosphere.*

ing while the frogs, evolutionarily speaking, were stuck in the mud, in spite of their protein evolution. "This necessarily implies that protein evolution in both groups occurs independently of whether or not evolutionary changes are taking place," the researchers concluded. The group then looked for any type of genetic change whose evolutionary rate could be correlated with the rapid rate of evolution necessary to explain organism development in vertebrate evolution.

They further expanded the study to include botanist D.A. Levin's comparison of the rates of chromosomal changes with their biological index of rates of evolution among many species. Chromosomal changes were measured both as the number of chromosomes in the nucleus of the cell and as gross changes in those chromosomes, measured by the number of chromosomal arms (ordinarily most chromosomes have two "arms") in each cell nucleus.

These broader studies were limited to those species for which evidence existed in the fossil record, thus allowing a measure of species age, and for which there were chromosomal studies. The aim was to determine whether some quirk in the nature of chromosomal or gene evolution in either the frogs or the placental mammals accounted for the protein evolution results or whether these results reflected broader phenomena. The studies involved 1,230 vertebrate and nonvertebrate animal species, plus almost 9,000 plant species—more than 10,000 species in all (Wilson 1975, Lavin 1976, Bush 1977).

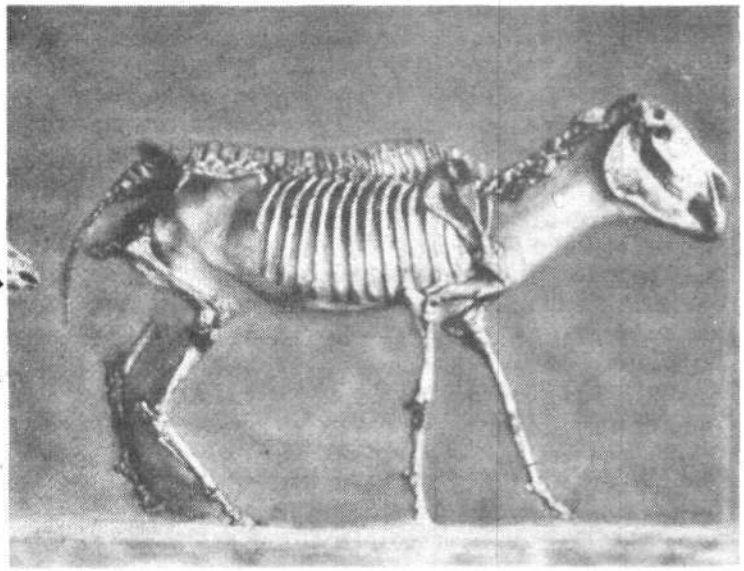
The results were most interesting. Although point-mutations were found to occur at an equal rate in placental mammals and lower vertebrate species (Wilson 1974), changes in chromosomal arm numbers were found to occur roughly five times more rapidly in placental mammals compared to other vertebrates, and changes in chromosomal number roughly seven times more rapidly (Bush 1977). Thus, the chromosomal changes, not the point-mutation changes, occur at a sufficiently rapid rate to account for speciation among vertebrates.

A limited study of mollusks (nonvertebrates) further heightened the difference in rate of evolution between more evolved and lower animals. Changes in chromosomal number were found to occur on the average 14 times more rapidly in placental mammals than in mollusks.

More detailed studies comparing more rapidly and less rapidly evolving placental mammals indicate that given new ecological opportunities, these relatively rapid chromosomal changes will occur even more rapidly in species with a more tightly organized social structure. This is especially the case with those species that have small, permanent breeding groups (generally consisting of one male and several females), and a social structure prone to disperse readily into new ecological opportunities. Rapid evolution—of the sort that could account for the mainline fish-to-amphibian-to-reptile-to-mammal vertebrate development—is thus not related to random variations created by point-mutations in genes. It is related to higher-ordered rearrangements in chromosomal structure apparently caused in placental mammals by advances in social structuring of the species under favorable ecological conditions (Wilson 1975, Bush 1977).

This last point is further demonstrated by the parallel study published by Wilson and Levin in 1976 on plants that compares the rate of chromosomal evolution to the rate of species evolution and comes to similar conclusions. The most rapidly evolving herbal (nonwoody) angiosperms* have a relatively restricted breeding group with relatively high dispersability of seed into new ecological opportunities, compared to shrub or tree angiosperms or the more primitive and slowly evolving gymnosperms.*

Wilson et al. then began to look in more depth at the characteristics of the rapidly evolving species of placental mammals and herbal angiosperms, which, prior to the emergence of human society, functioned as the most recent dominating biological *singularity** in the evolutionary development of the biosphere. They discovered that placental mammals have an exceptionally small, socially cohesive unit, characterized by strong social bonds and a permanent harem type unit—one breeding male to several breeding females plus the young (Wilson 1975).



Under static conditions, this could be accounted for as a simple case of a small population's recessive trait inbreeding. Inbreeding does bring to the fore genetically mediated species variation, such as mongolism, hairlip, and insanity—as the historical case of the inbred Hapsburg nobility attests—but *this occurs only under static equilibrium conditions*. The form of social organization that produces rapid evolutionary change occurs within the dominating characteristics of a singularity, which is hardly a static condition.

The Singularity

Since the singularity is explicitly created as a coherent nexus of species collectively transforming and expanding the previous boundaries and geometry of the biosphere, this creates a general situation in which the expanded and transformed more-differentiated biosphere experiences a net cumulative increase in biological energy flow. Within such a singularity, all those peculiar characteristics of social organization associated exclusively with its rapidly evolving species channel and amplify in a nonlinear way the cumulative increases in biological energy flow experienced collectively by that species into its progeny. Rapid speciation of a positive sort—as opposed to the static equilibrium inbred type—with associated chromosomal changes thus is a lawful outcome that self-perpetuates the capacity of the singularity to transform the biosphere further.

For example, let us take the case of the rapid evolution of the horse and other ungulates, which occurred in the context of rapidly evolving herbal angiosperms—such as the grasses capable of collective expansion into and transformation of arid, previously marginal, boundary environments. The crucial feature of the social organization of the horse as a species, as Wilson's work has emphasized, is that the permanent pair-bonded harem unit is explicitly organized to provide maximum energy throughput investment in the future generation (that is, in the breeding females and the young) and to maximize the postgestational playfulness and social training of the young that is necessary to maintain a cohesive group (Wilson 1975).

The rapidly evolving herbal angiosperms, although they obviously lack direct social interaction, have an equivalent small breeding unit structuring (Levin 1976). Like placental mammals, they have a heavy investment of maximum energy throughput in the next generation in the form of flowering and fruiting bodies. Albeit in symbiotic interaction with mammals, this process guarantees the seed a very fertile start and much larger ecological colonizing opportunities than nonflowering and nonfruiting plants. The interplay of placental mammals and herbal angiosperms sets up a situation in which the singularity perpetuates itself.

The use of the siabon hybrid ape offspring as a living case of chromosomal reordering to support the conclusions of the Wislon et al. studies is not just a potshot at a minor weakness in the Darwinian approach to evolution and molecular biology. It is a healthy sign of a more advanced epistemological approach to evolution than that taken by the molecularly oriented zoologists and biologists.

The molecular geneticists have used Darwin to reduce evolution and the biological domain to a simple linear extension of the random-type thermodynamics of physical chemistry, a linear extension of the physical domain. It is not suprising, therefore, that their linearized model appears to work best in the most crude, linearized, primitive, available living case: the bacterial prokaryote.

The Wilson group's experiments indicate that evolution does not proceed by any such linear mechanism, but by higher-ordered modes generated by its own successes. In this view, favorable environmental conditions and a capacity to harness successful development during previous evolutionary eras replace the Darwinian dogma of limited resources, scarcity, and survival-of-the-fittest battles. A *succession* of highly ordered chromosomal changes mediates within the nucleus the genetic development of a new species, which reflects the overall development of an ecologically more successful, more differentiated biosphere.

In both the plant and animal cases studied, the development of more advanced, more socially structured and restricted breeding groups in the more evolved species clearly occurs within the context of a more successful, more highly ecologically differentiated biosphere—not in the context of lethal battles over limited food or breeding female "resources" for the perpetuation of progeny.

The Case of Wheat

If you ask a biologist what caused the speciation of wheat, he will probably tell you that it was two successive episodes of hybridization and polyploidy.* Wheat is typical of the angiosperms surveyed in the Wilson-Levin study that demonstrated that hybridization-polyploidy cycles form a very significant percentage of all chromosomal reordering in this plant group leading to a new speciation.

If you ask an anthropologist, however, he will tell you that man caused the speciation of wheat. Hans Helbaek of the Copenhagen National Museum, for example, has established irrefutable evidence that man set up the conditions (circa 6000 BC) under which the first of those two separate episodes of hybridization and polyploidy was completed. In effect, *man*

willfully mimicked those "natural" conditions that foster rapid speciation: limited breeding groups and highly favorable ecological conditions; this was one of man's early highly successful cases of domestication, deliberate speciation (Bourliere 1964).

The apparent cause of rapid speciation has changed. Man has subsumed the previous biological mode of evolution. Yet the negentropic invariant—the emergence of a still more rapid rate of speciation and differentiation of the biosphere—remains the same.

Thus, the reality of evolutionary processes is that they progress from the lower-order domain, which may be called n, to successively higher-order domains, which may be called $n + 1$, $n + 2$, and so on. The motion from lower domains to higher may be characterized as N, an invariant progression of negative-entropic development from what the 19th century mathematical physicist Bernhard Riemann characterized as one set of multiply connected manifolds to the next (LaRouche 1980). In the case of evolution the realm of inorganic physics may be repesented by n, the emergence of the biosphere may be signified by $n + 1$, and the advent of the human species by $n + 2$.

The well-documented case of vertebrate evolution leading to the more rapid evolution of placental mammals in coordination with herbal angiosperms forms a beautiful temporally nested series of biological manifolds, culminating with the emergence of human society. Like a properly performed rendition of Beethoven's Fourth Symphony in B-flat, this nested series, with the emergence of man, suddenly explodes into a new, higher-ordered nested series whose rapid pace of evolving motion suddenly overwhelms the previous pace.

As in the musical case, the initial motion and predicates of the new higher-order manifold series causally reflect back on the previous manifold-series, but the quality of motion occurs on a still higher transfinite level. In the biological manifold series, one finds social organization of biological species that nonlinearly amplifies biological energy flows into more highly developed progeny capable of increasing that singularity's capacity to further transform the biosphere. In the human manifold series, such a nonlinear amplifying organization becomes both still more pronounced and also self-conscious in humanist conspiracies of Reason. Such conspiratorial singularities generate the historical Renaissances that have repeatedly transformed the biosphere itself, through a whole new pace of human scientific and technological activity. One is no longer dealing with an increasing ratio of highly differentiated biological energy flow channeled into the future, but with reasoned human social energies consciously lifting the human species from the burden of beastlike pursuit of sustenance to its highest creative potential. Evolution proceeds at a much more hurried pace, but on a totally transformed level.

It is this negentropic invariance, a capacity for Riemannian reorganization to a higher level of the geometry of energy flow within the biosphere, that must be understood if scientists are to understand advanced cell life on a level sufficient to grapple with the problems of cancer, aging, and chronic disease that still plague humanity, even in our advanced technological society.

PART II
BIOLOGICAL SPACE: HIGHLY ORDERED ENERGY FLOW

Once it has been established that evolution occurs on the chromosomal and not on the gene level, one or another clever student will inevitably conclude that the epistemological features of this argument are just rhetoric. Since a chromosome is assumed to be composed of a random assortment of genes, like beads on a string, this student will argue that it is simply necessary to conduct research from the standpoint that genes are not randomly mutating internally, but randomly reordering. Given such random reordering of genes, "natural selection" would then determine which genes are successful, which create new speciation—Mother Nature rolls the dice. Thus, with minor readjustments the epistemological marriage of Darwinism and molecular biology can remain sound. One need only replace the "point-mutation" clause with "gene reordering."

Unfortunately for this clever student, experiments over the past few years have elaborated some of the gaping holes in this argument. Critical experiments in both plants and animals have demonstrated *nongenetic* transformations that have proven inheritable. Such transformations, indicating higher-order qualities for genetic material, contradict some fundamental tenets of neo-Darwinian-Mendelian genetics generally postulated in basic and practical biological research. That is, these transformations are not based on hybridization-selection techniques, nor do they result from DNA mutational events.

For example, experiments have shown that in response to a particular array of environmental stimuli, young flax plants have undergone a qualitative transformation in size that has proven inheritable over many generations—even though the original stimuli are no longer present (Pollak 1977). Additionally, the DNA content was increased in the cells of the transformed plants. Under certain conditions this DNA level reverts to the previous (nontransformed) level, but the plant size remains at the transformed large size (see Figure 2).

The flax experiments indicate that the qualities of genetic material are not locatable in discrete molecules, the activities of which are essentially linear. Rather, the experiments demonstrate that the theory of heredity must include nonlinear genetic events of a geometric quality that reflect an interaction of the totality of cellular constituents within a changing ecology. The genetic events are of a global quality such that they reflect an interaction that is geometric in nature; that is, individual, discrete particulars (such as genes) are redefined to assume new qualities under a globally interacting array of molecular constituents that, in turn, reflect the larger interacting ecology. It is only using this conceptual framework that the earlier described areas can be coherent with an expanding and self-developing ecology, one not in equilibrium nor fixed at a given mode of lawful interactions.

The importance of these findings for medicine, agriculture,

and all other biologically related practices cannot be overestimated. An understanding of the most fundamental aspects of genetics—that is, of the global basis for cellular and organismic development—opens the door to basic reordering of total ecologies. A genetic theory that is premised on global geometric interactions (as opposed to discrete molecular interactions) allows an intervention that immediately maximizes energy-throughputs in a directed way and allows for the directed development of successively higher-order ecologies.

To take another example of holes in the Darwinian argument: Various experiments have shown that genes that appeared to have integrity in bacteria as one continuous linear unit of sequential coding for one protein have been demonstrated in eukaryotic organisms to be broken by huge noncoding segments referred to as "nonsense." As noted biologist Francis Crick recently put it: "In higher organisms a gene has, if anything, more nonsense than sense in it." Making this specific, Walter Gilbert at Harvard has estimated that the so-called genes have five to ten times as much "nonsense" as "sense" (Miller 1979).

Lima-de-Faria of Sweden, who has done much of the research on chromosomes, began in 1976 to demonstrate extensive evidence in a series of papers for the conclusion that genes are not distributed randomly on the chromosome and that mechanical interpretations of the way they are distributed or the way that distribution changes with evolution are bound to fail. Lima-de-Faria also concluded that natural selection plays at best a secondary role in chromosome evolution.

What this evidence establishes is that no scientist who seriously desires to create the kind of fundamental breakthroughs in understanding differentiated eukaryotic life that will be measurable in major spin-off advances in the medical treatment of cancer, aging, and related chronic diseases can begin from a Darwinian hypothesis.

If we smash the mysterious idol of natural selection, and throw away its dice, what kind of causality can we come up with? How can we begin to establish boundary conditions for the types of chromosomal changes that lead stably to new speciation while others lead to rapid instabilities and cell death? What evidence is there that a succession of highly ordered chromosomal changes, rather than random chromosomal changes, mediate within the nucleus the development of new species? How and why should those highly ordered chromosomal changes reflect in some way, the overall development of an ecologically more successful, more differentiated biosphere? What evidence is there, besides the molecular geneticists' discovery of huge amounts of noncoding sequences of DNA in eukaryotes, that genetic structures do more than coding functions for synthesizing proteins?

The Internal Riemannian Metric

In the mid-19th century, Louis Pasteur was the first to intensely study the optical activity of biologically synthesized crystals, such as tartrate, a residue produced in the fermentation of wine. He concluded that the geometry of living metabolic processes is ordered in such a way that it produces crystals that

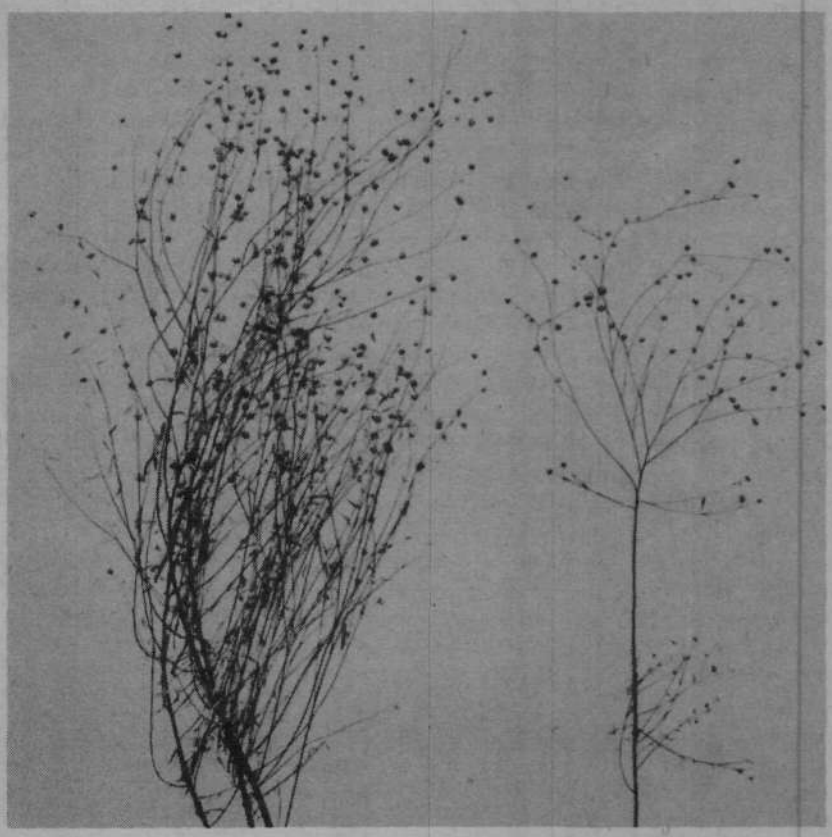


Figure 2
NONGENETIC INDUCED INHERITED CHANGE

The fourth generation of flax plants grown in a warm environment with nitrogen-potash fertilizer (right) or in a warm environment with nitrogen-potash-phosphate fertilizer (left). The descendants of the first-generation plants maintained their change in size over the 17 generation follow-up study, regardless of the fertilizer and temperature conditions imposed after the first generation. The original parent plants were intermediate in size between the two plants shown.

Source: A. Durrant, *Heredity* 17:27 (1962)

are selectively optically active; that is, crystals right-handed or left-handed in their chemical structure, but not both (see Figure 3). He also established that the space of nonliving chemical processes is not ordered in this fashion but produces a random mixture of right-handed and left-handed crystals (Hamerman 1977).

P. Curie continued this work, as did V.I. Vernadski, who was the first besides Riemann to suggest that biological space was subject to the ordering processes identified by Riemann. Vernadski wrote:

> We will start with the working scientific hypothesis that the space inside living matter is different from that inside the inert natural bodies of the biosphere. The state of the former space is not confined within the limits of Euclidian geometry. Time may be expressed in this space by a polar vector. The existence of rightness and leftness and their physico-chemical inequality points to a geometry different from Euclid's, a special geometry of space inside living matter. . . . It is possible that this would be one of the geometries of Riemann's type [Hamerman 1975]. . . .

Since Pasteur's time, it has been possible to examine two-dimensional squash preparations of the nucleus of preserved stained cells under the microscope. As the technology of microscopy improved, it became possible to view distinct orderings of chromosomes during the phases of both mitosis and meiosis in cell division. These ordered phases were followed by a longer nondividing cell phase, called the interphase, in which the nucleus appeared as a hazy blur with no chromosomes of distinct ordering (Figure 4).

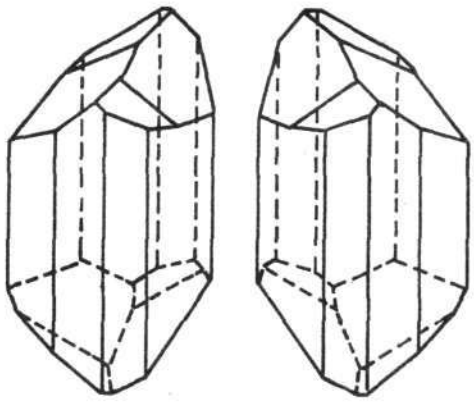


Figure 3
PASTEUR'S OPTICALLY ACTIVE CRYSTALS
In these original sketches by Pasteur, the right organic crystal (tartrate) rotates the plane of polarized light to the right and is referred to as the dextro form. The left tartrate crystal rotates the plane of polarized light to the left and is referred to as the levo form. In the biochemistry of living organisms, organic substances exist consistently in only one form. Such optical activity, however, does not occur outside of the biological realm. If produced under laboratory or industrial conditions, the same organic substances will yield a 50–50 random mixture of levo and dextro forms that are not optically active.

Molecular biology has assumed that the distinct ordering of these discrete chromosomal units resulted from the fact that during the reproductive phases the genetic material was tightly packaged and condensed into discrete chromosomal units so that all coding material could be systematically passed on to daughter cells. In contrast, during interphase when the cell was metabolically active, "packing" ordering was assumed to disappear, and the interphase nucleus was assumed to follow the Euclidian space and random thermodynamics of physical chemistry.

In 1977, Sedat and Manuelidis from Yale University succeeded in preserving the three-dimensional structure and internal ordering of the interphase nucleus. What they found was not random thermodynamics but extensive evidence of ordering, particularly with scanning electron microscopy (SEM) and polarization microscopy. All other microscopy techniques used, including phase-contrast microscopy, fluorescent microscopy, transmission electronic microscopy (TEM), and high-voltage stereo electron microscopy (HVEM), provided supporting evidence confirming the highly ordered nature of the interphase nucleus.

Sedat and Manuelidis's polarization micrographs of the interphase nucleus reveal not a simple, ordered, fixed, homogenous crystalline type of space like Pasteur's optically active crystals; but a still more complex highly ordered differentiated space. This higher ordering structure became visible when the nucleus was rotated under polarized (optically coherent) light. Some structures increased their intensity of brightness on rotation, while others lost intensity until extinction (Figure 5).

This and other work provides strong evidence that the integrity of the chromosomal structure is maintained during interphase, indicating that the chromosomal structure is not just an epiphenomenon of packing coding material, but a highly defined, differentiated continuum, capable of ordering transitions in geometry that coordinate different aspects of cellular activity. These orderly transitions preserve the continuity of relationships among different portions of that differentiated continuum. (This differentiated-continuum character of chromosomal structure is something Lima-de-Faria in 1976 referred to as the "chromosomal field.")

Sedat and Manuelidis found in order to study the three-dimensional multibodied, interphase nucleus, they had to come up with a way of preserving the original morphology of the nucleus long enough to study it. After trying different buffer systems, they devised a special high-potassium (0.1 *M*) and low-sodium (0.01 *M*) buffer. Anything altering this high potassium-to-sodium ratio, they found, would significantly and abnormally alter the band morphology—that is, the internal differentiation—of the chromosomes (Figure 6).

Little is currently known of the *in vivo* ionic environment of active interphase chromosomes, but similar research using

field focusing nuclear magnetic resonance (FONAR), focusing on energy-ordering relationships of tissue by Damadian et al. from Downstate in Brooklyn indicates that a cytonus limited-water state in a normal healthy cell maintains the high potassium-to-sodium ionic ratio. This limited-water highly ordered cytoplasmic state, measured by FONAR, is associated with normal energy flow within the tissues. In an increasingly entropic energy state—caused by malnutrition, poor circulation, cancer, and so on—tissues become bloated (edema), visibly disordered in cell ultrastructure, and progressively de-differentiated. This relationship between the highly ordered, high-potassium limited water state of healthy tissue and normal healthy metabolism (energy flow) has been further elaborated in the successful clinical research of Sodi Pallares of Mexico using glucose-insulin-potassium (GIK) therapy to treat cardiac problems, cerebral stroke, shock, and malnutrition (Sodi Pallares 1979).

The same relationship between clinically entropic energy flows and structural disordering holds in the nucleus. In 1977, Gupta et al. in Bikaner, India found a statistically significant correlation between increased chromosomal abnormalities, (isochromone gaps, chormatid gaps and breaks, ring chromosomes, and so on) in children suffering from severe protein-calorie malnutrition compared with healthy children. Their results were similar to more controlled studies on mice.

A still more interesting case is the 20-year studies of chromosomal evolution of Ehrlich-Lettré-Diploid (ELD) mouse tumors, a cancer cultivated over generations in mice by serial tumor transplant. The ELD tumor apparently has an unstable genome* that slowly sheds chromosomes during this prolonged period of study. Within that genome, however, certain specific chromosomes appear very stable, while others tend toward abundant structural rearrangements and trisomy or tetrasomy* of the entire chromosome or just a specific section. More intriguing, upon the shocking decrease of energy associated with the switch from *in vivo* culture (inside a host mouse) to culture in an outside vessel, sudden radical changes in the ELD genome result in rapid abundant structural rearrangements and wide scattering in chromosome number, which suggest general cell polyploidy (Nielsen 1967, 1976).

Chromosomal studies of various well-studied human cancer types indicate a similar nonrandom and multiphased degeneration. Aberrations cluster around restructuring in chromosomes number 1, 7, 8, 9, 14, 20, 21, and 22, and most frequently involve specific nonrandom breakpoints. The multistepped entropic disintegration of normal chromosomal ordering follows a similar pattern (Figure 7). In the early stages of primary tumors, genomes tend to be hyper or hypodiploid,* with specific chromosomal aberrations, generally involving trisomy or tetrasomy of specific chromosomes or chromosome sections. In the later stages, such as in patients studied with malignant melanoma who died shortly after the study, the loss of specific chromosomes and generally polyploidy are dominant in tumor cells (Kakati 1977).

Although the exact causal sequence of events in the multiphased degeneration of cancer tissue has yet to be established, the terminal polyploid phases of the cell nucleus—in which the cell is effectively multinucleated, with the nucleus dividing

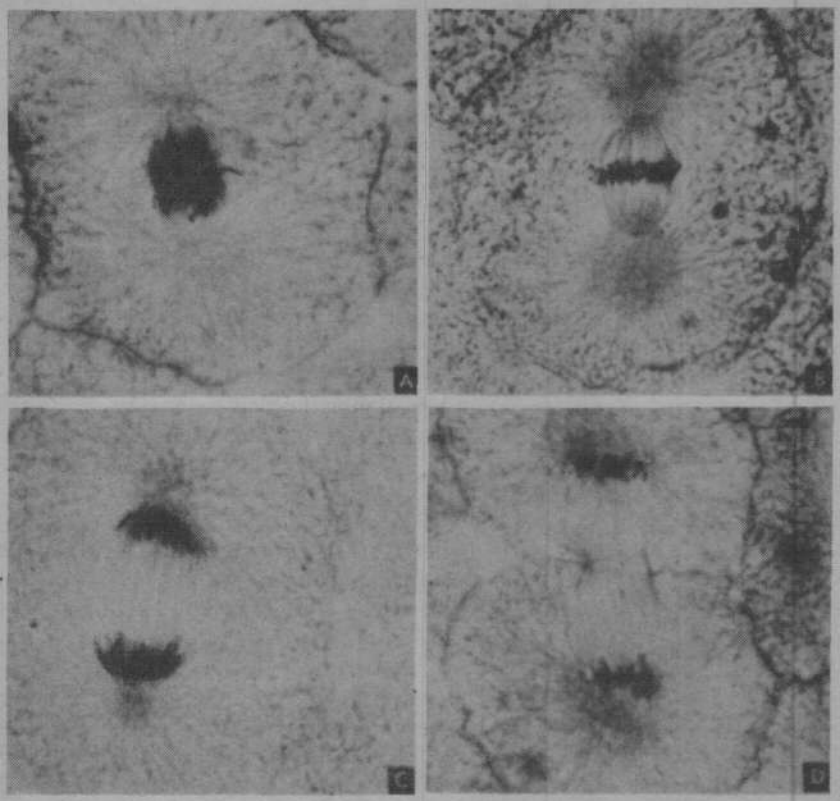


Figure 4
CELL DIVISION IN THE WHITEFISH

Mitosis (cell division) in the whitefish, as seen under the ordinary light microscope. Four phases of mitosis are shown, in which the condensed chromosomes appear as distinct dark strings. During interphase (not shown in this set of pictures), the chromosomal material is very diffuse and difficult to distinguish from the cytoplasm, except where the nuclear membrane is visible.

Source: David M. Bonner, *Heredity*, Englewood Cliffs N.J: Prentice-Hall, Inc., 1961, p.5.

faster than the cytoplasmic cell body—are associated with the more entropic phases of metabolism in the cancerous cell cytoplasm. In the bloated and disordered terminal phases of cancerous tissue, the mitochondria* fail to function in the cytoplasm, eliminating the highly efficient oxidative phosphorylation pathway of respiration, forcing the disordered cell to rely on the much less efficient fermentation pathway. This metabolic switch is a huge and terminal step downward—the cell is no longer capable of supporting the energy flow required for normal reproduction.

There is another characteristic of cancerous cells that should be associated with progressive disordering of the cell nucleus. Cancer cells are anarchists with respect to their rate of cell division. They have totally lost the harmonic ordered relationship that characterizes ordinary differentiated cells in normal healthy tissue. Molecular biology tends to look upon such tissue relationships as if they were governed by chemical gradients. Yet simple computer calculations can rapidly establish that such an approach would give DNA far more to code for than its total quantity within the genome would allow—even without considering a further necessary reduction of coding DNA due to "nonsense" (noncoding) DNA.

The rediscovery in 1974 (using a refined generation of photon counters) of mitogenetic radiation, originally discovered by A.G. Gurvidza in 1923 but treated skeptically (Gamaleya 1977), suggests that there is much more to the higher-ordered energy flows and structuring of the nucleus, which relate to the coordination of broader cell-specific and tissue-specific energy flow and metabolism, than simply the production of on-off coding control for production of enzymes and other proteins. The initial discovery—that dividing cells give off a very weak ultraviolet radiation that stimulates the division of other cells, even through a quartz barrier—is backed up by spectral studies that show that DNA emits and absorbs light in the ultraviolet range. Yet this is ignored as if the hypothesis that DNA, in its peculiar chromosomal structuring, is just an elegant coding device that will at some mysterious point in the future suddenly become sufficient to unlock the mysteries of cell differentiation, aging, cancer, and so on.

These examples and the ones that follow, taken singly, can each be explained as results within the basic tenets of molecular biology—if one does the kind of juggling indicated above. However, taken as a whole, these results point up the fraudulent epistemology of molecular biology. Furthermore, they

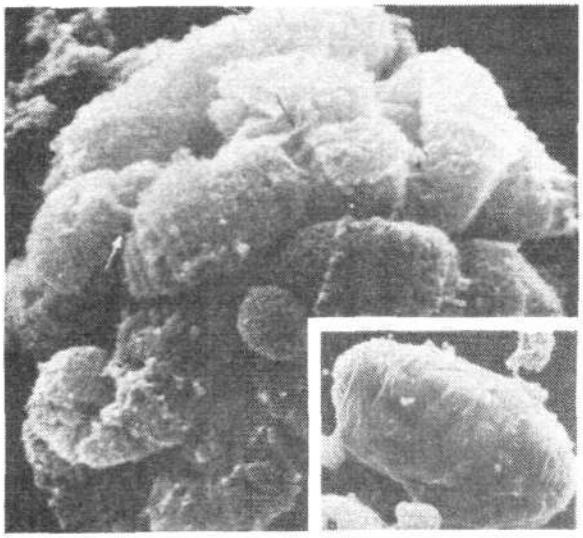


Figure 5
CHROMOSOME ORGANIZATION IN THE NUCLEUS

A scanning electron microscope view of a fruit fly (Drosophila) *nucleus after gentle removal of the nuclear envelope. The inset shows the nucleus before removal of the nuclear envelope. The polytene or giant chromosome organization of the fruit fly is created when a group of cells no longer divides but instead continues to replicate its DNA in a geometric manner leading to a banded giant chromosome composed of hundreds of duplicate DNA molecules arranged in parallel.*

Source: J. Sedat and L. Manuelidas, "A Direct Approach to the Structure of Eukaryotic Chromosomes," *Cold Spring Harbor Symposia on Quantitative Biology, Vol. 42*, p. 334.

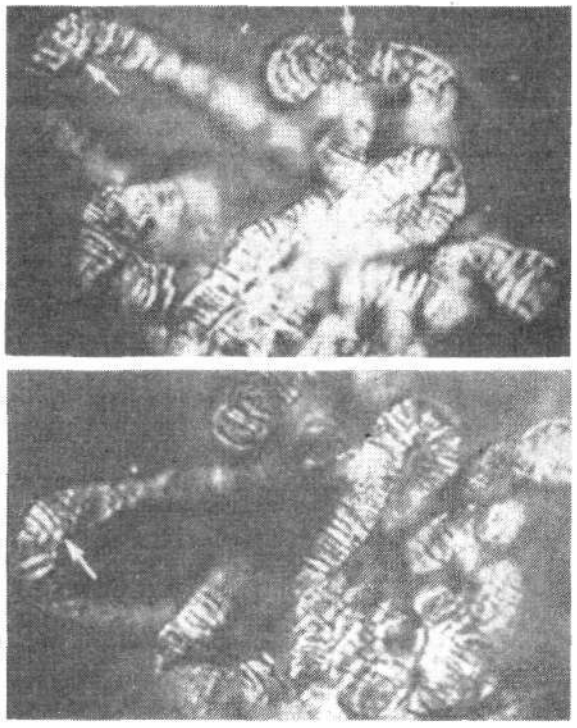


Figure 6
OPTICAL ACTIVITY IN THE NUCLEUS

The polytene or giant chromosomes of the fruit fly nucleus under the polarized microscope, revealing optical activity. The two pictures show specific change in intensity and direction of bright bands (compare arrows) in the giant chromosome structure as the sample is rotated.

Source: Sedat and Manuelidas, p. 335.

can be viewed as representi ng the development of new geometric orders of interaction for cells and ecologies, in response to transformations in energ y throughput.

Thus far, I have looked only at boundary-condition distinctions between obviously clinically entropic and negentropic living subcellular ultrastru cture and energy flows. Now I will discuss one last energy flow boundary condition that is absolutely crucial in the biological but not in the physical realm: the distinction between li ving and dead subcellular ultrastructure and energy flows.

On the subcellular le vel, a crucial sense of the degree to which highly differentiated energy flows are responsible for the structuring and org anization we call life has been developed in studies on pos terior necrotic zone (PNZ) embryonic chick cells and embryonic spinal chick neurons. These cells are not diseased, but a re slated to die at a certain stage of the embryonic developme nt of the chick.

In the PNZ chick cell, studied through the microscope, the entire cell begins to shrink. In particular, the nucleus becomes pyknotic* and collapsed into a condensed form, and the nuclear and cytoplasmic membranes (endoplasmic reticulum, golgi apparatus) beg in to degenerate. Throughout the endoplasm vaccuolizatio n occurs with the appearance of distinct crystalline structures, built of ribosomes and various cytoplasmic proteins (Figure 8).

Such degenerati on follows the same pattern regardless of whether the cell is normal but embryonically slated for necrosis, or whether it is induced by hypothermia, or whether it is induced by poiso ning of the mitochondrial system by vinblastine or vincristin e. Experiments have shown that vincristine-induced formati on of protein crystals in PNZ chick cells is a reversible phenomenon, capable of being transformed into filaments, depending on the energy flow of the cell (Mottet 1972). Later studies of necrotization in embryonic chick spinal cord indicate that the degeneration begins with clumping and condensation of chromatin beneath the nuclear membrane in increasingly large oval masses. The nucleus becomes increasingly irregular in shape; the cytoplasmic membranes disappear in the case of the golgi complex and become highly fragmented and disordered in the case of the endoplasmic reticulum. In addition, the previously endoplasmic-reticulum-bound ribosomes are now free within the cytoplasm. The nuclear membrane breaks down, ribosomes now form crystalline aggregations, and mitochondria are swollen and begin to aggregate, apparently sharing membranes in some cases (O'Connor 1974).

Such studies emphasize that the higher ordering of the living biological realm is totally unlike that of physical chemistry. It is a highly differentiated realm of multiply connected Riemannian manifolds, where the ordering and energy flow associated with the highest manifold—the nucleus—dominates the ordering within the cytoplasm. Only when this higher-manifold energy flow breaks down do these interconnections between multiconnected manifolds disintegrate, leaving the cytoplasm with the kind of crystalline ordering associated with physical chemistry and the Second Law of Thermodynamics. This is an explicit example of a collapse from the highly differentiated energy flow of the $n + 1$ realm back down to the n realm—biological death.

This jump in the pace of motion between the fixed ordering of the n realm of physical chemistry and the $n + 1$ realm of evolving biological life—like the jump between the $n + 1$ realm and the $n + 2$ realm with the emergence of man—

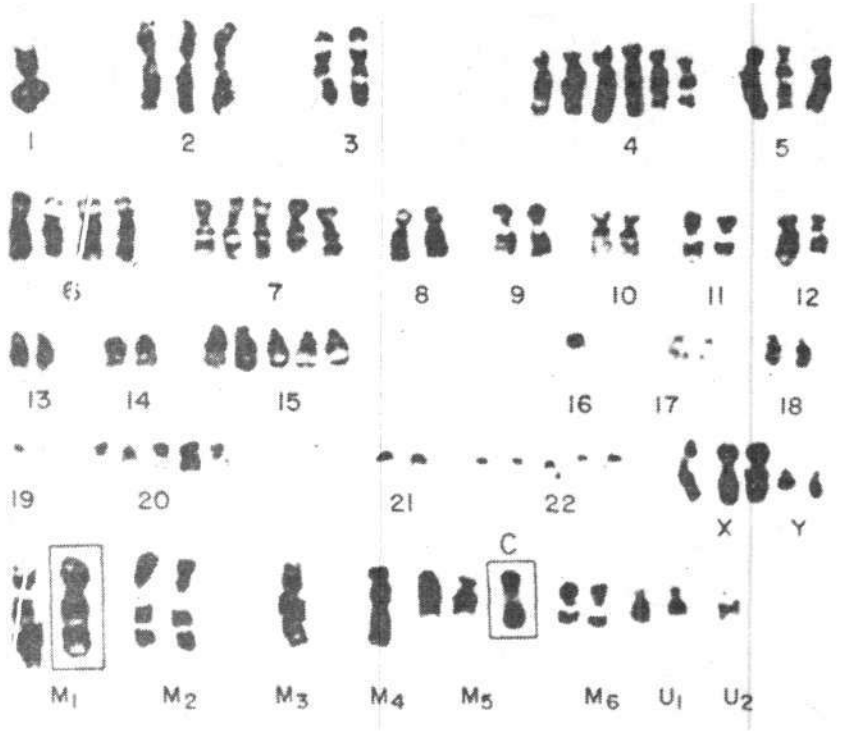


Figure 7
CHROMOSOMES IN HUMAN CANCER

Chromosomal aberrations in the dark pigmented tumor tissue of a 55-year-old man with metastatic malignant melanoma (cancer). A normal healthy male human nucleus would have exactly 22 pairs of chromosomes, plus the xy pair of sex-linked chromosomes. The tumor tissues of the patient shown has extra chromosomes in some pairs and chromosomes missing in others; plus an additional number of totally abnormal chromosomes (bottom row) not present in healthy tissue. The lumpy banding of these chromosomes reflects the supercoiling in the individual chromosome structure. The patient died six months after the chromosooe study, after unsuccessful radiation therapy and chemotherapy.

Source: Kakati et al., "Chromosomes and Causation of Human Cancer and Leukemia," *Cancer*, 40 (1977), p. 179.

demands that the scientific mind look for something far more profound and exciting in evolution than the various Darwinian or random-genetic-drift explanations that until now have dominated the biological sciences.

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Note

1. Structure as a differentiated ordering or geometry of energy flow is empirically accepted in the phase changes of matter from solid to liquid, gas, or plasma. Unfortunately, however, our conception of energy flow in such situations is tied to a notion of entropic dissipation of energy: temperature. Lacking knowledge of the internal ordering of energy flow within particulate structures of matter, we assume that particulate structures that have a high-density internal energy flow must also have large entropic proportional dissipation of energy externally.

   Like superconductivity in the *n* realm of physics, crucial biological structures (such as those involved in photosynthesis) that have been tested for efficiency in energy flow have been found to have an exceedingly efficient (99 percent) use of energy. It has also been suggested that DNA is superconductive—implying the same nondissipative efficiency in energy flow. This issue—which will be discussed further in an upcoming article on biological superconductivity—is not a trivial one, since it is most useful to look at atomic and molecular structures as an organized metastable highly internally differentiated energy flow of plasmoid nature.

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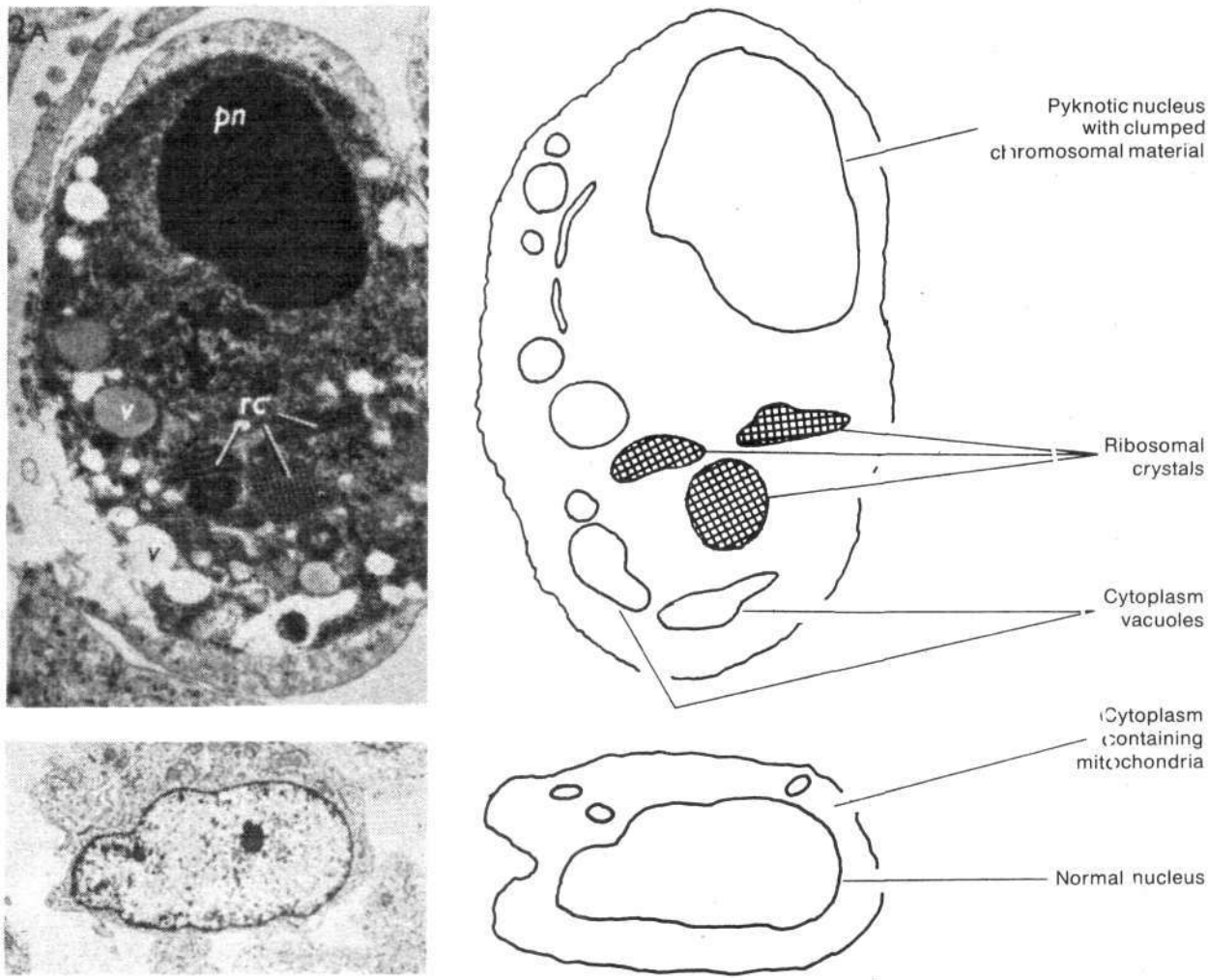

Figure 8
CRYSTALLINE NECROTIC CELLS

A degenerated interphase cell from the posterior necrotic zone (PNZ) of a chick embryo is compared with a normal cell (bottom) from surrounding tissue. Note the exceedingly condensed collapsed pyknotic nucleus of the degenerate cell compared to the diffuse character of the chromosomal material in the normal interphase cell nucleus. In the normal cell cytoplasm, the ribosomes are visible only as dots scattered throughout the cytoplasm.

Source: N.K. Mottet and S.P. Hammar, "Ribosome Crystals in Necrotizing Cells from the Posterior Necrotic Zone of the Developing Chick Limb," *J. Cell. Sci. 2* (1972), pp. 411-412.

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Glossary

angiosperms: flowering and fruiting plants, the seeds of which are borne within a matured ovary.

chromosomes: discretely organized genetic material within the cell nucleus, readily visible under the light microscope during cell division in stained tissue. The number of pairs of chromosomes in the nucleus of cells of any kind of plant or animal species usually remains the same.

chromosomal trisomy or tetrasomy: the presence of three or even four copies of a chromosome, rather than the usual diploid number.

DNA: deoxyribonucleic acid, the double helix molecule that, combined with some basic (histone) proteins and certain acidic (nonhistone) proteins, makes up the chromosomes, the discretely organized genetic material in the cell nucleus.

eukaryote: a cell having a membrane-bound nucleus, membrane surrounded organelles, and multiple chromosomes in which DNA is combined with specific histone proteins; all multicellular organisms consist of such cells.

gene: an element of genetic material that transmits genetic information for one single trait; redefined by molecular genetics as a continuous sequence of nucleotides (subunits) in a DNA molecule believed to code for one particular protein.

genome: a (haploid) set made up of one chromosome from each pair of chromosomes in the normal cell nucleus. Such a set is believed to contain or "code for" all the genetic traits of that species, although in practice somatic cells function with a double genome (that is, in a diploid state).

gymnosperms: plants with naked seeds or spores, such as ferns and mosses.

hyperdiploid, hypodiploid: hyperdiploid means more than diploid, more than the ordinary double (paired) set of chromosomes in the cell nucleus; hypodiploid means less than the ordinary paired set of chromosomes in the cell nucleus. Both cases are clinically abnormal and generally refer to cancer cells.

Mendelian genetics: a series of laws based on the works of Mendel, an Austrian monk who crossed pea plants. The laws insist that only one of each gene or genetic trait in a pair of genetic traits is passed on from the parent to the offspring, through random, independent segregation in which the inheritance of one trait is unaffected by the inheritance of another trait. Mendel's work was later shown by rigorous statistical analysis to have been fraudulent, lacking in the random deviation ordinarily associated with honest reporting of experimental data. In addition, his law of independent assortment does not hold up for many interlinked traits.

mitochondria: the subcellular "power house" of the eukaryotic cell. A double-membrane-bound organelle in which carbohydrate bond energy is very efficiently recaptured through oxidative respiration.

polyploidy: a double, triple, quadruple, and so forth set of chromosomes; a multiple set of more than the usual haploid or diploid number of chromosomes.

prokaryote: a bacteria-like cell lacking a membrane-bound cell nucleus and membrane-bound cell organelles; a bacterium or blue-green algae.

pyknotic: highly condensed and shortened.

singularity: a transforming organization of matter and energy whose more rapid pace of evolution rapidly subsumes and reorders the previous situation.

Starfire
Toward a Commercial Tokamak Reactor

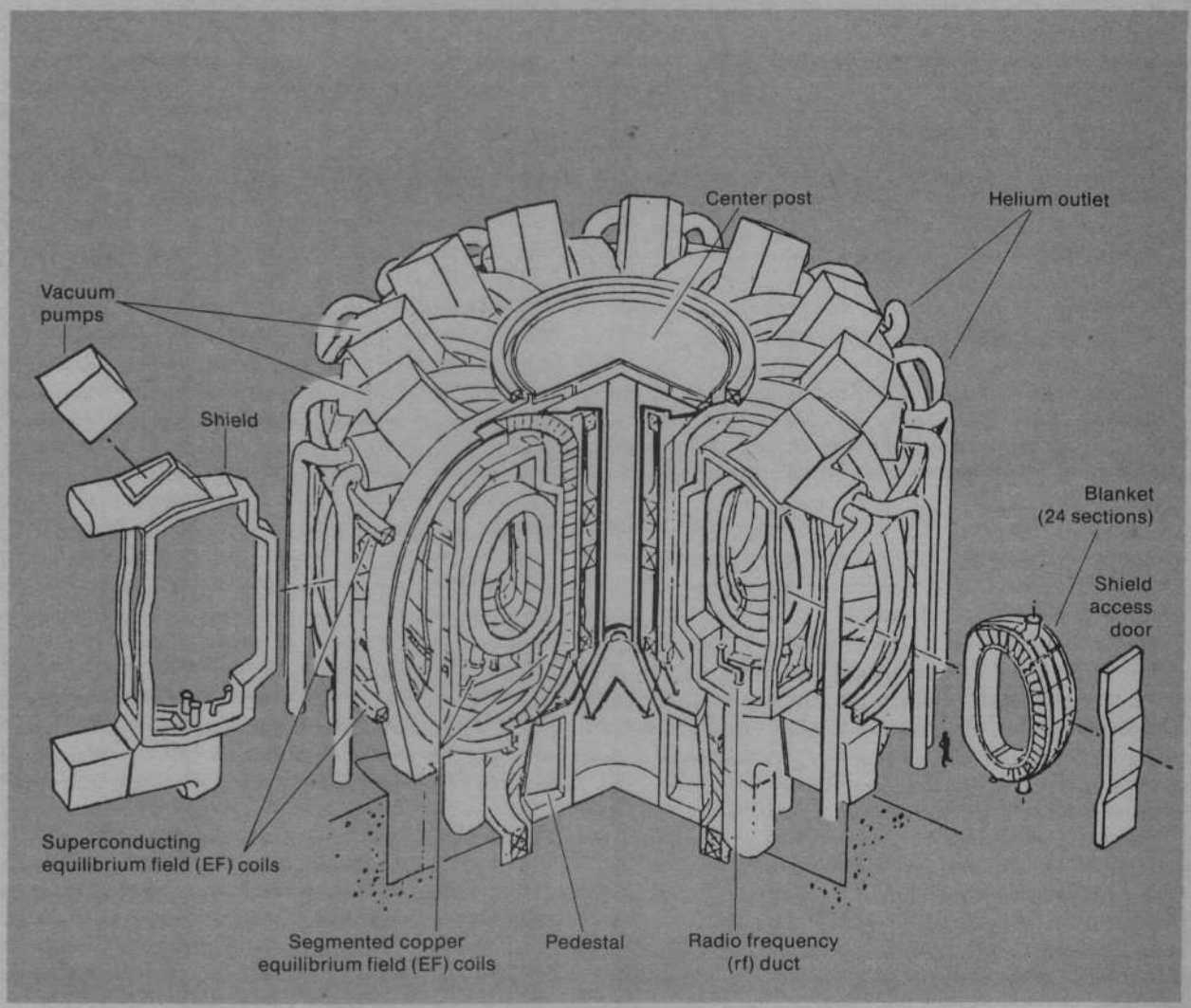


Figure 1
STARFIRE DESIGN POWER REACTOR CROSS-SECTION

The center post provides mechanical support for the inside portions of the toroidal magnetic field coils. The helium coolant outlets lead to a steam generator and provide the primary heat transport in this version of the Starfire.

A first wall/blanket segment is shown in detail and could be further broken down into 24 modular components. A shield access door, to permit access to the blanket segments without disassembly, is also shown in detail. Helium coolant inlets are located on the bottom of the reactor. The elbow shape of the radio frequency (rf) duct prevents fusion neutrons from gaining access to the rf generator itself.

Segmented copper equilibrium field magnetic coils are located inside the main superconducting toroidal magnetic coils, and the superconducting equilibrium field coils are located on the outside.

by Charles B. Stevens

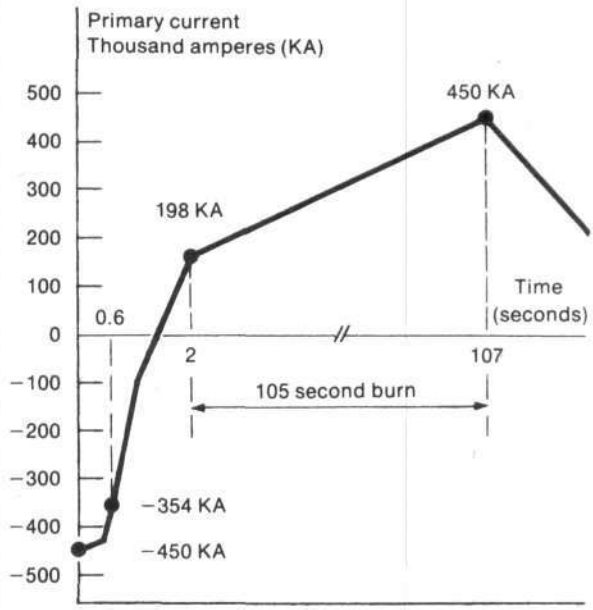


Figure 2
ELECTRIC CURRENT IN AN ORDINARY TOKAMAK

Depicted here is a typical plot of current versus time in an ordinary pulsed tokamak. The current shown in the primary loop induces the secondary current in the plasma itself, which confines and heats the plasma. Two important features are to be noted. First, current induced in the plasma is proportional to the rate of change in the primary current.

(This is because the plasma current is proportional to the electromotive force created around the circumference of the plasma, which being proportional to the change in magnetic flux through the plasma is, in turn, proportional to the rate of change of the magnetic-field-generating current in the primary loop.)

Second, when the direction of the rate of change of current in the primary loop itself changes (indicated here at the 450 thousand ampere level), the current in the plasma reverses and it becomes unstable, extinguishing the burn. Thus the plasma burn time is directly related to the transformer cycle time. In practice, the basic reason that this cycle time is limited is the materials limitation in handling the extremely high primary currents that would be involved in attempting to increase the burn time by extending the range of the primary current increase (or decrease).

A NEW REACTOR DESIGN called Starfire, now under development at Argonne National Laboratory in Illinois, promises some original solutions to a variety of technical problems associated with the tokamak approach to fusion energy and promises to lead to a more economical and workable design for future fusion power plants.

As the tokamak magnetic bottle approach has gained experimental success over the past few years, increasing numbers of designs for actual electrical power plants based on the tokamak system have been developed. Many of these conceptual designs have been carried through in great detail, with scores of engineering man-years invested. Until now, however, all of these reactor plans have been primarily concerned with extensions of ongoing experimental work or have been broadly based scoping studies to determine the key scientific and technological bottlenecks to the development of commercial tokamaks.

Although very important, these initial conceptual designs do not reflect the full commercial and technological viability of fusion. Now, a new generation of reactor designs is underway that has the primary objective of producing commercially viable, safe, and practical power plants. Argonne's Starfire Project—under Dr. Charles Baker and Dr. Mohamed Abdou and with major input from McDonnell Douglas, General Atomic, and the Ralph M. Parsons Company—is the first effort of this new generation.

The preliminary results of the Starfire Project were reported this winter at several scientific conferences, and the full details of the design are scheduled to be completed by fall 1980. This article is a preview of what a commercial tokamak fusion power plant based on the initial Starfire design might look like.

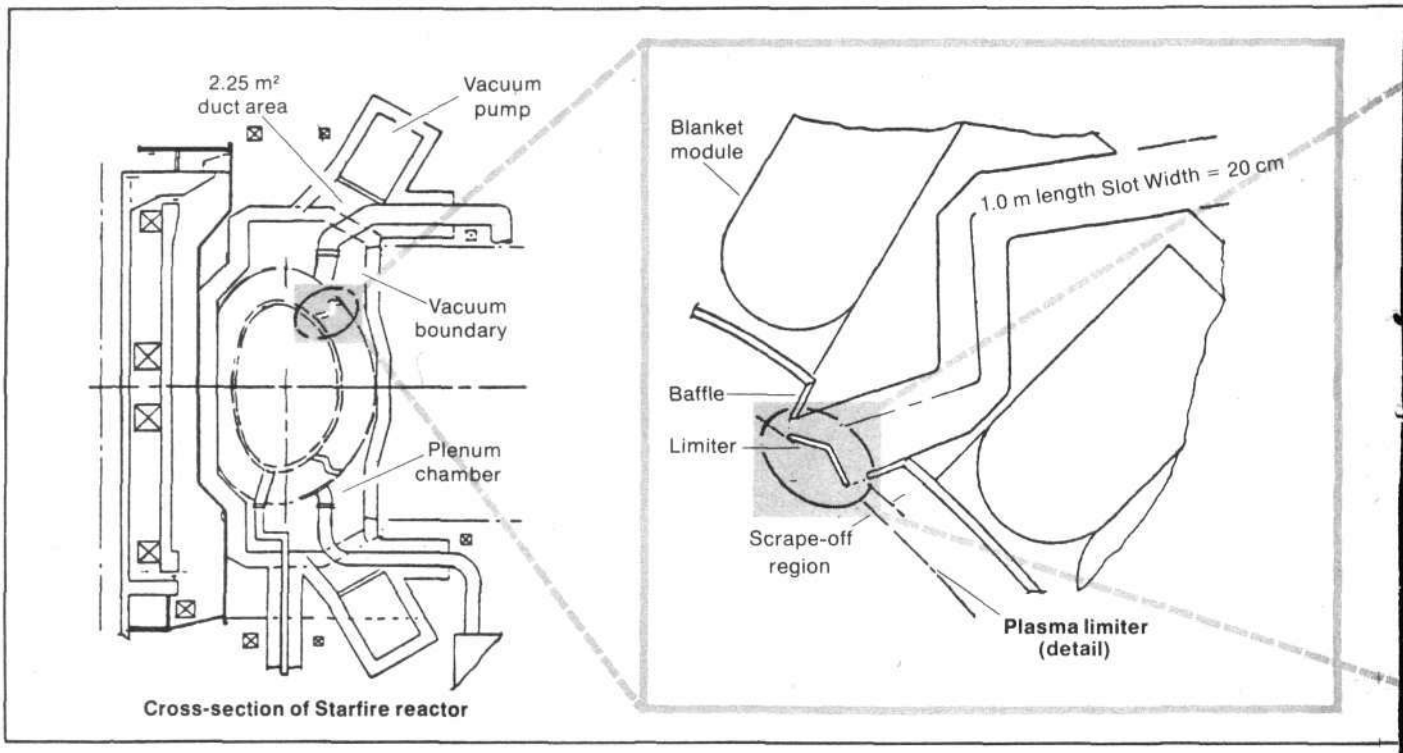
Major Parameters

The primary goal of the Starfire study is to select the most attractive set of design parameters and concepts that make tokamaks economically competitive and environmentally acceptable. Results and experience gained from previous fusion reactor designs have provided the starting point for Starfire.

The reactor is based on a tokamak magnetic bottle system using the deuterium-tritium-lithium fuel cycle. The major difference between Starfire and other tokamak reactor designs is that it is a steady-state reactor driven by radio frequency. Otherwise, Starfire takes the best options from previous reactor designs in terms of materials, blanket design, magnets, refrigeration, heat transfer, and so forth.

A cross-section of the Starfire reactor is shown in Figure 1, and a summary of the major reactor parameters and design features is given in Table 1. The reactor's thermal power is about 3,800 megwatts with net electrical power of 1,150 megawatts—about the same level of power output of current nuclear fission and fossil electric power stations.

The basic distinguishing feature of the Starfire is that it would operate in a steady-state mode instead of the pulsed operation on which previous tokamak reactor designs have been based. This major change in design leads to a very considerable easing of the technological problems encountered in previous designs and is a direct result of the rapid



Cross-section of Starfire reactor

scientific and experimental progress in current tokamak research and in plasma physics in general.

All experimental tokamaks involve a donut-shaped plasma in which a transitory electric current is induced. (The name tokamak is a Russian acronym that stands for the words torus with current.) This induced electrical current generates the essential poloidal field component of the magnetic bottle that confines and insulates the tokamak plasma, permitting the efficient attainment of hundred-million degree temperatures. The second and major component is that of the toroidal magnetic field, which is generated by the external magnetic field coils that surround the donut-shaped vacuum chamber.

The length of time that the tokamak plasma can be sustained is limited by the duration of the plasma current. In today's tokamaks this current is induced by means of ordinary transformer technology—the tokamak is a one-turn transformer of sorts. The pulse length of the transformer determines the outer limit for the timespan that a tokamak plasma can be maintained.

In previous reactor designs, transformers were designed to maintain tokamak plasmas for a few minutes up to an hour, then shut down for a short time and restart. This pulsed mode of operation caused a number of major engineering difficulties; for example, mechanical and thermal stresses as a result of between-pulse changes in temperatures and mechanical forces. Particularly when combined with the effects of fusion neutrons hitting the first wall of the reactor chamber, these stresses lead to significant degradation of the physical properties of the materials out of which the reactor is made. The degradation of the reactor chamber wall means that it has to be replaced every few years, a major capital cost. In addition, a large and costly energy storage system would be needed to maintain a constant power output from the power plant between cycles. And a second, very intense and reliable energy storage system would be needed to provide the power necessary to reignite the fusion plasma. In previous reactor designs, these additional systems lead to further, major increases in the capital costs of power plants.

Radio Frequency

The Starfire overcomes the difficulties of pulsed operation by projecting a steady-state tokamak reactor based on a continuous plasma electric current driven by radio-frequency electromagnetic radiation, or rf. In this new approach, which is based on recent theoretical and experimental studies, an rf generator will direct 100 megawatts (8MW/m² power density at the plasma surface) of electromagnetic energy into the plasma. The radio waves interact with the plasma to produce heating and an 11 million ampere electric current. Rf provides a convenient means to control the particular parameters of the fusion plasma such as temperature and density profiles, and may also provide a means of helping to purge the plasma of impurity elements (nonfuel elements).

Radio frequency heating works as follows: a plasma is made up of charged particles, electrons and ions. Electromagnetic radiation, in the form of radio-frequency waves, will interact with the charged particles of a plasma. This interaction can be quite complex, leading to heating of the plasma, to generation of various types of waves in the plasma, or to reflection of the incident rf wave.

The current theory is that rf waves acting on a tokamak plasma could directly transfer momentum to the plasma electrons, causing them to move in one direction in relation to the plasma ions. This, by definition, is an electrical current. Other

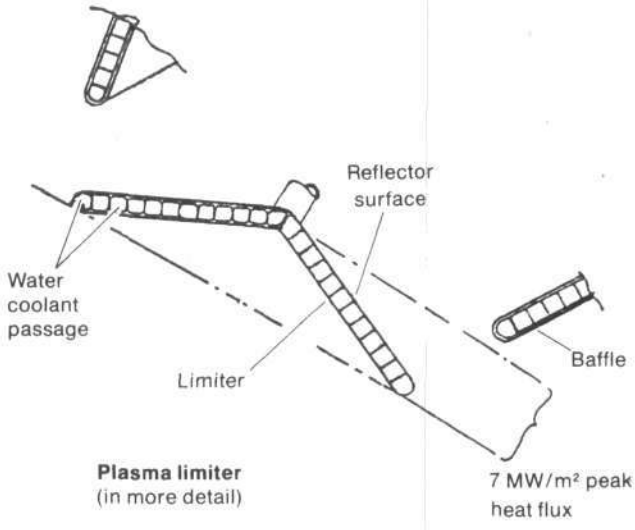


Figure 3
LIMITER/VACUUM DUCT IMPURITY REMOVAL SYSTEM

Shown above is a cross-section of the reactor donut and detailed blowups of the 60-meter toroidal plasma limiters, which pass circumferentially around the outer edge of the plasma region.

The limiter deflcts ions from the scrape-off zone in the plasma into adjacent slots in the first wall. It is cooled by water passing through interior tubes and receives a peak heat flux of 7 MW/m². Baffles on either side of the slots leading off from the limiter help prevent the fusion-generated neutrons from migrating up the slot (shown in detail in the larger blow-up).

These slots, 60 meters long and 20 centimeters wide, penetrate the first wall and blanket. The location and configuration of the limiter are designed to maximize the probability of a molecule entering the slot after striking the limiter. Each slot contains a step to reduce neutron streaming.

more complex mechanisms are also possible, depending on the configuration of the plasma and the rf and the particular frequency of rf used. For example, the incident rf wave could induce asymmetric trapping of electrons in the toroidal magnetic field. This generates an electric field that induces an electrical current in the plasma.

Experiments to test these various proposed rf-induced currents in tokamaks are now coming on line. Other continuous-current drive approaches under consideration by the Starfire design team include relativistic electron beams and magnetosonic waves.

Plasma Properties

The Starfire plasma has a major radius of 7 meters and a "D"-shaped cross section to permit higher plasma betas. The width of the plasma column is 2.88 meters and its height is 4.6 meters. The ion temperature and density are, respectively, 17 keV (187,000,000 C) and 100 trillion per cubic centimeter; for the plasma electrons, temperature and density are 22 KeV (242,000,000 C) and 1.3 hundred-trillion per cubic centimeter.

The projected average toroidal plasma beta (a measure of the efficiency with which the magnetic field confines the plasma) is a relatively modest .067. This leads to a fusion neutron power density at the wall of the reactor chamber of 3.5 megawatts per square meter.

All these plasma parameters, in particular the 3.5 megawatts per square meter power wall loading, are consonant with other recent tokamak reactor design parameters. The plasma density, though, is slightly lower, because a lower density is needed to permit penetration of the radio waves into the plasma. This is also why the plasma beta is kept at a relatively low value.

Table 1
STARFIRE MAJOR DESIGN FEATURES

Net electrical power	1,150 MW
Gross electrical power	1,600 MW
Fusion power	3,200 MW
Thermal power (nominal)	3,800 MW
Thermodynamic efficiency	41%
Overall availability	75%
Average neutron wall load	3.5 MW/m²
Major radius	7.0 m
Plasma half-width	1.94 m
Plasma elongation (b/a)	1.6
Maximum toroidal field (nominal)	11.0 T
Number of TF coils	12
Plasma burn mode	Continuous
Current drive method	rf
Plasma heating method	rf
TF coils material	Nb_3Sn/NbTi/Cu/SS
Wall structural material	Ferritic steel
Blanket structural material	Ferritic steel
Wall coolant	D_2O
Tritium breeding medium	Li_2O
Blanket coolant	Helium
Plasma impurity control	Low-Z coating + limiter and vacuum system + enhanced radiation + field margin
Primary vacuum boundary	At inner edge of shield

MW stands for megawatts; m stands for meter; b is the height of the plasma column, a is its width. T stands for tesla and is equal to 10,000 gauss. TF refers to toroidal field; rf refers to radio frequency. Nb_4Sn, NbTi, Cu, SS, D_2O, Li_2O are respectively niobium tin, niobium titanium, copper, stainless steel, heavy water, lithium oxide. Low-Z refers to low atomic number.

Table 2
SELECTED FIRST-WALL/BLANKET MATERIALS OPTION

	Coolant			Structure**	
Coolant	First wall	Blanket	Breeder*	First wall	Blanket
Reference	Heavy water	Helium	Lithium oxide	Ferritic steel	Ferritic steel
Alternate	Heavy water	Heavy water	Lithium oxide	Ferritic steel	Ferritic steel
Backup	Lithium	Lithium	Lithium	Vanadium	Vanadium

* Alternate options for the solid breeder include Li_2SiO_3 and $LiAlO_2$; a neutron multiplier will be necessary with these options.
** Austentitic stainless steel is an alternative selection for the first wall structure and both austentitic stainless steel and titanium alloys are possible alternatives for the blanket structure.

Among the factors important in selecting first wall/blanket materials and coolants are the need to breed tritium fusion fuel in the nuclear reaction between the fusion generated neutron and lithium; materials safety and compatibility (for example, using lithium as a coolant can be a potential fire hazard); the durability of the materials in the fusion nuclear and heat environment; and the engineering feasibility of the heat transport system.

Table 3
COMMERCIAL FUSION POWER REACTOR DESIGN PARAMETERS

	Culham, England MK-I	U. of Wisconsin UWMAK-I	Princeton Plasma Physics Laboratory MATT-1050	U. of Wisconsin UWMAK-II	U. of Wisconsin UWMAK-III	U. of Wisconsin JAERI-II	Oak Ridge National Laboratory Demo	Culham, England MK-III	General Atomic Demo	Julich W. Germany CTR	Mass. Institute of Technology HFCTR	U. of Wisconsin NUWMAK
Design year	1972	1973	1974	1975	1976	1976	1976	1976	1976	1977	1978	1979
Thermal power (MW) (average continuous)	5,830	4,665	5,146	4,712	4,735	2,000	2,150	5,830	1,676	5,000	2,470	2,097
Total electric power (MWe)	—	1,889	2,405	1,807	2,050	—	750	—	754	—	870	725
Duty cycle (%)	—	93.3	97	94.2	94.7	—	95	—	94.7	—	96	92
Net electric power (MWe)	2,500	1,473	2,030	1,709	1,985	—	Not given	2,500	611	—	775	660
Auxiliary heating power (MW)	—	15	None	200	200	—	100	—	100	—	100	80
Burn time (seconds)	—	5,400	6,000	5,400	1,800	—	1,200	—	800	—	500	225
Major radius (M)	12.5	13	10.5	13	8.1	10.5	6	7.4	7	6.93	6	5.13
Minor radius (M)	2.5	5	3.25	5	2.7	2.7	1.5	2.1	1.8	1.82	1.2	1.13
Plasma beta (%)	1.5	5.2	4	6.4	8.3	3.3	15	9.3	10	15	4	6.5
Toroidal field (T) (on plasma axis)	9.5	3.8	6	3.6	4	6	3.6	4.1	3.9	3.7	7.4	6
Plasma current (MA)	9.7	25.7	14.6	14.9	15.8	10.4	4	11.6	18.6	8.8	6.7	7.2

This table was taken from a recent U.S. Office of Fusion Energy report on fusion technology development. MW stands for million watts, M for meters, T for tesla units of magnetic field (1 tesla equals 10,000 gauss), and MA for million amperes of electric current. The neutron power densities on the first wall of the fusion reaction chamber in the early designs ranged from 1 to 2 MW/m², while those found in recent designs range from 2 to 7 MW/m2.

The chief portion of the Starfire magnetic coil system consists of 12 superconducting niobium tin, 11 tesla toroidal field coils. Other coils (equilibrium field coils) which are used to maintain the position of the plasma and give marginal trim and smoothing to the main magnetic field, consist of ordinary copper coils and niobium titanium field coils. The main toroidal magnetic field at the center of the plasma is 5.62 tesla. The need for this relatively difficult, high-field magnet system is also primarily due to the low-density, low-beta plasma.

The initial design for the Starfire heat transport system calls for a combination of helium and heavy water coolants, which both drive a secondary steam-turbine loop. An all-water coolant system is being investigated.

Plasma Impurity Removal System

The problem of removing tokamak-plasma impurities, such as the helium fusion reaction product and nonhydrogen elements originating from the reaction chamber wall and vacuum system, was recently identified by both U.S. and international design teams as the most difficult and potentially costly problem now confronting tokamak fusion development.

The Starfire project is developing several innovative schemes for resolving the impurity removal problem. One candidate under investigation is shown in Figure 3. This is a limiter/vacuum impurity collection system, which concentrates and pumps out an outer layer of the plasma column. (Limiters are used in tokamak experiments to protect the vacuum chamber wall from contact with the fusion plasma; it is simply a material barrier placed so that the plasma comes into contact with it before touching the chamber wall.) In this way, some of the impurities are removed from the plasma.

In addition, the toroidal field coils are being designed with sufficient strength to contain the excess plasma pressure of the helium fusion products. Other features of impurity control under investigation are the use of low atomic-number coatings and operation of the plasma so as to maximize the heat radiated from it, while minimizing the transported heat.

Major questions under thorough review include high heat fluxes, neutron radiation damage, and erosion caused by sputtering of plasma particles on the limiter/vacuum impurity control system.

First Wall and Breeding Blanket

At one time, the question of whether it was possible to find materials to withstand the fusion-generated neutron environment for the initial wall (the first wall) of the reactor chamber was thought to be the most difficult problem confronting tokamak plant design. Although this is still a significant problem, the question has been resolved to some extent in the light of actual simulation tests that indicate that standard stainless steel alloys could hold for at least five years in the fusion environment. At the same time, the prospects for developing new composite materials and alloys that can stand up for the full 30-year life of a power plant are greatly improving.

The steady-state mode of operation of the Starfire will provide an important means for obtaining these long lifetimes for reactor chamber materials.

Because of the importance of the design of the first wall and breeding blanket to the economics and safety of a fusion power plant and the close relationship of specific design to material lifetimes, the Starfire design team is taking a broad-based approach to the design of this particular subsystem, leaving open as many options as possible before completion of the overall plant design.

Table 2 shows three alternatives for the choice of the first wall/blanket materials, coolants, and breeding materials. A fourth alternative is being developed that utilizes an advanced austenitic stainless steel alloy. This is the first tokamak reactor design in which magnetic ferritic metal alloys are being seriously considered.

These alloys, relatively cheap and practical from the standpoint of fabrication, appear particularly resistant to thermal stress and radiation damage. But given Starfire's steady-state mode of operation, which dramatically minimizes materials damage from these mechanisms, utilization of stainless steel is also being thoroughly analyzed.

The chief goal of the Starfire first wall/blanket concept is to maximize safety and environmental acceptability. The primary guidelines are to keep tritium inventories low and to minimize long-lived activation products and stored chemical energy.

Conclusion

Starfire represents a totally new trend toward increasingly more economical and workable power plants. What this means specifically can be seen by comparing the Starfire parameters to those in Table 3, which gives the chief parameters of previous tokamak reactor power plant designs. As the table shows, the trend is toward physically smaller power plants with lower total electric power outputs—leading to much more economical electric power costs. For example, the cost projections for the 1979 Wisconsin University NUMAK design come in very close to current electrical costs at between 40 to 50 mills per kilowatt hour of electricity.

Once again, what the Starfire design shows is that the barriers to developing commercial fusion are not scientific but are a question of government policy and funding.

Charles B. Stevens, the director of fusion engineering for the Fusion Energy Foundation, is a frequent contributor to Fusion.

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IEEE/NRC Working Conf. on Advanced Technology, Jan. 15-17

Applying Space Technology to Nuclear Power

The Institute of Electrical and Electronics Engineers and the Nuclear Regulatory Commission's conference on "Advanced Electrotechnology Applications to Nuclear Power Plants" brought together some of the most competent and innovative engineers in the nuclear and aerospace industries. The purpose of the meeting was to encourage an interchange of information and experience between two of the most advanced industrial sectors on what kinds of electronic and control technology available in aerospace could be transferred to commercial nuclear power plant operation. More than 300 professional engineers attended the conference Jan. 15-17 at the Shoreham Hotel in Washington.

Moving Civilization Forward

Les Hogan, the IEEE executive vice president for 1980 set the tone for the conference in his welcoming remarks. "The most important question we have is supplying the energy we need to grow food and run the factories we need to keep our civilization alive. If we harnessed all of the ocean tides available on the U.S. coastline, we couldn't provide enough energy for even one state. Maybe we will have solar one day. It works in swimming pools, but can't run our factories," Hogan said.

"The cost of solar today is at least a factor of 50 greater than nuclear and there is no [solar] technology produced yet which produces more energy than is consumed in its production.

"We have been told that the keystone of our energy policy is conservation. We've invested hundreds of billions of dollars in buildings and industrial plants—they can't be converted to lower energy-consuming techniques overnight. . . .

"Some people would freeze our civilization at its present level of development . . . but civilization either moves forward or backward. . . . Today we have no choice but to use our best technology to develop civilization. . . ."

The only exceptions to this stated purpose came from the Department of Energy spokesmen in their official conference presentations (See Inside DOE, this issue, for details).

Specific Technology Transfers

The conference participants spent the next two days trying to locate specific technology areas where experience in the National Aeronautics and Space Administration and Nuclear Navy programs could be beneficially used in the commercial nuclear industry. Among the presentations and discussions in the eight conference panels were topics such as education and training of plant operators, simulating and analyzing reactor accidents, advanced control and instrumentation, computer software reliability and verification, risk assessment, systems management, and reliability engineering.

Engineers from U.S. nuclear companies explained to those with experience in the aerospace applications fields what the technical problems were in the Three Mile Island nuclear incident last March and how information needed by the power plant operator could be presented in a way the operators could understand better.

As one engineer from Babcock and Wilcox put it, in an emergency situation, and under stress, an operator can understand and process about 44 bits of information per second. At the same time, the computer system in the power plant is spitting out up to 650 bits per second. How can the data be preprocessed and given to the operator so he can act swiftly and correctly?

Engineers involved in current frontier design work in advanced aerospace applications described how an aerodynamically unstable aircraft was being designed for testing because the Federal Aviation Administration had found it to be more fuel-efficient. In order to pilot such a plane, three computers are placed on board that are continually doing aerodynamic calculations to keep the craft steady.

The three computers "take a vote" on each flight adjustment that must be made and report to the pilot what should be done. The plane is flown automatically, in terms of judgments and adjustments. Although an operator of any advanced piece of equipment must maintain the option of manually overriding any computerized decision, it was clear from this discussion that future nuclear plants could incorporate highly sophisticated computer control technology.

TMI Lessons Learned

Several panels developed specific suggestions for changes in the nuclear industry. John Selby, president of Consumers Power of Michigan, described the Institute for Nuclear Power Operation in Atlanta that was recently set up by the electric utilities to upgrade the training for utility employees and utility executives. The institute will develop comprehensive emergency response plans for the entire industry and institute experts will be ready to help any utility with a problem.

The head of the institute is retired Navy veteran Eugene Wilkinson, the first commanding officer of the nuclear-powered submarine, *USS Nautilus*. Selby explained that the institute will try to tap the Navy, which has operated 120 nuclear reactors, as a training source.

The institute starts 1980 with a budget of $11 million and hopes to have a staff of 200 people by year-end. Highly trained instructors will be joining to upgrade the quality of power plant operator skill and, as Selby described, the idea is to get the utilities to improve their operations by helping themselves.

—*Marsha Freeman*

Progress Report

FEF Economic Model Completes First Stage

The Fusion Energy Foundation began a year ago to develop a new econometric model designed to address the biggest deficiency in all current econometric models—the inability to deal with technological change.

The team of FEF researchers, under the direction of FEF director of research Uwe Parpart, has recently completed the first stage of development of a computerized mathematical model of economic growth. When applied to the U.S. economy, the result was a set of 76 coupled differential equations that track the profits, wage levels, and capital investments in a 25-sector subdivision of the economy.

A similar model and data base were developed for other major national economies, the world economy, and some special case studies.

The model has been successfully applied in several major studies. For example, the multisector model of the U.S. economy was used to study the effects of a number of controversial economic policies. The impact of trucking regulation on the U.S. economy was analyzed in a report that has since generated considerable alarm in the U.S. trucking industry, for the model predicted that a multibillion dollar loss of economic activity would result from a general slowdown in the rate of economic activity brought on by deregulation.

In a similar study of the impact of the Federal Reserve Board's tight credit policies, carried out in September 1979, the model predicted a 15 percent drop in industrial output by the middle of 1980. Now the recent layoffs in the auto sector portend a drop at least this serious.

The Effect of New Technologies

A different data base was used for long-term (20-year) simulation of different energy investment strategies. The model was used to compare economic activity under an intensive nuclear program (1,000 reactors for the United States by the year 2000), a version of President Carter's synthetic fuel program, and a so-called solar soft-path plan. The results, to be published in an upcoming issue of *Fusion*, show a dramatic "singularity" in the economy's energy situation occurring in 1990-1995. During these five years, either the economy will enter a period of unprecedented growth and development on its way to a fusion economy—if there is an aggressive nuclear policy; or, if either solar or synthetic fuels are used, the economy will suffer a disastrous depression in the early 1990s.

Most important, the causative factor in both situations is not so much energy prices as the cumulative effect of the development (or lack of development) of new technologies.

India's Development

The most recent application of the model involved a 40-year plan for the industrialization of the Indian subcontinent. The model showed that with a detailed hydraulic plan, a nuclear energy development program, and an educational proposal, there was a trajectory for the progress of the Indian economy from its present underdeveloped state to that characterizing a highly industrialized (but significantly agricultural) economy like the Soviet Union today. The results from this study will also be published in an upcoming issue of *Fusion*.

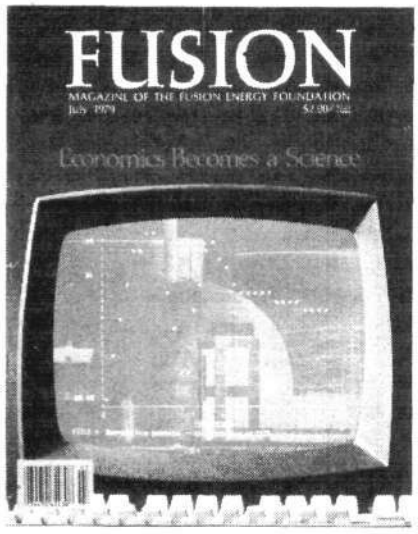
Current theoretical research on the model focuses on three areas:

First, we are considering the development of a new set of equations (still first order, ordinary differential equations) that will more accurately take into account the spectrum of capital investment. These new equations will allow a more differentiated treatment of the problem of obsolescence in the U.S. economy.

Second, we are looking at the development (and coding for solution) of a set of partial differential equations that include technological progress as a geometrical factor, rather than parametric one. These equations have been derived but have yet to be reduced to numerically solvable form.

Third, we are researching the derivation and analysis of a set of matrix input-output equations that model the dynamics of the material requirements of economic growth. To do this, we are using several case studies of rapid national development.

—Dr. Steven Bardwell



The Riemannian economic model was the cover story of the July 1979 Fusion.

Interferon Protein Is Produced In Laboratory

Swiss and U.S. scientists using recombinant DNA techniques recently succeeded in genetically engineering a microorganism to produce the protein *interferon* that is otherwise produced only in very minute quantities by human cells. The feat, achieved by a group headed by Dr. Charles Weissman, has been hailed as a vitally important step forward for both basic science and for medical practice. It also provides more evidence that recombinant DNA is a humane and vitally important area of scientific endeavor.

Interferon is a human protein that is a vital part of the body's immune system. During the early stages of a viral infection, interferon inhibits the replication of a virus, isolating it in the initially infected tissue area, while the rest of the immune system is being mobilized. Its role, therefore, is to minimize the possibility that a person will be overwhelmed by an infection. Interferon has also shown promise against certain forms of cancer.

Because of the immense difficulty and expense in obtaining sufficient quantities of this material—65,000 pints of human blood are required to get 100 milligrams—the ability to develop and test its use as a therapeutic agent and as a scientific tool had been virtually impossible. But once the interferon-producing gene has been put into a bacterium—the recent breakthrough—large vats of the chemical can be produced cheaply and quickly. The same goes for almost any other cell-produced material.

Interferon's Potential

Although interferon is undoubtedly a substance of great biochemical significance, the breakthrough in its production does not mean that a new "wonder weapon" against disease is now at hand. It is currently thought that interferon's effects are mainly in those cells that actually produce it; that is, only those cells that are virally infected manufacture it, and it is only those cells that use it to inhibit viral replication. Therefore, the effectiveness of exogenous application is a large unanswered question. Another problem with interferon's application is that its effectiveness seems to be most pronounced during the initial phases of infection, a period when an individual is not aware of being infected and, therefore, would not be treated.

Nonetheless, the use of interferon as a medical tool will generate new and more fundamental insights into the basis of the immune response to disease. For example, because interferon, unlike other parts of the immune system, interferes with viral spread in a way that is not specific to individual viruses but effective against all, understanding interferon can lead to unlocking many "secrets" of viruses.

Therefore, the importance of the breakthrough in interferon's manufacture lies not only in the potential therapeutic qualities of this agent and in its role in elucidating more fundamental processes in the physiological basis of disease-resistance and cure, but also in a better understanding of all biological systems.

Recombinant DNA

There has been a significant outcry in recent years over the alleged dangers in allowing recombinant DNA research to continue. Some have argued that recombinant DNA must be stopped because it is immoral to intervene genetically in nature. But as the recent advance shows, recombinant DNA represents the frontiers of the biological and medical sciences, exploring fundamental as well as practical questions in such areas as genetics, medicine, and agriculture. As such it is the counterpart of atomic and fusion power development in physics.

For example, directly raised are questions concerning the process-basis of the genetics of cellular function. Current outlooks hold that DNA is a static "tickertape" that functions by having its encoded "messages" read out so that the cell's metabolic constituents are manufactured; new findings have demonstrated that this view is inaccurate. The quest for a better understanding of its function will undoubtedly depend on the use of recombinant DNA techniques that allow the elucidation of the full scope of the genetic material, the physical changes that accompany changes in function. The interferon production capability discussed above shows how recombinant DNA technology can cause changes in medical practices and lead toward a fundamental rethinking of human physiology. And in agriculture, the use of recombinant DNA will bring about increases in crop yield and quality, through genetic engineering of plant metabolism.

The several recent successes in recombinant DNA technology for the production of biomedically important products has quieted many critics although efforts are still being made to halt recombinant DNA and related research and development. Anti-recombinant-DNA legislation is still pending in Congress. Presidential candidate Ted Kennedy has given backing to this legislation, for example, and has proposed a moratorium on this research until "stringent research guidelines" are implemented.

—Dr. Richard Pollak

Books

Medvedev's Horrible 'Truth'

Nuclear Disaster in the Urals
by Zhores Medvedev
New York: W.W. Norton & Co.
214 pp., $12.95.

Many of the readers who write *Fusion* magazine have asked me whether there are not some books being published that I could review favorably. "Is it really the case," they ask, "that only the antiscience mob is writing books on scientific subjects, that only the environmentalists write about nuclear power?"

Well, dear readers, here is a book that I can review favorably. Zhores Medvedev has done a masterful (if not supernatural) job of scientific sleuthing and has almost exposed the scientific secret of the century. Starting from rumors and inferences that a major nuclear waste release had occured somewhere in the Soviet Union's Ural Mountains, Medvedev doggedly tracked down every bit and piece of evidence in the public domain.

Searching the Soviet literature on radioactive biocenosis, he has determined on the basis of the types of plants and animals surveyed for radioactive contamination that a wide dispersal of radioactive strontium and cesium must have occurred in late 1957 or early 1958. The area affected must have been about 1,000 square miles and in the Chelyabinsk region of the southern Urals, he says.

According to Medvedev's evidence, and apparently supporting evidence recently released by the CIA, entire villages were bulldozed and the area was turned into a no-man's land. In fact, without his work to start from, I would never have uncovered the real truth of what began in Chelyabinsk in 1957.

Note that I emphasized above that Medvedev *almost* uncovered a major classified research project, still ongoing, and, according to the most recent inferential evidence, highly successful.

Let's review the information that Med-

Continued on page 70

A Nonquarkish View of Gluons

Recent experiments using the new electron-synchrotron high-energy particle accelerator, PETRA, in Hamburg, West Germany, have sent a ripple of excitement through the particle-physics community. Unfortunately, rather than probing their real significance, their results are being used to bolster an even more incredible extension of the already quite fantastic quark theory.

Using the PETRA facility, which includes an intersecting storage ring, physicists are carrying out collision experiments between electrons and positrons (antimatter electronlike particles) at extremely high energies that have never before been witnessed except in rarely observed cosmic ray events.

In collisions of this sort, large numbers of familiar elementary particles known as mesons are produced. By analysing the numbers, energies, and scattering directions of these mesons, the researchers attempt to reconstruct the conditions that led to their production.

During the postwar period, as particle accelerators have probed deeper and deeper into the structure of elementary matter, numerous new subatomic entities have been discovered. As new particles proliferated and demanded an explanation, theoretical physicists fell headlong into the intellectual trap of nominalism, naming what they observed but not explaining its existence.

Under the leadership of Murray Gell-Mann of Cal Tech and Yuval Ne'eman, an Israeli physicist and intelligence expert, the hunt for the quark—the ultimate particle—began in the early 1960s.

It was a simple and appealing idea. The bewildering array of new elementary particles could be grouped into multiplets representing determinate relations among the quantum numbers such as charge, spin, mass, and so on. The relation of one elementary particle to another in a multiplet was to be determined by the mathematical process of a group theoretical rotation. That is, the relations could be represented as something akin to exotic geometrical-symmetry properties.

The postulation of the quark, as a theoretical entity, not as a material quantum, came when the theoreticians noticed that the various rotation groups for different multiplets of elementary particles could be constructed from a more simple group, whose physical members would then be the "building blocks" of the observed particles—the quarks.

Elegant, But Wrong

This is all very elegant, but wrong. The quark theory explains nothing. It simply names things. The symmetry groups simply facilitate the classification of what are presumed to be fixed entities in what is presumed *a priori* to be a static universe.

As the quark theory (known among its adherents as quantum chromodynamics) was developed, it became necessary to postulate the existence of more and more quarks to account for the continuing proliferation of new species of elementary particles. At the same time, it was recognized that an exchange particle for the quark-quark interaction, the binding force that holds quarks together, must exist as well. By analogy to the other exchange particles of quantum field theory, just as the photon exists for the electromagnetic interaction and mesons for the strong nuclear interaction, the *gluon* was proposed to mediate quark interactions.

Enter the PETRA experiments. Generally, in high-energy collision experiments most of the mesons ejected from the collision leave the site in fairly well-defined jets of material, two in number, closely paralleling the trajectories the incident particles would have taken had the collision not occurred. According to quark theory, in some collisions, a gluon might appear as a separate entity for an extremely short period of time, too short to be directly observed. However, its presence could be indirectly sensed as a *third* jet of mesons. The third jet was evidently observed in data taken using the intersecting storage rings.

Setting aside quarkish interpretations of elementary-particle data, this observation is potentially significant. Progress in our understanding of nature typically has been characterized by recognition of the characteristic metric and symmetry relations appropriate to different scales of observation in the physical realm.

Historically, the simple Euclidean space and scalar invariants of classical mechanics gave way to the more complex wave relations appropriate to the atomic scale that are reflected in the quantum theory. And as we probe the subatomic world, there is no reason to suspect that the geometry of quantum mechanics should continue to be appropriate.

In fact, properly interpreted, the symmetry relations used for bookkeeping purposes in the quark theory could very well be an important clue to the nature of the metrics on Riemannian manifolds exhibited on the scales of interaction and energy density characteristic of high-energy particle collisions.

The process of universal self-reproduction and evolution involves an interaction among phenomena on different scale lengths. These are characterized by different but causally related geometrical relations, with the more highly organized phenomena determining these relations with respect to the lower.

This is what we are witnessing in the PETRA experiments. With the availability of immense amounts of energy to concentrate in the elementary particle reactions, the conditions exist for previously unobserved organizations of elementary matter. Scientists have created conditions that have never occurred except as a result of deliberate human intervention at the subatomic level.

—Dr. John Schoonover

Books

Continued from page 68

vedev has overlooked in his much touted antinuclear fairy tale.

First, please remember that this was the period of the Khrushchev thaw, that genetics, although still not officially accepted, was beginning to make a comeback since Lysenko's eclipse. Interest centered in the Soviet Union, as it did here, on the genetic effects of radiation. Hopes were high for using radiation to accelerate the rate of evolution and to produce stronger, more resilient species.

Now, let's review the continuing disputes at recent Olympic games. How often has it been said of Soviet women athletes that they could not really be women, that they must be men in disguise or that they must be using illicit hormone treatments?

Well, President Carter, through the CIA, got wind of the real truth within the last couple of months. Those were really women athletes. In fact, they were early models in radioactive genetic transformation experiments done in the Chelyabinsk region! The horrible truth is that not only women, but men superathletes have been systematically bred behind a smoke-screen story that the area had been heavily contaminated by a nuclear accident.

Our Chief Executive has done the only thing he could in the face of overwhelming strategic superiority. He has pulled the United States out of the Moscow Summer Olympics and started a crash program to develop radioactive athletes.

You didn't really believe that the Olympics pull-out was triggered by Afghanistan, did you?

—Dr. John Schoonover

"The danger inherent in the use of nuclear energy has been with us for decades. . . . Nuclear Disaster in the Urals is a chilling and sobering revelation of the terrifying path we are being led down."

—Book jacket
Nuclear Disaster in the Urals

Inertial Confinement

Continued from page 34

lion per year over the next several years," Foster said.

Foster reported on the importance of inertial confinement research for meeting the nation's future energy needs and for restoring public faith in science: "The public has become in the past few years suspicious of the very technology which maintains society. No one has suggested rejecting refrigerators, weather prediction, or vaccination, but this suspicion that technology is itself the root of our problems has led to public distrust of scientists and science, and, by inescapable implication, of the single value which science proclaims, the value of objective knowledge. The fusion program presents us with the remarkable opportunity to reject any notion that there is virtue in ignorance and to fashion of that rejection an enduring solution of one of the greatest peacetime challenges of our age."

Books Received

Benjamin Thompson, Count Rumford. Sanford C. Brown, Cambridge, Mass.: MIT Press, 1979, 361 pp., $19.95.

Energy Future. Robert Stobaugh and Daniel Yergin, eds., New York: Random House, 1979, 353 pp., $12.95.

Nuclear Fuel and Energy Policy. S. Basheen Ahmed, Lexington, Mass.: D. C. Health-Lexington Books, 1979, 158 pp., $17.95.

Rutherford and Physics at the Turn of the Century. Mario Bunge and William R. Shea, eds., New York: Neale Watson Academic Publications, 1979, 184 pp., $20.00.

James Prescott Joule and the Concept of Energy. Henry John Steffens, New York: Neale Watson Academic Publications, 1979, 172 pp., $20.00.

Memoirs of a Physicist in the Atomic Age. Walter Elsosser, New York: Neale Watson Academic Publications, 1978, 268 pp., $15.00.

Energy: The Next Twenty Years. Hans H. Landsberg, Study Group Chairman, Cambridge, Mass.: Ballinger Publishing Co., 1979, 628 pp., $9.95.

The Changing Earth. Brained Mears, Jr., New York: Van Nostrand Company, 1978, 550 pp., $12.95.

Regulating Safety: An Economic and Political Analysis of Occupational Safety and Health Policy. John Mendeloff, Cambridge, Mass.: MIT Press, 1979, 204 pp., $15.00.

The Soviet Energy System. Leslie Dienes and Theodore Shabad, Washington: V. H. Winston & Sons, 1979, 298 pp., $19.95.

The National Air and Space Museum. C. D. B. Sryan, New York: Harry N. Abrams, 1979, 504 pp., $50.00.

U.S. Breeder Reactor Program. Richard G. Richels, New York: Garland Publishing, Inc., 1979, $17.00.

Energy in America's Future. Sam H. Schurr, Baltimore: Johns Hopkins U. Press, 1979, 555 pp., $10.95.

Communications for Tomorrow. Glen O. Robinson, ed., New York: Praeger Publishers, 1978, 526 pp.

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THIS TIME... ELECT A PRESIDENT

A STATEMENT BY

SCIENTISTS & ENGINEERS *for* LaROUCHE

We in the scientific and engineering professions now have a rare opportunity to support a presidential candidate with a total commitment to scientific progress—Lyndon H. LaRouche.

In the course of his nationwide campaign for the Democratic Party nomination, now focused on the February 26 primary in New Hampshire, Mr. LaRouche has gained widespread recognition as the foremost proponent of nuclear energy. However, LaRouche's international leadership role in science goes much deeper.

For example, LaRouche's breakthrough contributions in economic science have made it possible for the first time to demonstrate directly the necessity of scientific and technological progress, and to identify those areas of research where advances are most urgently required. His fundamental contribution to the methodology of science has also made it possible to specify some of the most fruitful approaches to the solution of basic problems in plasma physics and biology.

Those of us who are working professionals in the scientific and technical areas of production, research, and education know that the erosion of our country's scientific base cannot be permitted to continue. The ongoing attrition of our R&D and training programs and the lack of a sound national science policy not only is hurting us, our students, and our colleagues, but also threatens our national security.

Lyndon LaRouche has taken his stand on behalf of the scientific community. Now it is time for us to reciprocate.

We urge you to join in endorsing Mr. LaRouche's candidacy, in giving financial support, and in building Scientists and Engineers for LaRouche into a vital part of his campaign.

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A copy of our report is on file and available for purchase from the Federal Election Commission, Washington, D.C.

FEF News

FUSION MAGAZINE'S TMI SERIES WINS AWARD

News Flash! The Freedoms Foundation at Valley Forge has awarded the Fusion Energy Foundation the George Washington Honor Medal for its published article series in *Fusion* magazine on "The Harrisburg Hoax." The award announcement termed the series on Three Mile Island "an outstanding accomplishment in helping to achieve a better understanding of the American Way of Life."

LEVITT TOURS CAMPUSES FOR NUCLEAR DEBATES

As a leading spokesman for an Apollo-style fusion research and development program, FEF executive director Dr. Morris Levitt has been touring the nation's college campuses over the past few months to debate the issues of environmentalism, conservation, and low technology versus a national energy policy based on nuclear development. Levitt's opponent in this series of debates, Stuart Diamond, is the energy and environment writer for the Long Island New York newspaper, *Newsday*.

Most recently, Levitt addressed a day-long "town meeting" Feb. 6 in Austin, Texas on "Energy Sources for the Future." He shared the podium with Austin Mayor Carole McClellan, who recently introduced and won a referendum to ensure continuation of a nuclear construction project in southern Texas, and leading energy technology professors from the University of Texas, including Dr. John McKetta.

See the Fusion calendar for notice of upcoming debates.

PARPART DISCUSSES INDIA'S DEVELOPMENT

Uwe Parpart, director of research for the FEF, gave the featured presentation Jan. 30 at a day-long seminar on the Riemannian economic model sponsored jointly by *Fusion* magazine and the *Executive Intelligence Review* at the Hotel Biltmore in New York City. Parpart discussed in detail how the Riemannian computer model was used in the preparation of a development program for India. Other presentations were by Dr. Steven Bardwell, director of plasma physics for the FEF, and David Goldman, economics editor for the *Executive Intelligence Review*.

The model, unique in that it takes into account technological change, is discussed in the research section of this issue.

Newnan, Ga. Times Herald

Rotarian John Gray, left, and FEF representative Michael Schlanger.

LEVITT KEYNOTES FLORIDA CONFERENCE

Dr. Morris Levitt, FEF executive director, delivered the keynote address to the Jan. 25 conference in Daytona Beach of the Florida Civitan—a statewide organization of men and women business and community leaders. The topic was "Citizenship and Responsibility," and Levitt focused his remarks on the responsibilities of a republican citizenry to be informed on such crucial issues as energy policy and on the responsibility of the nation's leadership to provide accurate information

FEF SPOKESMAN ADDRESSES GEORGIA ROTARY CLUB

"We don't have an energy crisis; we have a crisis in not having enough energy research," FEF southeast coordinator Michael Schlanger told the Rotary Club in Newnan, Georgia Dec. 16. Schlanger explained to the Rotarians that the United States has to develop a crash program for fusion modeled on NASA, and that with such a program fusion would be possible within 10 years.

FUSION LAUNCHES DEVELOPMENT PROGRAM

Foundation members should soon receive the first quarter 1980 "Members Bulletin" and with it an appeal for names of friends and associates who are prospective subscribers to *Fusion*. The FEF is urging every member to send us five to ten names—the people who currently borrow your copy of the magazine or read it over your shoulder. Every person suggested by members will receive a subscription promotional sample and a follow-up telephone call.

Now that you've read Fusion, join the Fusion Energy Foundation—

the organization dedicated to restoring the United States to first place in nuclear power and theoretical science.

As a member in the fast-growing FEF, you will receive one-year subscriptions to *Fusion* and the quarterly *International Journal of Fusion Energy*, member bulletins, and special rates for FEF conferences, seminars, and research reports. And your individual membership or sustaining membership will help ensure that the FEF continues its "firsts":

- the first (and only) group to expose sabotage at Three Mile Island
- the first exposé in October of how Iran was part of the Council on Foreign Relations' plan for "controlled disintegration" in the world economy.
- the first to expose that the only "secret" behind the U.S. classification policy is that it's holding back progress in fusion research and advanced science in general.

Join the fight for progress now!

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In This Issue

SHOWDOWN IN SWEDEN

This exclusive Nuclear Report documents how an antinuclear environmentalist movement was imported to sabotage Sweden's role as a world leader in nuclear technology. The showdown is a nuclear referendum March 23 that has been forced on the population by a tiny antinuclear minority.

Front cover design by Christopher Sloan; photograph of the Forsmark nuclear plant built north of Stockholm by Asea-Atom, courtesy of the Swedish State Power Board. The pronuclear button, "Nuclear Power. Yes." and the poster shown here are distributed by the FKU, the Association for Nuclear Power and Development, a group that collaborates with the Fusion Energy Foundation.

NASA

PLATO'S TIMAEUS AND MODERN PHYSICS

Historically, the Platonic tradition has produced the most creative currents in science, from Nicolas Cusanus and Bruno, to Kepler and Galileo, to Leibniz, Riemann, and Cantor. Dr. Steven Bardwell outlines how Plato's epistemology is essential for advancing plasma physics today.

EVOLUTION: A RIEMANNIAN APPROACH TO BIOLOGY

Biologist Carol Cleary shows how recent experiments in many areas of biology research—from chromosomal studies to the evolution of species—demonstrate that the Darwinian "natural selection" theory doesn't have a scientific leg to stand on.

Photograph of Siabon ape by Sister Moore, Atlanta, Georgia.

STARFIRE—A COMMERCIAL TOKAMAK REACTOR

Argonne Laboratory's Starfire tokamak concept, described here by Charles B. Stevens, is the first in a new generation of reactor designs for commercially viable, safe, and practical fusion energy power plants.