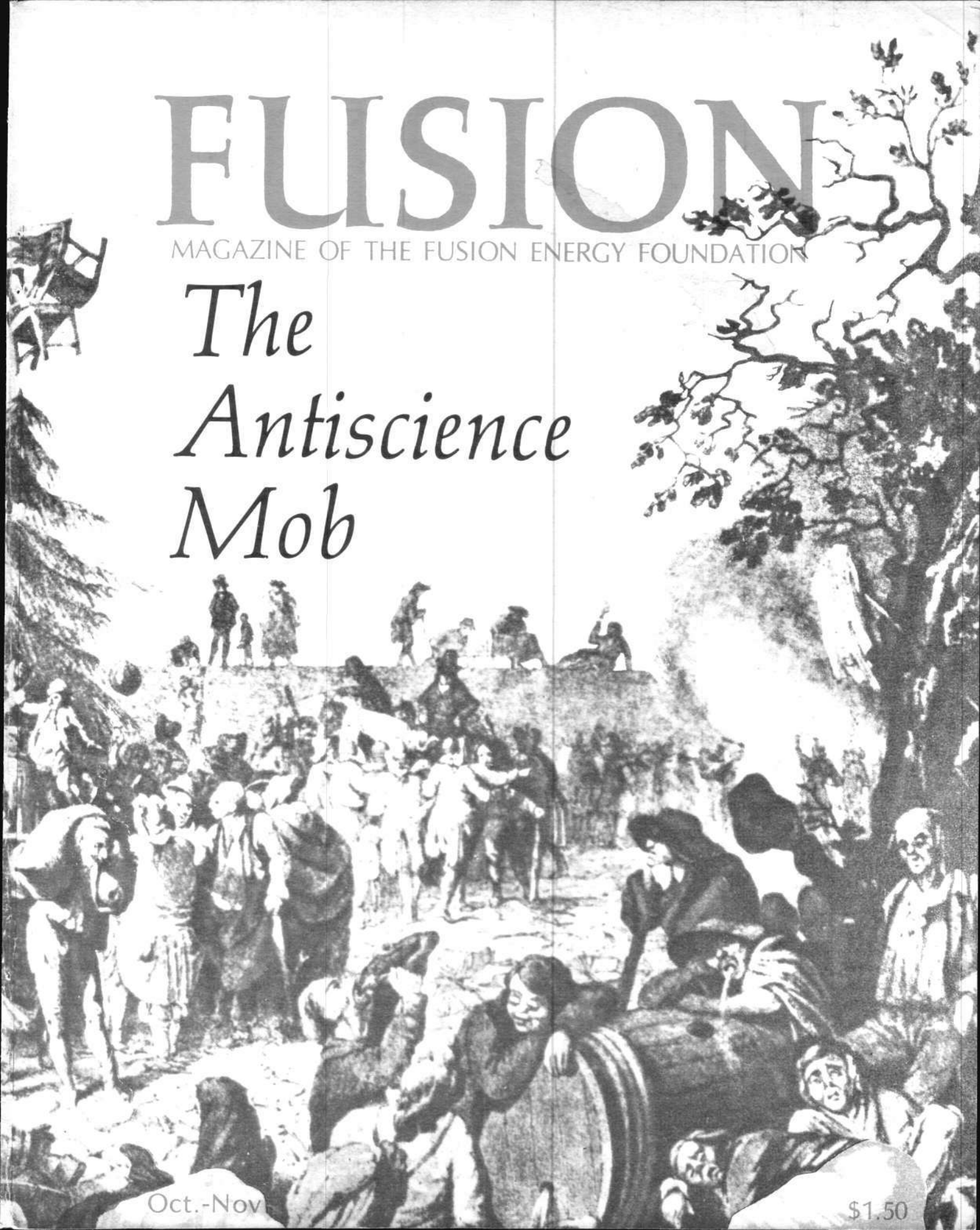
FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION

The Antiscience Mob



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Editorials

Winning the Energy War

For the first time since the Carter Administration announced its conservation-oriented energy policy, the momentum has begun to swing back toward the supporters of an energy program based on growth and advanced *hard* technology. From mid-September on, the Senate has appropriately buried the Carter program, measure for measure. Now the Senate leaders of this sane proenergy policy have proposed a concrete alternative to the Dark Ages program of Carter and his Energy Secretary James Schlesinger.

In a statement before the Senate Finance Committee, committee chairman Russell Long announced his intentions to draft legislation for an Energy Development Corporation that would solve the nation's unemployment problem by creating a vast number of high-technology jobs in energy-related industries. Long stressed that his proposal would not only eliminate unemployment, but would "solve the problems of the steel industry" with its call for "big investments in oil rigs, mines, and development of alternative energy sources." "I mean $12,000 to $18,000-a-year jobs. That's the way we do things in the United States. I'm not proposing leaf-raking," Long said.

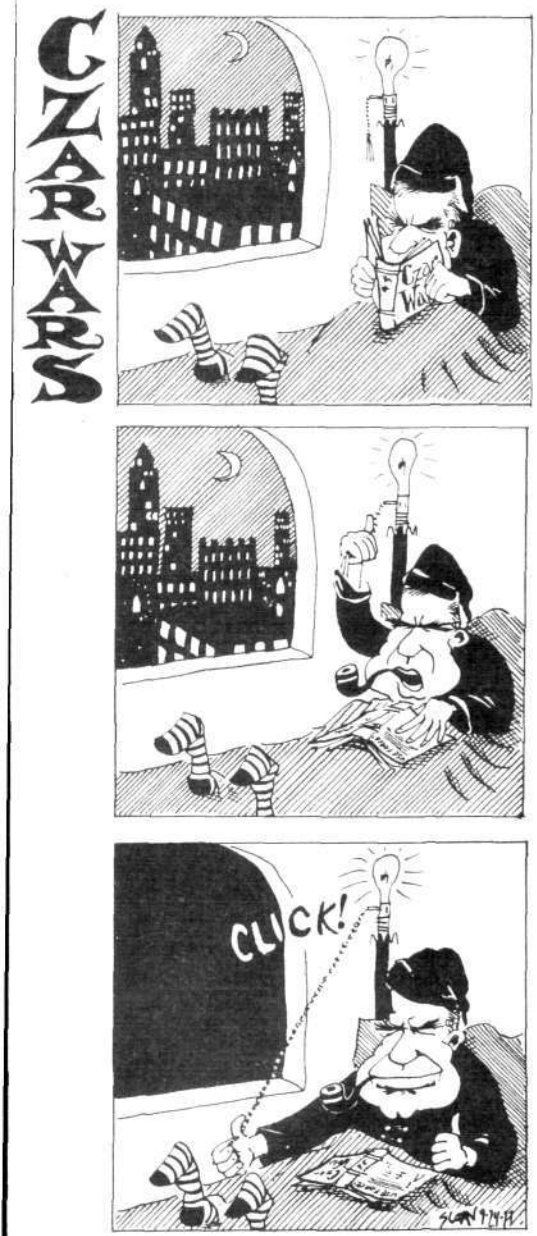
The Louisiana Democrat's proposed Energy Development Corporation provides a rallying point for congressional forces and for the majority of the population who want this nation to regain its preeminence as a world industrial leader. Many of this prodevelopment group have already spoken out. Most significant outside the Labor Party and the Coalition of Independents on Issues has been John Connally who last week addressed a Republican governors conference with a call for nuclear power and a real resurgence of production: "Over the years we have fostered dissension between labor and management while other countries fostered cooperation. Labor, management and government are not competing. What we need is an alliance of labor, industry, and government to ensure that we have the kind of production we need."

The positive action by Senator Long and his Senate supporters was made possible by a show of force from industrialists, trade unionists, scientists, and others around the country, but it was passed by his committee in the form of a trust fund to be made up of revenue from Carter's wellhead tax and others. More pressure from the country is needed to establish a competent EDC with the necessary content — as elaborated in the U.S. Labor Party Nuclear Development Act of 1977, legislation prepared by the research staff of the Fusion Energy Foundation.

A Golden Opportunity

The forces for development in this country have to capitalize on this golden opportunity. We have effected the first explicit congressional call for high technology and energy resources other than conservation and windmills. Now we must fight to win the energy war by ensuring that the proposed energy development corporation includes a competent, comprehensive energy plan for nuclear fission and fusion and that the capital loans for development are long-term and low interest (3 percent) so that real development is possible.

As the Nuclear Development Act of 1977 spells out, the opposite of conservation is not simply quantitative growth. Economic growth at any stage must be based on a well-defined Research & Development program for new, more productive technologies that are allocated an appropriate percentage of investment capital. To quote from the bill: "...the basic criterion for the selection of new energy technologies is that they reduce the total social cost of energy production and thus increase the amount of total net profit available for growth in the number of skilled jobs in the revitalized national economy. In scientific terms, to the extent that energy technologies increase the 'energy flux density' of an energy source...the amount of megawatts of power per square meter, such technologies reduce the cost of energy production. By producing power more densely, these technologies...reduce the total amount of capital and labor



required to capture a given unit of energy, increase the thermodynamic efficiency of energy use, and decrease energy waste and loss."

The most energy-dense production technologies known today are those of nuclear fission and fusion. Thus, it is with scientific certainty that the Nuclear Development Act of 1977 proposes a national energy policy goal of the development of commercial thermonuclear fusion power by 1990, the production and bringing on line of 1,000 nuclear fission plants by 1990, the commercialization of liquid metal fast breeder reactors by 1983, and the commercialization of the hybrid fission-fusion reactor by the late 1980s.

Only a crash investment program in nuclear energy technologies of the sort described in the Labor Party bill can guarantee that our nation — and the world — has a future. Nuclear power is an idea whose time has come. It's up to us to make it happen.

The Antiscience Mob

The ransacking of scientist Joseph Priestley's house and laboratory in 1791, depicted on the cover of this issue, aptly represents the witchhunt against scientific progress directed by today's mob equivalent, the zero-growth environmentalist movement and its bankers and foundation sponsors.

As a leading humanist in the Franklin circles of late 18th century England, Priestley was a central figure in the Lunar Society, a coalition of scientists and industrialists committed to technological progress. In the year 1791 the British monetarists watched with horror the growing success of republicanism in France and the potential for a French-American alliance against British reaction. The chief agent of British monetarists, William Pitt the Younger, attempted to destroy this budding alliance in England by decimating its intellectual leadership, in particular Priestley and other members of the Lunar Society.

The current attacks on science occur at another critical point when humanity is faced with a choice between continued progress or economic and political collapse. Once again financier interests, grouped around the slogans like "too much technology," are out to destroy the practice of advanced science as well as the very idea of progress.

Most despicable is the attempt to shut down the basic biological sciences in the crucial areas of recombinant DNA and cancer-related changes in physiology. The DNA research is crucial to understanding the fundamental processes of genetics as well as providing a technology for the mass production of such important substances as human insulin.

The Recombinant DNA bill proposed by Senator Kennedy would virtually end research in this field by setting up local biohazards committees to police research, with the power to shut down programs first and offer explanations later. In the charged atmosphere created by the press lies about scientists creating a "monster gene," the environmentalists would have a field day closing labs and discouraging new construction.

As for cancer research, in the National Institutes of Health, the National Cancer Institute has already caved in to environmentalist pressure by changing its emphasis from basic science to the testing of possible environmental carcinogens. The cancer research program includes many areas of basic science, such as embryology and immunology, that were brought in under President Nixon's cancer research funding program, since an understanding of these processes is central to the question of pathological changes. Although the program has been poorly managed and is dominated by the reductionist assumptions pervading nearly all current biology, the decision to spend the majority of Institute funds on environmental screening spells death for the basic science research and for basic biology as a whole.

The most devastating result of today's antiscience mob is to cut short work on the theoretical implications of the nonlinear processes that abound in biology and that are directly relevant to central questions on the frontiers of science in

Calendar

OCTOBER

10-13 Int'l Meeting on LMFBR Fuels, American Nuclear Society, Tuscon, Ariz.

10-14 Int'l Symposium on Application of Reliability Technology to Nuclear Power Plants, IAEA, Vienna, Austria

17-21 Int'l Symposium on Neutron Inelastic Scattering, IAEA, Vienna, Austria

19-21 Nuclear Science and Nuclear Power Systems, IEEE, San Francisco, Cal.

24-28 Annual Conference, Am. Society of Civil Engineers, Pittsburgh, Pa.

25-27 Laser Institute of America, Anaheim, Cal.

25-28 7th Symposium on Problems in Fusion Research, American Nuclear Society and IEEE, Knoxville, Tenn.

27-29 Nuclear Physics Conference, American Physical Society, Rochester, N.Y.

31-Nov. 2 Industrial Power Conference, American Society of Mechanical Engineers, Cleveland, Ohio

31-Nov. 3 Advancing Energy Technology, Institute of Fuel, Eastbourne, U.K.

NOVEMBER

4 An Energy Program for North America, Fusion Energy Foundation, Toronto, Canada (for details see advertisement inside)

7-11 Plasma Physics Conference, American physical Society, Atlanta, Ga.

13-17 70th Annual Meeting, American Institute of Chemical Engineers New York, N.Y.

27-Dec. 2 Winter Meeting, American Nuclear Society, San Francisco, Cal.

FUSION invites readers to send the schedules of events they wish to appear in the calendar column to *FUSION Calendar*, P.O. Box 1943, New York, N.Y. 10001.

Letters

EDITOR'S NOTE

The editors received several letters of congratulations and comment on the new magazine format. One consistent theme of criticism from readers was that the biological science conference material was too difficult to understand for the lay reader. We feel that the point is well taken and we plan in the future to present articles that will develop some of these difficult yet necessary concepts at more length. Our intention is not to "snow" the lay reader but to introduce him or her to subjects of scientific importance. We recognize our responsibility to convey exciting developments in fusion research and basic science in terms that are comprehensible to our varied readership.

The editors welcome letters and comments on topics of interest to *Fusion* readers.

the physics of plasma, superconductivity, and superfluidity. These biological processes, such as global oscillatory activity in the brain and the developing geometries that determine embryology, can be approached competently only from the standpoint that the process of development, whether in the biosphere or under the microscope, is an invariant. It is this standpoint from which Priestley and Franklin proceeded in science and politics, and which we today have to fight for against the antiscience mob.

Yes to the Soviet Proposal

The leaders of the U.S. and Soviet fusion research establishments have shaped a proposal worthy of emulation in statecraft. To stave off the threatened attrition of the U.S. fusion program and to reap the benefits of combining recent Soviet experimental advances with now-idled U.S. technological capabilities the fusion leaders proposed to set up a version of the Soviet emploding liner device at the former Scyllac theta pinch site in Los Alamos, New Mexico.

This breakthrough represents a years-eliminating shortcut to proof of commercial feasibility of fusion. Just as important, the cooperative effort could bring the U.S. on line with the Soviets' recently released fusion research proposal, a crash effort.

Failure to take advantage of this opening will likely result in a string of uncontested Soviet research breakthroughs in both civilian and strategic military areas over the next few years, while the U.S. dashes backwards to 19th century levels of technology.

The choice is obvious. Yes to the joint project, yes to a coordinated crash program.

The Lightning Rod

Dear Readers:

For my column this issue I am publishing a timely commentary submitted to me by Cambridge reader Odde Bodkin concerning the latest craze in U.S. philosophy, one Saul Kripke. I feel assured that the article's attention to the truth of the Kripke matter cannot fail to delight my scientific audience. I recall some 200 years ago that we men of science were beset with antiscience nonsense similar to Kripke and reinforced — as in the case of my dear friends Priestley and Lavoisier — with the blood cry of the mob.

From time to time I shall be pleased to devote my column to other pertinent commentaries from Fusion *readers.*

Benj. Franklin

From Wolfboy to College Professor

The public relations office of a super-secret think-tank located somewhere in the vicinity of Greater Boston has just unveiled what it represents as the institution's boy wonder, a 58-year-old professor of anal philosophy whom the institution proposes as "America's greatest philosopher."

The object of this public relations caper is Professor Perfervid Nitpicker, who began his astonishing history as the foster-child of Colorado coyotes after being abandoned in infancy by his natural father, a wandering Zen-Buddhist monk. Professor Nitpicker attributes the origins of his present theories to three early childhood experiences. It was the challenge of picking nighttime nourishment from garbage dumps and cesspools in the outskirts of Colorado townships that impressed upon the young Nitpicker the importance of determining the "meaning of phenomena by their internal structures."

Professor Nitpicker is best known among his intimates for his assertion that there is no knowable truth in science or morality. He summarizes his philosophy on that point, "A donkey's offal is a scarab's dinner," and traces his intellectual forebears to such unamerican figures as Professor Fabian Hustle and the Steyermarkian soothsayer Letto von Wildschwein.

"My greatest achievement," Professor Nitpicker writes, "is the development of what I call the omega-function." After scratching under his armpit with his great toe, he continues:

"There is no truth, there is only

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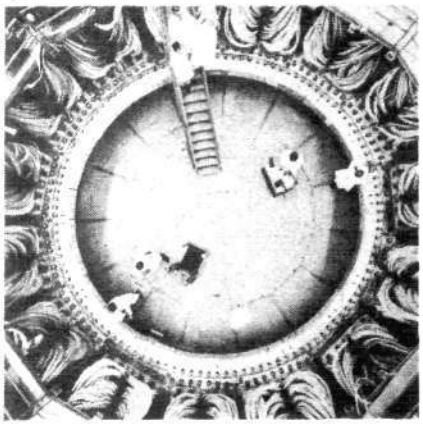
News Briefs

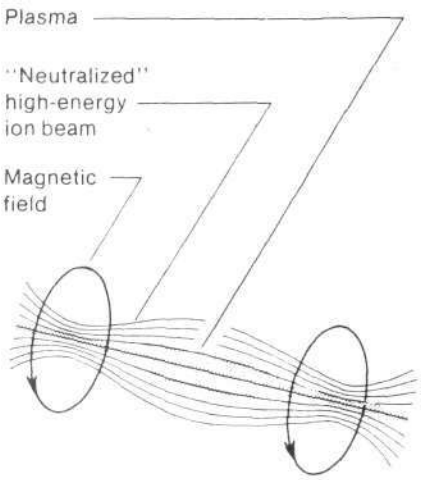


The Scyllac theta pinch at Los Alamos. Its fast-pulsed electrical energy storage system makes it ideal for testing the proposed Soviet breakeven fusion program.

SOVIETS OFFER JOINT BREAKEVEN FUSION EXPERIMENT TO LOS ALAMOS

The United States and the Soviet Union are on the verge of concluding a historic agreement that could mean construction and successful testing of a joint breakeven fusion energy experiment within the next few months. According to leading U.S. fusion researchers, the Soviets proposed the joint program during last summer's U.S.-Soviet Fusion Power Coordinating Committee Conference in Princeton, N.J. At the conference, Dr. E. Vehlikov, director of the Soviet Fusion Energy Research Program, suggested that the experiments based on new Soviet breakthroughs be carried out at the New Mexico Los Alamos Laboratory. At the end of September a team of Los Alamos scientists will leave for the Soviet Union to complete arrangements for the joint effort.

The proposed experiment consists of a hollow metal cylinder, a few centimeters in diameter, in which a plasma of fusion fuel is injected. A gigantic pulse of electric current then collapses or crushes the cylinder, compressing the plasma and producing the high densities and temperatures needed to ignite the fusion reaction. This system would produce a burst of fusion in a way similar to that in laser and electron beam fusion. Since a collapse time of 5 million centimeters per second is needed with a total electrical energy of 8 to 10 million joules, Los Alamos with its fast-pulsed electrical energy storage system is ideal. The Los Alamos system was previously used on the Scyllac theta pinch experiments, shut down last year because of funding cuts.



Magnetic bottle containment showing "neutralized," high-energy ion beam entrapment.

PRINCETON TOKAMAK ACHIEVES SUCCESS WITH NEUTRAL BEAM HEATING

Scientists at the Princeton Plasma Physics Laboratory reported initial success in September with neutral beam heating on their PLT Tokamak. The Soviet-designed tokamak is the most successful magnetic bottle device for harnessing fusion reactions, and both U.S. and Soviet fusion research programs have plans to develop a commercial power plant based on the concept by the 1990s. Neutral beam heating utilizes accelerated, high energy ions that are "neutralized" so that they can penetrate the magnetic fields confining the tokamak fusion plasma. After penetrating the plasma, the beams of neutral high-energy atoms are ionized by collisions and trapped by the magnetic field, thus heating the plasma.

The Princeton PLT is the largest tokamak in operation today and has previously demonstrated the type of scaling needed to confine reactor-grade plasmas in tokamaks. The problems on the PLT that the latest experiments seem to solve concern impurities from the vaccum chamber wall diffusing into the plasma and degrading its operation. It was believed that increasing the temperature of the plasma by injecting it with intense neutral beams would overcome this problem, and the initial experimental results with low levels of neutral beam input indicate that this is the case. More definitive studies should be finished in time for the November Plasma Physics Conference of the American Physical Society in Atlanta, Georgia.

LOS ALAMOS REPORTS BREAKTHROUGH ON CARBON DIOXIDE LASER

In the first two weeks of September fusion researchers at the U.S. Energy Research and Development Administration's Los Alamos Scientific Laboratory reported achieving a major breakthrough in the development of carbon dioxide lasers for pellet fusion research. Laser pellet fusion, which uses inertial confinement, and magnetic confinement are the major approaches to fusion.

During the first series of experiments with the new Los Alamos carbon dioxide laser scientists found that the system's output was 20 percent more powerful

than expected. The new system is a one-beam prototype for the Los Alamos eight-beam system scheduled for completion later this year. The one-beam model achieved an output of up to 1,500 joules with an overall efficiency of possibly up to 10 percent. This breakthrough is especially encouraging to the Los Alamos fusion researchers since they had had great technical difficulties in getting the carbon dioxide lasers to operate correctly.

While the measurements are preliminary and must be corroborated, the relatively high efficiencies achieved are well within the range of those needed for a commercial laser fusion power plant. Los Alamos researchers had stated when they made their initial fusion breakthrough last spring that the carbon dioxide system could make commercial laser fusion energy a reality in the 1980s, and this recent success reinforces the optimistic forecast.

JAPAN MAKES PUSH FOR FUSION POWER

Japanese Prime Minister Takeo Fukuda has ordered his cabinet ministers in charge of energy to promote the development of nuclear fusion as a viable energy source in cooperation with the United States and the Soviet Union. According to the Sept.8 *Mainichi Daily News*, Fukuda had first made public the government's keen desire to develop fusion in a press conference the previous week. Fukuda's orders for action on fusion development come after various government ministers had reported on the progress of studies in that area. The *Mainichi* reported that one of the ministers, Science and Technology Director Sosike Uno, will discuss fusion power cooperation with U.S. officials when he is in Washington later in September to sign the agreement reached with the U.S. concerning the Tokai-Mura reprocessing plant.

Prime Minister Fukuda

REPORT JAPANESE COMMITMENT TO TOKAMAK

U.S. fusion scientists in close touch with researchers in Japan have reported that the Japanese government has made a major commitment to the rapid development of fusion energy based on the Soviet-designed tokamak magnetic bottle. The commitment is in the form of financial backing for the construction of the JT60 tokamak test fusion reactor, scheduled for completion in Japan in 1980. The Japanese government is reported to have said that if $600 million, or even $1 billion is needed to complete JT60 on schedule, the funds will be forthcoming.

The only other tokamak test fusion reactor currently under construction is the Princeton TFTR, which is scheduled for completion by 1981 or 1982 at a total cost of $230 million. The large-scale parameters of the JT60 will bring it much closer to the requirements for a working commercial fusion plant.

FRENCH ENERGY OFFICIAL CALLS FOR FUSION DEVELOPMENT

M. Sourdille, Special Advisor to the French Ministry of Industry for Energy Affairs, issued the strongest call to date from his government for the rapid development of fusion power in an interview published Aug. 30 with the West German industrial daily, *Handelsblatt*. France is moving very quickly, he said, to bring a fast breeder program into operation, but an international program is necessary to make available all technologies leading to fusion.

Sourdille criticized the European Economic Community for its failure to promote the Joint European Torus (JET) fusion program. JET has been bogged down for months in arguments over a site while the key technological issues were neglected, he said.

The Lightning Rod

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meaning, *Das ist ganz klar.* The meaning of everything is, of course, the deeper structure of the phenomenon. This is also *ganz klar.* This, however, was already the position of my predecessors, Professor Fabian Hustle and Herr Wildschwein. However, Professor Hustle only began to understand the possibility of the omega function. I, naturally, have solved this problem."

Reluctantly putting his hindpaw back into his shoe, Professor Nitpicker continues: "The solution I discovered by asking myself the meaning of the hole. Naturally, my hole-ism is not to be mixed up with the holism of Professor Smuts or von Bertalanffy; I mean the sort of hole any sensible coyote knows is a real hole, and other kinds of holes besides. All kinds of holes.

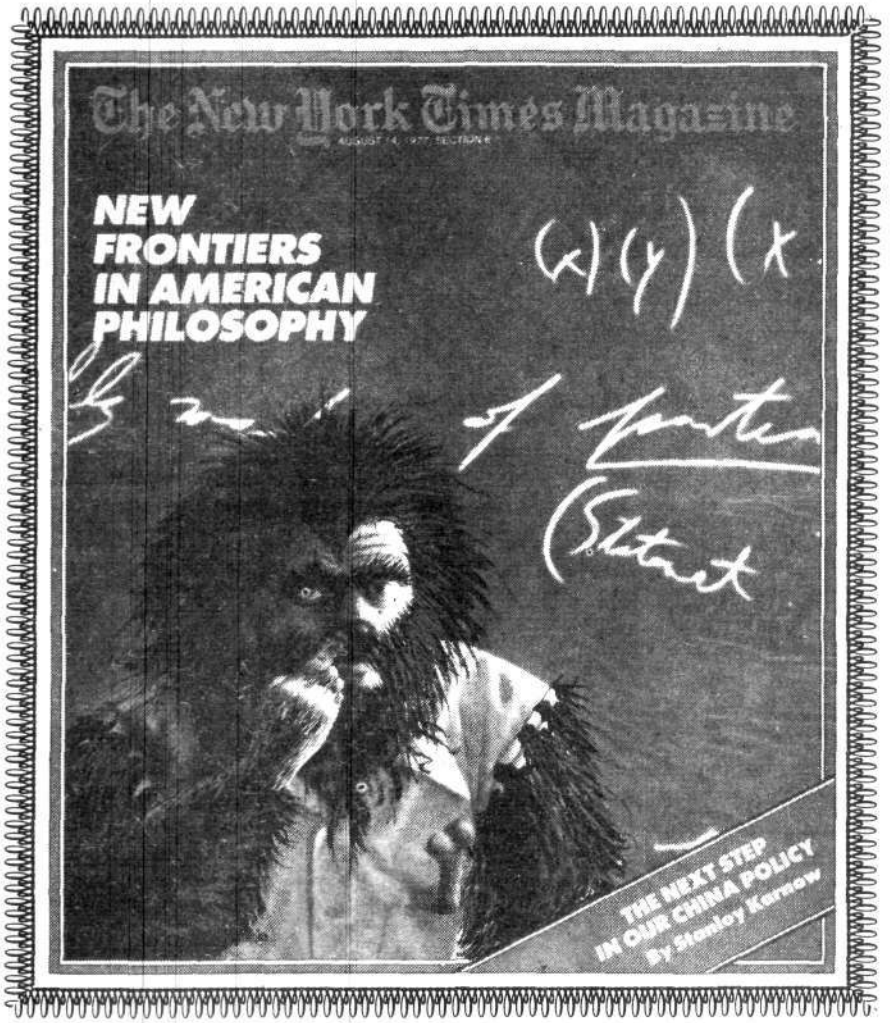
"Naturally, every hole has the same meaning as every other hole. Even Professor Chomsky understands that fact. But what is special about holes? I will tell you. Holes are empty. So, you see, holes are all the same. They all have the same internal structure. There is no difference in meaning between one hole and another. This is absolutely *ganz klar.* However, and I must absolutely and unequivocally emphasize 'however,' the internal structure of a hole is quite different from the other kinds of internal structures we anal philosophers have to consider. A hole is an absolutely pure structure and nothing else, which is why holes are the essence of anal philosophy.

"You see, you think I am picking my nose. In an ordinary person it would be correct to say, 'he is picking his nose.' In my case it is a philosophical inquiry. This is what is known as 'transactional philosophy.' A transaction between my finger and my nostril is an empirical relationship between a philosopher and the essence of his subject matter. This is my philosophy in practice. You see, if I did not explain this, you would make the ordinary layman's blunder and say that I was picking my nose. You would not know that this was a profound philosophical transaction unless I first educated you on this matter. Maybe you begin to see how important my philosophy is, *nagh?*

"But I must educate you about my omega-function.

"You see, the problem of the philosophy of Professor Fabian Hustle was that it was full of holes. I must say in defense of Professor Fabian Hustle that he did propose a crude approximation of my omega-function, but I must also say he did not sniff out the essence of the hole as I have done. Like Professor Hustle, wherever I find a hole I put an omega. That is *gans klar.* Ah, but my knowledge of the universe is full of holes. Perhaps you begin to sense the genius of my discovery! The universe is completed by filling it full of omega-meanings. You see now. If the ordinary person sees only holes, he says that these holes are matters of his ignorance. However, I, by giving the meaning 'omega' to all these holes have given complete meaning to everything in the universe. You see, anyone who accepts my doctrine of the omega-function is able to say that he knows the whole anal truth about everything."

Although certain elements of Professor Nitpicker's biography are carefully withheld "in the national security interest," sources cautiously confided that there will soon be a major publicity campaign in behalf of Professor Nitpicker's reputation in some leading newspapers and magazines, and that it is expected that Professor Nitpicker will soon be appointed official philosopher to the Henry Kissinger White House. ❁



Professor Perfervid Nitpicker, aka Saul Kripke.

In the News
Washington Report

Department Of Energy Act Gives Schlesinger Dictatorial Power

The Department of Energy Act of 1977, which was rammed through Congress this summer, gives U.S. Energy Secretary James Schlesinger carte blanche to wage energy warfare on the U.S. population.

As the sections of the bill excerpted below indicate, the secretary of the Energy Department is given dictatorial powers over the nation's energy supplies, unchecked by Congress. When the act takes effect Oct. 1, Schlesinger will command a department of more than 20,000, have the power to raise, shelter, feed, stipend, and deploy an army of "volunteers," and press into service the U.S. Army, under his direct command.

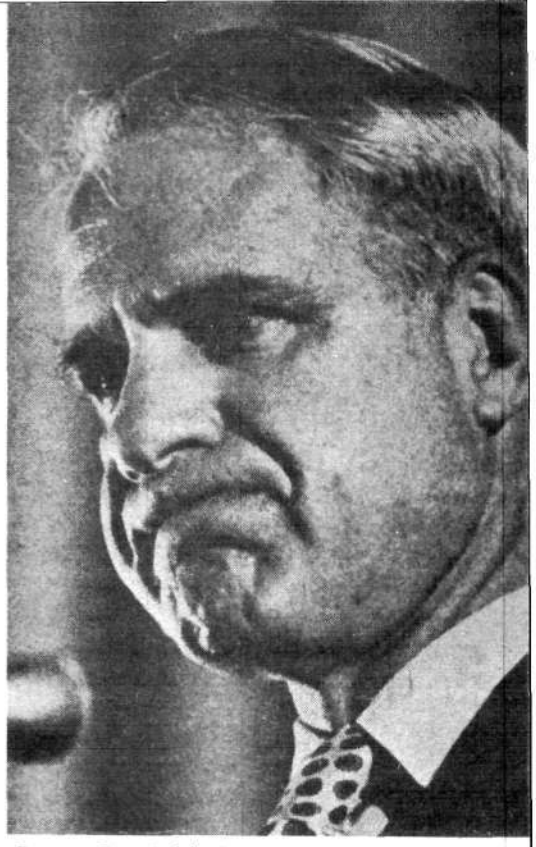
Sec. 603. The Secretary is authorized to prescribe such policies, standards, criteria, procedures, rules, and regulations as he may deem to be necessary or appropriate to carry out functions now or hereafter vested in him...

Sec. 611. [a] *The Secretary is authorized to recruit, train, accept, and utilize, without regard to the civil service and classification laws, rules, and regulations, the services of individuals without compensation as volunteers for or to aid or facilitate the work of the Department.*

[b] *The Secretary is authorized to provide for incidental expenses, including, but not limited to, transportation, uniforms, lodging, and subsistence for such volunteers. . .*

Sec. 612. [a] *The Secretary is authorized to provide for participation of Armed Forces personnel in carrying out his functions. Members of the Armed Forces may be detailed for service in the Department by the Secretary.... A member so detailed shall not be subject to direction or control by his Armed Forces...*

One Schlesinger aide said in a Sept. 13 interview, "You could say that we have been told to go out and do a job and they are going to let us do anything that we want for a while to see what we can get done....Read the act yourself and you will see that we can do almost anything we want."



Energy Czar Schlesinger

Bills Curbing DNA Research Flounder

Senator Edward Kennedy is reportedly withdrawing his bill restricting recombinant DNA research. The bill S-12-7, would have reinstated mob rule in science by establishing an appointed regulatory commission with a majority of non-professionals and local community groups to fine and stop research programs without appeal. Mounting opposition to the Kennedy bill from the science community apparently convinced the senator to withdraw before his antiscience, zero-growth position had any more adverse publicity. Kennedy is now calling for a year-long extension of the current National Institutes of Health guidelines on recombinant DNA to apply to industry as well as university-based research.

Another bill to regulate biomedical research, HR 7897, was introduced in the House in late June by Florida Democrat Paul Rogers. Geared to head off the Kennedy legislation as well as to curb the proliferation of local research policing measures, the Rogers bill is well intentioned but suffers from provisions that would allow the same kind of environmentalist lawsuits against research projects as those that have sabotaged the development of nuclear power plants across the country.

The Rogers bill is also running into trouble on Capitol Hill. It is stalled in the House Interstate and Foreign Commerce Committee with almost no prospects of getting through the House in this session.

In the meantime, opposition to any bill shackling biomedical research continues to mount in the scientific community. Interviews conducted by the FEF Biological Sciences Division with officials of the National Science Foundation indicate that the foundation's position, as well as that of the National Institutes of Health, has shifted away from initial support of the Rogers bill to a point of view that coheres with that of the FEF: that no federal action should be implemented that has the potential for inhibiting recombinant DNA research.

The State of the Carter Energy Program

This chart gives a rundown of the main proposals of the Carter administration's energy program and where these proposals stand in Congress. In contrast to the no-energy program of the administration, we have presented a point-by-point summary of the progrowth energy program of the U.S. Labor Party.

CARTER ADMINISTRATION PROGRAM	U.S. LABOR PARTY PROGRAM	CONGRESSIONAL ACTION
Fusion Power		
Maintain funding at ERDA's Logic I level that insures that commercial fusion power will never be developed. Proposed budget —$342 million	Fund a brute force fusion R and D program that would ensure commercialized fusion power by 1990. Funding should be multifaceted with funds for all viable approaches. $6 billion	*House:* Voted only token increases in the fusion budget. *Senate:* Supported the administration's drastic budget cuts.
Breeder Reactor (Clinch River Program)		
Eliminate all funds for commercialization maintaining only token R and D funds. Proposed budget—$33 million	Commercialize the breeder reactor as quickly as possible. $237 million	*House:* Full House voted to continue stop-gap funding at the full, $150 million level allowing the breeder to enter its commercialized stage. *Senate:* Supported a $75 million compromise pushed by Sen. Frank Church (D-Idaho) that will allow the breeder to continue in its present R and D state but prevents commercialization of the breeder.
Plutonium Reprocessing (Barnwell, N.C. Plant)		
Eliminates all funds for Barnwell Reprocessing Plant. Includes funds for alternative fuel cycles. Proposed budget—$32 million for alternative fuel cycle R and D. Nothing for Barnwell.	Expanded funding to set up additional plants. $120 million	*House:* Action still pending. *Senate:* Added $31 million including $13 million for Barnwell Reprocessing Plant. Authorization is limited to alternative fuel use.
Natural Gas Pricing		
Raise the price of natural gas to $1.75 per 1,000 cubic feet for both interstate and intrastate natural gas beginning 1978.	Long-term goal of lowering prices to increase supply.	*House:* Total deregulation failed, but a liberalized version of the administration's proposal to raise the price of newly discovered natural gas from $1.45 to $1.75 per 1,000 cubic feet was passed. The House version broadens the definition of "newly discovered gas." *Senate:* Floor action pending on total deregulation although the measure was defeated by a 9 to 9 tie in committee. The outcome is uncertain. If decontrol fails, a raise in price to $1.75 will likely pass.

CARTER ADMINISTRATION PROGRAM	U.S. LABOR PARTY PROGRAM	CONGRESSIONAL ACTION
Gasoline Tax		
Reduce gas consumption 10% by 1985: enact a standby gasoline tax of up to 50 cents a gallon by 1985.	No increase in gasoline tax.	*House:* Defeated tax bill but voted to repeal the federal tax deduction for state and local gasoline taxes. (Senate reversed this.) *Senate:* No action yet but overwhelming defeat is expected.
Gas-Guzzler Tax		
By 1985 a purchaser of a car getting fewer than 12.5 miles per gallon would pay a tax of $2,488. A rebate would be given to customers buying fuel-efficient cars.	No gas-guzzler tax. Automobiles should be made more fuel efficient by improved technology such as the diesel engine. Vastly increased funding should be available for mass transit R and D.	*House:* Gas-guzzler tax passed in even harsher form than the administration's proposal. *Senate:* The Finance Committee rejected the gas-guzzler's tax. the full Senate voted to ban the production of gas-guzzling cars rather than to tax the individual owners.
Well-head Tax and Rebate		
Phase in well-head tax equal to price of imported oil over three years. Proposed rebates to everyone for full amount of money collected from the crude oil tax, estimated to amount to $47 per person.	No increase in tax. Encourage full exploitation of existing wells and further exploration.	*House:* Carter's proposal to tax the price of domestic oil to equal the world price was passed without modification. *Senate:* Action is pending. Senate Finance Committee chairman Russell Long (D-La.) is threatening to kill the tax unless the consumer rebate is removed and tax revenues are plowed back into fossil fuel production. Senate liberals are threatening to kill the tax if consumer rebates are removed.
Coal Conversion		
Punitive tax on all utilities and industries using oil and natural gas, thereby forcing conversion.	Opposes conversion because oil and gas are more efficient than coal.	*House:* A modified version of the administration's coal conversion passed with taxes scaled down and certain companies exempted: conversion for nonexempted companies is mandatory. *Senate:* The full Senate passed an extremely weak bill eliminating all forced conversion for industry and requiring only new utilities to use fuels other than oil and natural gas as primary fuel.
Renewable Resources (Solar energy, geothermal, wind power, etc.)		
Full support for increased funding of solar and other forms of renewable energy. Will encourage solar home conversion.	Opposes funding for solar and related "soft" energy forms since the energy throughput is so low that costs are prohibitive.	*House:* No action. *Senate:* No action.

Recombinant DNA: The Promise of Genetic Engineering

by Dr. Richard Pollak

THE HOTTEST ISSUE in the basic biological sciences is recombinant DNA. Although vilified by zero-growthers and other know-nothings, this technique holds the key to breakthroughs in our fundamental understanding of human genetics. Recombinant DNA promises to unlock the secrets of the causes of cancer and aging and to reveal the lawfulness of embryological processes. It could also make available entirely new approaches to medicine, agriculture, and even industrial manufacturing.

The technique of recombinant DNA is actually a form of genetic engineering, a term which refers to the increasing human hegemony over biological processes. This hegemony is most readily demonstrated at present in the historically increased health of the population and the domestication of crops and animals for enhanced agricultural production.

The recombinant DNA process is one of combining the genetic material DNA (deoxyribonucleic acid) of one organism with that of a second, and the subsequent insertion of these "spliced genes" into a host where they will both replicate and produce the molecules for which they encode (Figure 1). Although scientists' control over this process has made great strides in the last four years, genetic transfers in a less deliberate form have been done in laboratories for more than three decades.

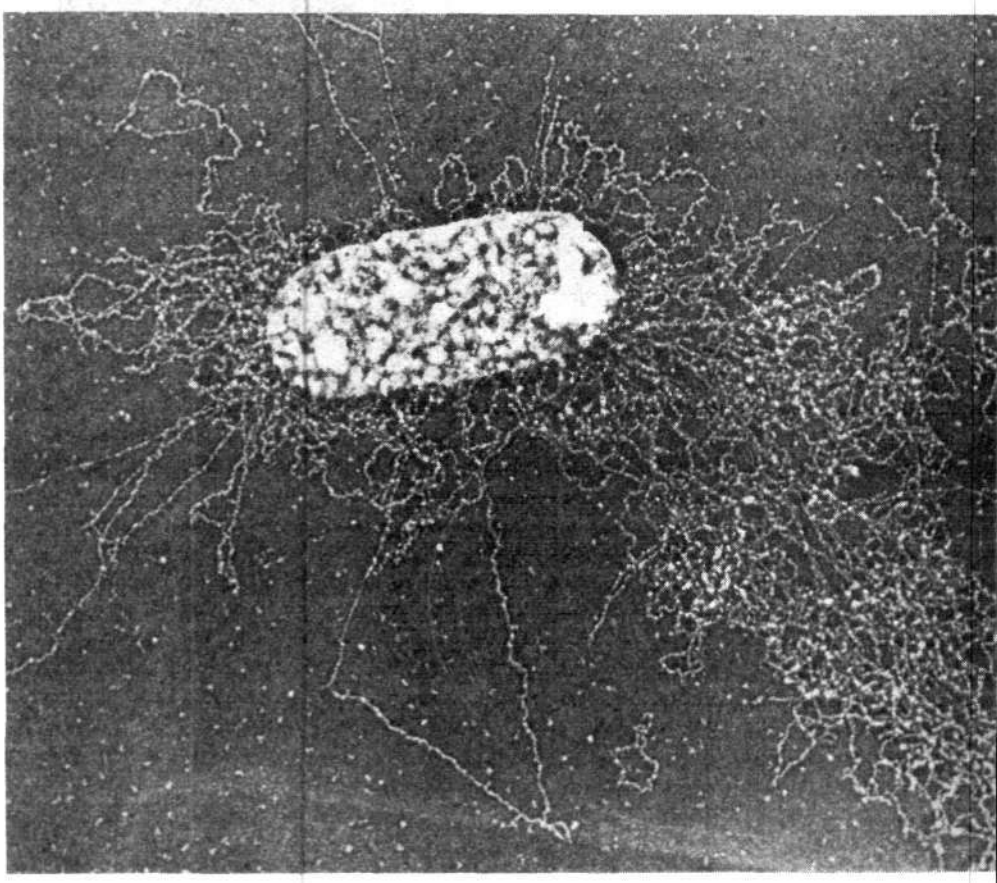
As the host organism that contains the recombinant DNA undergoes its normal metabolism, two events of experimental and practical significance occur. First, the recombinant DNA, along with the usual DNA, is replicated in a normal fashion. This means that the descendants of a single bacterium, known as a clone, all contain identical copies of the recombinant DNA, thereby yielding the genetic material in previously unattainable amounts and purity. Second, the recombinant DNA often expresses itself, that is, it has its message "read out" and translated into specific products by the metabolism of the cell. Then the products and control of this expression are available for either analysis or harvesting.

As this technique becomes widespread and increasingly sophisticated, we can expect that it will precipitate a general crisis in the bioscience community. The reductionist tenets of contemporary molecular biology will become increasingly and even more obviously unable to account for any higher-order activities in biological processes, mandating a reconceptualization of the empirical data and the realization of a new lawfulness of biology.

In other words, the understanding of DNA as an informational molecule that controls cellular and organismal activities *only* by control of the individual sets of molecules comprising individual genes will have to give way as this computer-like model proves inadequate to account for such diverse phenomena as evolution, embryology, and mentation.

What is demanded is a view of genetic phenomena predicated on interactive processes of the cytoplasm (the cell material) and the entirety of the DNA complement of the cell. Molecular genetics must then attempt to elucidate the geometries of these interactions and the process of change of these geometries. This will require that the more global properties of DNA—including configurational, electromagnetic, and even possibly superconducting properties—be understood as *basic* aspects of genetic control processes.

This is analogous to the present crisis in physics wrought by the break-



An electron micrograph of E.coli bacterium spewing out DNA through its chemically disrupted wall.
Scientific American

throughs in plasma physics. The Second Law of Thermodynamics (entropy) is not only obviously inadequate but also flatly wrong when it comes to accounting for the appearance of *self-developing* structures in plasmas, in which global phenomena override the particulate aspects of the gas. Similarly, the self-developing phenomena of the biosphere, from evolution to thought, cannot be accounted for by focusing on the behavior of individual particles, such as genes, but can be located only in determination of the processes by which this self-development occurs. Genetics must reflect that global behavior.

A Range of Applications

The most readily apparent application of the recombinant DNA technique is the insertion of genes into a host bacterium that will code for the production of a substance that is useful and relatively difficult to obtain. For instance, insulin, now obtained from cattle and swine, is becoming increasingly scarce while the number of diabetics is rising. Current science is now at the point where the isolation of the human gene for insulin is obtainable; recombinant DNA research holds the promise that genetic manipulations could produce a *microorganism* that would produce *human* insulin for society's needs.

Recent successes in this field point to the imminent reality of this possibility. Just a few months ago, sequences of DNA that code for insulin in the rat were successfully inserted into the genetic material of the bacterium *E. coli*. Although insulin proteins were not manufactured, the DNA was faithfully replicated in amounts sufficient to determine the base sequence of the DNA molecules. This elucidation of the DNA sequences that code for the insulin proteins, as well as their DNA control sequences, is an essential step along the road to the production of human insulin by microorganisms.

Much as we today use microbes in bread and beer manufacture and in the production of drugs such as penicillin, the insulin-producing methodology could be safely under scientific and industrial control for tremendous human benefit.

This is just one possibility, however. A more far-reaching one involves interferon, a human protein that is a part of the body's immune system. During the early stages of a viral infection, interferon inhibits and isolates the replication of the virus to the initially infected tissue area, while the rest of the immune system is being mobilized. Interferon has shown promise against certain forms of cancer, and is obviously a substance of great clinical significance; but both its basic biology and its therapeutic possibilities remain largely a mystery because of its unavailability. Recombinant DNA techniques using human genes spliced into a microorganism for the produciton of interferon should rapidly turn this around, thereby opening the door to the development of a qualitatively new way to deal with disease.

There are several other proteins associated with the immune response to disease that, through recombinant DNA techniques, can for the first time be considered potential therapeutic agents and not just laboratory tools. Current medical practice often uses broad-spectrum antibiotics to treat bacterial infections, a shotgun treatment that often eliminates microbes normally present and important to human physiology. Viral infections are currently not treatable by drugs at all, and recovery depends on the body's immune mechanism. Utilizing

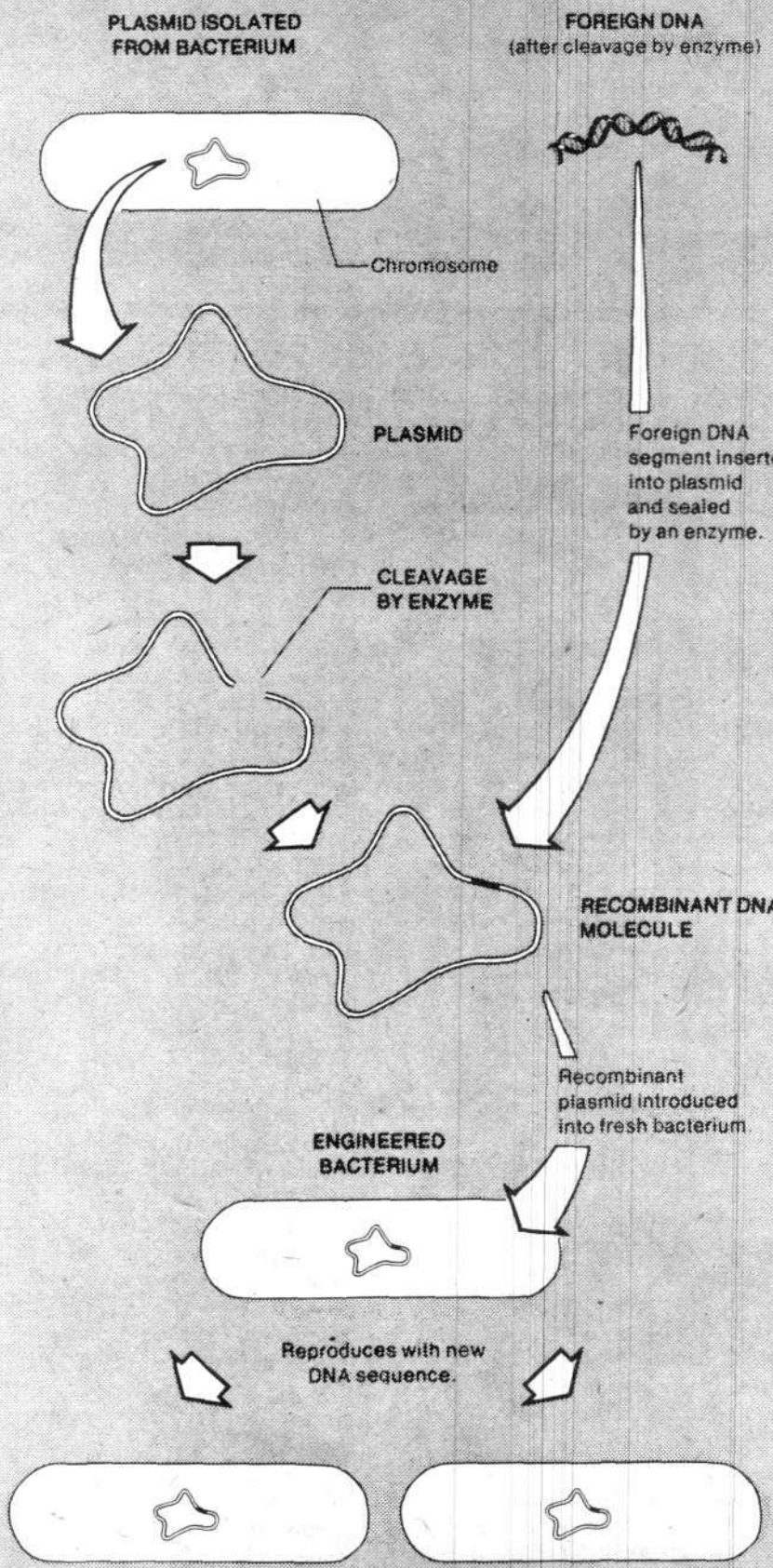


FIGURE 1

How Recombinant DNA Works

The organism of choice in recombinant DNA experiments is Escherichia coli, a bacterium whose physiology and genetics have been the most thoroughly characterized of any bacteria. Strains of E. coli are available that are incapable of living outside the laboratory environment, thereby ensuring that any undesirable combination of genes that might be created would have no chance of spreading.

The genetic material of the bacterium is found mostly in a single, large, circular molecule of DNA, containing approximately 4,000 genes. Additionally, much smaller loops of DNA, consisting of only a few genes are part of the bacterium's genetic complement. These loops, called plasmids, are often the vectors of the recombinant technique.

By the use of the specific lytic and centrifugal techniques, the plasmids can be separated from the rest of the bacterial DNA. They then are placed in solutions containing biological catalysts known as enzymes that cleave the plasmid DNA at specific points. This DNA is mixed with similarly treated DNA from other sources; the two DNAs are then "spliced" together by a ligase enzyme.

These new plasmids, now containing the genes of two different organisms, are introduced into the host bacterium where they become part of the host genetic make-up. As the host bacteria replicate, they create duplicates of their chromosome and their recombinant DNA plasmids. Now the bacteria are a new species with characteristics dictated by their original chromosome and by the new, scientifically determined genetic material of the plasmids. This now-abundant genetic material can be isolated for further experimental work.

recombinant DNA technology, it appears that it will be possible to manufacture certain proteins (known as antibodies, part of the normal immune system) that would bind specifically to the infective organism, thereby making it harmless. This would both alleviate the side effects of antibiotic therapy, such as the increase in drug-resistant microbes or the unintentional elimination of necessary microbes in the body, and introduce, in a practical way, a medical response specific to a particular viral infection.

Much has been written about the possibility of engineering bacteria that will be able to fix nitrogen while living symbiotically with a variety of crop plants. This sophisticated feat requires the successful insertion of a large number of genes that code for a complex of enzymes into a bacterium capable of a symbiotic relation with the desired plant. It should be emphasized that while this would have the potential to immediately raise agricultural output in the underdeveloped countries, the real long-term solution to agricultural productivity lies in capital-intensive development of fertilizer production capacities and related infrastructure. Nonetheless, this development assumes importance as part of such an overall development perspective, because of the tremendous contributions that will derive from the increased understanding of the processes that determine plant growth and, more broadly, the genetic and molecular basis of symbiosis and other ecological processes.

Higher Organisms

All the processes mentioned so far are realizable through the use of recombinant DNA with a microorganism acting as the host. Although profound biological questions must be answered before they will prove beneficial, recombinant DNA techniques with higher organisms hold even greater promise.

Certain species of plants have photosynthetic efficiency and reduced photorespiration rates such that they are twice as efficient as other plants in their use of sunlight for growth. Both processes are genetically controlled, and genetic engineering using recombinant DNA techniques could well allow us to transform less efficient plants to the levels of more efficient types, raising yields by over 50 percent.

Another area of research involves the unique capability of desert plants to take up carbon dioxide at night, which inhibits water and material loss, as compared to current crop plants. Again, recombinant DNA science holds the key to realizing this metabolic behavior in all plants, either by the insertion of the genes that directly code for the enzymes that carry out this process, or by the use of genes that control the process itself. It is estimated that by the use of the increased photosynthetically efficient process and the carbon-dioxide fixing process, crop yields could be increased by as much as 300 percent.

Gene Therapy

One final medical area of direct application of recombinant DNA techniques is in what is known as gene therapy. There are over 1,500 distinguishable human diseases of known genetic origin, and new ones are reported every year. Many take the form of a defective protein which in its normal form is necessary for the digestion of a substance that becomes toxic as the presence of the defective protein allows it to accumulate (for example, phenylketonuria). Others show a defective structural aspect that prohibits normal functioning under certain conditions; sickle-cell anemia is a common example. Still others take the form of the lack of a needed product, such as insulin absence in certain forms of diabetes. Gene therapy refers to the technique of medical insertion or activation of genes that will code for the needed product.

Although this is still in experimental stage, certain findings give hope that this technique will become a realized medical treatment. It was discovered that rabbits lacking an enzyme necessary for the digestion of arginine were able to metabolize this amino acid (which is toxic in large amounts and causes severe retardation in humans who are genetically incapable of digesting it) after infection by viruses containing the genes for the corresponding enzyme, arginase.

There are questions about the direct causality of the therapy, but the essential point is that the production of a desired enzyme is under genetic control and can be medically intervened on. Determining which genes will be successful in this intervention is a scientific problem. The manufacture and testing of those genes uses recombinant DNA technology, and thereby opens a unique area of medical therapy for long-term and fundamental treatment of hereditary disease.

A Revolution in Biology

As important as these basic applications are the theoretical implications of recombinant DNA research have even more profound implications for human progress. The contemporary view of gene activity is that the DNA molecule is basically a computer-like linear informational tape, whose parts are sequentially read out or shut off as various signals reach them. Essentially its entire meaning is assumed to be located in the sequence of the bits of information (the molecules) of which it is made up. While much of a cell or organism's genetic material exhibits behavior consistent with this model, there is a great deal of unexplained DNA that does *not* code for particular proteins and is not an obvious control sequence. In addition, while the known control mechanisms of a microorganism's genetic processes do frequently function in a fairly straightforward "on-off" manner, essentially nothing is known about the regulatory mechanisms in human genetics. This knowledge is mandatory for fundamental advances in the human condition—for the ability to deal with aging, diseases such as cancer, and embryonic and congenital malformations and to intervene in a deliberate fashion for the enhancement of the whole ecology.

How will recombinant DNA techniques help bring about this revolu-

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tion in our understanding of nature? On the simplest level, the increased availability and purity, and thus the increased manipulability, of the genetic material derived from the cloning of the DNA of higher organisms will provide insights into the makeup of the human chromosome.

It has been shown in both procaryotic and eucaryotic cells that certain genes have relatively unstable positions in the cell genome. Discrete genes are known that assume different positions on the chromosomes; and with this change in position there are changes in the cell's genetic expression for both the moving pieces and for those DNA sequences in close proximity to the moving pieces. The causes of this change in genetic behavior are not understood; obviously they could provide key insights into genetic interactions.

By use of annealing techniques, where the purified DNA of known sequence and perhaps known function is fitted and mapped onto chromosomes, the relationship of gene structure and activity to its position on the chromosome and to its proximity to other known genes can be clarified; the functional quality of the recombinant DNA-determined gene can be related to its position in life. Since this ability to clone higher-organism DNA in host bacteria has already been demonstrated, it should not be long before these insights into the human chromosome begin to be determined.

Knowledge of the basic structure of the chromosome—its map and certain invariant features of its architecture—is just a beginning. Recombinant DNA techniques, by permitting the analysis of the location, sequence, and variation in certain physiological parameters, such as associated proteins or altered control sensitivities for the human chromosome, will provide fundamental insights into genetic events that control cellular metabolism and differentiations. In lower organisms this has already been done—and the unexpected results, although simple, are sure to provoke rethinking of some of the basic tenets of molecular genetics.

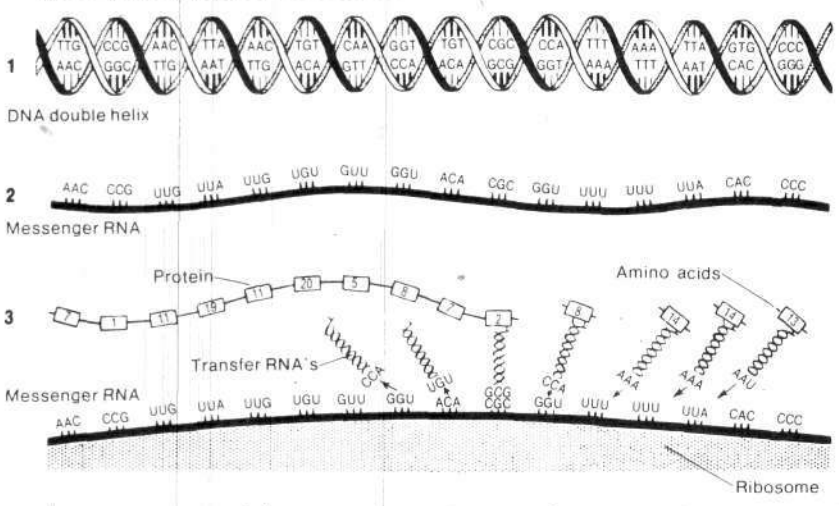
Unexpected Results

To take one example, there is a unique gene "switching" in certain bacteria that does not readily fit into current concepts of gene control. The flagella (the hairlike organelles on the surface of bacteria) of these bacteria are made up of one of two possible proteins. The chromosome of any given bacterium contains the genes for both these proteins, but only one is read out at any time.

The mechanism by which the switch from protein one to protein two (or vice versa) occurs was not understood until recombinant tech-

FIGURE 2

How DNA Manufactures Proteins



Molecular biologists have successfully uncovered the mechanism by which proteins are manufactured from the "blueprint" encoded in the DNA molecule. [1] A gene, made of DNA, consists of a sequential array of nucleotides. Each nucleotide is indicated by a letter signifying the base of that molecular part and its connecting piece: A-adenine; T-thymine; C-cytosine; G-guanine; and in RNA, U-uracil, which replaces thymine.

[2] In the usual case, a single strand of the double helix [here the light strand] is "read-out" or transcribed, with the resultant messenger RNA [m-RNA] molecule a complementary copy of the appropriate DNA strand [G is complementary to C, and vice versa; T or U is complementary to A, and vice versa; T or U is complementary to A, and vice versa].

[3] The messenger RNA then moves to the area of the cell where the proteins are made, joining up with the ribosome. *This complex structure then, by virtue of the m-RNA's linear sequence of bases, directs the assembly of appropriate* amino acids *into the linear protein molecule, a process known as* translation. *The translation occurs as follows:* transfer RNA [t-RNA], *with a specific amino acid attached to it, contains a triplet base sequence complementary to a triplet on the m-RNA. When the appropriate amino acid-bearing t-RNA is in the proper relationship to its complementary m-RNA triplet, the amino acid is attached to the growing protein chain.*

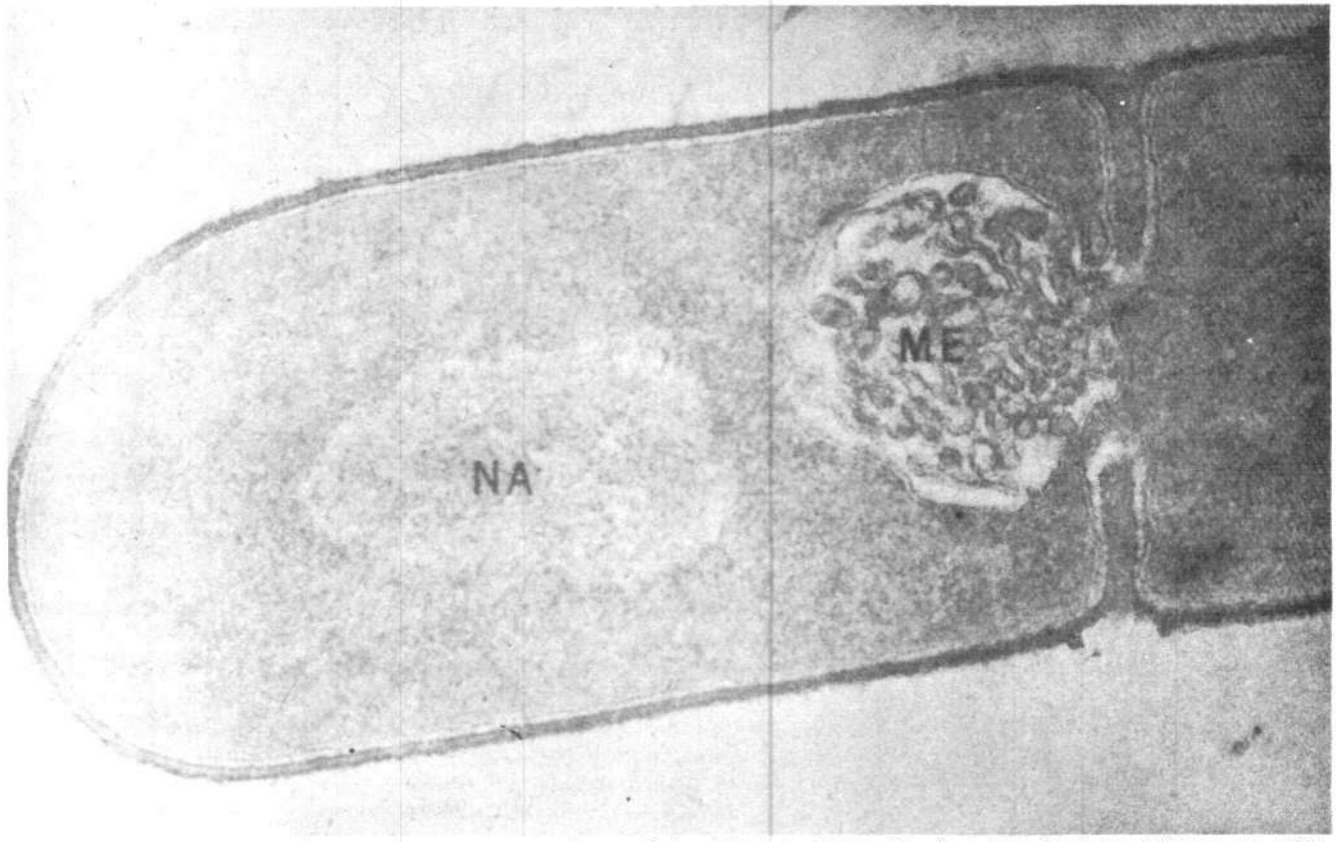
With slight variations, this linear relationship of DNA-RNA-Protein is the central dogma of molecular biology today. The entire meaning of the DNA molecule is held to lie in this sequential, linear array of its building block nucleotides. While many of the cell's metabolic and structural components are encoded by the mechanism illustrated here, it is obvious that this computer-like scheme is inadequate to account for the full physiological, developmental, and evolutionary repetoire of an organism.

niques were used. The sequence of genes, including the control piece, was isolated, inserted into a host bacterium, and cloned. It was found that those clones of DNA from bacteria making their flagella from protein one had their DNA sequences in the order *a-b-c-d-e*, while the clones of DNA from bacteria using protein two for flagella manufacture had their DNA sequences in the order *a-d-c-b-e*. That is, the switching of the readout of the genes for protein one to those for protein two resulted from a metastable inversion of the control DNA segment—a direct violation of the notion of the unswerving integrity of the single-molecule bacterial chromosome.

It is difficult to envision that these mechanisms, although startling, would be sufficient to account for the necessary coupling of the environment and the genetics of the cell, either in terms of evolutionary or embryological development. A recent finding is provocative: the attachment of a repressor protein to the first of three contiguous DNA control sequences had the effect of a five- to tenfold enhancement of the readout of the gene these sequences control. Although other possibilities were not ruled out, one explanation for the unexpected effect is that it is caused by a slight change in the DNA structure; that is, a conformational shift in the local geometry of the DNA results in an increase in genetic activity by an order of magnitude. This geometric quality of cellular control has tremendous implications for the field of genetics (see below).

The question that immediately arises is whether this mechanism is operative in the differentiation of the cells of higher organism. It if were, it would not be surprising. But higher organisms show a much greater degree of complexity, both at the level of chromosome and the cytoplasm. They also show a greater capacity for change, both at the level of the cell and of the organism as a whole. Therefore it *would* be surprising if the control mechanisms were restricted to changes only at the level of sequence alterations, either at the in situ level or due to translocations of gene sequence from one chromosome, or part of it, to another.

By use of recombinant DNA techniques it will be possible to answer such questions for human genetics. For example, it should be possible to locate sequence changes or gene shifts as differentiative events occur. This type of alteration should also be testable for evolutionary changes, for it has already been shown that quite dissimilar species often have very similar proteins and genes that code for them— and it is postulated that the evolutionary shifts



Source: *Cell and Molecular Biology*, New York: Holt, Rinehart and Winston Inc. (1971)

An electron micrograph of a bacterium, magnified 58,000 times, in the process of dividing. Note that the cell wall material has almost completely separated the two daughter cells. NA refers to the nuclear area, where nearly all of the DNA of the bacterium is found. Plasmids, containing very small amounts of DNA, are located throughout the cytoplasm of the cell. ME is the mesosome, a membraneous invagination where the cell's energy production is thought to occur.

must be the results of shifts in control of the gene readouts.

But what happens when the combinations and permutations of particular genes and their various readout schedules are exhausted? Does cellular differentiation or evolution end there? The answer is an unequivocal *no*. The fact is that the biosphere demonstrates that the invariant of the universe is one of an increasing tendency for evolution to occur, and to occur at increasing rates, and this does not come about by juggling the timing or combination of genes that are "on" and "off."

The type of interaction referred to above—where a subtle shift in the geometry of the DNA in response to products of cytoplasmic functioning results in a significant shift in genetic behavior—could lead to a qualitative reevaluation of the nature of cellular interactions. It is true that this example still leaves intact a reductionist biofeedback view of cell function; however, it does open the door to a conceptual breakthrough that would incorporate the ordering qualities of biological functioning on the level of the geometric interaction of genetics and environment.

This breakthrough would not be limited to the geometrical qualities of the DNA. DNA has a capability of reordering and redefining the relationships of the processes that determine cellular and organismal functions, and it can reflect and stabilize these changes in the relationships brought about by the environment. The conceptualization of DNA's capability— the fact that changes in evolution and heredity are coupled coherently with the self-development of the biosphere at the macro level—will allow scientists to reach revolutionary new levels of understanding of causality in science.

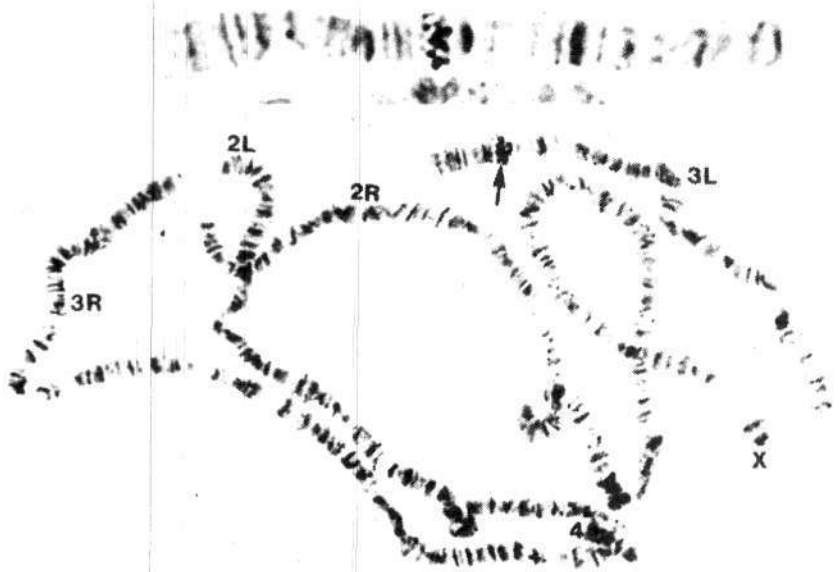
It is precisely at this point, where the sequence differences, determined by recombinant DNA techniques, are found to be insufficient to account for the current reductionist explanations of the events of molecular biology, that the revolution in scientific thought will be mandated. Through recombinant DNA research, major breakthroughs will occur that will qualitatively raise man's hegemony over nature and create the conditions for a qualitatively new understanding of fundamental processes in nature.

The Zero-Growth Counterrevolution

Exactly this potential for major breakthroughs has provoked the

FIGURE 3

Determining the Location Of a Specific Gene



This figure depicts how recombinant DNA techniques give us the ability to determine the location of a particular known and characterized gene.

The striped, tube-like structures are the chromosomes from the salivary glands of one of the geneticists' favorite organisms, the fruit fly, Drosophila melanogaster. *The numbers on this chromosomal squash refer to the different pairs of chromosomes; 1, 2, and 3 are the autosomes [the somatic chromosomes], and 4 and X are the sex chromosomes.*

Using recombinant DNA techniques, the researchers inserted a piece of Drosophila DNA into a bacterial plasmid, inserted this plasmid into a host bacterium, and then grew the bacteria such that they were able to obtain millions of identical copies of the plasmids which included that single piece of Drosophila *DNA. [See Figure1]. This DNA was then isolated from the bacterial culture and used for experimental purposes, including the characterization of its exact molecular makeup.*

In one of the experiments using the DNA, copies of RNA were made that were exact and complementary to the isolated DNA. These RNA molecules were labeled with a radioisotope [a radioactive molecule] and then exposed to a Drosophila *chromosomal squash under experimental conditions where the RNA molecules attached themselves to that area of the DNA whose base sequence was complementary to the RNA base sequence.*

The hybridized squash was then coated with liquid film that dries for later processing. Later development showed a darkening [see black spots in figure] of the film over that area where the radioisotope-labeled RNA attached to its complementary DNA, was located. Thus, the piece of DNA originally cloned using the recombinant DNA teachnique was found to have been originally derived from a particular area of a particular chromosome.

concerted efforts to curtail recombinant DNA research. It is apparent from the spate of recent literature as well as arguments heard at various meetings called to discuss the issue that the anti-DNA battle has no merit on any scientific grounds. The fight is a political one, with the forces of zero-growth calling for an end to basic scientific research as one of the so-called evils of progress.

"...All this (industrial and scientific progress is—RP) amounting to an interference with the homeostasis of the world, with the evolutionary balance, as the history of civilizations has never experienced before in its long course."

This statement by an eminent biochemist in his call to end recombinant DNA research has its roots in the anti-science, zero-growth movement bankrolled by foundations like the Rockefeller Brothers Fund and carried out by the Carter administration in its no-growth austerity economy. It is now generally assumed as the result of the zero-growth propaganda that the recombinant DNA research is of great potential danger environmentally and, furthermore, that it is morally suspect.

For scientists trapped in this creeping environmentalism, the questions have become not the survival of U.S. science but whether or not to allow this DNA research and if so, under what restrictive conditions.

The problem is that progrowth scientists fail to recognize the political terms of the battle. Their arguments range over one or another seemingly scientific issue: Is this organism a safe one to use as a host? Is this facility well equipped? etc. But the basic issue—are we to let zero-growthers shut down basic scientific research in the same way that they are trying to shut down basic industry—becomes lost in a morass of discussions of what the restrictions should be on DNA research.

Nobel laureate James Watson in a recent article comes close to cutting through the scientific baloney surrounding the DNA fight:*

> Much too late, I have come to believe that the two types of experiments under the original moratorium pose no real threat to the general public. Much too quickly, we the scientists who initiated the recombinant-DNA research debates concluded that it was dangerous to make bacteria which are resistant to many antibiotics or which *can* synthesize a deadly poison even though they normally don't. Instead, we should have focused upon the fact that most, if not all, bacterial species already exchange DNA with each other in nature—for example, through the infection process. Thus, if through recombinant DNA technology, we were to make an E. coli strain that, say, makes the cholera toxin, we are very likely repeating what nature has done many times in the past. There is every reason to believe that even if it did escape from the laboratory it would not pose any major public health threat. Even less convincing, especially in retrospect, were the arguments against putting the genes of tumor viruses into laboratory strains of bacteria. The argument here was that such cancer-gene-bearing bacteria might accidently colonize parts of the human body, releasing cancer-causing DNA that might pass into our cells and initiate a cancer. By the time of Asilomar,** however, we already realized that many, if not all of the so-called DNA tumor viruses were in fact ordinary animal viruses that routinely infect most of us early in life. By still unknown means, they remain latent in our bodies for the remainder of our lives, usually only expressing themselves as disease-causing agents under various physical conditions (such as Herpes virus-induced cold sores). So, the danger we face from our intestinal bacteria acquiring a little cancer virus DNA must be negligible compared to that we face every time we are infected with any of the innumerable DNA-containing viruses.
>
> Particularly misguided was the placing of work with human DNA in the highest potential risk category, thereby restricting it to biological warfare-like facilities and insuring that almost no one in pure research could work it. Yet this is a DNA to which our ordinary intestinal bacteria must be constantly exposed, for it is very hard to imagine that none of the human DNA released from the normal sloughing-off of dead gut cells does not occasionally enter neighboring bacterial cells and become integrated into their DNA.
>
> The almost unanimous final consensus at Asilomar reflected oft-repeated speculation that human DNA might carry the genes of the so-called RNA tumor viruses. There is, in fact, no real understanding of why such cells harbor potential sources of trouble. No enlightened person, liberal or otherwise, would want responsibility for the slightest chance of increasing the incidence of human cancer. But, we should have considered that all vertebrate cells most likely carry many such genes as normal genetic components. Their real function must not be to cause cancer, and we should not have panicked about potential exposure to DNA sequences which we already possess.

The biologists who recognize the importance of the recombinant DNA

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* James D. Watson shared the Nobel Prize with Francis Crick and Maurice Wilkins for their 1953 work on the molecular structure of DNA. The author of *The Molecular Biology of the Gene* and *The Double Helix*, Watson is currently the director of the Cold Spring Harbor Laboratory.

** Asilomar refers to a 1975 conference at the Asilomar Conference Center in California where 150 biologists gathered to discuss the recombinant DNA issues. The self-policing guidelines set up at this conference are the basis of the current National Institute of Health rules.

work have assumed such a defensive position that *they* are the ones calling for the DNA guidelines, hoping to placate their enemies enough to allow them to get back to the labs. How *foolish*!

There are already myriad restrictions placing stumbling blocks in their way, similar to the environmental impact statements that have halted the construction of nuclear power plants. Every grant application for federal funds now must have typed in boldface on the front page "THIS APPLICATION DOES/DOES NOT INVOLVE RECOMBINANT DNA"—a chilling reminder to the potential recombinant DNA researcher that he might not get funded, no matter what the merits of the work. On campuses committees must be formed to rule on the adequacy of each laboratory's precautions—whether the proposed research "justifies" the "risk"—before the grant can be submitted to the funding agencies.

Then there is a proliferation of local community rules that, according to federal laws, will supersede the proposed federal guidelines *if they are more restrictive*. The ability of a local group to blackmail an industry or university by threatening to close down its research can prohibit the realization of recombinant DNA research, and all that it promises for society's well being, before it ever gets started.

As James Watson put it, this situation will "legitimize a control over the direction of science that we have not seen since the Middle Ages....We are likely to find that our opposition is for the most part led, not by individuals with any deep knowledge of or even fear of our work, but by persons who, for myriad reasons, do not like the fruits of science, if not of the intellect, and see us as the most vulnerable foe." ✡

A shorter version of this article appeared in New Solidarity, *April 16, 1977.*

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The Argonne Experiments *and the End of Quarkery*

by Eric Lerner

FOR THE PAST 15 years the study of the fundamental structure of matter has been bedeviled with the increasing absurdities of the theory of quarks, the supposedly ultimate particles of matter. Recent experiments at the Argonne National Laboratory have conclusively refuted the quark theory and some of the basic assumptions of quantum mechanics. Correctly interpreted, the Argonne results show the way to a new, more productive approach to understanding the structure of elementary particles.

Experimental results obtained over the past year at the Argonne Zero Gradient Synchrotron in Illinois have conclusively refuted the basic

The bubble chamber is one of the major tools of high energy physics. In the chamber, charged particles leave tracks of bubbles in liquid hydrogen that is at the boiling point. Here a neutrino, a neutral particle that leaves no track, collides with a proton whose tracks are seen.

Argonne Photo

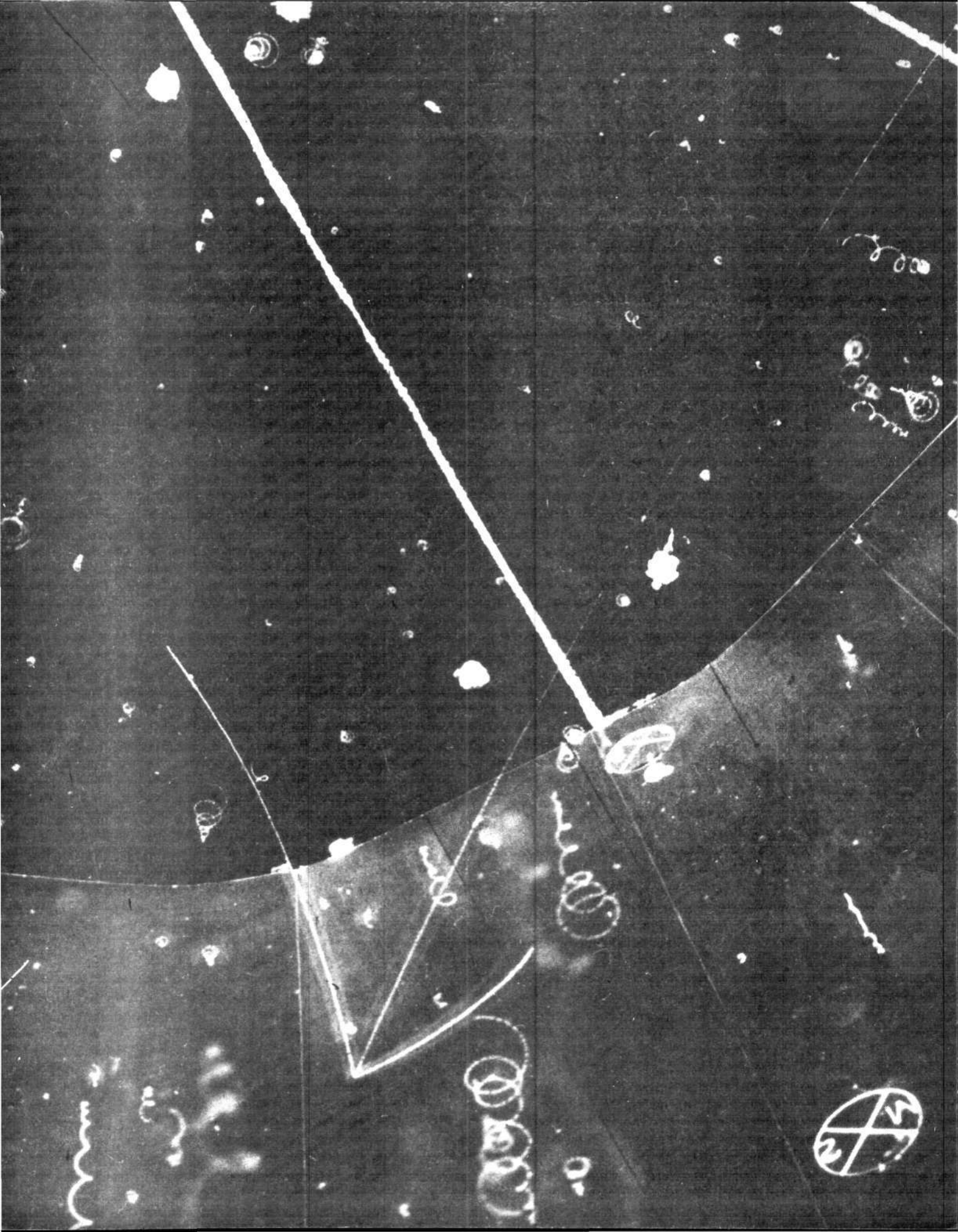
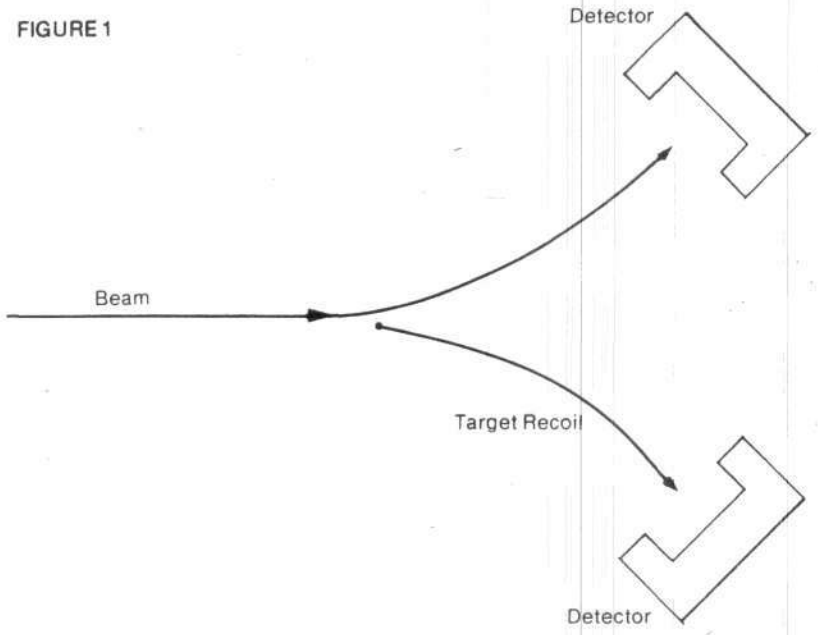


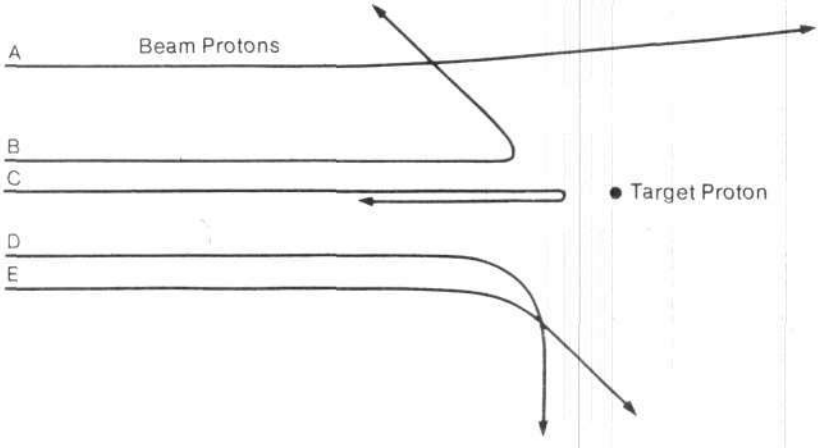
FIGURE 1



The Argonne Experiment

A beam of protons from the Synchrotron is shot at a target of protons [liquid hydrogen]. Both the beam and the target protons have precisely aligned spins. The deflected beam particles and the recoiled target particle are both captured and recorded by detectors, movable complex electronic devices that count the number of particles at various angles of scatter.

FIGURE 2



Scattering Angles

The closer one proton approaches another, the more forcefully it is deflected and therefore the greater the angle of scatter. The diagram shows how distant approaches like A are just slightly deflected; B, D, and E are increasingly deflected; and C, a head-on collision, is deflected 180 degrees. Since more protons undergo glancing collisions than very close collisions, a definite relationship between the number of scatters and the scattering angle can be calculated.

assumptions of the quantum mechanical approach to high-energy physics and its degenerate end-product, the fantastic theory of quarks.* At the same time, by demonstrating the existence of dynamic geometric structures at subnuclear levels, these experiments point the way to a new theoretical framework for high-energy and elementary particle physics, a framework premised on the same self-organizing processes fundamental in plasmas, and, for that matter, in biological and social evolution.

For the past 50 years physicists have attempted to use quantum mechanics to explain subnuclear particles (protons, electrons, and so forth) and fields on the basis of two fundamental assumptions: (1) that all matter is composed of point particles, without structure or dimensions; and (2) that the interactions of these particles are controlled by potentials — fixed laws governing the forces they apply on each other.

Any sort of geometrical structure on a scale smaller than that of a proton (about 10^{-13} cm) was excluded by the quantum mechanical "uncertainty principle." Just as the Ptolemaic astronomer piled epicycle onto epicycle to cover over the gap between their assumptions and observations, so, especially in the past 15 years, most particle physicists have stuffed a mixture of Buddhist metaphysics and pure humbug into the chasm that separates the ultimate particles — quarks — from anything resembling reality.

Galileo's telescopic observations of Jupiter's moon, flatly contradicting the Ptolemaic assumptions of an earth-centered universe, swept the field clear for Kepler's breakthroughs. Today, the unarguable observation of subnuclear geometric structure performs the same task in eliminating the old quantum structure, quarks and all.

The Argonne Proton Spin Experiments

The Argonne experiments, like all experiments in high-energy physics, consisted of accelerating subnuclear

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Eric Lerner is director of physics for the FEF.

particles (in this case protons) to high energies, hurling them against similar targets, and observing the results. The aim of all such experiments is to obtain some notion of the nature of the particles by observing their interactions. The Argonne experiments were uniquely advantageous for the study of the internal geometry of particles because they allowed the experimenter to precisely fix the alignment in space of the accelerated beam protons and those of the target protons.

Protons, like all other subnuclear particles, possess a magnetic field, similar to that created by a charged body spinning on its axis; the direction of the axis of the magnetic field is called the *spin alignment* of the proton. In a normal accelerator, protons of all different spin alignments collide with the target, thus blurring out any geometrically determined interactions. Even if the accelerated proton beam begins as a polarized beam, with the spins all aligned in one direction — either parallel or antiparallel to the overall magnetic field in the accelerator — the rapidly changing magnetic fields in the accelerator tend to flip or depolarize the protons long before they have achieved very high energy. The Argonne synchroton accelerator, which has weaker focusing magnetic fields than any other accelerator of its size, can with certain modifications accelerate the protons without depolarizing them. In 1973, the Argonne Lab became the first high-energy accelerator to collide spin-aligned protons with spin-aligned targets (liquid hydrogen), and it still is the only accelerator with this capability.

In the synchrotron, protons accelerated to 12 billion electron volts energy (12 GeV or the equivalent of a temperature of 120 trillion degrees centigrade) collide with hydrogen nuclei and are scattered into detectors arranged in a given plane and at definite angles. Since both the beam and target, or recoil proton, are observed, the dynamics of the interaction can be calculated, and by moving the detectors, the entire scattering pattern can be determined (see Figure 1).

Theoretically, the expectations for the spin-aligned experiments were unexciting. Since spin is considered to be a very small magnetic effect, not really geometric but just another minor field, the theorists expected that at high energies spin effects would become very small or even disappear entirely. The exact opposite occurred.

The experimenters at Argonne found that spin-aligned effects were *thousands of times stronger than expected at high energies*, and were especially strong at large recoil angles, that is in the more "head-on" collisions where the interactions of the particles were the strongest. Specifically, they found that there was much greater scattering when the spins of the two protons were parallel than when they were opposed (see Figure 2).

Second, when the spins were parallel and the spin direction up, there was far more scattering to the left than to the right. This asymmetry, similar to the ability of optically active molecules to rotate the polarization of light, was concentrated in certain high angles of recoil, thus producing "jets" of protons in certain directions (Figure 2).

Third, the experimenters found that the apparent "shape" of the proton was very much nonspherical. When the proton spins were aligned along with the beam, there was about twice as much scattering as when they were aligned at right angles to the beam.

These results were startling and disturbing enough in themselves. The existence of very strong spin effects at high energies and the fact that these effects were strongest for the most violent and penetrating collisions immediately imply that spin is not some simple magnetic effect but is intrinsic to the geometric structure of the proton. If the proton as a whole poses an asymmetric (nonspherical) structure associated with its spin, then this has further implications for the famous parity experiments performed in the late 1950s at Columbia University and never since adequately explained.

These experiments showed that in the decay of certain radioactive elements such as cobalt, electrons were emitted with their spins aligned in the direction of their motion, while positrons, the antimatter equivalent of electrons, were emitted with spins aligned opposite to their motion. It was perplexing that this asymmetry implied that positrons and electrons in some way were mirror images of each other, but were not mirror images of themselves — they possessed left- and right-handedness. That is, a sphere when reflected in a mirror will be identical to itself, but a right- or left-handed glove will not be, nor will a particle whose spin is aligned with its motion.

The obvious implication was that this parity violation was a symptom of a geometric asymmetry in the structure of the electron similar to that of isomerism in organic molecules (where chemicals with the same formula have different geometric structures). The Soviet physicist Lev Landau suggested this in the late 1950s, but he was generally ignored. The Argonne results demonstrate that such geometric asymmetry in fact exists at the most fundamental structural level of the proton, at least, and quite possibly the electron as well.

The Scattering Curve

Although it is disturbing, this aspect of the results does not flatly contradict the quantum assumptions, since we are dealing here with the geometry of the proton as a whole and thus at scales (around 10^{-13} cm) that are still allowable. The critical aspect of the Argonne experiments lies in the fine structure of the spin effects.

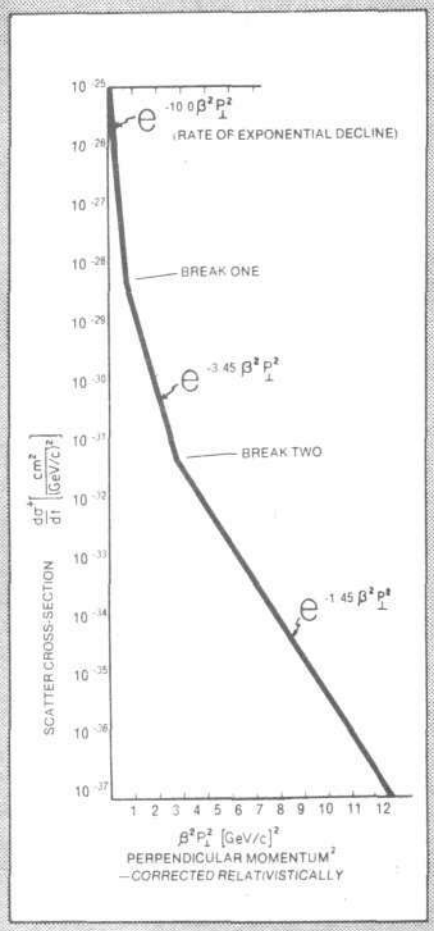
For about 10 years, it has been known that the proton appears to possess some internal structure. If it were totally homogeneous, the number of protons scattered over other protons would decline exponentially as the angle of scatter increased. Instead, there is a "break" in the scattering curve (see Figure 3a). As in the case of the famous Rutherford experiments with the

*Quantum mechanics is the physical theory of behavior on an atomic level. It is based on assumptions that the nature of energy in the small is discrete, discontinuous, or "quantized."

Proton Cross-Sections FIGURE 3

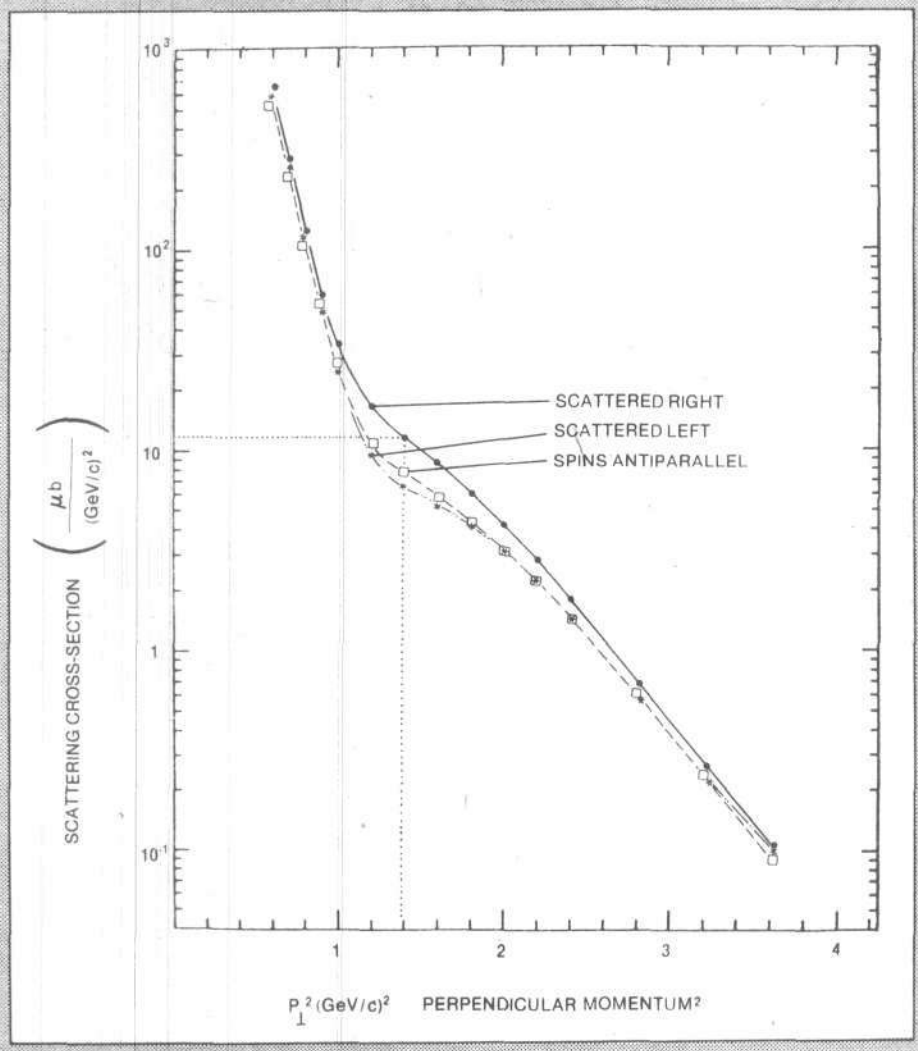
These three graphs show the number of proton scattering events plotted against the square of the momentum perpendicular to the beam. The larger the momentum, the larger the angle of the scatter. The total momentum of the beam is 11.75 GeV/c.

FIGURE 3a



The above graph shows the overall scattering cross-section—in effect, the size of the scattering target in proportion to the number of scattered protons. The cross-section falls off almost exponentially with the perpendicular momentum [squared and relativistically corrected]. The rate of exponential fall changes suddenly at two distinct breaks in the curve—at about 1.4 GeV^2 and 4 GeV^2. The two lower sections of the curve imply the existence of small "hard" portions to the field that scatter more than the overall proton field at large angles.

FIGURE 3b



Depicted above is the dramatic assymetry of scattering that occurs with the collision of spin-aligned protons. The top curve [designated by dots] is the scattering cross-sections for protons that have the same spins and that scatter so that the orbit of interaction is in the same direction, clockwise, as the spins. [See Diagram 3b.1.]

The bottom curve [designated by stars] is the scattering cross-section of the protons whose orbit is in the opposite direction to their spin, as in Diagram 3b.2. The middle curve [designated by squares] is the cross-section of protons, beam and target, whose spins are in opposite directions.

Note how the lines diverge sharply around 1 GeV^2 showing that at larger scattering angles there are far more particles scattered to the right than to the left. On the logarithmic scale here nearly twice as many protons are right-scattered as left-scattered and far more are scattered when the spins are parallel than when they are antiparallel.

Diagram 3b.1 and 2

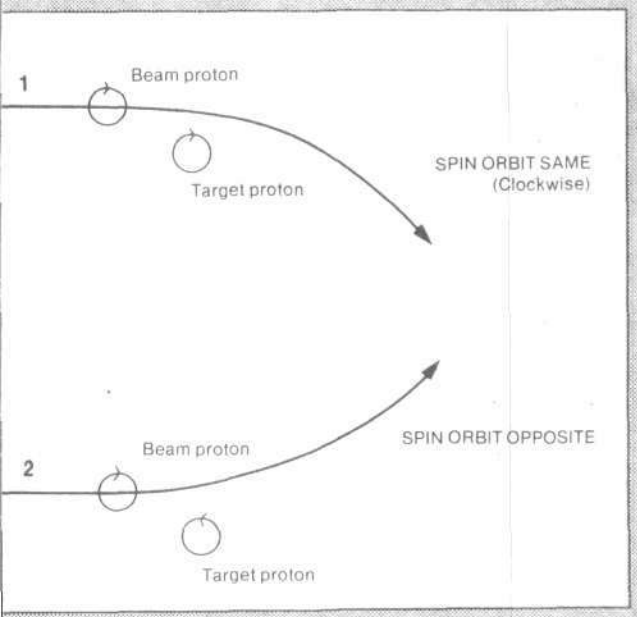
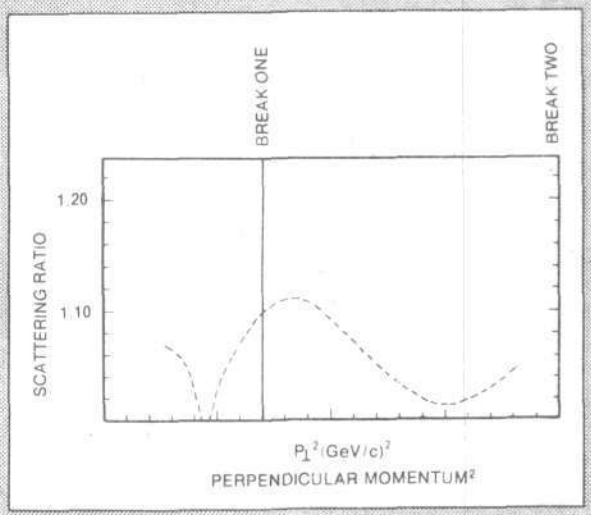


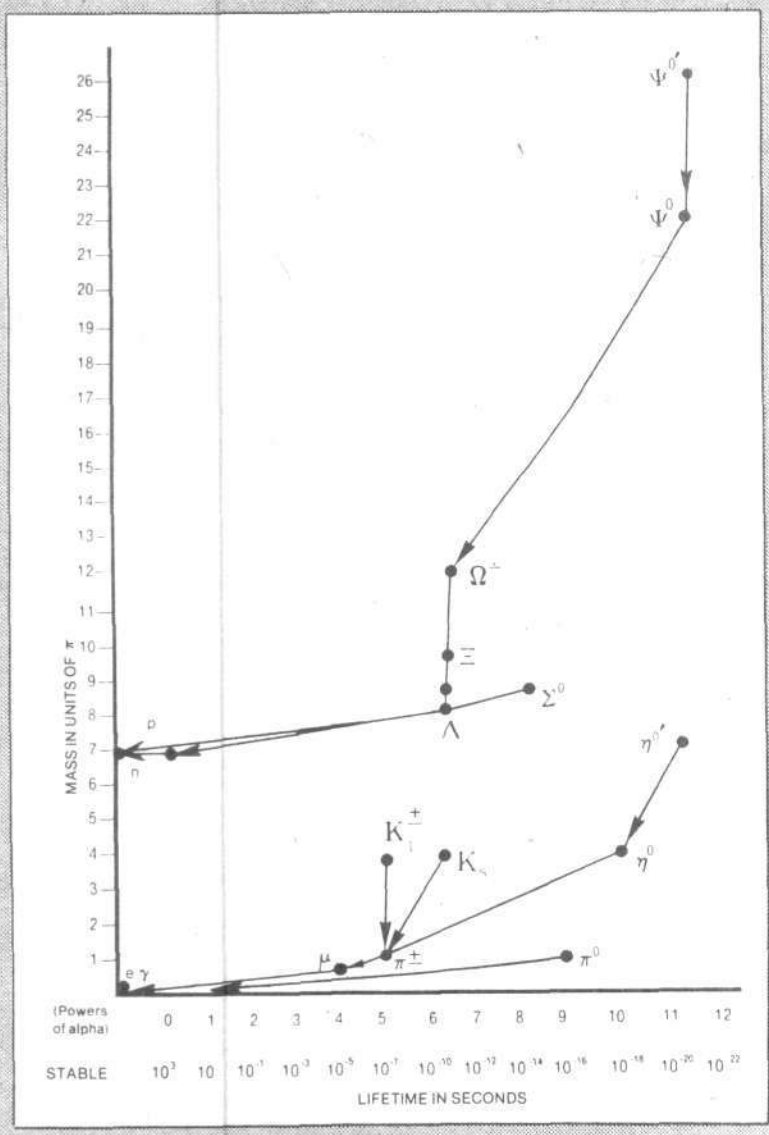
FIGURE 3c



The ratio of scattering of spin-parallel protons with spin-antiparallel protons is shown in the above graph. The assymetrical effect reaches a peak at a point very close to the first break in the overall cross-section curve and there is an increase as the perpendicular velocity approaches the second break. This strongly indicates that the assymetrical scattering is associated with the small-scale field phenomenon that creates the breaks in the cross-section curve.

The Elementary Particles FIGURE 4

The 18 known, stable [or long-lived] particles, designated on the graph by Greek or Roman letters, are plotted here against their mass and against their lifetime. Mass is measured in units of the mass of pion [one of the particles], which is 270 electron masses; lifetime is measured in factors of alpha. Lifetime increases from right to left. The 18 particles have some striking similarities. Almost all of them have lifetimes near integers on the scale, and many are near integral masses. Note the general similarity of the pattern of the nine particles decaying [the pattern of decay is denoted by the arrows] into protons [p] and neutrons [n] and the nine that decay into electrons [e] and photons [γ].



nucleus of the atom*, the higher-than-expected scattering at high angles implies a "hard core" smaller than the proton as a whole — in this case about three times smaller in cross-section. The normal explanation for this phenomenon has been that the proton, although not itself a point particle, is composed of point particles called partons, or the notorious quark (a nonsense word from James Joyce's existential novel *Finnegan's Wake*).

The immediate problem with this explanation, even for the proton-scattering result, is that there is a second break in the curve, implying a doubly compound structure. This problem cannot be avoided simply by postulating that the quarks have subquarks or their own, and so on, because this would still imply some real extended substructure within the proton on the scale of the first break, even if these are considered only as local clumpings of smaller point particles. But of course, since only scattering is being measured and not geometric structure, these results can, and were, dismissed as merely interesting.

The Argonne spin experiments explode this little coverup. Dr. Alan Krisch, one of the main Argonne experimenters (and not coincidentally, one of those involved in the earlier scattering cross-section experiments) discovered that the maximum spin effects occur at precisely the same angles of scattering as the breaks in the overall cross-section curve (see Figure 3). This is a critical experiment of the highest importance, since it demonstrates beyond a doubt that the *geometrical properties of the proton, its ability to asymmetrically deflect other particles, is itself distinctly inhomogenous on a scale of at least an order of magnitude smaller than that forbidden by quantum mechanics.***

This is the crucial point to the experiments and therefore deserves elaboration. The combination of quantum mechanics and relativity theory implies that for any particle of mass, M, there is a distance, $D = h/Mc$, called the Compton wavelength of the particle, where h is Planck's constant (quantum of action) and c is the speed of light. There can be no concentrations of matter within the particle that are smaller than this wavelength, except the special case of point particles. Thus, the experimentally verified existence of structures within the proton at least five times smaller than the proton's Compton wavelength implies either that quantum mechanics does not hold in the interior of protons, or that Planck's constant is at least five times smaller in that region, or that the speed of light is about five times larger, or some combination of all three!

The Argonne experiments still leave open the possibility that some strange combination of point particles and potential fields, even if organized on a finer scale than that allowed by quantum theory, could somehow account for the structure observed. However, other recent experiments have ruled out this escape hatch. If any sort of point particle potential combination is responsible for particle scattering in collisions, then it is only to be expected that at very high energies, as the beam particle spends less and less time in the other particles' potential field, that scattering cross-sections (the number of particles scattered at a given amount) will decrease.

In fact, even at very high energies, the scattering cross-section continues to increase — and this occurs not only for the presumably complex proton, but also for the electron, supposedly, the particle best understood by quantum mechanics. Taken together, the recent results in high-energy experiments totally undercut the foundations not only of current theories of elementary particles, but quantum mechanics in its present form.

The implications of these results are by no means generally recognized, not even by the experimenters themselves. However, it should come as no surprise that such results have been obtained; the real wonder is that the present theories have lasted so long.

The Paradoxes of Quantum Mechanics

Since its consolidation in the late 1920s, quantum mechanics has been bedeviled by epistemological blunders inherited from Newtonian mechanics, especially the notions of point particles and fixed interacting potentials. As demonstrated by Immanuel Kant in 1781, such point particles introduce inherent contradictions into any theory. For example, an infinitesimal electron will have an infinite electric field and thus infinite energy and mass. That the dominant formulations of quantum mechanics continued to insist on the Newtonian point particles is all the more remarkable when one considers that the most striking successes of quantum mechanics are based on the recognition of matter's continuous or wave character, the opposite of the ultimately discrete point particle.

But insist on it they did, and in a fundamental way the resulting theory of quantum electrodynamics was inherently contradictory. Results consistent with observation in the realm of atomic physics were obtained only by the use of various explicit and implicit approximation and renormalization techniques, all of which relied on the convenient fact that the electromagnetic coupling constant, which is about 1/137, got much smaller very rapidly, leading to a rapid convergence of approximations. In contrast, the strong or nuclear interaction has a coupling constant considerably greater than 1 (about 13) and therefore similar series of terms in powers of the coupling constant *do not converge at all.* Thus from the start, quantum mechanics'

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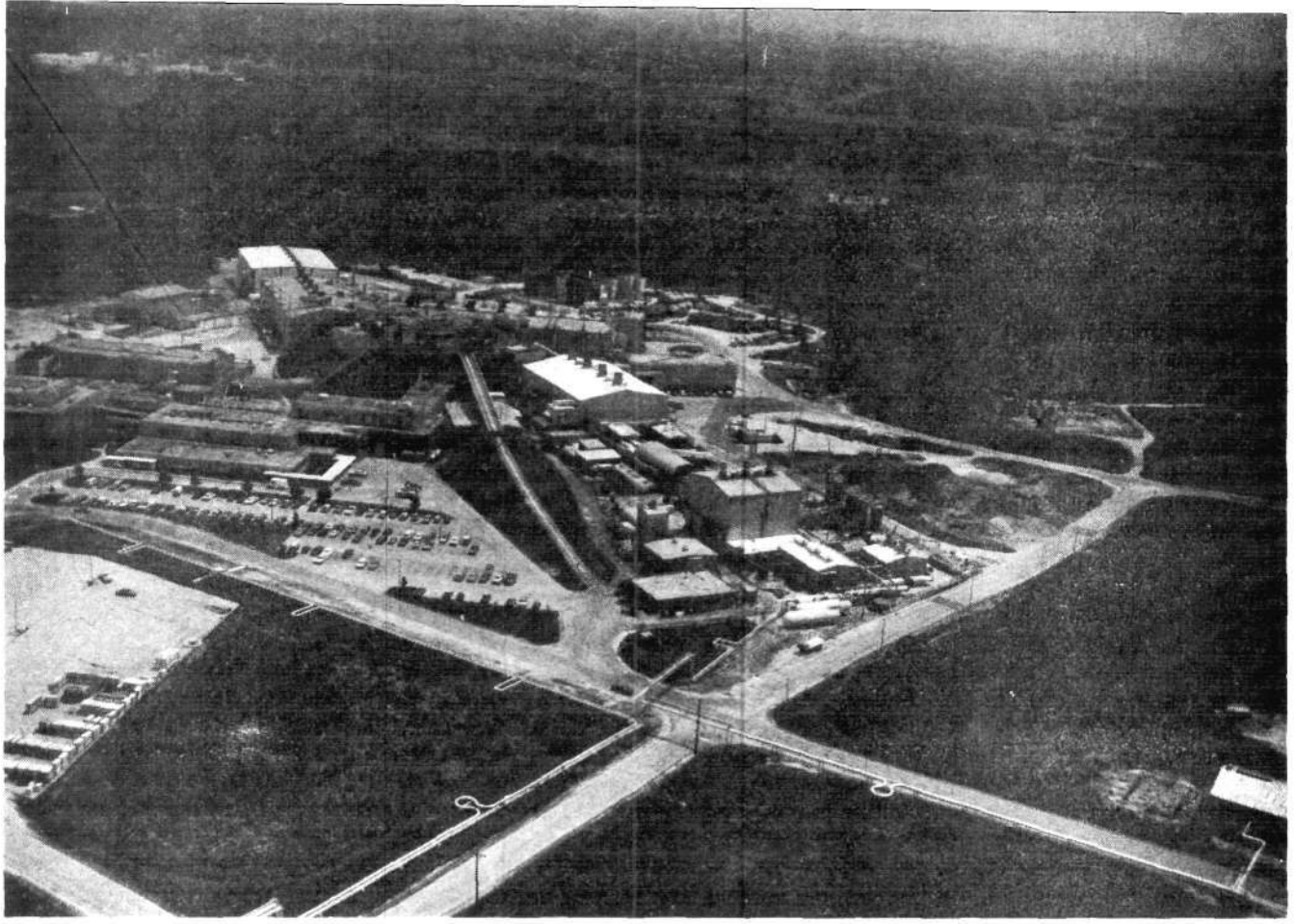
* In 1911, Ernst Rutherford performed an experiment in which alpha particles (helium nuclei) were scattered from a thin film of gold. The resulting scattering angle of distribution demonstrated that there was a small hard core to the atom, the nucleus

** Additional evidence inferring the existence of the geometrical substructures of protons was announced in September by the group working at Argonne with Dr. Krisch. The new results extended the scattering experiment further into the region of the second break in the cross-section curve. As predicted, the difference between the spin-parallel and spin antiparallel scattering cross-sections rose at the break to an even higher peak, with parallel scattering twice as great as the antiparallel.



The Zero Gradient Synchrotron facilities at the Argonne National Laboratories in Argonne, Ill. where the spin-aligned proton scattering experiments were conducted.

Argonne Photo

internal contradictions prevented a rigorous treatment of nuclear interactions.

Nor was such a treatment seriously attempted. Beginning in the late 1930s and with increasing speed after World War II, physicists fled from the problems of theory to the latter-day Holy Grail — the search for the ultimate particle. By the late 1930s, in addition to the electron and proton, three other subnuclear particles had been observed, the neutron and two so-called mesons, whose mass was intermediate between the electron and proton. These particles were observed as a result of radioactive decay of the collisions of high-energy cosmic ray particles with nuclei. After the post-World War II development of increasingly powerful particle accelerators, more and more elementary particles, both heavier and lighter than the proton, were observed. These particles were detected by their tracks through cloud chambers and photographic emulsions. All had very short lifespans, less than a millionth of a second, decaying into other short-lived particles and eventually into protons, electrons, and energy.

Each particle had a corresponding antiparticle, identical except for charge. Particle-antiparticle pairs could be produced from sufficiently strong electromagnetic fields, and the collision of particle and antiparticle led to mutual annihilation.

By the early 1960s, 16 such particles (and their antiparticles) had been discovered and two more were discovered in the past 15 years (see Figure 4). However, this already complex picture was further complicated by the epistomological blunders of the investigators. As accelerators grew more powerful, it became obvious that there were certain particular energies at which the interaction of two particles suddenly became stronger. These "resonances" could be interpreted as evidence of shortlived excited states of the particles involved, transient dynamic phenomena hardly outlasting the time of the collision itself and thus hundreds of times shorter than the fastest decaying stable particle. Unfortunately, the particle physicists decided to imbue these phenomena with greater dignity, and called them particles too. They thereby increased the number of elementary particles to well over 200, a number that grew with practially every new experiment.

The early 1960s was the logical period for physicists to step back and begin a fundamental reevaluation of their theories in light of the accumulated evidence. Unfortunately, this did not occur. Instead, high-energy physics was submerged in a wave of numerology and Buddhist mysticism, as various groups attempted to induce from the mass of data regularities that would allow classification of the data into various numerical groupings of various religious significances.

With several hundred so-called

"We also have it in a charming color of blue!"

particles, there was indeed quite a field for induction! Various symmetries and magic numbers — octets, nonets, dectets, sextets, and so on, were rapidly found and given appropriate names — like Nobel laureate Murray Gell'Mann's Eightfold Way. After a while, the quest for doctrinal simplicity led to the theory that all of the 200 particles and resonances were made up of a single ultimate particle — a quark.

The Quirks of Quarks

Quarks, once invented, seemed to have the capability, as mere mental constructs, to multiply faster than rabbits. First of all, to account for all the different particles it was immediately necessary to theorize several types of quarks that could combine to make up the particles. Gell'Mann therefore created three quarks, distinguished by an imaginary quality he called "up," "down," and "strange" — quark flavor. After a good deal more theorizing without particular reference to any experimental results, it was decided to add a fourth flavor — "charm."

This however was insufficient, since if several identical quarks came together in one bigger particle, a fundamental dogma of quantum theory would be violated — the exclusion principle, which prohibits the cohabitation of identical particles. Thus to distinguish the similarly flavored quarks, a new property was invented — "quark color." Each flavor now had three colors — red, green, and blue, as well as colored antiquarks — cyan, magenta, and yellow. (If the reader's credulity is now somewhat strained, he is referred to the January 1977 issue of *Scientific American*, where the quark theory, in living color, is described by its own proponents.)

By this time the number of elementary and unobserved particles had climbed to 24, not counting a few which, like the electron, were not included in the first place. But the quarkists were not through — they had to have a force to hold the quarks together, and thus a particle to carry that force. Eight of these so-called gluons were deemed about right, bringing the total number of new particles to 32, considerably worse than when they started some 15 years previously.

(Not only have particles multiplied, but so have force fields. At last count theoretical justifications had been produced for at least three other forces besides the observed electromagnetic, gravitational, and nuclear forces.)

One serious problem remained. The quarks (charmed, colored, and flavored), have stubbornly refused to put in an appearance. Despite looking high and low for them with multimillion dollar accelerators, not one of these mythical beasties has yet been found. Unlike the Loch Ness monster, they have not even been glimpsed. Such an embarrassing lack of connection between theory and observation gives free play to the imagination, but also leads to nasty questions about the worthiness of the endeavor.

The quarkists have an explanation: "the law of quark confinement." This conveniently dictates that quarks can exist only inside other particles and thus can never be observed. This intriguing idea has led one devotee to ask rather plaintively, "If a particle cannot be isolated or observed even in theory, how will we ever know that it exists?"

We have thus arrived today at the putrescence of the elementary particle. It is high time that physicists use the new results to sweep up the debris of quarkery. It is no coincidence that many of the most prominent particle physicists today reflect the same existentialism in their lifestyles as in their Buddhist physics. Einstein's violin and Mozart have been replaced by Feynman's bongos and rock music. One Nobel laureate

recently made headlines by testifying in California against an ordinance prohibiting sex shows and nude bars, stating that after the long grueling hours of quark theory he often frequented such scenes.

Fixed Field Laws

It should not be thought that merely junking point particles for pure continuums will be all that is necessary. The problem is more fundamental. *It lies in the notion of fixed field laws, valid at all times and in all situations. Any such simple continuums lead directly back to the conundrums of point particles.* Take, for example, the current confusion about black holes. General relativity predicts that any sufficiently massive body will collapse under its own gravitational force without limit down to an absolute point — a point singularity, having infinite gravitational fields. Any object near such a singularity would get sucked in and disappear "over the edge of the universe," as it were.

Until recently, it was thought that such singularities would be demurely covered up, preventing physicists from ever observing and having to worry about one. Since light itself could not excape from the region around the singularity, a black hole of finite extent would be formed, within which nothing could be observed. The singularity would be out of sight and presumably out of mind. Unfortunately, physicists have been unable to separate the dilemmas at the opposite ends of the magnitude scale, and at a recent astrophysics conference in Boston, quark met the black hole with disastrous effects. Calculations were revealed showing that pair formation would lead to energy and mass slowly leaking out of the black hole, eventually destroying it and leaving behind the naked singularity. Morality and physics both trembled at the thought!

Thus the study of pure fields ends up in the same mess as the study of elementary particles. (Interestingly enough, the existence of gravitational singularities, which is found so shocking on an astronomical scale, is blithely ignored on the microscopic scale. Electrons, if they were point particles, of course would have gravitational singularities. To ignore these singularities because they are quite small is to imitate the famous young lady who was just a little bit pregnant.)

The first step in redirecting subnuclear physics out of its present cul de sac is to throw overboard the fundamental assumptions that got it there in the first place — both point particles and unchanging fields. In place of these axioms, subnuclear or high-energy physics must adopt assumptions coherent with the directions already demonstrated in plasma physics, and, in an epistemological sense, in ecology and economics. The fundamental characteristic of the universe is *evolution*; this is obvious at the level of the biosphere or human society but coherently must be true of the physical universe as a whole. Thus it must be the case that the laws of the universe themselves evolve. In plasmas it is demonstrably the case that the evolution of a physical system is mediated through certain definite self-organizing geometric structures, such as the vortices common in energy-dense plasmas. Subnuclear physics, which is simply the extreme high-energy extension of plasma physics, must be characterized by similar phenomena.

The working assumption that must replace the current axiomatic system is that subnuclear particles are self-organizing geometric structures comparable with plasma vortices. Such structures mediate through their concentration [capture] *of energy the development of new field interactions, which in turn lead to new levels of self-organized structure.*

The postulate that subnuclear particles bear a resemblance to self-organizing entities in plasma physics is not all that speculative. It is indisputable that such particles do in fact concentrate immensely the field energy in coming into being in pair production; the field in fact organizes itself into the particle. The Argonne experiments prove beyond a doubt that we are indeed dealing with geometric structures, and, taken together with the phenomenon of pair formation, self-organizing structures. In addition, the characteristic asymmetries of the Argonne experiments and the much earlier parity experiments are exactly what one would expect from specifically *vortical* structures.

Nor is it speculative to postulate fields that change their laws with time and space. As we have seen, *nonconstant values of c and h are in* fact necessary to account for known experimental results, and without such changes in the "small," there is no way of avoiding the production of point singularities. Since geometric vortex-like structures can have greatly different interactions at short and long range, such changes of interaction law are coherent with their existence.

Such a working assumption enables us to begin to answer the question of why such a variety of short-lived particles — the 18 so-called stable particles — should exist in the first place. That is, what role do they play in mediating the capture of energy? For example, in an extremely high-energy plasma of electrons or electrons and positrons, direct energy capture through positron-electron pair production is extremely slow. However, energy capture is mediated far more rapidly through the production of the short-lived particles that in turn decay into the stable, captured energy forms — the proton and electron.

As was first pointed out last year by the physicist Malcolm H. MacGregor, it is striking that the lifetimes of the particles are nearly evenly spaced from each other by factors of alpha — the electromagnetic coupling constant, 1/137. If very different forces, electromagentic, strong, weak, are supposedly at work in these decay times, as is generally supposed, such a regularity of lifetimes must be considered a remarkable coincidence. However, if it is assumed that the particles are related to each other as various compoundings of vortex-like structures, then the regular relation of their energy throughput rates, and

Continued on page 30

Soviet Report Describes Vast Program for Fusion

by Charles B. Stevens

A SOVIET REPORT made available to the Fusion Energy Foundation in July by the U.S. Electric Power Research Institute shows that the Soviet Union is pursuing a crash program of tremendous scope to achieve the virtually limitless potentials of thermonuclear fusion by the mid-1980s.

The document describes how the Soviets are working on the evolution of mainline fusion technologies, such as the tokamak, into commercial reactors, and lays out how more conceptually advanced approaches, like the Linus and electron beam systems that are now considered merely speculative in the West , will be put on a crash schedule.

The internal Soviet document outlines a bold program calling for the integration of basic research and applied technology development and uses the most advanced existing technologies,such as superconducting magnets and inductive energy storage, on near-term experiments. At the same time, scientific research oriented to the outermost frontiers of existing physics knowledge, together with the more conventional mainline fusion systems, will be pursued on a crash basis. The intersection of these two programs represents the most ambitious science-technology development program ever implemented.

The implications of the Soviet report for the current U.S. energy fight are devastating. While the Carter administration orders the U.S. to meet its energy needs by "making do with less," by the middle of the next decade, the Soviet Union will be able to select from among a half-dozen entirely different fusion energy system, including fission-fusion hybrid reactors to serve in the transition to the cheap and abundant energy of a fusion-based economy. If, by contrast, the Carter-Mondale team's Malthusian energy program prevails over what has so far been astonishingly flabby opposition from Congress, the U.S. will have plenty of kinds of conservation to choose from, but no energy.

Exchange of Ideas

Institute Director Chauncey Starr obtained the report from Soviet scientist V.A. Glukhikh, while Starr was in the Soviet Union on a trip involving negotiations on the recently signed agreement between the Institute and the Soviet Kurchatov Institute for joint work on the Soviet Tokamak T-20 reactor. The Electric Power Research Institute, which has translated and circulated the Soviet fusion report, is the research institute of the U.S. utilities industry, and the largest source of fusion research funds

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Continued from page 29

thus their lifetimes, is completely expected.

A Program for High-Energy Physics

The adoption of the proposed working hypothesis immediately implies a theoretical and experimental program for the development of high-energy physics. Theoretically, the examination of the interaction of compounded vortex-like geometries requires a considerable extension of current mathematical techniques. One method of attacking this problem is using three dimensional hydrodynamic computer simulation of collision of vortices, multiple votrice geometry, and so forth. The second is the development of techniques to deal with hyperspaces in which the rate of energy capture is the primary metric, defining the evolution of the system as a geodesic in such a space (a line of maximum rate of energy capture).

Experimentally, a number of lines of investigation are immediately suggested: (1) the repetition of the Argonne experiments with spin-aligned electrons and positrons, and their extension to higher energy regimes using colliding beam techniques; (2) the study of the dynamic evolution of particles by attempting to find changes in interaction behavior with increasing age of individual particles or particle beams; and (3) the development of techniques for examining possible collective modes of interaction at high energies by increasing the densities of both accelerated particle beams and thermonuclear plasmas to extremely high values.

It is not surprising given the current antiscience, antitechnology direction of the Carter administration that the current budgetary plans of the U.S. Energy Research and Development Administration call for the closing of the unique Argonne accelerator at the end of this year, an action equivalent to destroying Galileo's first telescope.

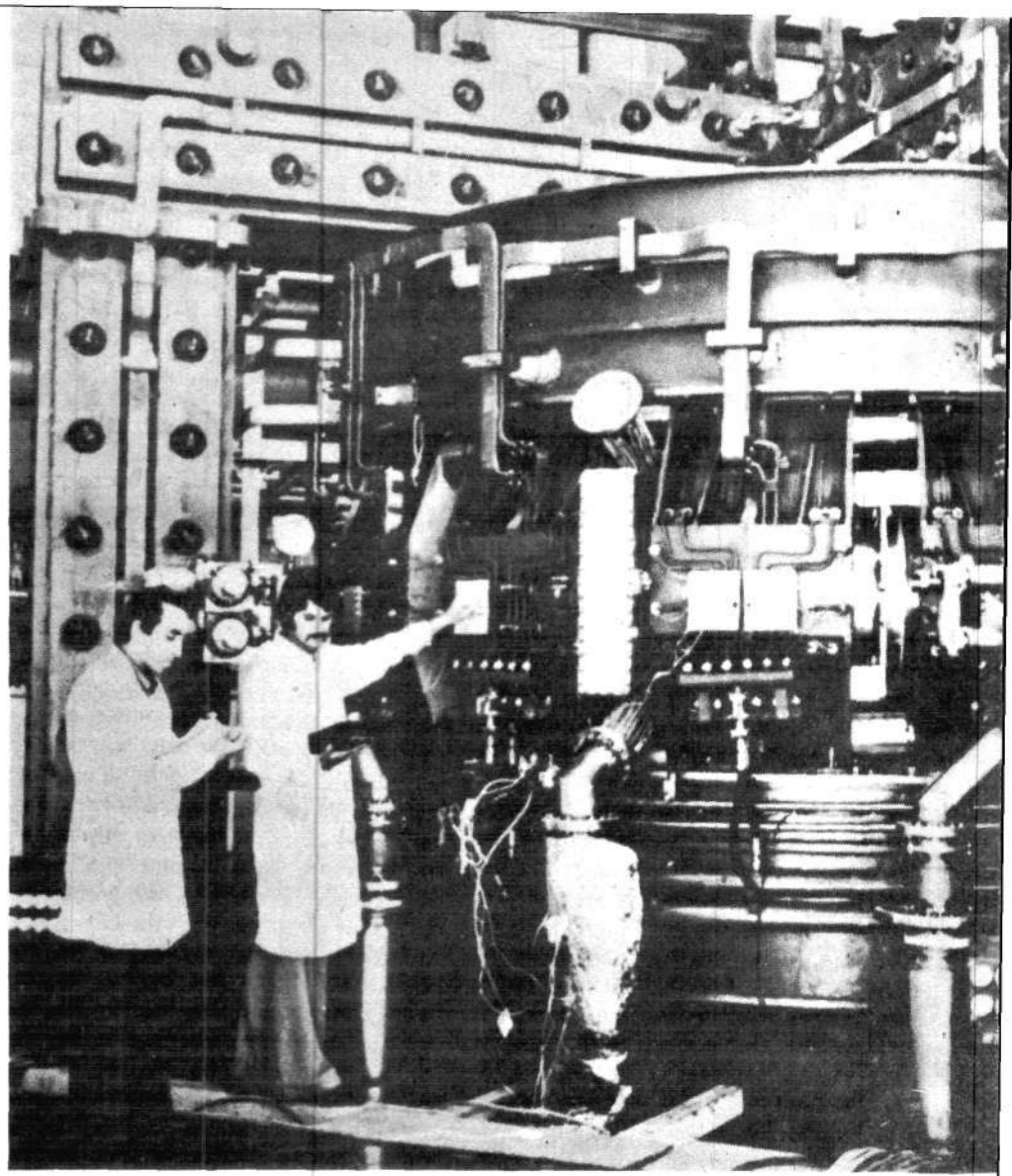
The requirement is just the opposite — to subsume the investigation of self-organizing phenomena in the high-energy realm within the broader context of the theoretical plasma physics program the Fusion Energy Foundation has proposed as the core of a fusion power development plan, and to give it full financial support.

in the 1980s

in this country aside from the federal government.

The report is titled "NIIEFA Research and Design Work in the Area of Controlled Thermonuclear Fusion," with the initials standing for the Efremov Scientific Research Institute for Electrophysical Apparatus; Glukhikh is the Efremov Institute's director. This research institution stands at the crossroads defined by the report's two themes of development of advanced existing technologies and crash research efforts into the most crucial questions of basic physics.

The Efremov Institute has built some of the largest scientific equipment in the world over the past several decades, and has only recently begun major efforts in fusion. One U.S. laser fusion scientist described



The Tokamak T-10.
Tass from Sovoto

The benefits of such a research program inevitably will be very great. For the fusion program itself, there will be a vast increase in the sort of useful cross-fertilization of research on high-energy and thermonuclear plasma phenomena, that characterized the Soviet electron beam work. But beyond this, the understanding of the nature of the subnuclear realm over the long run will be essential to man's conquest of the universe, the development of interstellar flight. Above all, it will give coherence to a new scientific view of the universe in which the same self-developing creative tendency that characterizes human thought will be empirically demonstrated as an immanent quality of matter at its most primitive level.

And, of course, the quarks can be quietly returned to their original home in some bottle of old Irish whisky.

Postscript

Recent studies at Stanford University have purported to prove the existence of quarks, or, more precisely, the existence of some particles with one-third the charge of the electron. In essence the Stanford work is a repetition of the famous Millikan oil drop experiments that led to the first measurement of the charge on the electron.

The Stanford group reported that charges one-third that of the electron were detected at a rate of one to 10^{19} nuclei. These results, however, were contradicted by other Millikan oil drop experiments, one of which detected no such anomalous charges down to as low as one part in 10^6.

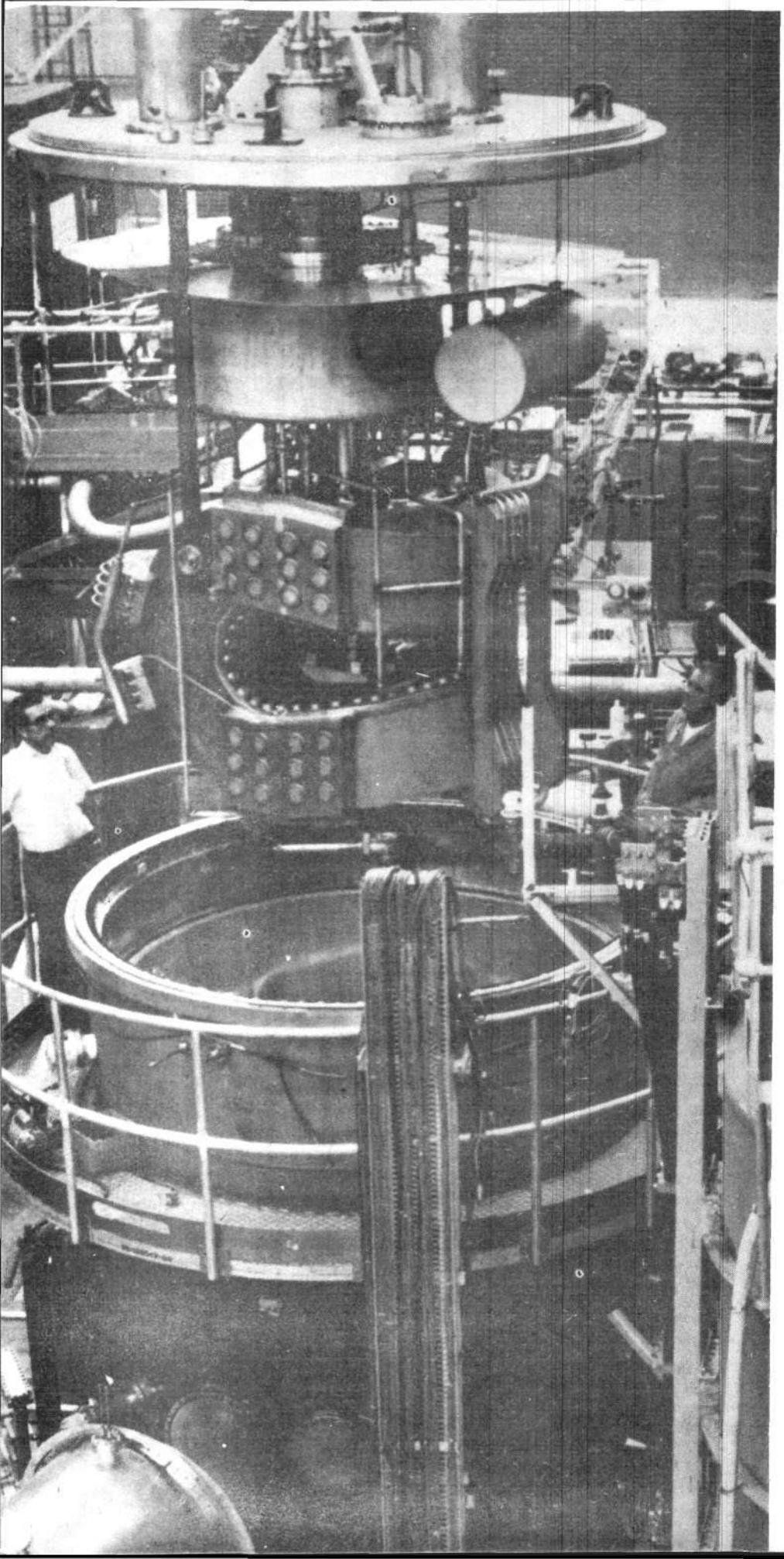
Thus, despite the Stanford announcements, the quark remains in the realm of the undiscovered. ❁

References

There are three unpublished articles on the Argonne experiments available from Argonne National Laboratories: "Proton Scattering" by A. Yokosowa: "High Energy Experiments with a Polarized Beam and Target" by A. Krisch: and "Measurement of Total Cross-Section Differences for Proton Scattering in Longitudinal Spin States," by I.P. Aues, et al.

For a discussion of quarks, see Yoichiro Nambu's "The Confinement of Quarks" in *Scientific American* Vol. 235, No. 5 (Nov. 1976).

An alternative view of electromagentic theory and an elaboration of the vortex hypothesis are presented in Carol White's "Energy Potential: Toward a New Electromagnetic Field Theory" to be published in October 1977 by Campaigner Publications.



Efremov's program to build two massive laser systems for the Kurchatov and Lebedev Institutes as being on the scale of a major industry: "They have a factory putting out the laser amplifier modules in Leningrad on an assembly-line basis," he marveled. The "factory" was one of the Efremov Institute's divisions.

In the case of the mainline tokamak program, the Glukhikh report details how the existing T-10 experiment will be converted to the first large-scale tokamak in the world with superconducting magnets. This will re followed up with a new, redesigned prototype fission-fusion hybrid tokamak reactor, the T-20, and then by an actual commercial power plant.

The other systems described in the report — approaches to fusion considered so far in the future in the West that they have never received more than minute funding and were cut in the Carter budget — will follow similar schedules.

Tokamak Power Plants in 10 Years?

The tokamak is essentially a donut-shaped magnetic bottle for confining the thermonuclear plasmas in which controlled fusion is to be induced. In existing experiments the powerful magnetic fields of the tokamak are maintained for pulses of no longer than 10 seconds, and consume up to 1 million kilowatts during that time. For actual power plants these pulses will have to be extended to a virtually continuous operation, with much less power consumption. Magnets utilizing ordinary conductors such as copper do not appear to be capable of this; instead, what are called superconducting magnets will have to be utilized.

When certain materials are refrigerated to temperatures near absolute zero they conduct electricity with virtually no measurable resistance — they are *superconductors*. Besides the engineering problems involved in refrigerating large volumes of material to such low temperatures, superconducting

The Baseball II superconducting magnet at Lawrence Livermore Laboratories.

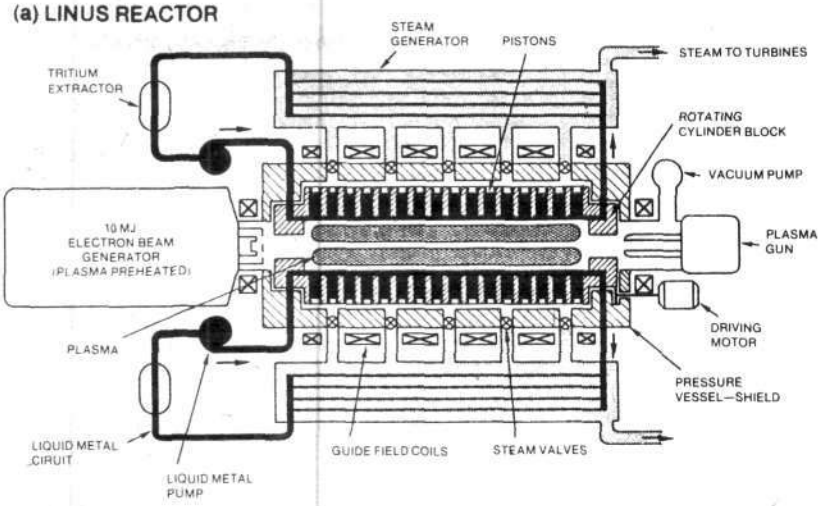
ERDA

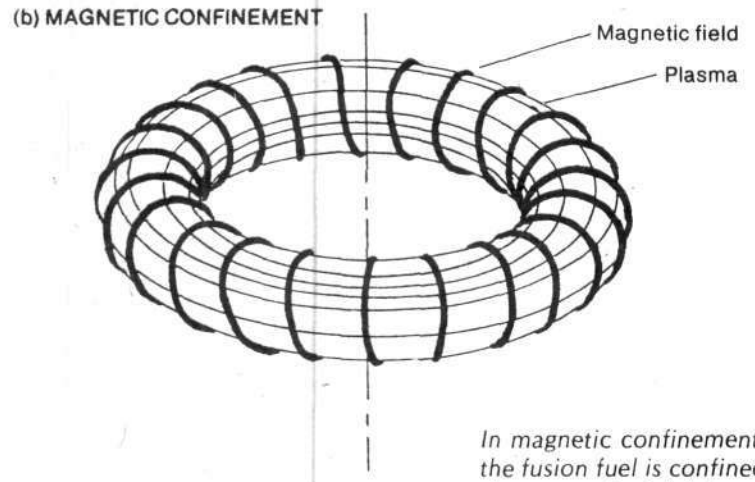
magnets are also subject to large mechanical stresses generated by the interaction between magnetic coils. Superconducting materials are normally quite brittle, and therefore the construction of the complex superconducting magnets needed for fusion involve the most difficult materials and mechanical engineering problems.

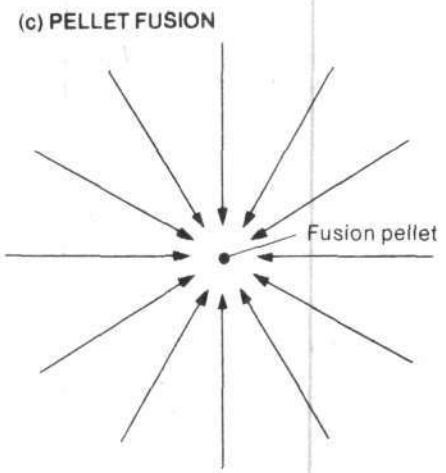
The Soviets' T-10M tokamak, to be built in the next two years, will have the largest and most difficult superconducting magnet ever constructed. The unique long-pulse experiments possible on the T-10M, together with the applied engineering development involved, mean that the T-10M is a quantum step toward fusion technology.

Last year the Soviets successfully initiated operation of the T-9, a prototype superconducting tokamak. And the Soviet Union leads the world in the development of applied superconducting technology. By the early 1980s, the Soviets will burn their large Siberian natural gas reserves at the wellhead and convert the energy thus released to electricity by utilizing MHD (magnetohydrodynamic) generators which operate at up to 100 percent better efficiencies than existing methods of electrical generation. The electricity will then be transmitted across thousands of miles to industrial centers in European Russia. Both the 1,500 kilovolt line needed to accomplish this efficiently and the magnets on the MHD generators will be superconducting.

Following the successful operation of the T-10M and T-20, the next step in Soviet development of tokamak systems would be an actual prototype commercial power plant. While the Efremov report characterizes its reactor design as "conservative" — "The plasma parameters must not be extrapolated far beyond the limits of ... existing experimental fusion facilities," and fairly low energy densities are projected — the suggested prototype is, by all standards, huge. The reactor would generate 6.9 million kilowatts of thermal energy with an electrical power output of 2.5 million kilowatts, about two-and-one-half times more than the output of the largest existing







In magnetic confinement [b] the fusion fuel is confined by the magnetic field that prevents the fuel from escaping and maintains it at a density sufficient to cause fusion. Shown is a closed [toroidal] confinement field. In pellet fusion [c], the fusion fuel is compressed to high densities and instantaneously heated to fusion ignition temperatures that burn up the fuel before it blows apart. The liner device [a] [Shown here is the Linus, a liquid metal liner] is similar to pellet fusion except that a cylinder is used to compress the fuel. As in the pellet, the fuel burns up before it can escape at the ends of the cylinder.

nuclear fission power plants. Moreover, the reactor would produce 4,200 kilograms of plutonium per year from uranium-238. This is sufficient fission fuel to run approximately nine 1-million-kilowatt nuclear fission reactors for one year. Altogether, the fuel and direct energy from this one reactor could power all of New York City — without blackouts!

Moving Up the Timetable

The Electric Power Research Institute has previously described the Soviet Tokamak T-20 as nothing less than a crash program. The latest design for the T-20 further emphasizes the most rapid development of the practical utilization of the tokamak approach to harnessing fusion energy.

Originally the operation of the T-20 was to be broken into two stages. In the first phase, projected for 1982 to 1983, only a nonreactive plasma with the lighter isotopes of hydrogen would be used in scientific experiments. The second stage would involve the use of actual fusion fuel, deuterium (D) and tritium (T). During the second stage, the fast neutrons produced by the fusion of deuterium and tritium (the neutrons contain over 80 percent of energy released by the fusion reaction) would be used to test various designs of breeding modules to be placed in the wall of the vacuum chamber of the reactor.

These modules would contain uranium-238 and thorium that can be transformed through the absorption of a neutron to isotopes that support fission chain reactions and therefore are good fuels for ordinary nuclear fission reactions. Furthermore, the process of absorption of the fusion neutron in the breeding blanket multiplies the total energy output of the fusion plasma. In this way, only a small net energy output from the fusion plasma is needed to drive the total fusion-fission hybrid system, with very significant total net energy output. The necessary fusion plasma parameters of confinement time, temperature, and density in this hybrid case are not too far from those already experimentally acheived.

Now, according to the Efremov report, the program is leaping ahead to the second stage originally scheduled for 1983 or after: "In view of the fact that reconstruction of the T-10 facility, resulting in the production of a plasma having parameters approaching thermonuclear, is planned after completion of the scheduled research program the extent of hydrogen plasma research on the T-20 can be greatly reduced and the emphasis of program can be shifted to the study of the D-T plasma and the blankets (that is, the breeding modules — ed.)."

Other Approaches

Alongside the tokamak push, the Soviet Union is also scheduling experiments to come on line within the next two years that will definitively prove the feasibility of two other lines of attack on the fusion problem, the Linus system and the electron beam pellet fusion approach. These approaches, totally different from the tokamak, are the sort of advanced, still largely unexplored avenues that Western scientific officialdom has dismissed as "speculative."

In particular, the Linus approach could be rapidly developed and brought on line in the 1980s, especially in light of recent experimental successes by Dr. Dan Wells of the University of Miami. Of all existing proposals for fusion reactor systems, the Linus approach appears to have the least number of potential technological problems associated with it.

The Linus system works in the following manner:

Magnet systems are ordinarily limited to magnetic fields of less than several hundred thousand Gauss (Gauss is a unit of magnetic field measurement), since larger fields generate stresses much greater than even the strongest steels can withstand. This limit can be superseded, however, if a dynamic approach is taken. In the collapsing liner system, the electrical conductor generating the magnetic field is designed to collapse under the stress of its own magnetic field. The conductor has the shape of a hollow cylinder, and as it collapses due to the pressure of the portion of the magnetic field outside, it compresses the magnetic field on the inside so that fields of up to 1 million Gauss are obtained. For a reactor system the hollow liner would have to survive such a collapse process intact.

Given large pulsed magnetic fields, many possible fusion systems exist that are straightforward candidates for acheiving power outputs. One such system is that of Dr. Wells. Recently Wells documented achieving plasma temperatures of 66 million degrees and densities on the order of 100,000 trillion nuclei per cubic centimeter for over six-millionths of a second. While still below what is needed for breakeven by more than a factor of 100 in terms of density and confinement time, Dr. Wells's results have demonstrated in principle the feasibility of his approach, if given magnetic fields on the scale of those produced by a Linus system.*

Over a year ago, scientists at the U.S. Naval Research Laboratory in Washington, D.C. demonstrated that one-dimensional collapsing liner generation of magnetic fields could be used repetitively when the hollow cylindrical liner consists of liquid metal.

Now the Efremov report describes similar but more advanced experiments on reproducible Linus systems at the Efremov Institute. It is indicated that Soviet scientists have achieved stable three-dimensional liner collapse, which would permit the use of a far greater variety of "closed" magnetic bottle geometries to permit the construction of a compact fusion reactor based on the Linus technology.

Toward Breakthrough

The last section of the Soviet report describes some detailed aspects of the design of Dr. Leonid I. Rudakov's demonstration experiment in electron beam pellet fusion, the Angara 5, which is to be completed in 1980.

(Dr. Rudakov is perhaps best known in the U.S. for the incident last summer involving his attempt while on a visit to the U.S. to reveal to

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Charles B. Stevens, a leading international reporter on fusion research, is a staff member of the Fusion Energy Foundation.

Edward Kintner [l], head of the magnetic confinement division of ERDA, visiting Moscow for a 1976 meeting of the Soviet-American Coordinating Commission on Thermonuclear Power.

Tass from Sovfoto

scientists here some previously classified aspects of his research program. The U.S. government immediately slapped strict "national security" wraps on the Rudakov disclosures — which revealed tremendous Soviet advances over U.S. research — going so far as to impound the blackboard on which Rudakov had written.)**

The electron beam pellet approach is based on inertial rather than magnetic confinement. A minute pellet of fusion fuel is compressed to high densities and heated to fusion temperatures with 48 electron beams. At these high densities the fuel needs to be confined for only a few billionths of a second in order to achieve net energy output, and it is confined only by its own intertia.

Rudakov has already demonstrated experimentally the workability of the electron beam method for achieving the heat and compression needed to induce fusion reactions on the earlier Angara-1.

The Efremov report comes out with details on the design of the reaction chamber of the Angara-5, which is expected to produce net energy. Large magnetic fields will be used to guide the electron beams to the pellet, and special provisions have been made for replacing the wall of the reactor chamber at regular intervals to allow the testing of various materials, with an eye to what will be required for an actual power plant reactor chamber.

Point by point, the Efremov report is a clear demonstration of the Soviet Union's hard-nosed commitment to developing commercial fusion energy in the 1980s, on the basis of a wide-ranging program of scientific and technological research. The way in which the report was transmitted to U.S. businessmen and scientists is one more example of the Soviets' leading role in fostering international collaboration on fusion research.

Recently there have been indications that the Soviet Union will propose something even more dramatic — cooperative international projects to build prototype fusion reactors. Will the U.S. be allowed to contribute its unmatched scientific and engineering arsenal to this world historical undertaking? Or will the nation permit that capacity to be destroyed by the Carter Administration's headlong plunge toward fascist austerity and war? ❁

A version of this article appeared in New Solidarity, Aug. 6, 1977.

• Dr. Wells reports on his latest results in full in the winter 1977 issue of the *International Journal of Fusion Energy*.

•• For details on the Rudakov affair see the July-August 1977 issue of *Fusion* and the May 1977 issue of the *FEF Newsletter*.

The antinuclear mob storming the Creys-Malville nuclear plant site in France.

Der Spiegel

Who Are the Nuclear Terrorists?

The people in this picture are part of the European terrorist networks responsible for the violent antinuclear demonstrations in June at Creys-Malville, a nuclear breeder plant site in France, and for similar demonstrations at a Brockdorf, West Germany nuclear plant last spring.

The French have no illusions that this mob is a spontaneous, well-meaning group concerned about the environment. Soon after the Creys-Malville affair, various French press and leading political figures spelled out how the groups were started, and who was supplying them with funds, and the national danger of letting the ecologists continue their rampages. The Bulletin of the French Oil Industry, *Bulletin del-Industrie Petroliere*, Aug. 8 directly linked the ecology groups to U.S. financial institutions, specifically Chase Manhattan Bank, the Ford Foundation, and the J.M. Kaplan Fund, (the latter is a long-time conduit for CIA funds named as such by *Newsweek* magazine back in 1968.) The *Bulletin* article pointed out that the Carter administration's hostility to fast breeder reactors in the U.S. has lead to such attempts to block breeder development in other countries.

As for the French and West German mentors of the ecologist movements, the *Bulletin* pointed out that these were all well known: Alain Touraine, Serge Moscovici, Andre Gorz, and Jean Paul Sartre. The first two are department heads of the Practical School for Higher Studies which is under surveillance by the French government as part of its crackdown on terrorism. The school receives the bulk of its funding from the Ford Foundation and the Council on Cultural Freedom, a group founded by former U.S. intelligence operatives. Gorz and Sartre are tied to anarchist, Social Democratic circles.

The *Bulletin* analysis was echoed the following week in *Ener-Press*, a similar European-wide publication. Most recently the French Journal *Energies*, in a Sept. 16 article titled "From Austerity to No-Growth," linked the international deployment of various antitechnology and anti-energy groups to the policies of "U.S. financier factions" intent on maintaining the present monetary system.

Several French papers condemned the environmentalists in editorials, including *Le Figaro*, *L'Aurore*, *Le Monde*, and the daily of the French Communist Party, *L'Humanite;* and prominent national leaders, including Gaullist Michel Debre also jumped into the fray. Debre published a biting attack on the ecologists in *Le Figaro* comparing their antics to the back-to-the-land movement created by the Vichy government in subservience to Hitler. "Without science, without technology, without industry, where would we be," Debre wrote. "Ecologists beware . . . Who can assure us that the cohorts of foreigners who come to support disorders here are entirely made up of pure and peaceful spirits? . . ."

Soviets Refute Turner Report On Energy

Top Soviet commentator Viktor Matveev soundly refuted the conclusion drawn by the April Central Intelligence Agency's so-called Turner Report that the Soviet Union was verging on economic collapse and facing a severe shortage of domestic oil supplies. Writing in the government daily, *Izvestia*, Sept. 14, Matveev termed the CIA report simply an excuse for expanding "the presence of U.S. military in the Persian Gulf." Matveev then described the ongoing Soviet collaboration with European and Japanese oil independents to exploit off-shore oil deposits.

The Turner Report, which contradicts information developed by the U.S. Energy Research and Development Administration, the Shell Oil Corporation, and others, was reportedly motivated by the administration's desire for the U.S. to control the Third World's raw materials. The analysis of the Soviet economy as collapsing was supposed to inspire U.S. politicians to become alert to Soviet attempts to gain control of Mideast oil supplies and pre-empt such action.

In a recent interview, the economist who prepared the CIA report, identified only as "McDonald," admits he did it "on orders" using only current oil production data and ignoring Soviet oil reserves or capacity to improve production. McDonald admitted that this methodology was questionable.

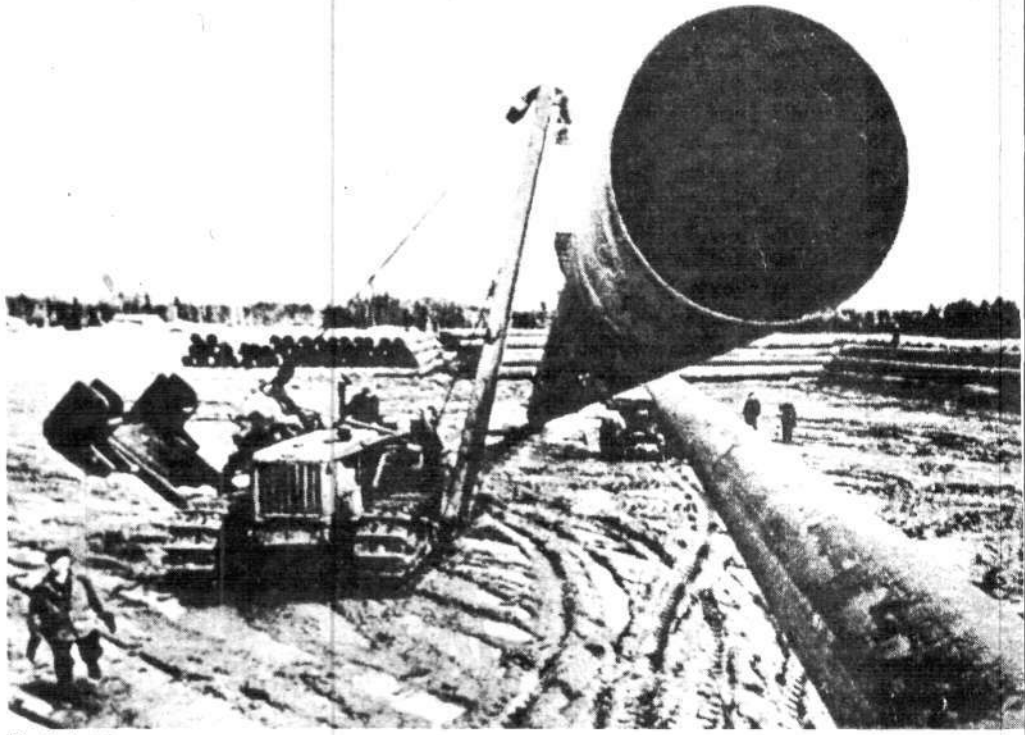
Study Contradicts CIA Report

The Institutes for Contemporary Studies, a nonprofit think-tank funded by energy-related corporations, issued a major study Sept. 14 saying that world oil and natural gas supplies are not in serious danger of running out. The study flatly contradicts earlier reports by the Central Intelligence Agency predicting such shortages. According to the report, the removal of federal government price controls over natural gas and oil would actually increase U.S. oil production from the present 9.7 million barrels per day to 11 million barrels by 1981. The Carter administration plan, on the contrary, proposes new taxes on energy that will raise prices, suppress demand, and retain controls on existing oil reserves, all "to prevent windfall profits." The administration estimates production of 10.5 million barrels per day by 1985 under its plan, an estimate sharply disputed by various industry experts.

Soviets to Build Major Pipeline

The Soviet Union announced the construction of a new 2,100-mile oil pipeline in September press dispatches. The new pipeline, which will move oil from the Siberian oil field to refineries in European Russia and for export, will be three times as long and wider in diameter than the Alaska pipeline. It will be the third major pipeline linking the Siberian field with outlets to the West.

Currently existing pipeline produces 40 percent of the Soviet national oil output, a figure that should jump when the new pipeline is completed in 1981. Contrary to CIA Director Stansfield Turner's controversial report that the Soviets would peak in oil production in the early 1980s and then face a shortage of oil domestically, the new pipeline emphasizes Soviet confidence in their oil-producing potential.



Der Spiegel

Soviet pipeline construction in Siberia...running out?

Source: The Overseas Electrical Industry Survey Institute, Inc.

Japan and U.S. Compromise On Tokai-Mura Nuclear Plant

Japanese and U.S. negotiators announced a compromise agreement Sept. 2 over the Japanese use of the Tokai-Mura nuclear reprocessing plant that clears the way for the plant to open just two months behind schedule. The Carter administration had blocked the opening of the plant, using as leverage the fact that the U.S. is Japan's only supplier of enriched uranium. The U.S. had demanded that the plant produce no plutonium for safety reasons.

In return for U.S. permission to open the plant, and produce plutonium on a two-year trial basis, the Japanese government has agreed to indefinitely postpone a $15 million conversion plant scheduled to go into construction next year that would prepare plutonium for use in a breeder reactor. (The process is equivalent to enriching uranium.) During this period, Japan has agreed to make a major effort to develop alternatives to the plutonium form of breeder technology — alternatives already shown to be far less efficient than plutonium itself. At the end of the two-year trial period, the two nations will review the reprocessing issue.

While State Department nuclear expert Joseph Nye told reporters that the Japanese government had "come around" to the Carter administration's view that plutonium technology is "premature," Japanese officials said that if suitable alternatives to the plutonium breeder had not been developed within the trial period, Japan would go ahead fully with the plutonium technology.

The Tokai Power Park of the Japan Atomic Power Co. that includes the new reprocessing plant.

British Nuclear Fuel Reprocessing Stalled By Environmentalists

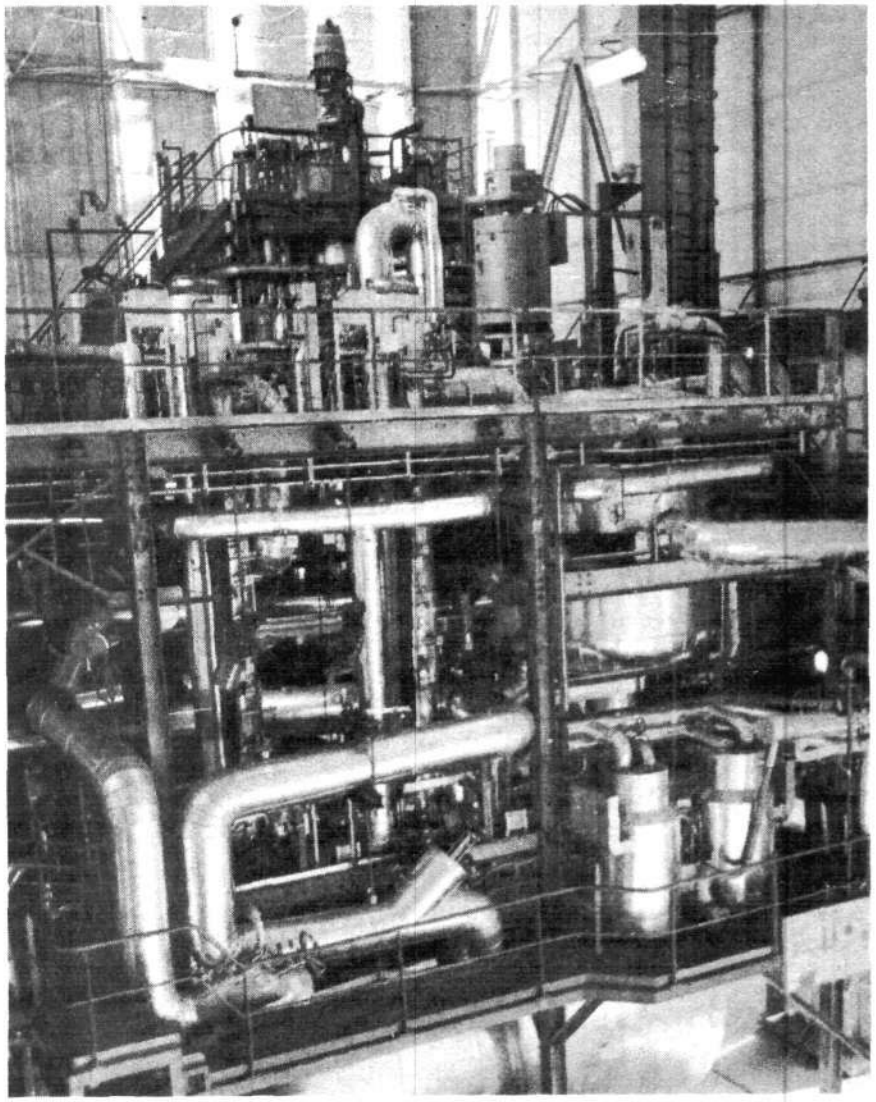
With the British effort to expand nuclear fuel reprocessing stalled in a government inquiry inspired by the environmentalists, the French Atomic Energy Commission subsidiary Cogema announced in early September that it would unilaterally sign a $600 million contract with Japan for spent nuclear fuel reprocessing. Unless the British resolve the controversy and go ahead with the proposal of British Nuclear Fuels, Ltd, to expand its reprocessing facilities at Windscale, France could quickly become the only Western country with an established nuclear reprocessing industry.

A special nuclear installations inspectorate in the government Windscale inquiry testified in hearings the week of Aug. 18 that "there appear to be no significant safety problems that cannot be overcome." The environmentalists, led by the British affiliate of the Rockefeller-funded Friends of the Earth group, have tried to whip up public hysteria against the Windscale expansion with the scare stories of nuclear danger. In other testimony at the inquiry, Dr. Stanley Bowie of Aberdeen University dispelled the favorite environmentalist myth that the plutonium byproduct of such reprocessing was one of the world's most deadly substances. The caffeine people drink in their coffee every day, Bowie said, is pound for pound equally deadly.

Soviet Union Offers To Enrich Japan's Uranium

The Soviet Union offered to enrich uranium for Japan as part of a package deal including Soviet purchase of a Japanese nuclear reactor, the Japanese press reported. The uranium would come from Niger, where Japan and France have a joint venture, and would mark the first time Japan had its uranium enriched outside the U.S. The Soviets have not attached conditions to the use of the uranium, and the arrangement would be part of broader atomic energy cooperation agreements to be negotiated between the two countries.

The Soviet offer was made during the first day of a five-day meeting of the Japan-Soviet Economic Commission in early September. Many Japanese businessmen have urged acceptance of the offer in order to diversify the country's uranium sources.



A test component of the French Super Phenix, a commercial breeder reactor that will be on line in 1980. The Phenix breeder reactor has been in operation for two-and-one-half years.

Algerian Natural Gas Called 'Life Preserver' For Europe

Algeria's natural gas is a "precious source" of energy for Western Europe in the 1980s and 1990s and a "life preserver," the French financial daily *Les Echos* wrote Sept. 1. The European use of Algerian natural gas has skyrocketed from 2 percent in 1965 to 16 percent in 1976, with the future looking even better, *Les Echos* said. The Algerians have been looking to Europe as a major outlet for liquified natural gas as contracts with the United States have fallen through because of interference with the Federal Power Commission.

In addition to German, Dutch, and French deals, Sonatrach and Gaz de French have signed an accord that calls for an elaborate pipeline to be built by 1983 across the Mediterranean, through Spain, to France.

Especially after 1990, liquified natural gas will play a major role in energy supplies thanks to the massive increase in technological progress associated with the processing of this form of energy," *Les Echos* wrote.

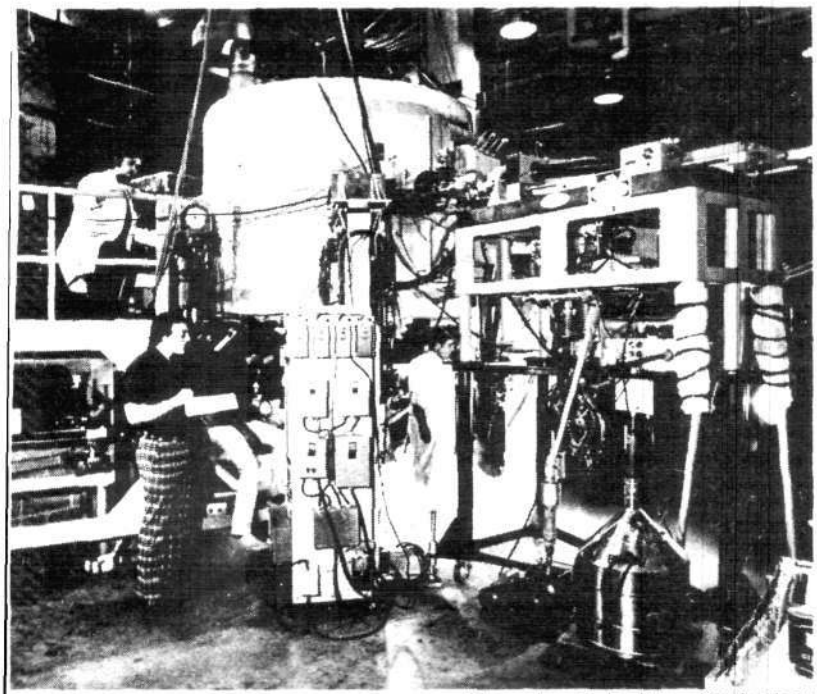
France Has Huge Deals Underway For Nuclear Fuel

Ongoing negotiations between the French nuclear fuel reprocessing firm, Cogema, and the nuclear agencies of Japan, Sweden, West Germany, and other nations could amount to as much as 10 billion French francs, a Cogema spokesman said. According to a report in the Sept. 7 French daily *France-Soir*, the only conditions on the deal are (1) that the enriched plutonium, uranium, and waste be sent back to the country of origin after the wastes have been "neutralized" or "vitrified" by an exclusive process Cogema developed, and (2) that the plutonium be treated so that is usable only for civilian purposes.

France Soir said that these reprocessing agreements will give France a real control over the world nuclear power industry at a time when the U.S. is trying to halt the development of nuclear reprocessing and fast breeder technologies. The paper added that by allowing its uranium to be reprocessed in France, West Germany will demonstrate to the rest of Europe that Western Europe has no hidden military designs in the nuclear area.

Iran, France Sign $5 Billion Nuclear Deal

France and Iran successfully concluded a $5 billion contract negotiation for the delivery of two French-built nuclear reactors to Iran, the French financial daily *Les Echos* reported. France will also take a leading role in the training of 600 technicians and engineers and the infrastructural development and fuel supply for the reactors.



Massachusetts Institute of Technology

The Alcator at MIT is one of the world's smallest tokamaks.

In the News
Research Report

MIT's Alcator Shows

Preliminary results obtained this summer on the Alcator tokamak at the Massachusetts Institute of Technology indicate that the Alcator's fusion plasma is dominated by "classical" confinement — a finding that if substantiated in further experiments would lead to the rapid development of this approach to working fusion reactors. The classical confinement is longer and thus 1,000 times better than what is needed for producing fusion reactors.

Until this latest breakthrough in the Alcator, the dynamics of the operation of the successful tokamak fusion experiments were understood only pragmatically, and each new experiment necessitated a totally new physical principle. Generally, tokamaks other than the Alcator appear to be dominated by the influx of impurities into the hydrogen fusion plasma from both the vacuum wall and the limiter, a shield used to prevent the fusion plasma from contacting the vacuum wall. The dynamics

U. of Wisconsin Experiments Refute 'Survival of the Fittest'

Recent experiments at the University of Wisconsin have yielded results that contradict the incorrect but widely held theories of molecular genetics and evolution. Doctors Daniel Perlman and Robert Stickgold have demonstrated that bacteria are capable of undergoing appropriate, *nonrandom* changes in response to altered environmental conditions, and that these changes involve specific alterations in the genetic material.

According to current biological dogma, variations among members of a species are produced by *random* changes (mutations) in the genetic material, DNA, and these varied species members then compete with one another for survival in an essentially nonchanging, nonexpanding biosphere. This selection process is held to be the motor force for evolution.

The Wisconsin experiments refute this concept by demonstrating that there is a causal or coupled relationship between the environment and the hereditary makeup of organisms within that environment. This finding furthers the concept that the self-development of the biosphere involves a reflexive interaction of organisms and environment.

The Wisconsin scientists grew a certain type of bacteria in media that contained the drug chloramphenicol, an antibiotic that usually stops bacterial growth. The bacteria used, however, had a gene that "coded" for an enzyme that destroys the chloramphenicol.

It is generally assumed that if bacteria survive and grow in the presence of chloramphenicol, the following happens: the appropriate gene's computer-like "information tape" is "turned on" in response to the presence of the harmful drug, the enzyme is produced, and, when all the drug is destroyed, the gene reverts to its "off" condition. Throughout this process, it is assumed that no changes occur within the gene itself, only in its state of activity.

In stark contrast with this model, the investigators found the bacteria that grew under these conditions had made *multiple copies* of that part of the DNA that contained the protecting gene. When the scientists changed the conditions so that the bacteria could not multiply these genes, the bacteria could not grow, even though they had the gene for the drug-destroying enzyme.

The activity of creating the multiple gene was highly specific: only the genetic segment containing the appropriate gene was involved, that is, the organism did not multiply all its genes.

These findings are consistent with the flax experiments, discussed in the May 1977 *FEF Newsletter* that documents hereditary "jumps" crucial to the notion of qualitative advances in the evolution of the biosphere as a whole.

The Wisconsin results were reported in the *Proceedings of the National Academy of Sciences*, Vol. 74.

'Classical' Confinement

and effects of these impurities is a major research question in magnetic fusion experiments.

Over the last two years, the high field Alcator, with a magnetic field strength twice that of conventional tokamaks, has obtained astounding results. It was the first device to reach the theoretical Lawson breakeven confinement parameter (a density confinement product greater than several hundred trillion nuclei per cubic centimeter-seconds), while simultaneously achieving an almost pure hydrogen plasma. Because of its intense magnetic fields, the Alcator has obtained higher energy densities and plasma densities than any other tokamak.

When the original magnetic confinement experiments were conducted in the 1950s, it was found that the fusion plasma's confinement by the magnetic field time *decreased* with increasing temperature. This disastrous result was exactly opposite to what classical plasma theory predicted and the experimental behavior was termed Bohm diffusion, as opposed to classical diffusion.

In the late 1960s the Soviet tokamak broke through the Bohm barrier and obtained better confinement with increasing temperature, but the actual classical, or rather neoclassical (that is, taking into acount that the magnetic field in a donut-shaped tokamak is curved), result was still not fully achieved.

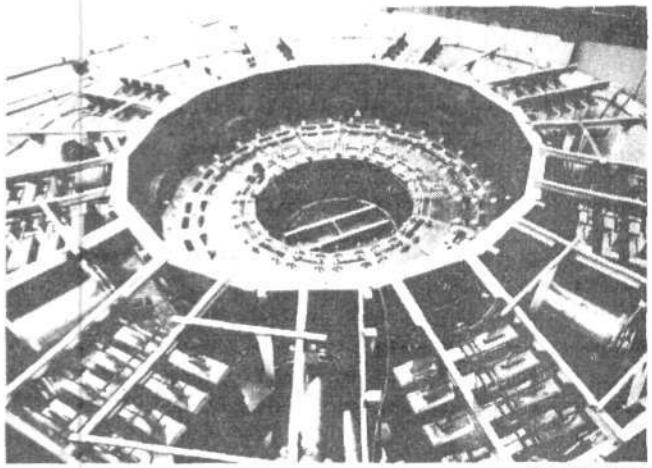
Led by Ronald Parker, the Alcator experimental group began this summer to look for evidence that the Alcator plasma behaved in a classical manner and obtained exactly this result. Further experiments will be needed to make this result conclusive, and new plasma (trapped particle) instabilities could arise as higher temperatures are reached. But if the classical behavior proves correct, the prognosis is quite good for dealing with these future problems and for the rapid development of magnetic fusion energy.

Luce Results Replicated

The highly successful work in plasma collective acceleration of ions by Dr. John Luce, of Livermore Laboratories has been replicated by two other experimental teams. Dr. Martin Reiser of the University of Maryland and R. "Bruce" Miller of Curtland (New Mexico) Air Force Base Weapons Laboratory both reported on similar successful experiments in the July 1977 *Nuclear Science Proceedings* of the Institute of Electronics and Electrical Engineers.

Plasma accelerates ions through intense, internal

Continued on page 43



Sandia Photo

The giant electron beam accelerator under construction at the Sandia Laboratories in Albuquerque.

More On Electron Beams

A report on the work of researchers at Sandia Laboratories in New Mexico duplicating Soviet achievements in obtaining fusion with electron beams is to be released in a future issue of *Physics Today*. First reported several months ago by the FEF, the electron beam work now in progress at Sandia has remained classified. The successful Sandia approach most likely involves some variation of the developments released to U.S. scientists at Livermore Laboratories in July 1976 by Soviet fusion scientist L.I. Rudakov.

More news on the electron beam research has appeared in recently obtained Soviet scientific literature. The September 1976 issue of *JETP Letters* which has Rudakov's report on his successful electrons beam fusion experiments, also has a second article on electron beam deposition referring to two articles that appeared in the July-August and September-October 1976 issues of the Soviet journal *Fizka Plazmy*. Both *Fizka Plazmy* articles propose an experimental setup very similar to that used by John Luce (see above).

Likewise, a 1975 review article on collective acceleration by Soviet physicist Plyutte, discussing Soviet experiments similar to Luce's, is now being translated at Sandia and Livermore Laboratories.

The indication of all the Soviet papers is that research into nonlinear behavior of energy-dense plasma, both with collective ion acceleration and pellet fusion, is beginning to merge.

Nuclear Power Plants Can Be Produced On Assembly Line

United States, French, and Soviet nuclear reactor industries are currently developing a little-publicized method of producing nuclear power plants by assembly-line mass production. If fully applied to growing world energy needs, this assembly-line process can have a revolutionary impact on the feasibility of crash programs of industrialization in developing countries and the rapid expansion of industrial and energy capabilities in the advanced sector.

The technology is commonly referred to as the floating nuclear plant, or FNP, and as the name implies, it involves construction of nuclear power plants on barge-like structures that can be floated to the desired final location, either off an ocean coastline or in a sufficiently deep river estuary.

The revolutionary aspect of the FNP concept is not that the power plants float but that that fact allows a whole new approach to development of the power-generating and related industry along the lines of using modular mass production techniques, computerized production processes, and similar methods long common to high-technology industries like aerospace.

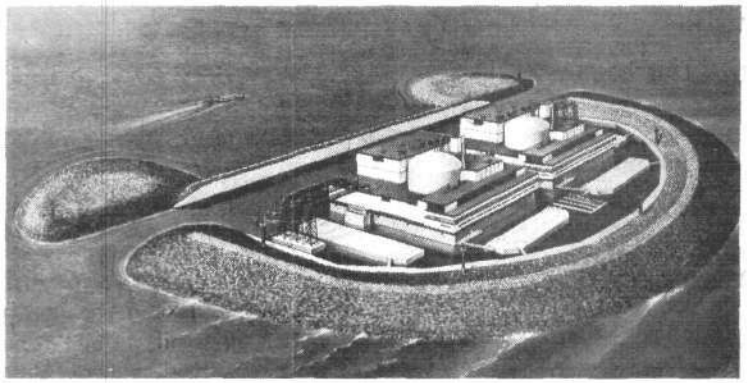
The Concept

The present methods of constructing nuclear power facilities, usually taking up to five to six years per plant, are based on case-by-case individually designed construction siting that must be made to fit widely varying terrain and other special requirements. The enormity of each project site (one 1,000-megawatt nuclear plant can provide enough electricity to power a city of 750,000) means that teams of highly skilled workers have to be recruited and assembled on a decentralized basis for each plant site.

With the FNP, all plants are built from a standard physical design and are centrally assembled at one facility much as shipbuilding is now done in advanced yards around the world. Thus all major subassembly work is centralized at one site.

Westinghouse Offshore Power Systems division, currently the only ones in the world constructing FNPs, estimates that once the production of several such plants has allowed development of maximum production process efficiency, it will be possible to construct a 1,000-megawatt complete nuclear plant — from the initial laying of keel to final delivery — in 27 to 30 months.

Although no current shipyard facility in the world is now adequate to produce the 400-square-foot barge-like structure needed for a 1,000-megawatt reactor, the technology of any shipbuilding country is readily adaptable to construct a site with a special large overhead gantry crane and subassembly production factories surrounding it that allow production line assembly by crane.



An artist's rendering of the Atlantic Generating Station of the Public Service Electric and Gas Co. of New Jersey.

Westinghouse began the serious development of the FNP in the early 1970s in cooperation with the Public Service Electric and Gas of New Jersey and plans a completed FNP by 1984. Their experience in preparation for the construction of the Atlantic Generating Station 2.8 miles out in the ocean about 12 miles from Atlantic City has provided some of the most exhaustive oceanological testing to date. In particular, the research found that the structures devised for the FNP could withstand winds up to 204 miles per hour and could absorb the impact of a full-speed collision by a 326,000-ton supertanker with no damage inflicted to the plant.

Also, contrary to the environmentalist litany, the heated water emerging from the power plant — 4 to 5 degrees warmer that the ocean water — actually attracts and provides a sanctuary for marine life.

Based on the Westinghouse results, the only thing holding back the FNP is the environmentalists' clamp on nuclear posr expansion and a lack of investment funds.

— *William Engdahl*

Wells Reports Cyclops

Dr. Dan Wells of the University of Miami has reported a major breakthrough in the Cyclops theta pinch experiments conducted by his fusion research group, in Coral Gables. In the Cyclops, ion temperatures of 66 million degrees have been measured and corroborated with both spectographic Doppler broadening and fast neutron measurements. The intense heat is a prerequisite for a working fusion power reactor.

The Cyclops consists of two conical theta pinch guns that shoot counterposed plasma vortex rings through a mirror magnetic field. When the two plasma rings collide they form a stable structure that is then compressed and heated by increasing the magnetic field strength of the mirror. The 6KeV ion temperatures — the equivalent of 66 million degrees centigrade — were achieved with the capacitor bank for the mirror magnetic compression field running at 14 million volts. It is expected that when the

Continued from page 41

electromagnetic fields rather than in the usual case by by voltage applied between electrodes. It is an efficient means of energy compression because the nonlinear interactions in plasma produce fields that are stronger than in any other state of matter.

In the past three years, Dr. Luce has reported almost unbelievably successful experimental results. The Luce approach uses an electron beam to efficiently accelerate ions through the plasma field to as much as 10 times the potential of the originally accelerated electrons. In his most recent results, Luce obtained approximately 1,000 trillion protons accelerated to around 50 million electron volts with up to 1 trillion neutrons produced by the collison of the proton beam with a target.

Although neither the Maryland nor Curtland groups agree with Luce's theoretical explanations for these results, a scale-up experiment designed by Luce for the Curtland electron beam could conclusively demonstrate the potential scientific, military, and energy applications of this system. The Curtland project has been stalled by the Division of National Security of the Energy Research and Development Administration.

In a paper reviewing ion beam accelerators for ion beam pellet fusion, Reiser noted that the Luce type of collective ion acceleration is the best candidate for this ion beam pellet fusion energy system. Another potential application noted is breeding fissile fuel for nuclear reactors. The Reiser paper was presented at the Chicago IEEE conference in March.

This research became a focus of controversy following reports last spring of strong evidence that the Soviet Union is carrying out a crash program to develop a powerful ion beam for destroying ICBM's based on plasma collective acceleration. (See article on the Soviet "superweapon" in *Fusion*, July-August 1977.)

Theta Pinch Breakthroughs

bank is run up to its maximum of 18 million volts, ion temperatures of 10KeV will be achieved.

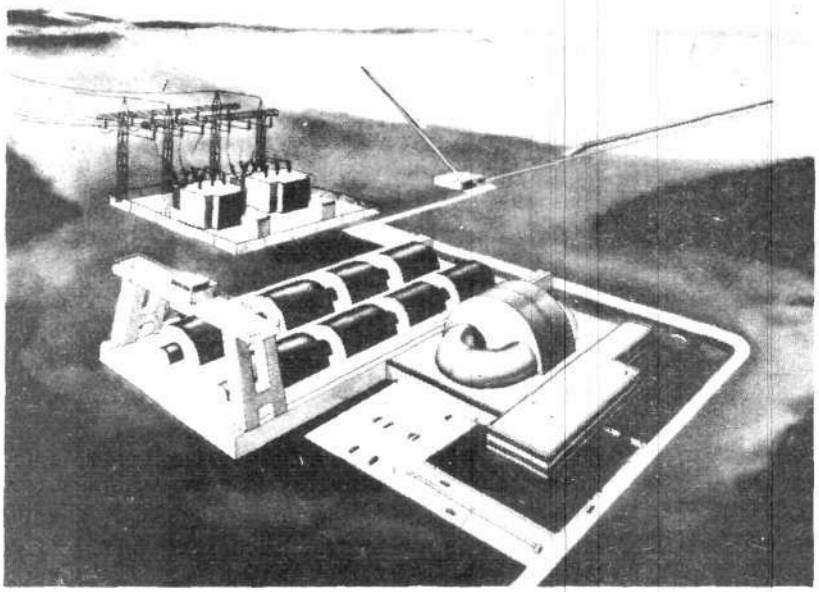
The confinement time (the length of time this temperature is maintained) of the Cyclops compressed plasmoid is now only 8 microseconds because of the limited flat top operating time of the compression capacitor bank. Using the Wells approach in a Linus-type liquid metal device with more than a megagauss of pressure would immediately lead to a reactor grade plasma. Wells expects soon to begin experiments with a new capacitor bank with a 100 microsecond confinement that could lead to the development of a reactor grade plasma.

The latest Wells results will be reported in full in the next issue of the *International Journal of Fusion Energy*. The results noted here are from abstracts of the papers to be presented at the November meeting of the Plasma Physics Division of the American Physical Society in Atlanta.

A Conference sponsored by the Fusion Energy Foundation:

An Energy Policy for North America

An artist's conception of a central station reactor



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Also in November

Fusion and Rebuilding the Industrial Heartland

Scheduled for Lansing, Michigan—Nov. 18

ProFusion Briefs

Pittsburgh ACLU Sponsors FEF Suit Versus FBI

The Pittsburgh chapter of the American Civil Liberties Union agreed in September to undertake sponsorship of the Fusion Energy Foundation's lawsuit against the FBI in the U.S. District Court for the Western District of Pennsylvania. The FEF case has been pending before Federal Judge William Knox since that court granted a temporary restraining order to stop FBI and government harassment of the foundation and its supporters just before a major FEF conference in Pittsburgh April 29. (For details on the harassment case, see the July-August issue of *Fusion*.)

The First Amendment

In its proposal to the ACLU, the FEF stated: "What is at issue is that in its philosophy and its scientific, educational, and policy formulating activities, the FEF stands for industrial and scientific progress, the type of role for science in an expanding economy envisioned by the Federalists in the founding of our republic...Such facts are dangerous and subversive to an administration pursuing a scientific policy and associated social policies emphasizing 'zero growth,' 'energy conservation,' 'sacrifice,' and the wholesale deindustrialization of the U.S. economy...." From the evidence available, the FEF concluded, there is the "prospect of winning significant ground on the FEF's First Amendment activities even before the trial."

The case is now going into the discovery process, and depositions will be taken from those persons the FEF has named as leading the harassment, including Energy Secretary James Schlesinger.

POSSONY ADDRESSES CONF.

"We have to make the basic issue understood: the choice for society is either growth or death," Dr. Stefan Possony told a Los Angeles FEF audience. Possony, director of the International Politicial Studies Program at the Hoover Institute, gave the keynote address at the FEF's Conference on Solving the Energy and Water Crises July 7. The conference drew 50 students, city and state officials, scientists, professors, and corporate representatives from McDonnell Douglas Aircraft, Lockheed, Western States Oil, and manufacturers of aerospace-related products. Possony debunked the environmentalist scare stories of resource scarcity and showed how at present rates of consumption, existing fuel supplies would last society 200,000 years.

STEVENS TESTIFIES AT CANADA HEARINGS

FEF staff member Charles B. Stevens testified for two-and-one-half hours before the Canadian Royal Commission on Electrical Energy Aug. 24 on why Canada needs a fusion energy program. Commisson Chairman Arthur Porter questioned Stevens closely on the relevance of theoretical questions in plasma physics to the government's energy policy. Extensive radio and television coverage of Stevens's testimony reached an estimated 1 million Canadians.

Campus FEF Chapters

The Fusion Energy Foundation is setting up chapters on campuses around the country. If you are interested in establishing an FEF branch on your campus, contact:

Dr. John Schoonover
Campus Coordinator
Fusion Energy Foundation
G.P.O. Box 1943
New York, N.Y. 10001
(212) 563-8645

Books

Anti-Antinuclear Is Not Enough

by Dr. Steven Bardwell

Peter Beckmann, *The Health Hazards of NOT Going Nuclear*, (Boulder Colorado: Golem Press, 1976); 190 pp. $5.95 paperback, $10.95 cloth.

Jacque Srouji, *Critical Mass: Nuclear Power, the Alternative to Energy Famine* (Nashville, Tennessee: Aurora Publishers, 1977); 209 pp. $11.95 cloth.

These books are the first and so far the only entries into the anti-antinuclear field by commercial publishers. Reports or position papers on the need for large-scale energy growth previously have been published only by scientific groups, industry, or the government. The various news media have not touched the subject; instead they have advanced the works of the zero-growth experts like Paul Erlich, Ralph Nader (both just published books opposing nuclear energy), Barry Commoner, and the like.

As Beckmann put it, one of the biggest myths of the so-called nuclear debate is that there is a debate; it is in reality a *monologue* against nuclear energy. The very appearance of these two books attests to the rule: Beckmann had to start a publishing company to print his book, and Srouji has received almost as much harassment as the FEF for hers.

Both books are excellent introductions to the other side of the "monologue." Beckmann's book, especially, is a clear and accurate statement of the basic questions of energy production that includes some critical features of nuclear energy previously not available to the layman. To summarize these points:

(1) No energy source is *safe*: all involve some risk. Nuclear energy happens to be the safest known way of producing large-scale concentrated energy. Any implication to the contrary is, as Beckmann notes, a sign of "abysmal ignorance."

Peter Beckmann

(2) Reactor safety devices are not designed to activate when something goes wrong; instead they are kept inoperative only if everything works right. This same principle keeps elevators safe. The elevator can travel in the shaft only when the cable is properly taut. If the cable should lose its tension, a pair of jaws kept out of the way by the tension resumes its natural position, jamming the elevator in the shaft until the cable is taut again.

(3) An overall assessment of safety, including mining, transportation of fuel, operation and maintenance of the reactor, and disposal of wastes, shows that each plant producing 1,000 megawatts that depends on nuclear rather than fossil fuel *saves between 20 and 100 lives per year*. These deaths are not hypothetical; they are recorded annual deaths from coal-mining accidents and air pollution.

Beckmann says regarding the calculation of these very conservative figures:

> Every year of delay in which a nuclear power plant is *not* built to replace 1,000 megawatts of coal-fired power kills between 20 and 100 people. True, cancer, arterial and respiratory diseases kill a total of about 1,300,000 Americans every year, and the names of a few hundred among them who were killed by lack of nuclear power are unknown. Their widows and orphans do not come to weep in the offices of Nader's Public Citizen, Inc.
>
> But that does not make Nader's or Brower's* attitude any less despicable. Having flatly denied that the nuclear power issue can be left to scientists, but must be settled by "citizen activity," they cannot escape the moral responsibility for these deaths. It would be callous enough to crusade against a technology that saves hundreds of lives every year, whatever the alleged motivation. But it is vile to crusade against it in the name of safety.

The Three W's

Srouji, who began her research as an antinuclear journalist and who has a nontechnical background, does a commendable job in debunking some prevalent lies about nuclear energy. The chapter called "Why a reactor won't go 'poof' in the night" is excellent for answering the most widespread scientific absurdity in popular currency — that nuclear power equals bombs. As the Navy nuclear engineer she interviewed put it:

"Honey, you learned the Three R's in school. Right? Now you got to remember the Three W's in respect to this bomb stuff. A reactor can't be a bomb because it has:

W number 1:
Wrong composition.
W number 2:
Wrong surroundings.

W number 3:
Wrong timing.

Both books serve well as handbooks providing long-needed accurate information on a subject where every other popular source uniformly has offered deliberate lies, distortion, half-truth, and a sprinkling of honestly misinformed opinion.

What To Do About It?

Five years ago some clear, reasoned, accurate technical facts on the energy issue would have been adequate. Today, with an administration that looks at the likes of Nader for advice on safety, the National Wildlife Foundation for advice on human beings, and Zero Population Growth, Inc. for advice on the country's future*** we need some tough political savvy as well as technical information if we are to avoid a rapid descent into the Middle Ages. (This particular immoral option, by the way, was recommended by Carter's advisors affiliated with Lindisfarne, a Laurance Rockefeller recreation of a sixth century Irish community that purports to offer a "model for man's future.")

Such savvy is precisely what is missing from both books. Beckmann and Srouji are confronted with the *politics of energy* on every page of their books. For example, in the process of documenting the authoritative account of the Karen Silkwood Affair — the not so mysterious death of a would-be terrorist in a drug-related auto accident, and for a while a cause celebre among the antinuclear crowd — Srouji was fired from her job, sued three times, and investigated by the FBI.

Beckmann presents an ingenious theory of how the tiny antinuclear movement gets its influence from a group he calls, accurately enough, the "Penthouse proletariat." He, like Srouji, traces the money and influence of this group of largely ignorant, affluent, and middle class Penthouse proletariat to the foundations that fund them, provide glowing press coverage, and legitimize the cause of terrorism and a

Jacque Srouji

modern-day Luddite movement. But Beckmann and Srouji stop there without examining what stake these forces have in preventing nuclear energy.

Know the Enemy

Under the cover of the rather shopworn antiestablishment populism that spawned the antinuclear movement, the very, very establishment foundations**** and their associated think tanks — like MITRE Corporation and the Massachusetts Institute of Technology — have purveyed the antinuclear line to the country as a whole. Now they have a president and energy czar doing the same.

The basic, simple fact is that there is a political faction in the United States that perceives its self-interest to involve the destruction of nuclear energy. Like all political factions this faction has campaigned for its self-interest in the name of the popular good. However, the program it proposes is one of deindustrialization, destruction of energy production, and harsh austerity. The internal logic of this position is twisted; it involves the financial perception that it is preferable to strangle one's debtors rather than allowing them to continue to work and generate income. The external logic, however, is simple. No one would willingly consent to attacks on his or her own living standard unless of course, it is scientifically necessary — if resources really are finite — if we really do have too many people....

This faction is not the "Penthouse proletariat." It is a group of large,' predominantly New York-based banks and their foundations, their think tanks (the most recent and influential being the Trilaterial Commission), and their politicians (including James Carter).

The scientists and liberals who have joined the antiprogress campaign of the environmental movement have done so because they feel guilty at having been part of the intelligentsia that helped produce the atomic bomb and because they have a misguided populism that sees all big business as evil.

Having identified the antinuclear movement more accurately as an antiprogress, antiindustrial movement, it is essential that we make this fact the crux of a campaign to restore to the United States a rational policy like that of our founding fathers: investment based on the necessity of growth, energy, and rising population and living standards.

The fight now is for real. The ongoing wave of terrorism against nuclear plants and other environmentalist targets is not a

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*David Brower is a leading member of Friends of the Earth and other environmentalist groups.

** Unfortunately this quote relects the general tone of the book, an overly cute "simplified for the layman" style that frequently put me off. The environmentalists may not be able to understand technology, but most average Americans pride themselves on it.

*** To take the most egregious example, President Carter's energy program was based in part on *The Unfinished Agenda*, the name of both a book and a conference funded by the Rockefeller Brothers Fund that prescribed a program for finishing the human race: no more energy, no more food production, and fewer people. Carter's chief executive aide, Stuart Eizenstadt endorsed *The Unifinished Agenda* in public more than once, a fact that should erase any lingering doubts about Carter's direction for the nation.

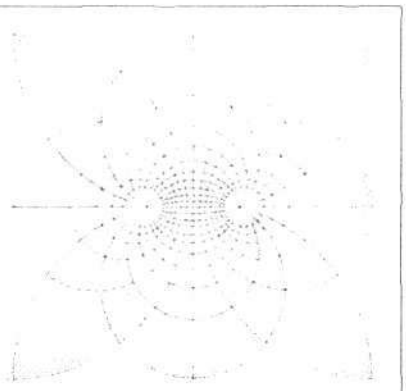
**** Public records filed with the Internal Revenue Service show that the generous funding by Rockefeller, Ford, and the other big foundations has kept alive Nader's various groups and the environmentalist legal teams as well as the terrorist-environmentalists connected to the so-called leftist Institute for Policy Studies.

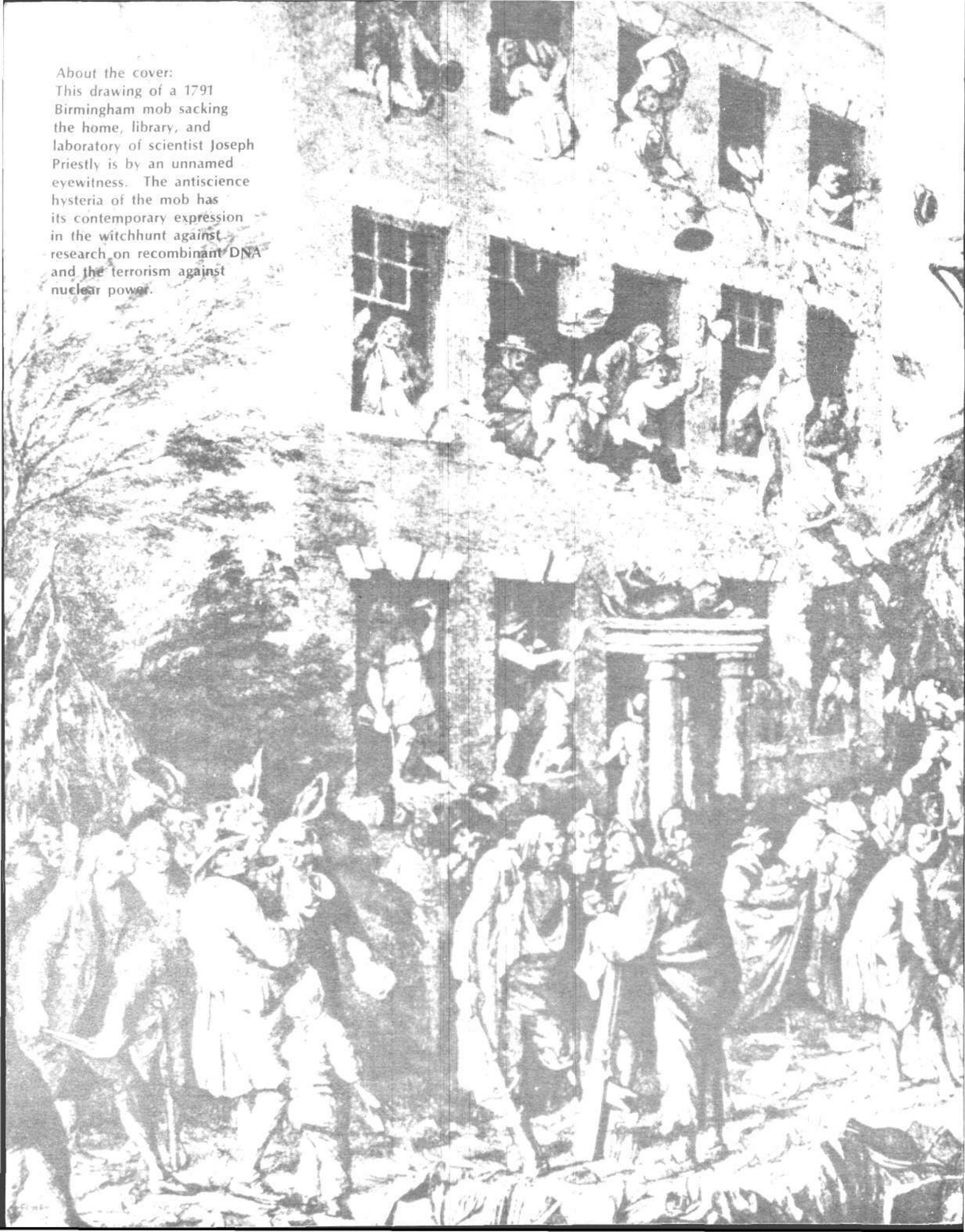
spontaneous sociological phenomenon but a covert intelligence operation planned and bankrolled by the New York banks and carried out by the zombies their networks control. This fact has been documented by the FEF and others. The Aug. *Bulletin de l'Industrie Petroliere*, the magazine of the French oil industry, for example, printed a full expose of where the terrorist environmentalists got their money.

To fight this operation, we need a principled political offensive for growth planned and carried out by a labor-industry alliance. Just such a coalition between French industrialists, Gaullists, and trade unions with Communist Party leadership who support industrial growth and nuclear energy is what led to the oil industry's expose of who is behind the zero growth movement. Similarly, the Seabrook, New Hampshire demonstration for the construction of the Seabrook nuclear plant in early August was sponsored by such an alliance.

We cannot be coy about it. The enemy must be identified publicly and the battle fought out in the open. The issue is not whether to go nuclear, but whether we have any energy for the future at all. Without nuclear energy we cannot generate enough energy now or in the future for the growth that is essential for survival. Without growth we will soon die of war, starvation, or pollution. This is the other side of the question that Beckmann and Srouji shy away from.

Steven Bardwell is the director of plasma physics research for the FEF.





About the cover:
This drawing of a 1791 Birmingham mob sacking the home, library, and laboratory of scientist Joseph Priestly is by an unnamed eyewitness. The antiscience hysteria of the mob has its contemporary expression in the witchhunt against research on recombinant DNA and the terrorism against nuclear power.