FUSION

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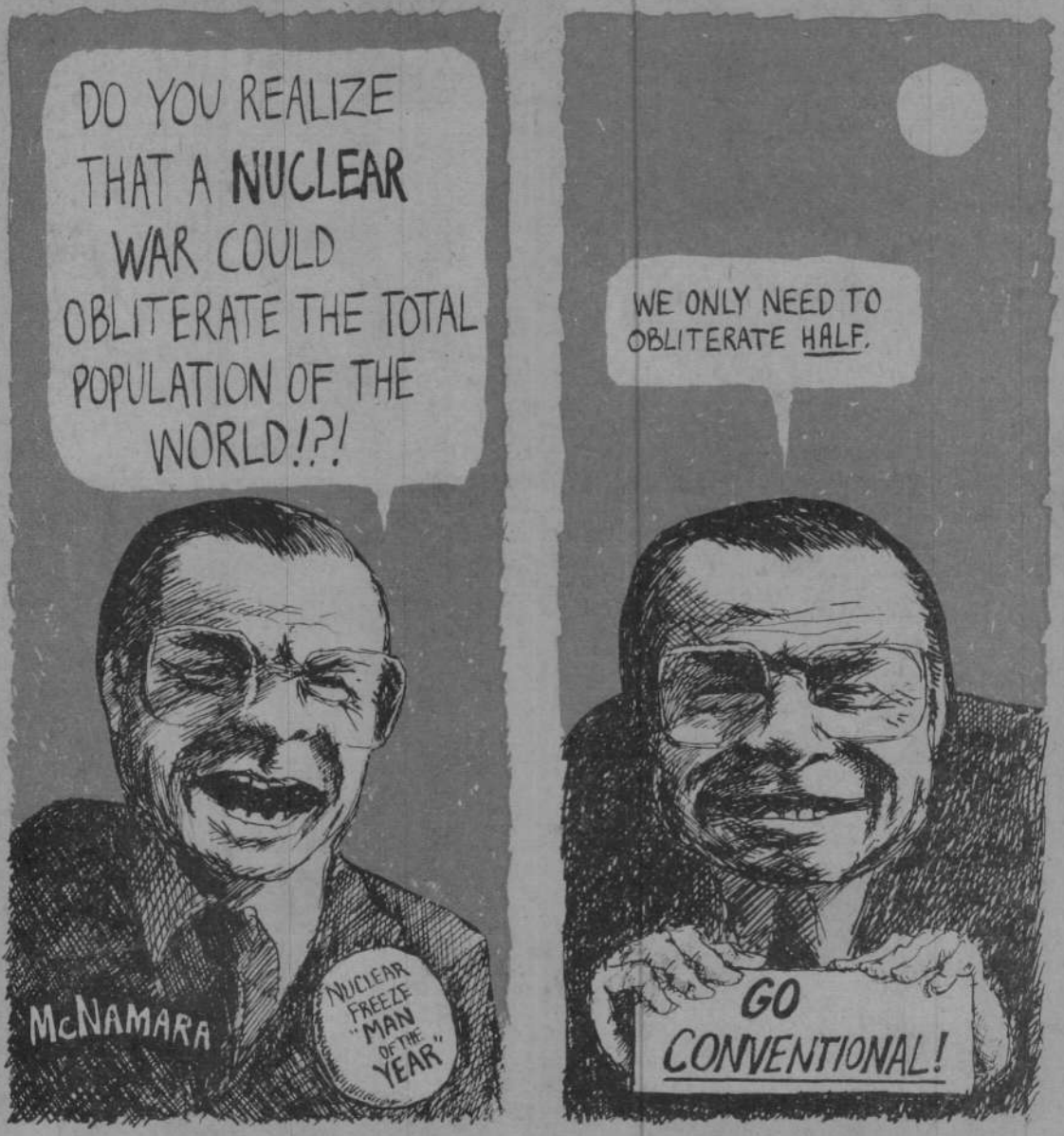

Beam Weapons

The Science to Stop Nuclear War

An Open Letter to Readers

At a time when "nuclear freeze" advocates are using antiwar rhetoric to promote a freeze on nuclear power plants, *Fusion* is not just a good magazine. It is the *only* science magazine fighting to continue the American tradition of progress.

The printing and mailing of our 1982 issues have been delayed because of our financial difficulties—difficulties that have been fostered by the same forces who bankroll the nuclear freeze and environmentalist movements.

We resumed regular publication in September 1982 with a special format issue of *Fusion*. This November issue, which contains feature material from the unpublished May 1982 issue, is our third special format issue. We plan to continue to publish more than one issue a month in order to send readers the highlights of all the back issues we have prepared, plus new materials. How fast we can catch up to our regular schedule and our full 64-page format depends on you.

With your financial help, we can win this fight for America, and get *Fusion* out regularly to its 200,000 readers.

- Join the Fusion Energy Foundation today. Memberships are $75 (individual), $250 (sustainer), and $1,000 (corporate).
- Send us a contribution to further our research and educational work and public lectures. Contributions to the FEF are tax-deductible.
- Donate subscriptions to your local schools, libraries, and legislators.

Paul B. Gallagh

Paul Gallagher, *Executive Director, Fusion Energy Foundation*

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Features

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The views of the FEF are stated in the editorials. Opinions expressed in articles are not necessarily those of the FEF directors or advisory board.

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Note to Libraries and Subscribers

To comply with postal regulations, the issues of FUSION in Volume 5 are numbered in the order in which they were printed and mailed. October 1982, Vol. 5, No. 4, follows September 1982, Vol. 5, No. 3, which follows December 1981, Vol. 5, No. 2.

Subscribers who purchased a 10-issue subscription will receive all 10 issues. The FEF expects to publish ten issues of FUSION in 1983, but only four issues in 1982. Highlights of the six remaining 1982 issues—January through August—will be included in future issues.

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Editorial

Beam Weapons, the Nuclear Freeze, And the 1982 Elections

This is a guest editorial by Lyndon H. LaRouche, Jr., a founding member of the Fusion Energy Foundation and a member of its board of directors. LaRouche heads one of the major political action committees in the Democratic Party, the National Democratic Policy Committee (NDPC).

The November 1982 congressional elections were, in the words of a popular idiom, a "Mexican stand-off." The Democrats gained 25 seats in the House of Representatives, a gain of no trend-setting significance, while the Republicans held their majority in the Senate. As a result, the real factional issues in the nation's capital at this moment are not between the two major parties, but across party lines.

The major fight at this moment is between backers of a Kissinger-guided State Department and backers of the Reagan Defense Department's push for the development of space-based antimissile beam weapons.

Otherwise, the important feature of the election is a profound discrediting of the right-wing conservative factions of both major parties, and also a significant, if indecisive, weakening of the left-wing forces of the Democratic Party. Under the pressure of a new economic depression, increasing portions of the electorate are looking back affectionately to the memory of President Franklin D. Roosevelt, and are turning their backs to both right-wing and left-wing varieties of political eccentricities.

The Beam Weapon Issue

Although the proposal to develop space-based antimissile beam weapons is only one among many major issues dividing forces in Washington, D.C., it is at the present moment the single issue upon which the entirety of near-term U.S. policy directions will turn. A summary of the history of the beam-weapon policy helps to make the issue and its connections clearer.

The discussions leading to the proposal of beam weapons began during the summer of 1977, through collaborative deliberations between retired Air Force Intelligence chief Major-General George Keegan and Dr. Steven Bardwell of the Fusion Energy Foundation. Putting their heads together, Keegan and Bardwell established beyond doubt that both superpowers had the scientific and technological means to launch crash programs to develop and deploy beam weapons capable of destroying large parts of the nuclear missile arsenal of the opposing superpower.

Although Keegan broke off direct collaboration during autumn 1977 over the issue of this writer's opposition to the "Camp David" policy, Keegan's and Bardwell's collaborators separately launched public campaigns for beam-weapon development during that autumn period, over hysterical opposition to both from the London International Institute for Strategic Studies (IISS).

During early 1982, this writer composed a comprehensive strategic policy draft, centered around a detailed proposal for a U.S. space-based antimissile beam-weapons development. This policy draft was circulated in prepublished form to key military and other circles, and later published with wide circulation as a policy study issued by the NDPC. A concerted effort of support for this policy proposal was launched during April-May 1982, and knowledge and support for the NDPC proposal spread.

As Dr. Edward Teller reported during an Oct. 26 public address in Washington, D.C., some of his "younger friends" won him over to becoming a spokesman for this policy. Teller has adopted the full range of proposed features of the policy. Defense Secretary Caspar Weinberger has publicly supported, at the very least, the military hardware features and implications of the same policy.

Currently, opposition to the policy comes chiefly from the allied forces of Henry A. Kissinger and AFL-CIO President Lane Kirkland, both supported by the "conventional weapons" build-up liberal faction of Governor Averell Harriman, Senator Edward Kennedy, and Senator Gary Hart.

In the layman's terms, the NDPC's beam-weapons policy has the following leading points:

(1) That the only possible means for ending the age of nuclear terror is the development of technologies through which nuclear missiles can be destroyed with more than 99 percent effectiveness in mid-flight. Without beam weapons, under present or foreseeable political conditions, neither superpower would be willing to reduce nuclear capability below its estimate of assured minimal capability for total physical destruction of the home-base of the opposing power.

(2) That the science and technology for such weapons-systems deployment exist at the established or early-potential capacity of both superpowers.

(3) That a "crash effort" to develop and deploy such antimissile defenses would incur no net cost to the U.S. economy, since the civilian-technological by-products of the development effort would stimulate a high-technology economic boom in the United States.

(4) That the only foreseeable trigger for actual thermonuclear war between the two superpowers now in sight would be a combination of "conventional wars" among regions of the developing sector and a significant weakening of the relative strategic power of one of the two superpowers. A weakened and threatened superpower, either the United States or the Soviet Union, would fall

back on the last resort of its thermonuclear arsenal, using thermonuclear blackmail to correct the imbalance. Thus, the savage weakening of the West through the present world economic depression, combined with regional conventional warfare in the developing sector, makes the otherwise unthinkable thermonuclear war an increasing possibility for the years immediately ahead.

(5) That the agenda of arms-negotiations between Washington and Moscow must be scrapped and replaced with a new agenda based on a policy of development of defensive beam weapons to the end of ending the age of thermonuclear terror (the policy of mutually assured destruction—MAD).

(6) That this qualitative change in military technology will, by itself, merely postpone the danger of thermonuclear war. We must include a feature which carries us beyond mere war postponement into circumstances of durable peace.

(7) That the basis for durable peace, as Teller emphasized in his own choice of terms, is a U.S. commitment to high-technology economic development of the developing nations, seeking to win the Soviet Union to cooperating in this effort on behalf of the "common aims of mankind."

The additional special feature of the NDPC-policy outline is that it specifies that the research and development for this be civilian-based, rather than locked away in secret military projects. The NDPC has proposed that the United States launch several civilian-economy crash programs to perfect the technology used in antimissile beam weapons. For example: NASA should be given the assignment for keystone tasks, including the development of manned Earth-orbiting space laboratories, and a manned Mars landing, as well as manned Moon stations. Such civilian research will develop all the technology required to be properly repackaged as space-based beam-weapons systems.

An intensive schedule of speaking engagements by the FEF's Dr. Steven Bardwell substantially weakened the cause of the "nuclear freeze" movement in California during the two weeks immediately preceding the election. Bardwell's speaking-tour had two significant kinds of effects. Although Bardwell was one of the designers of the beam-weapons project, he has done his work outside the bounds of secret research. Therefore, Bardwell is free to offer the kind of technical-scientific clarifications of beam-weapons principles which Teller is not presently legally free to reveal publicly. Second, Dr. Bardwell succeeded in winning a significant number of university students and some specialists away from the "nuclear freeze" cause, by convincing them that beam-weapon deployment is the effective approach to ending the age of thermonuclear terror.

The General Line-Up

At the highest level of U.S. circles, the practical division of forces is between the supporters and adversaries of the "New Yalta" policy of Britain's Lord Carrington. Carrington, a long-standing controller of Henry A. Kissinger, is at the center of an Anglo-Soviet game intended to break Europe away from the United States, and to kick U.S. influence out of the Middle East and other parts of the world.

The principal bastion of pro-Carrington policies in the U.S. government is the State Department. Kissinger allies in the State Department and ultra-liberals in the Democratic Party are the principal backers of neo-Malthusian policies concerning population reduction, technology, and economic policy. This faction opposes beam-weapons development, and proposes to develop a reduced U.S. conventional military establishment, designed to conduct regional wars against nations in the developing sector.

This division of forces along policy lines overlaps a second division within U.S. leading circles. This second issue centers around the publicized case of alleged Soviet spy Geoffrey Arthur Prime, alleged to have delivered detailed NATO plans and U.S.-NATO codes to Moscow. British refusal to inform the U.S. government of the massive leak of U.S. secrets by Britain's secret services, and massive other indications of Anglo-Soviet collaboration against the United States, have infuriated large parts of leading military, intelligence, and other circuits in and around Washington, D.C.

Informed sources indicate that the Prime affair is generally viewed as a British smoke-screen, a diversionary operation, covering up a much more serious business. The fingers point in the direction of Lord Carrington's "New Yalta" package, viewed as "treasonous" by some critics, and also repeated charges to the effect that Kissinger was a Soviet intelligence asset during the period of his postwar service in the Oberammergau Center in occupied Germany: the so-called Odra Cell affair.

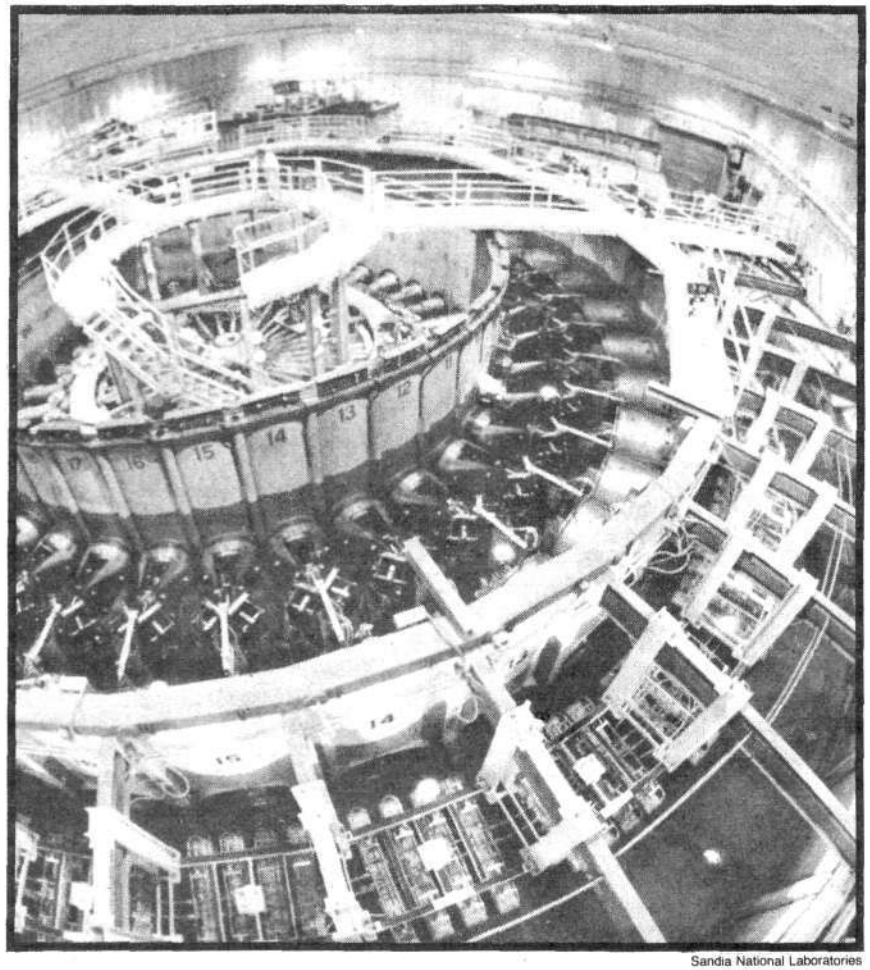
Although the general U.S. public is only dimly aware of such issues up to the present moment, the lines of cross-party divisions in and around Washington, D.C., intersect an eruption of rage against the effect of the policies of Federal Reserve Chairman Paul Volcker among the population generally. The recent elections reflect this rage only indirectly. Except in isolated cases, the percentage of the electorate participating in the elections was typical for a midterm election: approximately 34 percent. Also typical, the mobilization of certain sections of the electorate around special issues, such as the "nuclear freeze" referendum, tilted the results of the elections such that more militantly organized minority views within the electorate affected the overall vote in such a way that the result of votes cast does not efficiently represent the moods in the population as a whole.

In this election, the voters voted less frequently for candidates than against candidates. With relatively few exceptions, voters voted for candidates not because they like those candidates, but because they wished to destroy the political career of the opponent. The voters are not to be blamed for this; with few exceptions, they had no candidate or party policy worth voting for.

At the top, and among the electorate, the politicians of the United States are wobbling on a political knife's edge. Both the government and the electorate could easily fall to one side or the other, to the side of beam-weapons supporters, or to the side of Kissinger's friends. Whether President Reagan capitulates to Kissinger and Kirkland, or overrides Kissinger's State Department-centered backers, will probably determine the way the United States and the world go during the months immediately ahead.

Beam Weapons: The Science

by Dr. Steven Bardwell



Sandia National Laboratories

The PBFA 1, a particle beam accelerator used for electron beam production and focusing experiments in the fusion research program at Sandia National Laboratories in Albuquerque, N.M.

For years the threat of nuclear war has hung over the heads of Americans, the fear that by accident or design someone would press a red button and send a nuclear-armed intercontinental ballistic missile (ICBM) to turn U.S. cities into infernos. Now, after 30 years of living with this horrible possibility, there is a definite means to ensure that nuclear war will never happen: the technology of directed energy beam weapons.

We could have the first generation of beam weapons within 5 years—if the United States put a priority on beam research. Such beam weapons would be able to find, track, and destroy a nuclear-armed ICBM, preventing its explosion. And in another 10 to 15 years, we could develop a second generation of space-based beam weapons, giving even greater protection with a capacity to destroy 10,000 ICBMs at once.

Such beam weapons would make nuclear war obsolete. Beam weapons do not simply hit a missile silo or prevent a nuclear missile from being launched; they ensure that the nuclear warhead is destroyed in the stratosphere. There is no nuclear explosion, no nuclear holocaust.

The news media have portrayed the beam weapon as a "Buck Rogers" fantasy or as a "third generation nuclear weapon" that will "militarize" space by putting bombs there. But beam weapons are neither wonder weapons nor nuclear weapons. Directed energy beams can be of intense electromagnetic waves of the same wavelength (laser beams), of subatomic particles (electron beams, proton beams, or neutral particle beams), or microwave and plasma beams—all of which travel at or near the speed of light. The development of such beams would represent a qualitative leap in our understanding of physical science and technology, similar to the leap the world made with the use of nuclear fission.

For this reason, Dr. Edward Teller, who is often called the "father" of the hydrogen bomb, has termed the beam weapon the most important military development since the atom bomb. Whether or not the United States will embark on a new "Manhattan Project" effort to develop directed energy beam weapons depends on the success of Teller's ongoing public and private interventions into military policymaking, along with the initiatives of Democratic Party leader Lyndon H. LaRouche and the Fusion Energy Foundation, to shift this nation's defense policy away from the absurd concepts of mutually assured destruction (MAD) and deterrence, authored by Robert McNamara and the Rand Corporation.

A new Manhattan Project, ironically, would for the first time in 30 years free this nation from being held hostage to the threat of nuclear holocaust. More important, as LaRouche, the Fusion Energy Foundation, and, recently, Teller have stressed, a brute force research effort in beam technologies would have a revolutionary impact in accelerating the development of nuclear fusion for energy production, the development of plasma torches for materials processing and mining, and a host of other technologies.

Like the NASA Apollo program in the 1960s, an all-out research program in this frontier science area would spur industrial productivity and revive the U.S. economy, at the

to Stop Nuclear War

same time making the industrialization and development of the underdeveloped sector a reality.

The development of a beam weapon will open up a new chapter in man's history: the age of plasma technologies. These new technologies will have a more revolutionary impact on society than the introduction of electricity had 100 years ago.

The real source of the revolutionary impact of these technologies is the scientific challenge they present. The development of a beam weapon would require the resolution of the most profound problems of theoretical physics of the past several centuries.

How a Beam Weapon Works

A beam weapon system would have to meet the same requirements as any other conventional defense system against ballistic missiles. The Los Alamos National Laboratory's 1980 report on ballistic missile defense specified the problems to solve as follows: (1) early warning that hostile ICBMs have been launched; (2) detection and assessment of the threat; (3) derivation of trajectories and prediction of targets; (4) discrimination of warheads, reentry vehicles, and decoys; (5) targeting the interceptor (the beam); (6) guidance of the beam; and (7) destruction of the target.

Over the past 15 years, both the United States and the Soviet Union have perfected the early warning technology using satellites, and both countries routinely monitor all missile launchings. The more refined assessments are now accomplished using ground-based radar, but there are several new technologies that will greatly enhance the quick determination of where a missile is coming from, how fast it is going, and what its target is, and also discriminate between those missiles meant to hit their mark and the decoys.

The Los Alamos group has stated that the best way of using these new technologies for the job is to launch rocket-borne probes into trajectories above the atmosphere equipped with (1) a long wavelength infrared sensor technology that can detect fuel tanks in the hostile missile at distances of 3,500 miles, and (2) computer and communications technologies that can handle the data for as many as 20,000 targets in the infrared telescope's field of view.

Once the necessary information is processed, of course, the beam weapon must be aimed and must hit and destroy its target, as well as assess whether another shot is necessary. The technologies needed here are completely new, requiring unique solutions: Aiming a beam weapon at a target 3,500 miles away is like hitting an image about .00003 degrees wide—the same as a piece of thread seen at 100 meters—while it is moving at 20,000 feet per second!

It is generally agreed that the aiming and tracking technologies are within our scientific grasp today. What is required is concentrated work on the problem using existing optical systems (there are now cameras on civilian satellites that can point to a region of the sky with the accuracy required by a beam weapon) and fourth-generation gyroscopes now on the drawing boards.

The more difficult task will be powering the beam to the target with energy enough to destroy the target and energy of a sort that can be absorbed by the target so that it will be disabled.

These three problems—power, energy, and absorption by the target—are solved differently by each of the four types of beam weapons proposed: laser beams, particle beams, and microwave and plasma beams. However, all of them appear capable in principle of generating the required power and energy in a form efficiently absorbed by the missile.

The timetable is as follows: Within five years we could have a hybrid beam weapon system with an on-ground laser and a mirror in space (see figure). This would offer complete protection against an accidental ICBM launch or an attack by a runaway third power. In another ten years, a second-generation beam system could give us substantial protection; and in fifteen years, more advanced and much more attractive possibilities, like the X-ray laser, could provide us with defense against all-out nuclear attacks.

Laser Beam Weapons

Laser beams are perhaps the most familiar of the beam technologies. A laser beam consists of a beam of very intense, single wavelength electromagnetic waves, either light or high energy X-rays. Because the wavelengths of light are coherent—all the same frequency and phase—the beam of light can be focused very precisely.

There are four different types of lasers considered, all being researched at U.S. national laboratories both for weapons and fusion energy applications:

(1) In a **gas laser,** such as carbon dioxide, a burning gas is suddenly compressed and the resulting energy distribution is stimulated to emit single frequency light at high energies. Huge gas lasers are now being used here and in Japan in the nuclear fusion effort.

(2) A **chemical laser** uses a gaseous medium in which a chemical reaction is induced, the products of which then emit laser light. The Soviet Union last year in tests used such a laser to down a ballistic missile.

(3) An **electron discharge laser** uses the replaceable energy from an electron beam to create the source for laser light. This is the most attractive laser for space use because its energy source is not a chemical fuel that is used up but rather the electricity that drives the electron beam.

(4) There are two kinds of more speculative lasers that have not been perfected technologically but that promise the advantages of energy density and flexibility: the **X-ray laser** and the **free-electron laser.**

The X-ray laser, tested in the United States in 1981 and openly discussed in the literature last year, uses the X-radiation produced by a small nuclear explosive to "pump"

rods of a heavy metal medium that then releases its stored energy in a very concentrated, short pulse of X-rays.

The X-ray laser has the capability of such high powers and such efficient missile destruction (because the target efficiently absorbs the X-rays) that it is widely recognized as the most promising long-range laser for ballistic missile defense based in space. Although just a single pulse, the X-ray laser delivers thousands of times more energy per pulse than conventional lasers.

Given the state of technological development of the optical and power systems, there is not a competent scientist who doubts that a laser weapon capable of destroying an ICBM can be built. It is critical to understand that the most important objections to beam weapons, especially laser weapons, are political and military, not scientific.

Particle Beam Weapons

Particle beams, like lasers, deliver energy in a highly controlled pulse traveling at near the speed of light. But instead of a pulse of intense electromagnetic radiation, a particle beam is made up of subatomic particles (specifically electrons or protons), neutral atoms (usually hydrogen), or macroscopic particles (usually magnetized) that are accelerated to high speeds.

The destructive power of a particle beam is the intense shock wave that it creates in the target, which is like a small, very powerful hammer slamming down on the target.

All three types of beams have similar acceleration mechanisms, although the engineering is different: A magnetic wave generated by radiowaves or a set of magnetic coils is used to "push along" the particle. The magnetic wave stores energy from some electrical power source and transfers this energy to the particles.

The generation of **electron beams** is similar to the old idea of electron acceleration used in a vacuum tube. Electron beams are now routinely generated in the range of millions of electron volts, millions of amperes of current, and power densities inside the beam of trillions of watts per square centimeter.

What has continued to surprise scientists researching electron beams for military and civilian energy applications is that an intense electron beam is not actually a beam of individual electrons, but rather a complex structure of electrons and magnetic field. In electron beams of the order required for a beam weapon, the electrons actually increase their intensity by forming into a tightly bundled sheaf of separate beams in a vortex structure. These structured beams, which propagate together inside a protective shell of their own magnetic fields, can then carry higher currents and more energy longer distances at greater power levels.

Proton beams have been a subject of intense research, especially in the Soviet Union, for the past 30 years. These use an electron beam as a "seed" and then are accelerated in their own right. One of the newer technologies is a type of collective acceleration that uses an electromagnetic interaction to accelerate the protons to the same velocity as the electron beam "seed." Because the protons weigh almost 2,000 times as much as the electrons, having the same velocity means that they have 2,000 times greater energy. Again, these proton beams use their self-organizing capacity to "keep up" with the electron beam seed in the accelerator. The result is a very high quality beam with uniform energy density and uniform energy.

Neutral particles, because they are not charged, as are the electrons and protons, eliminate problem areas such as deflection in the atmosphere and electric forces between the charged particles and the background atmosphere that can degrade the efficiency and controllability of the beam. The technology for accelerating neutral beams was developed in the fusion program, where high density neutral beams are used as auxiliary heating for magnetic fusion devices. Because the technologies are not available to directly accelerate neutral atoms, the atoms (usually of hydrogen) are first ionized and then electrically or collectively accelerated. These accelerated particles are then passed through a dilute background gas and stripped of their charge, or neutralized.

By spring 1983, U.S. researchers will have produced a beam of protons at an energy of 2.5 million electron volts, traveling at 99 percent of the speed of light, as the first step in the large-scale testing of particle beam weapons.

The use of **macroscopic particles** accelerated in a rail gun—a magnetic track much like a linear induction motor—has been studied for applications that range from space propulsion, magnetically levitated trains, inertial confinement fusion energy, to weapons. These devices use a magnetic field to push particles (or whatever object is being propelled) down a track in the same way that the exhaust gases from a conventional shell push a bullet down the barrel of a rifle. Replacing the exhaust gases is a magnetic field capable of generating much higher pressures and therefore, much higher velocities (100 kilometers per second).

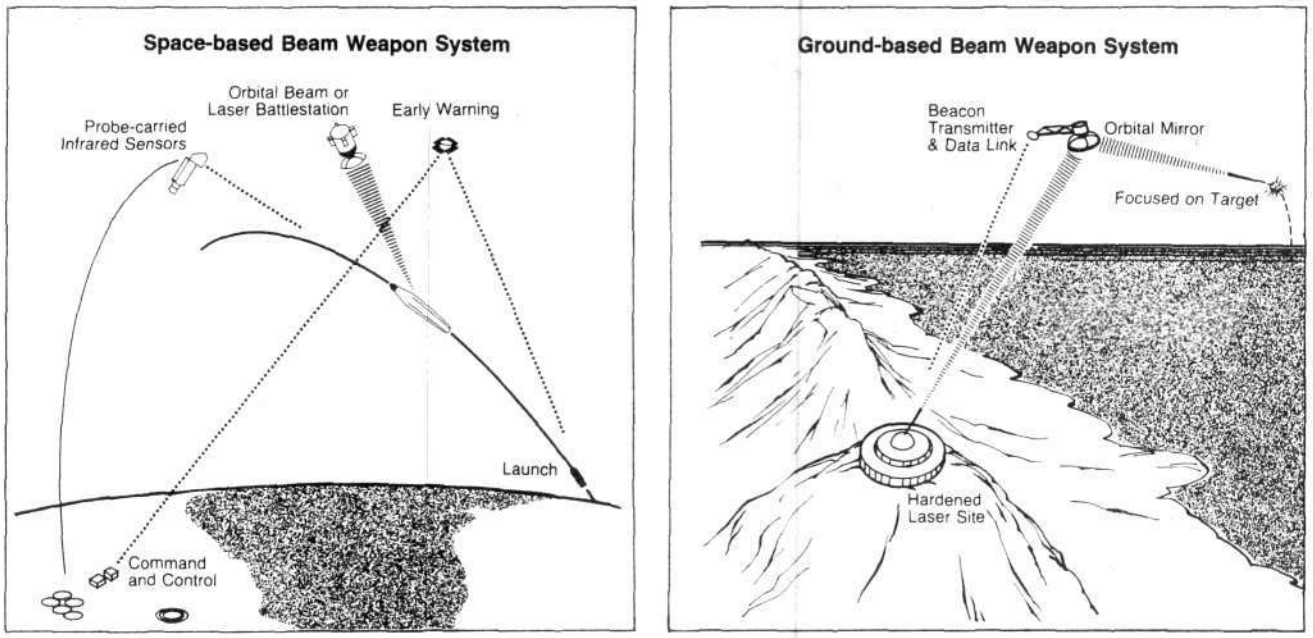
Although control and targeting would be more difficult with a macroscopic particle beam, its unparalleled power densities—because of the large mass of the particle—make it attractive as a beam weapon. According to U.S. weapons researchers, the Soviet Union has a large program devoted to the development of macroparticle beam anti-aircraft and antiballistic missile weapons, as well as anti-armor weapons and antiship weapons. There is no known armor that can withstand even a small projectile moving at the velocities attainable for macroscopic particle beams.

Microwave and Plasma Beams

Microwave and plasma beams have only been discussed in the United States in the last two years, although the Soviet Union has had a large program in both areas and is estimated to be about two to three years ahead in the production and propagation of microwaves and in the understanding of the interaction of intense microwaves with matter.

Intense, directional microwaves are generated when electron beams are propagated at or near the speed of light through a plasma. These microwave sources provide intensities many orders of magnitude greater than those associated with radar; and such beams, if focused, could destroy delicate electronic equipment in a target.

Plasma weapons offer even more of a challenge to sci-



The two modes of deploying beam weapons are shown here. The ground-based beam weapon (r) is simpler and can be developed in five years using high energy chemical lasers. A relay mirror in orbit around the earth provides aiming and tracking for the beam weapon. The longer-term space-based beam weapon design (l) shows a beam weapon mounted directly on a satellite orbiting the earth.

entists, and operate very differently from other beams. A plasma beam consists of the highest energy dense form of matter, a gas so hot that the electrons and nuclei have been separated. The "gas" is made up of electrically charged particles and the electric and magnetic fields they generate. This so-called fourth state of matter quite naturally forms into complex structures of particles and magnetic fields, which are spontaneously created and stable. One of these, shaped like a donut, is called a **plasmoid** and is the most frequent form of spontaneous plasma-field structure. It occurs naturally in the form of ball lightning, and has been reproduced on a small scale in the laboratory.

Plasmoids are contained by a toroidal magnetic field that spirals around the donut and reconnects with itself. This magnetic field simultaneously confines and insulates the plasmoid. Contrary to other beam weapons, for which the atmosphere hinders the guidance and propagation of the beam, the plasma beam could not exist without it; it requires something to "push against" to hold in the plasma. These closed field plasma blobs are extremely stable given their energy density, with a lifetime measured in seconds.

The exact physical mechanism involved in such closed field structures is the subject of heated debate here (some U.S. scientists even doubt the existence of such structures). Nevertheless, the Soviet Union has had a major research program in plasmoids since the middle 1950s, when the first plasmoids were produced at Lawrence Livermore National Laboratory in California. The first public indication of serious interest in a high energy plasma beam in U.S. military literature appeared in an April 1982 article that discussed the applications of a "collective accelerator based on magnetically confined plasma rings."

Such rings would be an almost ideal plasma weapon: They carry high energies, are stable, and can be accelerated to very high velocities. However, how such beams could be guided and targeted is still a matter of speculation.

The Science of the Beam Weapon

An engineering analysis shows that beam weapons for ballistic missile defense can be built. The problems of detection, discrimination, target acquisition, beam generation, and target destruction are all within our scientific and technological capabilities. Even for a chemical laser beam weapon, which is not "off the shelf" technology, there is no question that such a weapon could be built in the next five years with technologies available today. Despite this engineering certainty, the beam weapon confronts us with a host of fundamental scientific questions when it comes to a detailed understanding of the scientific basis of beam generation and propagation.

The fundamental scientific problems raised by the physical phenomena occurring in the energy-dense regimes necessary for beam weapons require working from the perspective of the German classical school of mathematical physics. This is not the method of analysis used by Western scientists. In fact, the tradition of Leibniz, Gauss, Weber, Riemann, and their successors, from which all the major discoveries of the past period have been derived, have been attacked with increasing success by the British empiricist or Newtonian school.

There are two main areas central to the question of the science of the beam weapon where the Newtonian approach cannot possibly explain the phenomena actually observed in experiments with high energy plasma physics.

First is the question of energy. While conventional Newtonian or Maxwellian physics defines energy as an inter-

nally measurable, conserved, scalar quantity, this view is untenable given the role of energy in the evolutionary properties of various beam weapon systems (for example, the self-organizing acceleration of proton beams).

Second is the question of the direction of evolution in physical systems. The fundamental assumptions of modern physics insist that changes with time in a physical system are the result of a summation of microscopic dynamics. In other words, particle-by-particle interactions supposedly "add up" to the global behavior of a physical system. In this view, the quality of the global evolution is statistical and random.

The behavior of high energy plasmas overthrows this premise. Beam weapon experiments, in fact, present striking evidence of a kind of global causality that directs the microscopic evolution of a physical system but is not reducible to microscopic interactions. There is a well-documented, spontaneous self-organizing behavior tending toward large-scale structure and more order.

These two opposing methods—Leibniz versus Newton—have been at the center of an intellectual and policy fight for 200 years, pitting the followers of the Newtonian atomistic tradition against the followers of the Leibnizian school. This is not merely an academic question today. In this country, the information that is classified in both fusion energy research and beam weapons research is the results of Riemannian physics that threaten the intellectual hegemony of the Newtonian ideas. At the same time, the mainstream of Soviet science is in the Riemann-Leibniz tradition, which explains the lead the Soviets have in physical research on relativistic beam weapons. If the United States is to develop beam weapons—as the Soviets are now doing—the Riemannian tradition will have to prevail in U.S. science.

The critics of beam weapons who challenge the very possibility of developing this technology do so on the basis of their Newtonian physics. How can beams propagate through the atmosphere without losing so much energy density that they will be unable to destroy the target? the critics ask. The answer is in the actual behavior of the plasma itself, which is not describable by means of conventional particle-based plasma physics.

The basic point of physical science is that a plasma is not in any real sense made up of charged particles and fields. To define a plasma in this way is much like saying a human being can be understood by studying the result of combining billions of single cells and the fluids around them. Rigorously, the problem a Newtonian faces when confronting these phenomena is that the causality for the macroscopic behavior is not contained at the microscopic parts of the system. The microscopic entities exist, but they are not primary; they are determined by the same global causality that shapes the general evolution of the system.

The Plasma Age

The development of beam weapons will not only free humanity from the insanity of having no defense against nuclear war; it will bring mankind out of the atomic age and into the plasma age, where we will be able to master technologies using the highest energy form of matter known today.

Mastery of a plasma would put at our command (1) an energy source—nuclear fusion—that has an unlimited fuel supply taken from seawater and is cheap, clean, and inherently safe; (2) access to a supply of raw materials that would be virtually inexhaustible through the technology of a fusion torch, which is capable of refining the lowest grade ores economically; and (3) new materials processing technologies that allow the creation of nuclear-tailored materials (isotope separation on a large scale), the degradation of radioactive wastes, and the ultimate recycling of wastes, using the plasma torch.

This is not science fiction, but what we can do in the next few years—if we win the policy fight for an Apollo-style program to develop beam technologies.

Real National Security

Beam weapons are inherently defensive technologies. The most important military consequence of this fact is that the national security of a country is not substantially affected if its putative adversary obtains these technologies. This, as Teller and the FEF have pointed out, removes any rationale behind the Schlesinger-authored security classification of the basic scientific research in the laser fusion program and in other beam-related areas. Such classification has hindered not helped the advancement of beam weapon research and scientific research in general.

For the layman trying to understand the military policy fight and how it intersects with the nuclear freeze movement, the important thing to keep in mind is the relationship of economic growth to national security. McNamara, Schlesinger, General Maxwell Taylor, and other freeze leaders advocate a postindustrial society, a curb on advanced technology, and new wars fought with conventional weapons to depopulate the Third World.

The traditional American military strategy of "winning the peace," nation-building domestically and abroad, has been the very opposite. This was the tradition in which General MacArthur rebuilt Japan, in which President Eisenhower proposed the Atoms for Peace program, and in which Admiral Rickover forged the Nuclear Navy and the civilian nuclear program as well.

The only way for the United States to ensure its national security is through the kind of rapid economic development that would result from a new Apollo program for the frontier science area of beam weapons. Real national security rests on economic growth, technological development, and human advancement that simultaneously provide a strong military and the objective self-interest that make war unlikely, if not unnecessary. A country producing new resources (rather than fighting for old ones), educating and training its citizens (rather than being plagued by unemployment or apparent overpopulation), and providing a hopeful future for its people, is a country with real national security.

Steven Bardwell, a plasma physicist, is editor-in-chief of *Fusion*. This article was adapted from his comprehensive report on beam weapons available from the FEF at $250.

SYSTEMS ANALYSIS
White Collar Genocide

by Lyndon H. LaRouche, Jr.

Part 2

EDITOR'S NOTE

"To replace Nazi-smelling eugenics, a new pseudoscience has been cooked up, and promoted as the putative 'scientific' basis for genocidal policies such as the Carter administration's *Global 2000* and *Global Futures*. That Malthusian pseudoscience in currency today is called 'systems analysis.' "

The proof of this thesis, that systems analysis is nothing but a rationale for policies leading to genocide, is the subject of part 1 of this provocative article by FEF board member Lyndon H. LaRouche, Jr. (see October 1982 *Fusion*, p. 3). Systems analysis, LaRouche demonstrates, as a "linear equilibrium model," is a doctrine of genocide because it ignores the role of technological innovation in economies and thereby precludes those very policies essential not only to support population growth but to permit the maintenance of even a fixed level of population. Under present world economic conditions, systems analysis is leading to mass-murder on a scale two orders of magnitude greater than that perpetrated by the Austrian hippie Adolf Hitler.

After noting that this evil methodology infects circles in both the East and West—including the State Department authors of the *Global 2000 Report*, the Draper Fund/Population Crisis Committee, the Aspen Institute, and other neo-Malthusian institutions based in the West; the Peking-allied Pol Pot regime that murdered 40 percent of the population of Kampuchea between 1975 and 1978; and the Gvishiani faction in the Soviet bureaucracy linked to the Vienna International Institute for Applied Systems Analysis—LaRouche traces the origin of modern systems analysis to the immoral "hedonistic calculus" of utilitarian philosopher Jeremy Bentham. Bentham, and following him the British economists John Stuart Mill and William Jevons, founders of the modern doctrine of marginal utility, rejected the possibility of founding a universal science of economics and instead maintained that economic processes are determined by the aggregation of marginal pleasure and pain experienced by individual buyers and sellers.

This pseudoscientific theory was continued by Alfred Marshall and J. M. Keynes and finally appeared in its most radical form in the modern doctrine and practice of systems analysis, typified by the influential *Theory of Games and Economic Behavior* coauthored by the mathematician John von Neumann and the Vienna neopositivist Oskar Morgenstern. Like all econometrics today, *Theory of Games* degrades economies to mechanical sorts of linear equilibrium models, which are axiomatically *entropic* processes; it considers nothing bearing on those crucial processes by which the productivity of labor rises or falls. As a policy-making tool, applied to "macroeconomies," systems analysis leads inescapably to economic devolution (depression).

There has been an equally continuous tradition of economic science opposing the marginal utility/systems analysis disease: the Platonic theory of scientific inquiry and practice, based on uncovering the negentropic quality of natural law. This theory is the most powerful weapon not only for destroying Malthusianism but also for building the technologies required to prevent genocide.

In part 1 of this article, LaRouche shows the coherence of the Platonic scientific tradition, leading up to his own discoveries as an economic scientist: Kepler's proof, in his works founding modern mathematical physics, that the

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Indicted Nazi leaders in the dock at the Nuremberg Tribunal October 1946, await sentencing for their crimes against humanity. In the first row of the dock (from left) are Goering, Hess, and von Ribbentrop.

universe is fundamentally negentropic, not entropic; Leibniz's insight (which grew out of his training in both German cameralism and French mercantilism) into the broad implications of the heat-powered machine—"by which one man can accomplish the work of a hundred others"—that successive rises in productivity, grounded in advancing technology, is the general principle of human existence; the unifying thesis of the anti-free trade American System economics of Alexander Hamilton, Henry Carey, and other patriots that value is located in "artificial labor," human improvements in raw nature; the rigorous proof by Riemannian physics (Bernhard Riemann, Georg Cantor, and their tradition in German 19th century science) that the Second Law of Thermodynamics, the so-called law of entropy, is a groundless fiction; and the negentropic outlook underlying the Judeo-Christian tradition, exemplified by the consubstantiality doctrine of Apostolic Christianity. LaRouche shows that far from being a merely theological issue of no importance to science, Apostolic Christianity's insistence on the universe as a process of lawfully ordered continuing creation is traced in literature to Plato's notion of the hypothesis of the higher hypothesis, which was the fundamental principle (often explicitly so) guiding the work of Riemann, Cantor, and every other major discoverer in the work of continental science.

LaRouche then establishes the notion of *potential relative population-density* as the central principle of Platonic economic science: "We must interpret all actual and proposed changes in society's productive behavior by the single parameter: Do such changes increase or fail to increase society's potential relative population-density?" Taking the example of resource exploitation, he demonstrates how this parameter functions as a measure of a society's progress: If a society remains within a relatively fixed level of technology, the variety of natural resources available to it is delimited, and the cost of exploiting these resources—the portion of the labor force that must be allotted to exploitation—must tend to rise through apparent depletion of the richest grades of ore. Less is produced per capita of the work force and per capita for the entire population. The relative potential population-density of the society falls accordingly. "Even the maintenance of a fixed level of population requires a constant change in human behavior, constant advances in the general level of technology of practice," LaRouche concludes.

From there, LaRouche argues that man's successful mastery of the universe, as measured by successive increases in potential relative population-density, is the basis of all science. Science is emphatically not a collection of isolated scientific experiments.

LaRouche's final point in part 1 concerns the notion of energy. Although advances in technology appear to correlate with increases in the energy transmitted per capita of the population, current notions of energy, as measured in scalar units such as calories, joules, watts, and so forth, are inadequate to mathematically describe the causal connection between the increasing energy density of production processes and rate of increase of productivity.

Geometry As the 'Language of Vision'

The best approach to succinct statement of the issues involved in study of the "energy" problem is found by referencing Kepler's three major published writings.[1] Admittedly, this writer did not have competent command of Kepler's writings, or of many other materials now in his possession, back in 1952. His principal methodological guides were a hatred of the mechanistic method, and a positive knowledge adduced from a few works of Leibniz[2] plus the fruit of his own de novo refutation of Immanuel Kant. However, the conclusions which this writer reached in 1952, and which continued to be his independent reference-points-in-chief into the 1960s, have proven, not accidentally, to be congruent with the superior quality of argument to be developed directly with reference to the work of Kepler and other resources added to the writer's repertoire at various points over the past two decades.

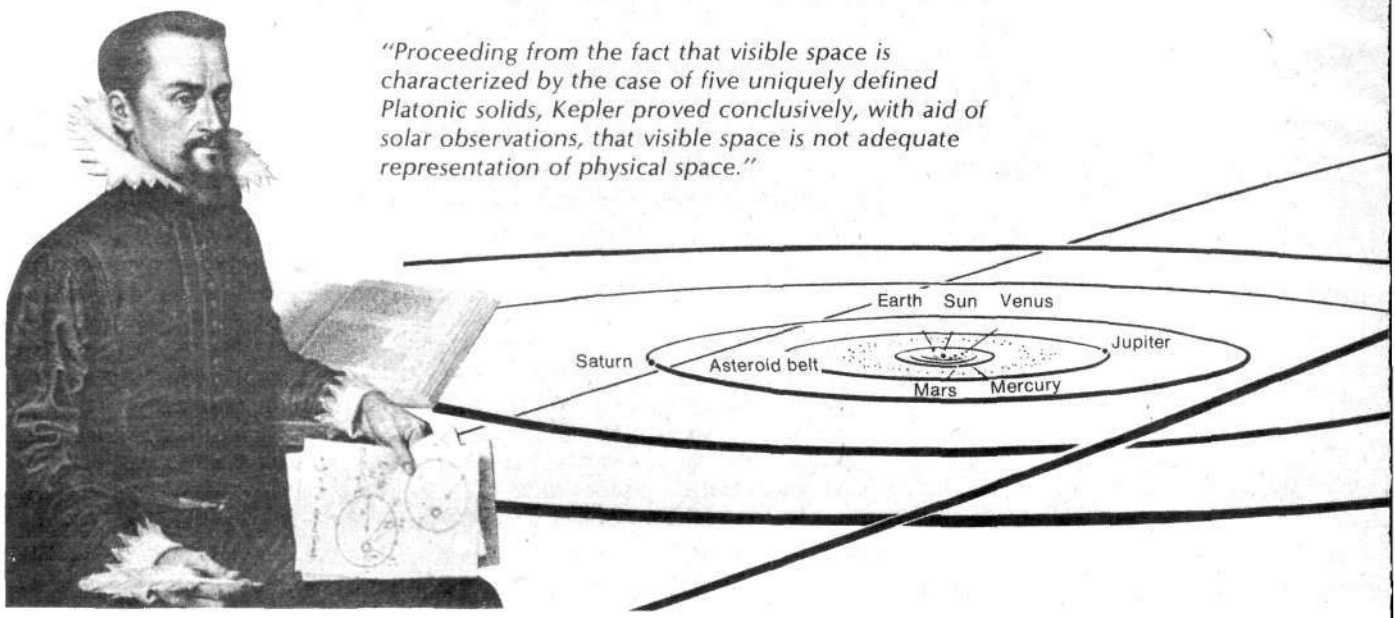
It were better to employ the improved form of argument brought directly in reach by resources not at the writer's original disposal, than to burden the reader with the more laborious approach the writer actually employed to develop the views described here.

One must appreciate the writer's anger at the wasted years occupied in accomplishing something which he might have more quickly accomplished and better, had the educational institutions to which he was exposed not been degenerated to the point their decay had already reached during his childhood and youth—long before the "new math" began destroying students' scientific potentials. He is therefore resolved that new generations of children and youth shall not be obliged to suffer the same costly deprivation, that the precious sources which every student ought to have available hereafter be available to them all. If there is any complaint to the effect that the writer is presently employing an argument considerably improved over that he actually employed to reach these same conclusions, the reader should not blame the writer for that, or regard it as in any way "intellectual dishonesty" that he honors a right method superior to the more laborious course he actually employed. Educate our students properly and such discrepancies need not arise in the future.

In respect to mathematical knowledge, the central issue of scientific work has been the question whether or not the universe as we see it is an adequate representation of the universe as it is.

If we see the answer to the question we have just identified rightly, we are led by rigorous steps to the discovery that there is no ontologically axiomatic "energy" in the universe, but that the phenomena of energy are a determined aspect of a more fundamental principle of our universe: *negentropy*.

This correction in thermodynamics, from the vantage point of Riemannian physics, is indispensable for solving the crucial problem of economic science. It leads us to a successful determination of the equivalence between an "injection" of *negentropy* into the productive process, and a correlated increase in the *negentropy* of the pro-



"Proceeding from the fact that visible space is characterized by the case of five uniquely defined Platonic solids, Kepler proved conclusively, with aid of solar observations, that visible space is not adequate representation of physical space."

ductive process, a *negentropy* measurable in terms of the work of increasing potential relative population-density.

The reader will soon discover why it has been necessary to identify the range of issues we have identified so far, to bring the report up to this point of elaboration.

Proceeding from the fact that visible space is characterized by the case of five, uniquely defined Platonic solids, Kepler proved conclusively, with aid of solar observations, that visible space is not an adequate representation of physical space (Figure 1). The fact that only five regular polyhedral solids can be constructed in Euclidean space—the space of vision—proves conclusively that Euclidean space itself is shaped by something external to it.

This was not new with Kepler. Plato understood this same point in exactly the terms we argue it here, in reporting that man does not see reality directly, but only the shadows of reality, as if viewing such shadows in a cave. Saint Paul writes that we see as in a mirror, darkly. Plato's scientific knowledge was enormous, in fact, a knowledge for which he was significantly indebted to the leading scientific institution of that period, the Cyrenaic temple of Amon, at which the uniqueness of the five solids was proven during Plato's lifetime. It is Plato's report of those solids and of their significance for physics which resulted in their designation as the "five Platonic solids."

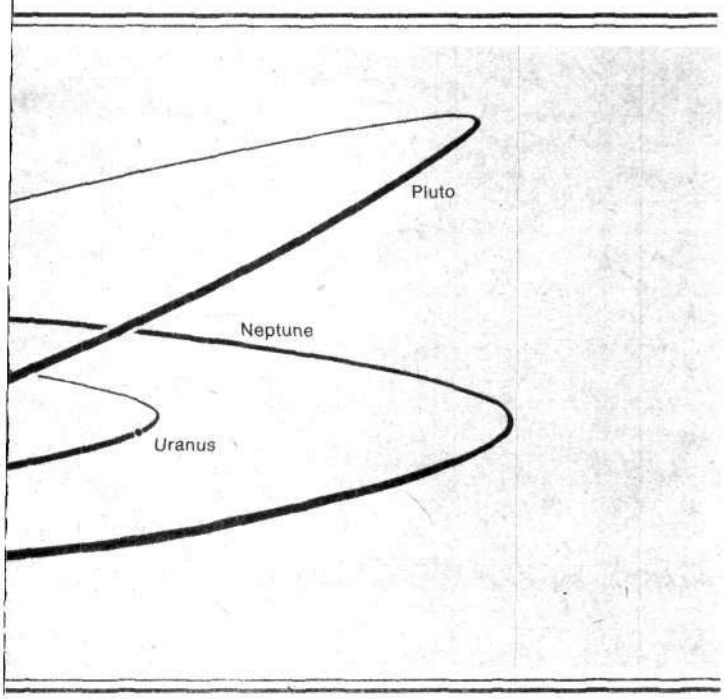
The principal stimulus for the revival of this Platonic approach to physics in relatively modern times was the scientific work of Cardinal Nicholas of Cusa, including Cusa's anticipation of modern topology in such locations as his "Sphere Play," and Cusa's general emphasis on a critical examination of the work of Archimedes.

The generation of Cusa's Italian successors, especially the circle associated with Leonardo da Vinci, and that generation's successors in the School of Raphael, had extensively explored all of the questions on which Kepler focused his own work. The *Divina Proportione* of Luca Pacioli, a collaborator of Leonardo, and of Pacioli's student Albrecht Dürer, as well as Giordano Bruno, are the immediate sources most strongly influencing Kepler in the direction of work he undertook.[3]

Also probably influential on Kepler was the work on well-tempered harmony by Bishop Zarlino, the latter also the proper ancestor of Bach, the late Mozart and, most explicitly, the late work of Beethoven. Although the work of al-Farrabi was key to pre-14th-century developments in music in Europe, and Leonardo is also influential on this matter, the agreement between Kepler and Zarlino on crucial points is most striking, perhaps conclusive, evidence of such an explicit indebtedness.

It was well developed before Kepler that principles of action in living systems, and other phenomena as well, were coherent with the so-called divine proportion, the golden mean. Kepler, who stressed this point, noted the central position of the golden mean relationship in the uniqueness of the five Platonic solids, as had his predecessors.[4] To test whether or not this predominance was in fact a lawful ordering of the universe, Kepler attacked the most conclusive body of evidence available to test this hypothesis: the solar orbits.

He proved that the orbits, including their variations in orbital velocity, were fully subsumed by the same principles of geometry which prescribed the well-tempered, 12-tone octave scale as the only lawfully determined tonal values and relationships within music. Although Kepler merely approximated values later determined more exactly by Riemann's comprehensive solution to elliptical functions, this element of approximation in Kepler's mathematics has proven to be no source of defect in the proof as a whole, as a proof of the hypothesis. Today, Kepler's method is eerily superior in quality as well as quantity to



any alternative method for describing the orbits of planets and moons.[5]

The proportions of the spiral nebulas are properly taken as complementary proof of Kepler's hypothesis, relationships coherent with the same principle of the five Platonic solids Kepler employed for the solar orbits. The fact that the principal asteroids, despite wildly different orbital paths, all "sing" in the same tone, is also collateral reenforcement of the notion of uniqueness for Kepler's proof.[6]

As Leibniz stressed the point against Descartes,[7] Kepler's proof subsumes the necessary conclusion that real physical transformations occur not as straight-line action in visible space, but in a manner implied by the Archimedean spiral, as the Riemannian theory of a complex variable elaborates this for physics today.

What, then, is the higher order of physical space, which shapes the characteristic form of transformations seen in visible space? This, since Kepler's proof, has been the central question of scientific work. In brief: How do we define a higher continuous manifold, such that the characteristic form of action is vortical (helical), such that projections of that higher space into the visible domain necessarily determine all of the characteristic features of the visible domain?

This is the problem which Riemann essentially solved, beginning with the statement of his program as early as the 1854 habilitation dissertation. There are omissions in Riemann's program, as he himself located such a deficiency in respect to the concluding subsection of his 1854 dissertation. These deficiencies, which bear on the determination of number relationship in a Riemannian form of continuous manifold, are implicitly overcome by the 1871-1883 work of Georg Cantor. For related reasons, it was not accidental that this writer discovered the significance of the 1854 dissertation for himself from the vantage point of Cantor's notion of the ordering of transfinites. This Cantor-Riemann method for analysis of higher-order continuous manifolds supplies, and uniquely so, the basis for solving the indicated problem of economic analysis.

We now elaborate the principal conceptual steps by which the meaning of the 1854 habilitation dissertation is to be correctly understood.

Visible space, with its apparent objects floating about and sometimes bumping one another, is what is described as a *discrete manifold.* Our problem is that of defining a *continuous manifold,* in which individual objects (qua objects) have no self-evident existence, but only a determined existence. The projection of the events occurring in this continuous manifold must account fully for all of the visible events of the discrete manifold.

The objects of visible space are not real objects, at least not in the sense naive opinion mistakenly assumes them to be ontologically self-evident. They are *shadows of reality,* and are real as *shadows.* Shadows do not *efficiently* act directly on one another to cause the movements reflected as movements of shadows. They do not *efficiently* bump, nor do they act upon another *efficiently* at a distance. There is no efficient causality contained adequately *within* visible space as such.

Efficient action, including our own efficient actions, occurs "out of sight"—as the movement of ducks swimming on the surface of the water occurs beneath the surface. So, in attempting to comprehend efficient physical space, we attempt to look beyond the "surface." We imagine the aspect of physical space which we see as broadly analogous to the projection of action in three-coordinate space and time upon two-coordinate space and time. We do not imagine that the higher-order space we infer "looks like" the images we construct to represent it. Rather, we use the analogies of projection of three-coordinate space upon two-coordinate and one-coordinate space as a "language of vision," and through refinement of use of that language, through observation and experiment, we make that language rigorous.

This heurism of "language of vision" we know to be valid, and uniquely so. If we know, as we do, that the ordering of events in visible space is geometrically rational, then reality, the projection of a continuous manifold upon a discrete manifold, is coherent with the rationality it projects. Therefore, we are permitted, on principle, to employ images which we construct in terms agreeable to our developed visual-conceptual powers, to represent visually thus a world we in fact cannot see. Our choices of imagery in this are limited to those options which are sufficient and necessary to describe a continuous manifold consistent with projections into a discrete manifold corresponding to the shadow-reality of our visible space.

The second of the two special problems is that of defining a continuous manifold which has an intrinsic metrical quality of action. Although the metrical qualities of a continuous manifold must be qualitatively different from those of a discrete manifold, there must be some metrical feature of the continuous manifold which ac-

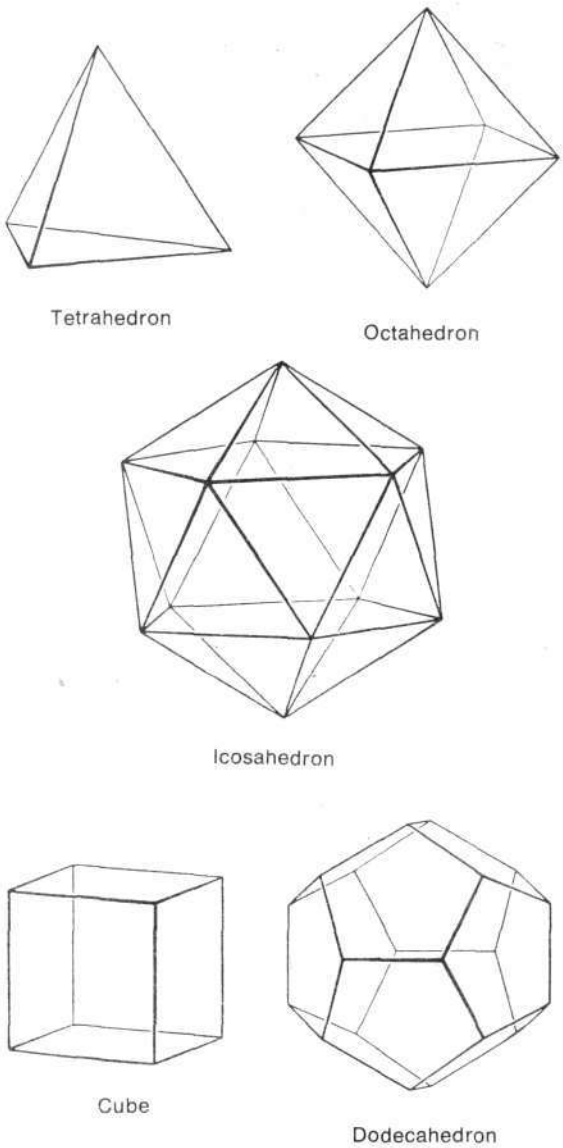


Figure 1
THE FIVE PLATONIC SOLIDS

The Greek geometers in Plato's Academy already knew that only five solid figures could be constructed all with equal faces and equal angles. These five "Platonic solids" are shown above. That exactly five such solids can exist in three-dimensional space is a profound fact about the intrinsic geometry of three-dimensional space and about the visual space of three degrees of freedom. The constraint of closure in three-dimensions—which leads to the existence of five and only five regular solids—is characteristic of the fixed, but geometric laws that govern visual space. A different kind of lawfulness is characteristic of the physical or continuous manifold whose projection we see in visual space.

counts for a properly adduced, characteristic metrical feature of our discrete manifold. This latter pair of problems of projections is the crux of Riemann's 1854 habilitation dissertation.

There is only one kind of continuous manifold which has both the needed, inherent metrical qualities, and which subsumes efficiency of local existence under that metrical quality. This kind of manifold is one in which the existing order, denotable arbitrarily by n, is passing over to a higher-order configuration, denotable by $n+1$.

The most appropriate term in the mathematics lexicon to describe the characteristic action of such an n into $n+1$ manifold is *negentropy. What appears to us as rigorously defined negentropic phenomena in terms of the visible manifold, is a projection of the characteristic, universal negentropy of the continuous manifold.*

For the purposes of this report, it is sufficient to direct our attention only to the most crucial features of this projective correspondence.

Our central problem is this. Although we know the continuous manifold to be in projective correspondence to our vision of the discrete manifold, there are characteristic differences between continuous manifolds and discrete manifolds, such that one cannot simply carry over certain kinds of secondary phenomena of the one to the other.

In a continuous manifold, for example, there can be objects (singularities), but no ontologically self-evident objects of the sort which naive common sense imagines itself to recognize in visible space. Similarly, there is no action at a distance among objects in a continous manifold. There are two leading additional considerations most crucial to defining the proper selection of continuous manifold.

Although the objects of visible space are merely shadows of reality, the shadows each correspond to an existence which is itself causally efficient. This is an impossible condition within a continuous manifold of a fixed order.

That is the gist of Riemannian physics.

This leaves us with an important problem to be resolved, a different sort of problem than we were obliged to emphasize on the pathway to Riemann's 1854 dissertation.

First, we were obliged to specify the conditions a continuous manifold must satisfy. Having defined those conditions, we must next concentrate efforts on developing methods for representing the conceptions we have reached in that fashion. Although one can develop geometric images of the transition from a specific n-manifold to a successor $n+1$-manifold rather directly, how do we generalize all such transformations, in the sense of generalization associated with geometrical mathematics as a whole? What we require, in order to represent such larger conceptions within our language of vision, is a method for defining coordinates in a three-space (visualizable image of space), such that conical-helical action (for example) in a three-space of such coordinates might subsume implicitly the general form of successive transformations. To this purpose, Cantor's notion of the orderings of transfinites is indispensable.

Figure 2
KEPLER'S PLANETARY GEOMETRY

Kepler developed his "Three Laws of Planetary Motion," upon which modern astronomy is based, out of his certainty that the universe was coherent and the Platonic insight that the laws of physics are the same on the Earth as in the heavens. His first law says that a planet sweeps out equal areas in equal time, no matter how far it is from the Sun. The second law states that the orbits of the planets are ellipses, with the Sun at one focus of the ellipse. Kepler's third law, which he considered to be his "great law," says that the ratio of the cube of the distance of a planet from the Sun to the square of the time it takes the planet to go around the Sun is the same for every planet.

Kepler insisted that the existence of the solar system in its present form must also be explained. In his years' long search to find a lawful principle to explain why the planets were spaced from the Sun in the distances that we empirically know them to be, Kepler initially determined that these distances could be derived by considering the planets to travel on orbits around spheres whose distance, one from the other, is determined by placing a three-dimensional, regular solid figure between each sphere, as shown in the model here. First, Kepler inscribed a cube inside a globe, representing the orbit of the farthermost known planet, Saturn. Then he put another globe inside the cube, representing the orbit of Jupiter. Then between the globes representing Jupiter and Mars, he put a tetrahedron. Around the Earth, Kepler placed a dodecahedron; inside the globe representing the Earth, he placed an icosahedron; and between Venus and Mercury, he put an octahedron.

As the accompanying table shows, Kepler was able to account for the six known planets and their distances with this construction. Later he rejected the specific construction using the Platonic solids, but he continued to point to it as an example of his geometrical method.

Model by Michael Micale; photo Carlos de Hoyos

AVERAGE MEAN DISTANCES OF PLANETS FROM THE SUN

(measured in astronomical units, A.U.; the distance of Earth from the Sun equals 1 A.U.—actually 92.9 million miles)

Planet	Kepler's Polyhedrons	Modern Astronomy
Mercury	.400	.387
Venus	.738	.723
Earth	1	1
Mars	1.432	1.524
Jupiter	4.881	5.203
Saturn	9.726	9.539

For spaces of orders n, $n+1$, $n+2$, . . . we are able in each case (actually or at least implicitly) to define arrays of characteristic relationships peculiar to that order of space. Yet, each such array for one space must be different from the array proper to another. Insofar as we can treat sequences of arrays, arrays each distinguished by a fixed order of space, as an ordered sequence, our problem of representation becomes implicitly solvable. The changes in the array denoted by n to yield the array denoted by $n+1$, are treated as the characteristic feature of the transformation from n to $n+1$. The characteristic feature of "extension" common to successive such characteristics implies the notion of ordering principle we require.

To elaborate a mathematical structure for this work is of the highest practical importance. Yet, a preliminary theoretical step toward that undertaking is far more important. The first, indispensable step, without which the detailed elaboration cannot begin to be developed, is to master a clear conception of this generalization as such.

There are, in the best judgment of the matter we have been able to assemble so far, two elementary problems which tend to prevent educated mathematicians from accepting the combined work of Riemann and Cantor on its own terms.

First, in order of commonplaceness, is the prevailing notion of *number* as such. Leopold Kronecker's famous, and mind-disabling dictum, "God made the integers," is exemplary of this problem. In fact, the evidence is over-

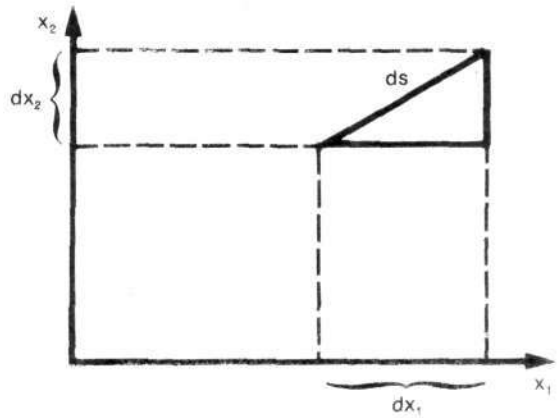


Figure 3
THE INADEQUACY OF PYTHAGOREAN DISTANCE AS A METRIC FOR PHYSICAL SPACE

In Euclidean-Cartesian two-dimensional space, the magnitude of displacement ds *of a point is determined in terms of the changes of its coordinates* dx_1 *and* dx_2 *by the Pythagorean formula* $ds^2 = dx_1^2 + dx_2^2$, *or* $ds = \sqrt{dx_1^2 + dx_2^2}$. *(More familiarly, this is* $h^2 = a^2 + b^2$ *and* $h = \sqrt{a^2 + b^2}$, *where* h *is the hypotenuse and* a *and* b *are the sides of a triangle).*

In the generalization of Euclidean-Cartesian space to any number n, *of dimensions, the corresponding formula is* $ds = \sqrt{dx_1^2 + dx_2^2 + \ldots + dx_n^2}$. *Another way of writing this is*

$$\sqrt{\sum_{i=1}^{n} dx_i^2}, \quad \textit{where} \quad \sum_{i=1}^{n}$$

represents the summation of all numbers from 1 as the index, i, *to* n.

This notion of magnitude of linear displacement as the model of the general notion of metric has become a major stumbling block for the further development of physics and economics, because it excludes the possibility of negentropic development in the universe. Suppose, however, that instead of measuring the internal geometry of a given manifold with such a displacement, we look at the change in the magnitude of this displacement as the manifold increases its number of degrees of freedom, or dimensionality. If we call ds_1 *the displacement for the first space, and* ds_2 *the displacement for the second, then a change in the displacement,* d(ds) *or* d^2s *can be heuristically written:*

$$d^2s = d_1s - d_2s = \sqrt{\sum_{i=1}^{n} dx_i^2} - \sqrt{\sum_{i=1}^{n+1} dx_i^2}.$$

This formula expresses the magnitude of the change in metric effected by a change in the order of the space from n *to* n + 1 *dimensions.*

whelming, that only what we term "complex numbers" have any primary sort of existence as number in respect to the metrical characteristic of our universe. The notion that the "simplest object" must be the most elementary is the broader fallacy underlying this.

Second, topology is burdened by repetition of the nonsense-assertion that there are no metrical features to topology as such. This is a tricky problem, since the development of topology has depended upon reexamining geometry freed of the burden of those metrical assumptions we associate with the visible manifold. Such metrics had to be discarded, in order to develop topology to the point at which the metrical features of a continuous manifold could be rigorously defined in such a way that we could be certain we had not carried over some exogeneous assumption borrowed from our naive view of the discrete manifold.

Plainly, many students of topology have forgotten why Leibniz undertook analysis situs in the first place. In order to adduce the characteristics of a continuous manifold in terms of characteristic transformations in a visible, discrete manifold, it was indispensable to discard from geometry of visible space only those features which were peculiar by their nature to a discrete manifold. We assume for properly obvious reasons, that those features of geometry which are not idiosyncrasies of discrete manifolds are the qualities carried over by projection from the continuous to the discrete. The end-object of this process of searching which is called topology, was properly to discover the *metrical characteristics* intrinsic to the continuous manifold.

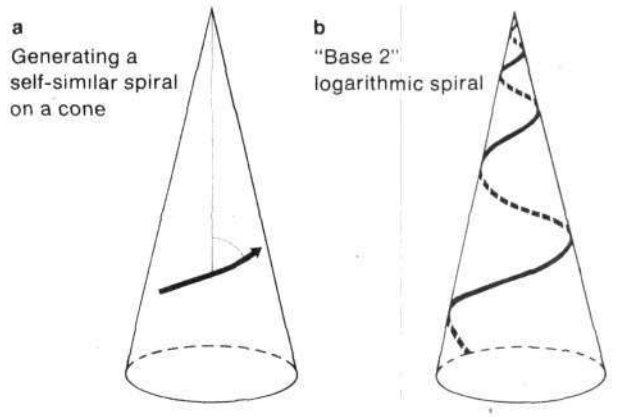
The topologist is too often like the fellow who took a journey to another city to fetch his bride, but, midjourney, became so fascinated with this excursion itself, that he began walking around aimlessly in one direction, then another, having forgotten what the purpose of the departure had been.

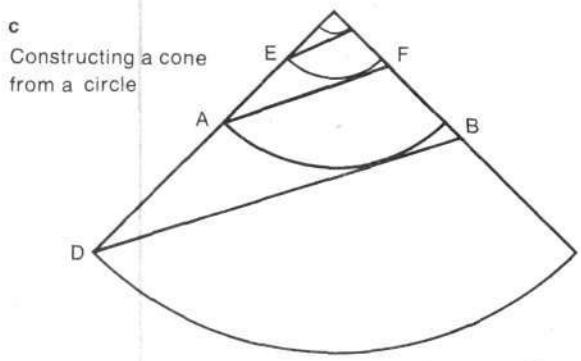
What we require is a characteristic metrical feature of a negentropic continuous manifold, which informs us how we must interpret the distance-function of phase space transformations in a discrete manifold, to the effect that this proper interpretation of phase spaces yields a characteristic, metrical feature of the discrete manifold, which is in projective agreement with the corresponding metrical feature of action in the negentropic continuous manifold. The simple Pythagorean expression,

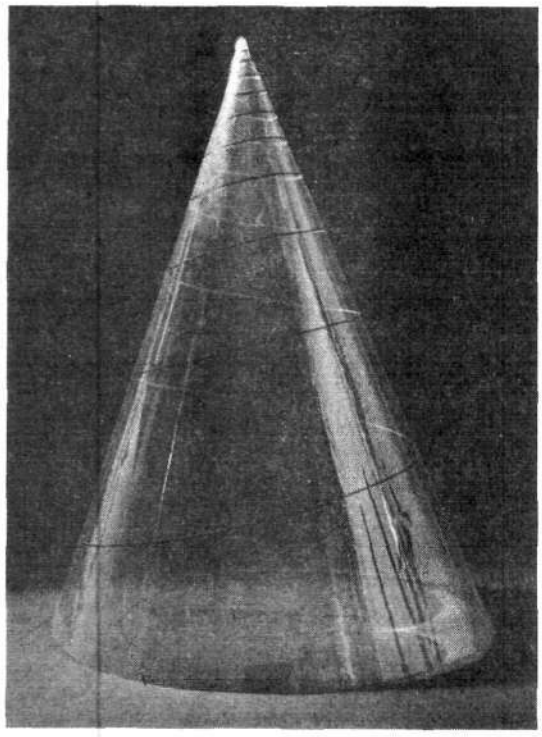
$$ds = \sqrt{\sum_{i=1}^{n} (dx_i)^2}$$

will not do (Figure 3). We require a measurement of d^2s for the case that the manifold is undergoing transformation from order *n* to *n+1*.

Such a correct approach to the metrical features of the discrete manifold defines this value, d^2s, as the unique measure of incremental *work*. This *work* must be defined in respect to the work of increasing the potential relative population-density of society through technological ad-







d) Model of a cone constructed of clear acetate

Figure 4
THE LOGARITHMIC (SELF-SIMILAR) SPIRAL ON A CONE

The conical form of the logarithmic spiral is generated as the trajectory of a moving point on a cone, whose angle α of ascent or descent, relative to the apex of the cone, remains constant **(a).** *This curve has the characteristic property that each successive "loop," differs from the preceeding loop only in scale, with a constant of proportionality that depends only on the angle of ascent or descent chosen. Thus, in a "base 2" spiral,* **(b)** *each successive loop moving away from the apex of the cone, doubles the distance from the apex.*

An easily constructed instrument for generating such spirals will be described in a forthcoming Fusion *article. A rough approximation can be obtained by folding a quarter-circle as shown in* **(c).** *A circle,* AB, *is drawn with radius half that of the original circle. Then, a straight line is drawn from the point* D *to* B *(this will form an approximation of the first loop of the spiral). Next, a circle with half the radius of circle* AB *is drawn,* EF. *The corresponding straight line,* AF, *gives an approximation to the second loop of the spiral. This process can be continued to generate a conical spiral with almost constant pitch.*

vancement. The *negentropy* of the system is the *work* of the system.

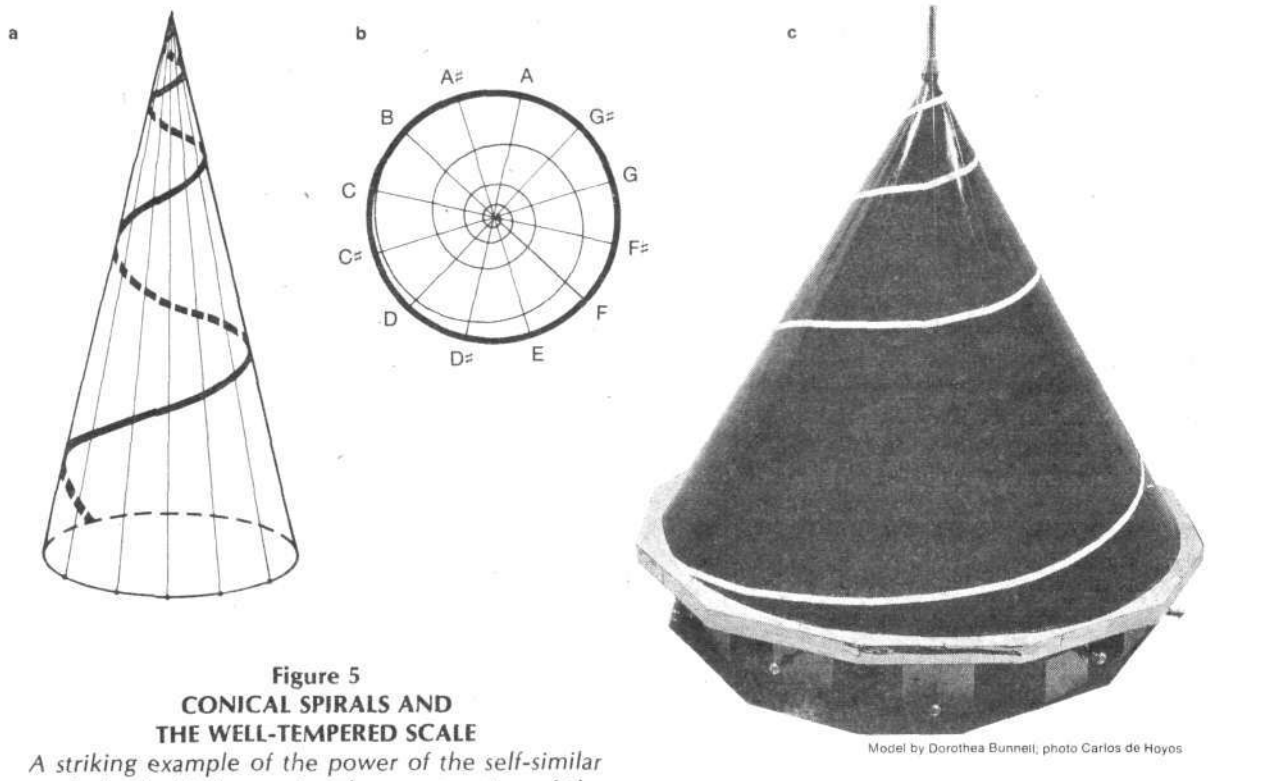
For related reaons, Riemann's 1859 hypothesis, setting forth the determination of acoustical shock waves under experimental conditions satisfying his "infinite cylinder" case, is the prototype of all valid scientific experiments, insofar as any experiments can be said to have authoritative bearing on knowledge of the lawful ordering of our universe. It is for this reason that the 1859 paper has been the model for crucial experimental treatment of relativistic phenomena in a broad assortment of cases outside of aerodynamics.

"Physical Topology"

That we be neither misunderstood nor give premise for misinterpretation of what we are about to say, we stipulate at the outset that the imagery we now introduce is a choice of pedagogical device—if it pleases you to call it such, a "heurism."

This writer does not assert that this is necessarily the most appropriate heurism which might be cooked up. He insists merely that it is the pedagogical imagery which presently appears the best compromise between the capacities of students and his own mental image of the material to be presented. Additionally, it contains no error as an image with respect to the points to be presented with aid of such a representation.

Imagine, first, a hollow sphere. You, the observer, are situated such that your eyes are looking into the sphere from a point we shall designate the "north pole" of that body. This sphere's south pole is sitting upon a flat surface. As you, the observer, attempt to view the images projected on that flat surface outside the sphere, what you are able to see is a shadow of those images. The shadow is that



Model by Dorothea Bunnell; photo Carlos de Hoyos

Figure 5
CONICAL SPIRALS AND THE WELL-TEMPERED SCALE

A striking example of the power of the self-similar conical spiral is its use for the construction of the well-tempered scale. If we project a "base 2" spiral (one whose inclination is such that a 360° loop of the spiral going up to the apex halves the distance to the apex), on the plane of its base perpendicularly (see **a***), we will create a flat exponential spiral. By dividing the circle of the base into 12 equal sections (see* **b***), the intersections of these 12 radii with the flat spiral determine a sequence of distances from the center of the circle to the spiral. These increasing distances are the lengths of the vibrating strings (assuming constant tension) that will produce the 12 tones of a well-tempered scale. If we call the longest distance the note C, the succeeding lengths moving inward on the spiral will correspond to D, D♯, E, F, F♯, and so on, as shown. Pairs of points corresponding to the same interval (for example, C and E with B and D, the major third) subtend the same angle at the center of the circle. In this representation, intervals correspond to angles and transposition from one tone to another to rotation through some angle.*

The strings on the model shown in **c** *can be plucked to play the well-tempered scale.*

defined by a line of sight drawn through the surface of the sphere and to the points of the image on the flat surface. You see the projection of that image on the interior surface of the sphere.

Now, to extend the description of this pedagogical imagery to include other considerations: The images on the plane surface are themselves projected images. They are the composite image of—in first approximation—several distinct cones, whose central axis may, in the simplest case, intersect at some common point on the surface.

The reader might, for example, construct a logarithmic spiral on a cone (Figure 4). Divide a circle into four equal parts, by means of two perpendicular diameters. In one quadrant, mark off inscribed quarter-circles by halving the radius successively. Now construct diagonal lines between the arcs, in the obvious way, and then cut out and fold-to-join the quarter-circle to form a cone.[8] This is an excellent exercise for the amateur mathematician, who having completed this construction, should reference Jacob Steiner's program for geometry instruction as to principles of geometric proof, and should also compare the result of this construction with Leonhard Euler's determination of the "natural logarithmic" value.

Having constructed the cone in this manner, imagine that the spiral (helix, vortex) so portrayed had been generated by continuous, homogeneous action, starting from the apex of the cone. This, of course, requires a function in terms of two variables. The first variable is a distance of displacement along the midline-axis of the cone, from the apex of the cone toward the base. The

second variable is a stretching and rotation action. The amateur mathematician should determine what kinds of numbers satisfy the conditions of variability for generating such a conical spiral. He should ask himself, what sort of ideas are suggested by this construction and this added analysis?

Suppose that the apex angle of the cone were made very small. Then, looking at a truncated interval of a very long such cone from the side, seeing it as an approximation of a cylinder, what does the amateur mathematician (for example, a high school student) now see? Let us assume the cone has been constructed of transparent plastic sheeting. What is the geometric connection among *e, pi, complex variables,* and *trigonometric functions?*

Now, look at this cone from the base side, toward the apex, or, using a light source, project the image of the spiral on the surface of the cone (constructed of translucent sheeting) onto a flat surface? Describe the shadow.

Now, make the midline of the cone intersect the flat surface at a right angle, and mark the circular perimeter of the cone's base. What is the image now projected on the flat surface? Divide the circle (the projection of the perimeter of the circular base of the cone) into 12 equal sectors (Figure 5). The distances marked off on the projected spiral (inside the circle) correspond, as chord lines, to the proportions of the 12 tones of the well-tempered octave. Show, by rotation, by intervals of fifths and minor thirds, that the well-tempered octave scales as determined by Kepler (*Harmonies of the World*) precisely agree with the chord lengths of this 12-part division of the spiral.

That is the simplest sort of co-projection we employ in the entire family of possible co-projections we impose upon the flat surface in this pedagogical device. Dr. Jonathan Tennenbaum has also developed a Weierstrass function as another example of the same family of projections (Figure 6).[9] The apexes of the various cones in such a co-projection are, clearly enough, in correspondence with points subsumed by other projections of the same sort, and so forth and so on. It is not necessary—for the purposes of this report—to expand further in such directions here. The amateur mathematicians have now a working image of what our pedagogical construction represents, and professional physicists and engineers ought to see clearly enough the direction in which we are pointing.

What we wish the reader to do next is to reflect upon the difference in images among: first, the cones being co-projected; second, the image co-projected upon the flat surface; and finally, what the observer at the north pole of the sphere sees as projected upon the interior surface of the hollow sphere. Our immediate purpose is to eliminate the mystification commonly attached to topology.

Pause for a moment before attempting to force a conclusion respecting this comparison of the images. Let us think about the simplest example of invariance in our observations of visual space. Is it not the case that we learn, early in childhood, to recognize a face of a person as being the same, no matter from what angle we view it, or even when the facial expressions change? What is it that we recognize, in light of the fact that the manifest

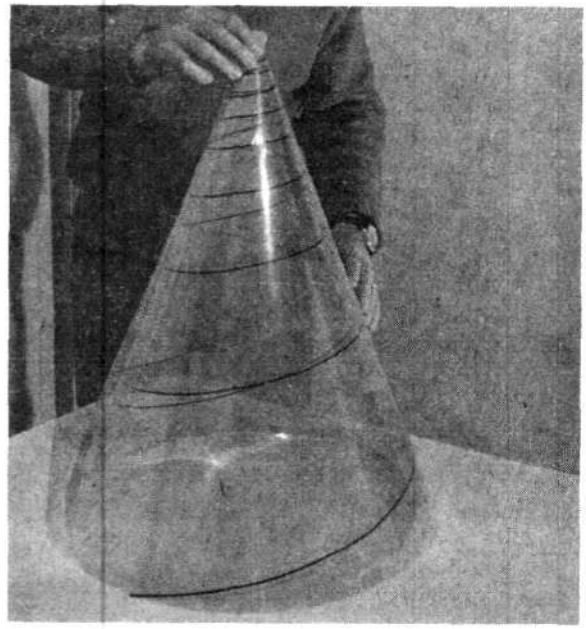


Figure 6
THE CONICAL SPIRAL AS AN EXAMPLE OF THE WEIERSTRASS FUNCTION

The conical spiral construction provides a very elementary geometrical example of a Weierstrass function, a function with everywhere-dense singularities. If two spirals with different inclinations are drawn from a common base point on the same cone, then they will intersect at an infinite series of points, which accumulate toward the apex of the cone. Now imagine a third spiral, drawn on a transparent cone with the same shape as the original cone. Let this transparent cone be fitted over the first cone so that the third spiral can rotate relative to the other two spirals. As the third spiral is rotated, it will create triple intersection points—where all three spirals appear to intersect—at various locations up and down the cone. Now imagine that each time that such a triple intersection appears, its "shadow" is cast radially down from the apex of the cone to the base circle.

Looking at the base circle of the cone as the third spiral is rotated, what will we see? Except for the degenerate cases of commensurabilities among the spirals, in general we shall see a highly discontinuous function: For every rotation of the third spiral, however small, the shadow will jump wildly about on the circle, in fact, visiting every region on the circle infinitely often in the course of that tiny rotation! This construction is a paradigm for how a continuous, highly lawful process (rotation of spirals) can "project" to highly discontinuous, apparently random "phenomena"—like the apparently random, discontinuous behavior of the shadows known as particles in quantum phenomena.

size and detailed features of the "flat-surface" or "three-dimensional" image projected upon our eyes has changed? We recognize what we sometimes term *invariant* features of that image, characteristic features which remain constant despite all of the changes in matter of detail.

The comparison of the images of the cones, their flat-surface projection and the flat-surface projection onto the interesting surface of the hollow sphere, informs us that we ought to be able to recognize an invariance among the three distinct kinds of original and projected images in this case.

It is not difficult to generate points, lines, and point/line relationships upon the interior surface of the hollow sphere in this configuration. In doing just that, we are illustrating the notion of the manner in which the appearance of a discrete manifold may be projected from a continuous manifold: at least, some of the aspects of such a distinction.

With this pedagogy, it should begin to be clear, that to adduce the invariance common among all three images we must eliminate from consideration any feature which is not consistently common to all three. That, and that alone, is all there is to simple topology.

This settled in that way, we do not yet have the kind of image of a continuous manifold needed to account fully for the discrete manifold we see in everyday life. We need *action*. Tennenbaum's image of a Weierstrass function is the simplest possible illustration of the kind of bridge in conception in which a universe of action can be imagined.

There must be action in the continuous manifold, otherwise, there can be no action in the discrete manifold. The only possible forms of purely geometric action must reduce to vortical rotation (for example, complex variables), whose characteristic form in geometry must reduce to simple geometric action of integration: from a continuous manifold of order n to one of order $n+1$. It is the metrical characteristics of action introduced to a continuous manifold by such n into $n+1$ transformations.

Hence, a topology which lacks such metrical determinants is an absurdity, a condition of mental pathology. To distinguish the simple, beginner's, classroom introductions to topologies of fixed manifolds, from the kinds of manifolds congruent with physical processes, we may find it most convenient to call the valid versions *physical topology*.

There are two kinds of action, as viewed among the shadows of the discrete manifold, to be taken into account. There are simpler actions, which ultimately, but not directly, reflect the negentropic transformation of the continuous manifold. There are also crucial definitions of action, which by their nature correspond directly to the negentropy of the continuous manifold. These latter are of the form of the change in the characteristic of action, d^2s, subsumed by transformation of a process from order n to $n-1$ (entropy). Riemann's shock wave experimental design (1859) is paradigmatic for such categories of action.

This pedagogical trick, so to speak, is the image the writer employs to think about economic processes, an approximation of the mental image of the universe he first encountered, through aid of Cantor and Riemann, back in 1952.

Applications to Economic Analysis

We must, therefore, formulate the study of transformations in economic processes from the standpoint of reference of such a notion of physical topology, from the standpoint of images of a negentropic (Riemannian) form of continuous, multiply connected manifold. We must study economic processes as wholes, treating *the whole as the primary existence*—the direct reverse of the pathological "Robinson Crusoe" image employed by the von Neumann/Morgenstern "model." These wholes must be studied as processes of transformation in entirely geometric terms of reference for analysis.

From the vantage point of reference of physical topology, the most obvious of the divisions within the closure of the whole economic process cycle is the social division of the population and its constituent households, a division defined in reference to the social division of goods-producing labor.

The modern form of classical study of such a division of labor is that emphasized by Alexander Hamilton. In good classroom work, we introduce the student to economic science's empirics by study of the manner in which the development of manufacturing, and of the transportation infrastructure associated with manufacturing, interacts with agriculture to determine a rise in the per hectare and per man-year output of agricultural production.

In such historical illustrative classroom study, we note inclusively the following most prominent points. The division of labor between agricultural and manufacturing production frees the farmer from household production of certain categories of artifacts, producing those artifacts at a lower cost to society than on farms. This frees the farmer to concentrate his efforts in a more concentrated fashion on those activities in which he is intrinsically more efficient: production of food and fiber, and improvements in lands, crops, and livestock. This division is made workable by improvements in transportation, and the development of institutions of commerce dependent upon relatively cheap and well-organized transportation.

The rather immediate effect of such division of labor is the farmer's possibility to exploit potentialities of specialization for market, to shift from emphasis upon "subsistence farming" to market farming. Cheap, efficient transportation is the key to successful development: improved waterways, roads, rails, and the cartage and railway enterprises which provide cheap, high-density, and reliable flows of goods between city and countryside.

By shifting the production of nonagricultural artifacts from inherently inefficient, and intrinsically crude rural "cottage industry," to concentrated manufacturing, we make possible technologically progressive, increasingly capital-intensive production of those artifacts. The improvements in productivity and quality made possible by this concentration lead to new categories of artifacts, including agricultural tools, machinery, and chemistry

"By shifting the production of nonagricultural artifacts from inherently inefficient, and intrinsically crude rural 'cottage industry,' to concentrated manufacturing, we make possible technologically progressive, increasingly capital-intensive production."

Alexander Hamilton

Henry Clay

products. This establishes the basis for agronomical science in respect to the improvement of the technology of agriculture.

The result, if this is pursued consistently, at fair prices to both farmers and manufacturers, is an explosion of productivity in both agriculture and industry, and also an allowance for transportation costs arising from such increases in productivity, which enables rapid improvements in transportation. Hamilton and Henry C. Carey outline this case with complete adequacy.[10]

The consequence of this dynamical interrelationship is a reduction in the percentage of the total labor force required to produce the food and fiber requirements of the entire population. The combined costs, of agricultural production as such, and cost of essential manufactured goods plus transportation, to agricultural output is progressively lessened as a social cost of food and fiber per capita for the entire population. Furthermore, on condition that the new technology so fostered is intelligently applied, not only is the fertility of land previously in use increased by "artificial means," but land previously unusable is brought into agricultural and related production. The potential relative population-density of society is doubly increased throughout this process of economic development.

From this starting point of classroom presentation, we proceed to a general analysis of other major categories of the social division of goods-producing labor and transportation labor.[11] We divide the classes of employment of operatives in urban occupations among transportation, consumer-goods production, and capital-goods production. At the beginning of such a process of development of agricultural production, the consumer-goods output per capita for the entire society cannot be, must not be, significantly better per capita than before the shift from cottage-industry to manufacturing. The emphasis must be upon capital-goods production for agriculture and transportation, and upon capital goods needed to give a technologically progressive, increasingly capital-intensive impulse to both agricultural and consumer-goods production. Capital-goods production and development of transportation are the "drivers" of economic growth and technological progress.

Later, the combined consumer-goods component of the employment of the labor force—both manufacturing and agriculture—must decline as a percentage of the employment in which the content of consumption improves goods production by the entire labor force: The capital-goods to consumer-goods ratio of employment of goods-producing and transportation labor must increase absolutely. The flow of costs and investment funds to capital-goods industries must grow absolutely relative to all commerce and production directed to manufacture and circulation of consumer goods, including services.

However, the services component of the employment of the whole labor force must nonetheless increase in terms of "market basket." The greater the rate of investment in capital goods, the greater the rate of development of new technologies must be. The ratio of scientists, engineers, and other technician-specialists per 100,000 of the goods-producing labor force must increase. The increased investment in developing the potential skills of each member of the labor force, and the extension of the span of educational years under this impulse, requires drastic increases in educational services (public schools and universities), and concentration on increasing average longevity: medicine, hygienic services, and so forth, as well as improved nutrition, increased cultural-directed leisure, and so forth.

The shifting social ratios of the social division of labor (and market-basket) per capita of the whole population is the first of the geometric features of the economic process which ought to occupy the student's attention.

Next, the student must view the dominant feature of development of machines as the compacting of the raw social division of labor of production into the design of machines.

Although "industrial engineering" has been dominated by unwholesome elements over the course of the present century to date, there are aspects of the characteristic

tasks of the industrial engineer's work which merit respect as tasks.

In the simplest approach to design of powered machinery, as "labor-saving" machinery, we analyze the necessary actions of manual labor into "motions." We remove these motions from manual labor and incorporate them into a designed-machine. The power transmitted to the machine thus replaces muscle-power in the effecting of these motions. Once such an initial transfer from muscle-power to heat-powered machines occurs, the development of machines moves to dimensions of quality beyond what muscle-labor might attempt. Yet, it is the division of productive labor which is the standpoint of reference from which the elaboration of the machine process—and other forms of productive processes—is to be understood.

Implicitly, anything repetitive can be done better by machines than human muscle-labor. The ultimate, irreplaceable feature of human productive labor lies in the unique powers of the human mind, to effect what no machine can effect, a change in the quality of productive technology, technological innovation. There is no danger, at any future time, that human labor will ever cease to be the essential determinant of production—the machine could never replace mankind. Rather, technological progress will properly assimilate all repetitive forms of application of technology, including, sooner or later, any application of an existing level of technology. In consequence of this direction of development of the productive processes' technologies, the form of human labor will shift toward the work of scientists and engineers only. Mankind's productive labor will become exclusively the creation of new productive technologies, the creation of new qualities of capital goods for the productive process.

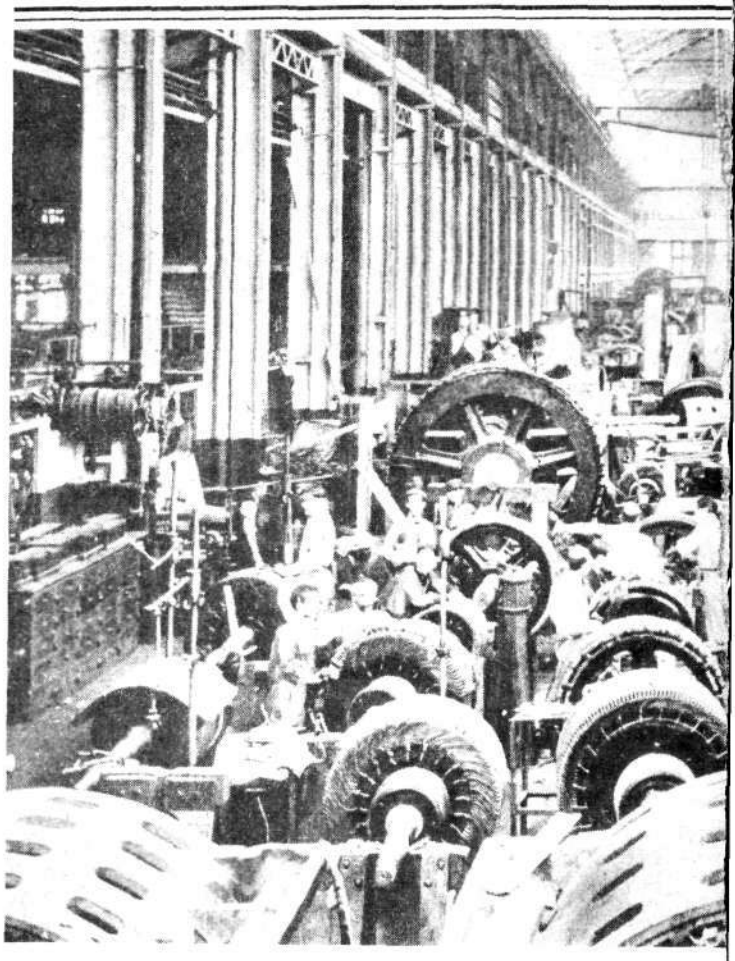
By seeing the coherence of the division of productive labor with the internal structure of machine design (for example), the student is enabled to envisage the case in which a cross-sectional slice of current production and circulation of goods might be represented as an input-output table. The inputs would be listed in rows, and the same inputs would also be listed as outputs, in columns. The table would show how outputs of each and every part of the network are distributed as necessary inputs to each and every part of the network.

In the relatively saner aspect of systems analysis, it is such matrices which are approximated.

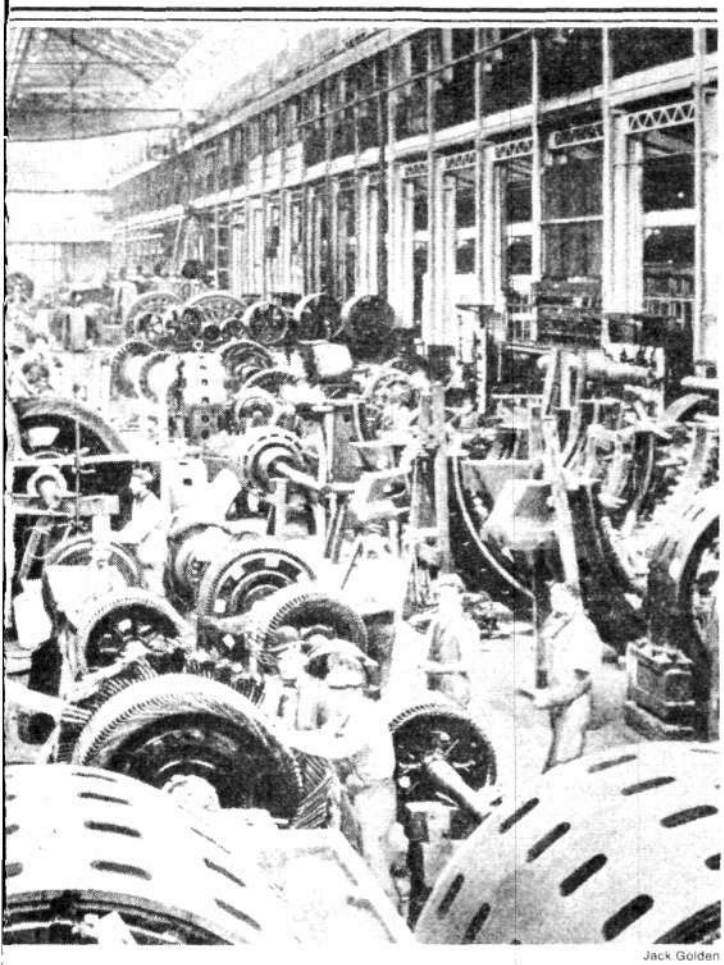
However, it ought to be clear immediately, that the attempt to analyze an economic process generally in terms of any such linear models is intrinsically absurd. Any society dominated by a fixed technology is a dying society, intrinsically entropic, for reasons we have summarized earlier in this report. It is technological progress, and technological progress alone, which permits a society to maintain even a constant value of potential relative population-density.

The characteristic reflection of technological progress is a change in the social division of productive labor. In other words, progress would take the reflected form of radical changes in these input-output tables analyzing relations of flow among elements of the division of labor. This progress is necessarily reflected, in approximations, as a series of input-output tables, $T_1, T_2, T_3, \ldots T_i, \ldots T_n$, such that from one to the next in that series, some terms of each table would drop out, others are added, and the coefficients of the matrix are transformed for persisting elements at the same time.

From the vantage point of the frustrated "econometrician," the characteristics of the economic process are "nonlinear" transformations—leaps among matrices. In principle, looking at the same evidence from the vantage point we have outlined earlier in this report, the economic process is essentially of the form of a negentropic manifold, in which transformations in the discrete manifold are characteristically projections of the impulse form of development of a continuous manifold from one of order n to one of order $n+1$. Hence, only Riemannian physics, complemented by the contributions of Cantor, can competently comprehend the determination of an economic process for analysis.



"Mankind's productive labor will become exclusively the creation of new productive technologies, the creation of new qualities of capital goods for the productive process."



Jack Golden

Here, a turn of the century Westinghouse factory showing the winding of rotating and stationary armatures for electric power systems.

The "energetics" of the development of the productive process ought to become clear in light of this comparison of economic processes to the general case of Riemannian manifolds.

"Energy," from the standpoint of a negentropic continuous manifold, is a reflection of *negentropy. Energy* is a phenomenon which reflects the going-over of a manifold from order *n* to order *n+1*. In respect to the transformations leading away from order *n*, the phenomena of energy correspond roughly to our image of "energy of the system" in ordinary thermodynamics. However, the going-over from order *n* to order *n+1* is itself expressed as comparable to the ratio of "free energy" to "energy of the system": *power, work, technology.*

This analogy is more than an analogy; it is key to the thermodynamic correlatives of rising values for potential relative population-density in the development of society through advances in productive technology. There is a coherence between the fact that negentropy has a "purely geometric" content in a Riemannian manifold, and that it correlates with an adducible "geometric" content for advances in the technological division of productive labor.

If the universe is governed by the *Logos,* as the Nicene doctrine prescribes the ordering of evolutionary development of the universe under continuing creation, then the principle of negentropy is the expression of that lawful process of continuing creation. Moreover, not only does this principle order changes in the universe, from relatively lower to relatively higher orders, but the very existence of a previously created order depends upon the efficiency of that same negentropic principle.

That observation must raise hackles among the intellectual heirs of the Jesuit-directed French Enlightenment, the "materialists." Yet, this was the basis for Kepler's establishment of modern mathematical physics. Agreed, Isaac Newton and others attempted to ridicule Kepler on this account, and that aspect of Kepler's work is generally either suppressed or referred to only by fraudulent, ridiculing gossip today. It happens that Newton's attack on Kepler is key to the manifest incompetence of Newton's physics relative to many matters including the behavior of Jupiter and Saturn, whereas Kepler's work remains valid precisely because of that fundamental feature ridiculed by Newton et al.

It is a simple mathematical fact, as we have indicated the proof of that fact here, that unless our universe were negentropic, our universe could not exist. No amount of Jesuitical sophistry, no amount of appeal to the ignorant prejudices of uneducated common sense, can push aside the efficient truth of that elementary fact.

This is the persisting issue of method and philosophical world outlook between the geometricians and algebraicists since Kepler and earlier.

Axiomatic algebra takes as self-evident the notions of quantity and simple number (for example, Kronecker) peculiar to an ignorant, naive perception of the discrete manifold of visual space per se. The argument of Russell and Whitehead, in the *Principia,* for example, carries the algebraicists' argument to an obscenely nominalist, radical extreme.[12] To the geometrician, the integers arise in physics only as topological singularities, as determined features of the continuous manifold whose image is projected in the appearance of the discrete manifold of visible space. Magnitude is necessarily a subsumed feature of those metrical features of a negentropic continuous manifold which make possible the necessary association of efficient casuality with the object-shadows of the discrete manifold, and make necessary the metrical characteristics of negentropic transformations witnessed in terms of reference of visible space.

The idea that "energy" must be an ontologically self-evident particularity, and associated with fixed, scalar magnitude, is not only a crude algebraicist's error of assumption, but is contrary to the fundamental principles of any universe which could actually exist.

"Hold that piece of chalk, Professor Algebraicist! The formulations you are about to elaborate have embedded in them what you logical positivists yourselves have fanatically insisted to be the 'hereditary features' of certain

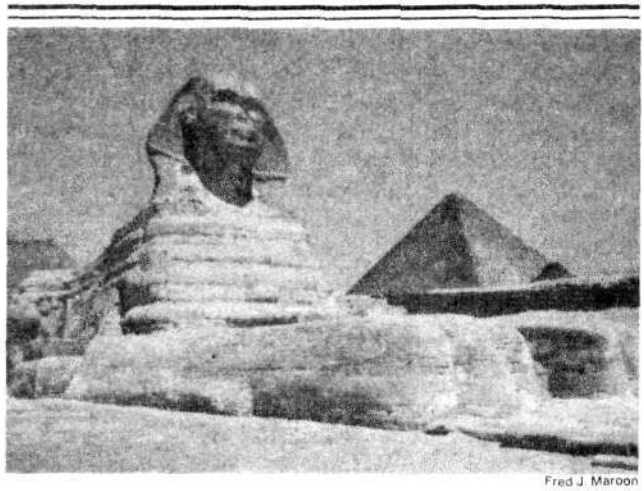
axiomatic assumptions. As you logical positivists yourselves have so often insisted, in defense of Russell, of the Viennese pathology, and of similar cult doctrines, the fact that you have assumed ontologically self-evident discreteness as the most fundamental axiom of arithmetic, means that wherever you naively interpret reality by means of your own algebraic constructions, you are able to adduce mathematical proof of the existence of entities which often, in fact, have no real existence, even as the discrete manifold of visible space."

This same problem has a simple demonstration in economics. "Mr. Accountant, please inform us how you calculate depreciation for today on one of the pharaonic pyramids of Egypt." The historical cost of an object is not determination of its proper depreciation value today. It is the cost of replacing a functional equivalent in terms of the costs determined by modern technology. If our accountant attempts to develop an historically based depreciation value he would probably be very much pleased with his own accomplishment if he conducted the following foolish exercise.

He would normalize ancient Egypt's prices to today's by comparing market-baskets of labor costs then and now. With aid of such "constant dollar" calculations, he would arrive at a "constant dollar" capital valuation for each of the pyramids. He would have ignored entirely the true differences in *productivity* of labor, the differences in potential relative population-density of the two societies.

One can not proceed from historical accounting valuations for depreciation to determine the "energetics" of an economy or section of an economy. Nor, in a sane economy, do we expend funds to simply replace the bricks and machinery of yesterday's investments. Rather, in a sane economy, we run old industries into salvage and scrap, and replace old machinery with modern, technologically advanced machinery. It is the ratio of "free energy" to "energy of the system" expressed by current output relations which determines values—and proper economic policies—including maintenance and investment policies. It is the negentropy of the system, not its average "energy of the system" levels, which determines economic values and proper maintenance and investment policies. In a sane economy, we do not maintain production capacities to resupply obsolescent forms of capital goods. We learn such sanity from the practice of the Composer of the continuing, negentropic creation we call the universe.

"Energy" must nonetheless be the appearance of the most important of all of the phenomena of the visible manifold. Energy reflects, in apparent terms of the thermodynamic state of the existing system, the negentropic principle underlying all action in the continuous manifold. It is the lawful unfolding of the negentropic continuous manifold, in terms of negentropic action which is the origin of all action in the universe, which obliges us to interpret all lawful features of the universe, including the appearances of the visible manifold, in terms of negentropy. Hence, thermodynamics, properly understood, is physics, and the theory of functions of a multiply connected continuous manifold, as a theory of negentropic thermodynamics, must be the only valid form of physics today.



Fred J. Maroon

"Mr. Accountant, please inform us how you calculate depreciation for today on one of the pyramids of Egypt."

Correspondingly, as mankind increases its mastery of the universe, as measured in terms of potential relative population-density, man's progress is in the form of increases of negentropy of human practice. It is only through that ordered process of successive discoveries, through which the potential relative population-density of society is maintained and advanced, that man proves a correspondence between the ordering of his discoveries and the lawful ordering of the universe, for which the empirical proof is man's increased power over the universe. The universe is therefore proven to be negentropically ordered.

Disproof of the "Second Law"

The Second Law of Thermodynamics pertains to a kind of imaginary universe which could not exist. The person who defends the assertion of such a "law of universal entropy" is saying, implicitly, "Ignore what I say, since if you believe what I say, neither you nor I believe that either of us exists." That is key to the true meaning of Leibniz's "This is the best of all possible worlds," in which an evil Voltaire could actually exist to circulate wicked falsehoods about that statement. It is not necessary that a Voltaire know and accept negentropy in order that a Voltaire might exist to babble nonsense, any more than a dog or a bacterium needs to know science truthfully in order to exist.

Naturally, some will retort angrily, "I can prove the Second Law!" It is amusing to hear that persons today take pride in proving that they themselves do not exist to prove such things.

Admittedly, we are rubbing salt into intellectual wounds. Even numerous among those who share to some degree our hatred against Malthusian arguments for genocide, will imagine themselves to be angered by such

ostensible insolence as categorical repudiation of such widely accepted notions as the Second Law of Thermodynamics and Conservation of Energy. Some of the objectors directly defend the "law of universal entropy." Others object to our presumed indiscretion in giving allegedly gratuitous and presumably politically counterproductive offense to the first group of objectors.

Although we have already identified, explicitly or by implication, all of the conclusive proof need to show the fallacies of the "Second Law" and of "Conservation of Energy," the opposition to our arguments, even among educated persons, springs from deeply embedded, such strongly conditioned views, that the argument wants summary restatement here and now, as a precondition for proceeding to our concluding arguments respecting systems analysis as such.

The presumption that there exists established or new experimental proof in support of the Second Law, or of the related fictional presumption, "Conservation of Energy," depends entirely upon two arbitrary fallacies respecting experimental proofs. In the last analysis, both of these two, widespread fallacies prove to be identical fallacies, although at first we must approach each as if it were distinct from the other. These two, ultimately congruent, fallacious assumptions, show us that no past experiment has ever proven a Second Law of Thermodynamics and that no future experiment is required to prove the contrary principle. All the experimental proof has already been accomplished; it is the interpretation of the experiments which has seemed to buttress belief in the prevailing fallacy of assumption.

We predict that, despite what we have written here, we will be strongly denounced for attacking the Second Law. We predict that those denunciations will overlook more or less entirely the proof we give here against the Second Law. We predict that some among the attacks will be in the form of attacks of one sort or another against this writer's personality, thus avoiding response to the proof given. We predict that others among the attacks will be in the form of simple, emotionalized explosions of outrage against the attacks upon the Second Law, and that these will make no effort actually to refute the proof given in this report.

The two, ultimately identical fallacies underlying all arguments in support of the Second Law may be respectively defined as "ontological" and "formal."

The ontological fallacy is, essentially, the assumption that the physical universe is adequately represented by the phenomena of a visible, discrete manifold. This subsumes the presumption that any inference of efficient principles of action must situate those principles within the axiomatic structure of a discrete manifold of the sort one imagines oneself to see. Typically, this means the effort to define efficient action in terms of either bumping or action-at-a-distance between ontologically self-evident forms of discrete objects.

The formal fallacy is properly argued to be the pathology intrinsic to the axiomatic view of algebra. The axioms of the Russell-Whitehead cult[13] are admittedly a radical version of the dogma of algebra, yet Russell is correct insofar as he represents that view as being a faithful representation of the underlying view of all empiricism and positivism. The assumption that only the simplest comparison among two discrete magnitudes, comparing these only as to scale, is the axiomatic root of algebra, cannot be denied as their own by the empiricists over the centuries to date. In other words, algebra so defined limits the possible universes to those kinds of discrete manifolds which share permeation by such an "hereditary principle" of reductionist algebra.

It was the celebrated, central feature of the Leibniz-Clarke correspondence, that Newton freely admitted that Newton's universe was entropic, that it was a universe which must necessarily have been like a clock running down the accumulation of work in its "mainspring," from the beginning of its existence. Therefore, either the essential form of action in the universe must be God winding the universe up, periodically, *from outside that universe,* or Newton's sort of universe is one which could never have begun to exist in the first place. This issue was not original to the Leibniz-Clarke correspondence; Philo of Alexandria had already conclusively refuted the Aristotelian dogma in these terms of reference nearly 2,000 years ago.

The classical, Neoplatonic proof of the absurdity of Aristotle, by Philo and the Christian Fathers, is worthy of and useful for reconsideration in this context. Not only is the argument devastatingly valid against the Second Law, but it was a well-known argument to all educated persons at the time such nonsense as Descartes's and Newton's absurd physics was concocted in defiance of such a well-known proof.

If the universe was created by a "big bang," as the Aristotelian (Apollo-Lucifer) cultists have insisted then and now, and if it is assumed that the universe so created is absolutely ordered by what the Jesuit agent Ferdinand Lassalle termed "iron laws" (parodying Goethe), then Aristotle and the Aristotelians are insisting that God ceased to be an efficient existence by virtue of the Creation. That, indeed, is the underlying logical theorem for the Nietzschean "God is dead" thesis. For, if God were efficient thereafter, he must violate his own "iron laws," making the universe unlawful.

If we assume a universe which depends upon repeated interventions by an efficient Creator, as Isaac Newton explicitly admitted his knowledge of the problem we have identified here, we have assumed a variation of the alternative case, in which the Creator's interventions are continuous. In either case, we have the subsuming, general case, that the Creator's interventions are themselves lawfully ordered, that the efficient will of the Creator and lawfulness are one and the same: *consubstantiality.* As we noted earlier in this report, man's manifest capacity to effect technological progress, as increases in potential relative population-density, is man acting efficiently *imago viva Dei*—in the image of the living God—according to the *Filioque* principle intrinsic to the notion of consubstantiality.

This, as we have emphasized earlier, is not some arbitrary sort of religious doctrine, extrinsic to science: It is the common principle upon which both theology and science are premised. There has never been any objection to this view, the counterthesis of the Apollo-cultist Aristotle included, which has not been shown absurd from the vantage point of such a rigorous criticism of practical implications of axioms.

To repeat what we stated a moment earlier, if I adduce from experimental evidence that the Second Law of Thermodynamics is true, then I prove that neither I nor the universe exists: a singularly uninteresting scientific result, scarcely worth the mental and other efforts of becoming a scientist. If I find myself reaching experimental conclusions, which conclusions implicitly prove that neither I nor my words exist, it ought to occur to me (as to René Descartes) that perhaps there might exist somewhere some small flaw in my experimental inquiry.

It is not difficult to show that the kinds of experimental designs employed in purported defense of the Second Law define the phenomena to be measured in terms congruent with the assumption that the physical universe is nothing but a discrete manifold. Empiricism and positivism assume this in a radical form. This approach to the experimental realm is governed by a view of algebra (including statistics) to the effect that the mathematical analysis employed is everywhere dominated by the "hereditary" influence of the algebraic axioms of discreteness and scalarity as universal elementarity (time, numbering). Thus, in respect of both the ontological view of the experimental domain, and the formal methods of analysis employed to design and interpret the experiments, the kind of universe variously adopted by Descartes or Newton has been chosen as the only kind of universe the experimenter will take into account. Any evidence which does not fit the axiomatic assumptions so chosen is axiomatically excluded from consideration.

All experimental "proof" of the Second Law (and of the "hereditarily" identical Conservation of Energy) are therefore to be ruled out of consideration as axiomatically merely tautologies premised upon falsehoods of governing axiomatic fictions.

This view of the matter is correct, but yet not adequate. We have indicated the proof that ontological and formal analytical assumptions of empiricism-positivism, as well as Aristotelian logic are absurdities. Negative knowledge is admittedly not by itself knowledge. The question, begged by certainty that "experimental proof" of the Second Law is absurd, is, how do we determine those kinds of experiments which do in fact have authority respecting the lawful composition of the universe?

In general, and otherwise implicitly, we have answered that question of adequate experimental approaches over the course of the report so far. We now, briefly, make the key point explicit.

Experiments bearing upon the lawful composition of

NSIPS

"A society which orders its response to nature according to the requirement that entropy must be served is a society which has ordered itself to follow an entropic course in its own existence. In brief, a society which has willed itself to die." Above, the antinuclear counterculture at a Harrisburg, Pa. demonstration, March 1981.

the universe must emphasize those classes of empirical phenomena which are most savagely paradoxical in respect to the obscurantist's algebraic point of view. The fact that the visible manifold permits construction of only five regular polyhedral bodies is exemplary of the kind of thinking with which scientific rigor begins. To see this as an idiosyncrasy of our visible manifold, as demonstration that the visible discrete manifold is delimited, shaped, is exemplary of the scientific method required. To see that a visible discrete manifold could not exist on its own terms, is a complementary recognition, the sort of recognition which characterizes the successful transition from ignorance to a scientific world outlook.

Otherwise, in the search for useful paradoxes in the experimental domain, we usually succeed if we follow either the precedent of Kepler, and conduct observations on the astrophysical scale, or seek to correlate lawful peculiarities of astrophysical and microphysical processes. These varieties of experiments enable us to adduce the necessary features to be included in construction of a mental image of the higher, continuous manifold, for which visible space is a projection. So, experimental inquiry leads us from the absurdities of the ontologically finite, to the discovery of the ontologically transfinite.

One will never discover much respecting the lawful composition of the universe by burning up an IBM 370 system, seeking to explore fully the inner psychological needs of the rearmost left leg of a common dog-flea by aid of statistical studies of that organ's behavior over many cases. One's choice and design of experimental subject matter must be congruent with the hypothesis being tested. One proves nothing, respecting the issues of a negentropic continuous manifold, by limiting experiments and experimental analysis to choices of array and method which exclude axiomatically any conclusions but those asserting the universe to be nothing more than a discrete manifold.

The source of the Second Law of Thermodynamics is not the available experimental domain, but, like the related cult-dogma, the Conservation of Energy, the Second Law is a willful intrusion into science of the cults of Isis, Apollo-Lucifer, and Mithra.

Belief, Policy, and Consequences

Although the "law of entropy" is a cultist's absurdity, it is a valid experimental observation to report that such absurdities are susceptible of being believed by even rather large proportions of the human population in general. What happens, then, if the people of a nation shape the nation's policies according to this absurd belief in a "law of universal entropy"?

A society which orders its response to nature according to the requirement that entropy must be served is a society which has ordered itself to follow an entropic course in its own existence. In brief, a society which has willed itself to die.

If it persists in such a policy of practice, that society will die. Is the lawfulness of the universe thus disproven, by such willful violation? Not at all. By destroying itself, the society has proven that nothing can exist if it violates the lawful ordering of Creation. By violating the law of Creation, the society becomes morally unfit to exist, and the law is served by its extinction. It has wrought the deadly judgment of the Creator upon itself.

Who are these Malthusians, these world federalists, whose influence is rendering the United States, for example, morally unfit to survive?

The British East India Company, the putative author of fascist economics and of Malthusianism, from the time of Malthus to the present, was, like the Dutch East India Company, an outgrowth of the conquest of the financial and political power of Britain and the Netherlands (among other nations) by the ancient and immensely wealthy "black nobility" associated with Venice and Genoa. These Venetian oligarchic interests, still today the greatest concentration of rentier-financier power in the world, were, in turn, an extension of the Byzantine aristocracy, and Venice was, from the time of the rise of the anti-Gnostic Paleologues, through the Napoleonic wars, the world political capital for that powerful faction of the Byzantine aristocracy.

To understand how Venice has figured in shaping the history and political currents of the present day, it is indispensable to know that the millennial combat between Western, Augustinian Christianity and the Eastern Rite was also the defining political struggle between republicans and oligarchs throughout the Mediterranean and adjoining regions. Although there were great Platonic (Neoplatonic) forces combating evil within the domain of Eastern pseudo-Christianity, from the time of Justinian, the Gnostic faction has controlled the hierarchy of the Eastern Orthodox Rite. Venice has been the leading conduit of this Gnostic-oligarchical force into Western Europe.

There was never anything trivial in the doctrinal issues separating Western and Eastern churches. The *Filioque* doctrine signifies in practice that man, *imago viva Dei*, is able and obliged to perfect his practice according to progress in exerting dominion over nature, and thus to bring individual man into practical atonement with the Logos, thus to become an instrument of the Creator in the ordering of the universe. The Eastern Rite (noting heroic and important Neoplatonic factions within the domain of its sway) rejected the Nicene doctrine, not only as a matter of liturgy, but as a matter of the very essence of both religious and secular practice.

The Eastern Rite's hierarchy, like the Roman imperial pagan priesthood, of which it is a consciously fanatical continuation in syncretic disguise, has been not accidentally, together with its later Jesuit offshoot, the mother of wicked cults, including the "Mother Earth-Mother Russia" cult which the Russian Orthodox Church introduced to that afflicted nation. Theosophy, the explicit worship of Lucifer, and secular cults such as the Cartesian form of the Enlightenment, Jesuit-controlled Francis Bacon's cult of empiricism, the Jacobin cult of 1790s France, and the modern socialist and communist cults spawned, together with fascism, by Giuseppe Mazzini's (and Lord Palmerston's) "Young Europe" radical network organization, are

also illustrations of this Orthodox-Jesuit cult-synthesizing activities.

In relatively modern times, especially since the 15th-century Golden Renaissance in Italy, the oligarchical fanaticism of the Orthodox-Jesuit forces has taken a characteristically anticapitalist form. On the one side, there has been overtly feudalistic anticapitalism, such as that of Oxford University's John Ruskin and his Coefficients, and Round Table followers. On the other side, these feudalists have been the principal sponsors and deployers of Fabian varieties of anticapitalist radicalism, creating "proletarian" movements of the capitalist form of nation-state republic. The general, utopian goal of the feudalist sponsors of such anarchist, socialist, communist, and fascist cults, has been to demolish the institutions of technological progress and the sovereign nation-state, to introduce a period of genocidal chaos, through which to return Europe (for example) to the chaos of the mid-14th century, as John Ruskin proposed.

Those interventions into the internal life of science, which we epitomize by the cases of Descartes, Newton, Cauchy, Maxwell, Mach, et al., were not autochthonous developments from within scientific inquiry—they were never "honest errors." Bacon was a Jesuit-coordinated agent against, among others, the greatest English scientist who ever lived, William Gilbert. Descartes's work was vastly inferior to that of Bruno, Kepler, Pascal, and Fermat, and Descartes was trained and directed by the Jesuit order. Newton was essentially a hired political thug, his mind principally occupied with the most obscenely superstitious black magic, deployed by the oligarchical faction against both English and continental science. Cauchy was entirely a Jesuit agent, whose work in science was entirely directed by the Jesuit order, with each intervention consciously conceived as a delphic trick for destroying science from within, for destroying the integrity of scientific method. Maxwell was a political tool of the Cecil family (Francis Bacon's family), in a consciously directed effort by British circles to destroy continental science.

If we peel away from modern textbook instruction everything which we know to be a willfully fraudulent intrusion through instruments of that oligarchical faction, a beautiful set of methodological foundations and specific achievements remains to us in the work of honest primary sources. The span we have traced from Kepler through Riemann and Cantor is exemplary of this.

This writer is honored to find himself in the position to defend the great and moral achievements of true scientists, to honor their contributions and also to seek to revive the spirit of scientific inquiry which they exemplified from the swamp of mixed frauds, empiricism, and positivism which destroy so much of the scientific potential of students and professionals today.

It is unavoidable, and also useful, to expose as fraud the myth that the internal methodological issues of scientific work are not "political." Only if issues permeated with the stink of the Jesuitical inquisitions from the past are understood to be nothing among the most profoundly political of issues, can scientific work generally liberate itself from the Jesuit-led "fifth column" whose agents have been destroying modern science from within.

Systems analysis, like its theological version, the Jesuit dogma of "bioethics," is directly, explicitly nothing but a product and instrument of the Gnostic cult's influence within the ranks of scientists and other policy influentials. It is intended to foster a feudalist's Malthusian policy of genocide, in the footsteps of John Ruskin, and is intrinsically a genocidal policy as well as a pseudoscientific hoax in its own right.

It is past time to see the systems analysts, as well as the Nuremberg criminal supporters of *Global 2000* for what they are: as the political heirs of the still-growing cancer earlier represented by that Austrian hippie, Adolf Hitler. The leading systems analysts are not merely "mistaken." They are wittingly evil in both their systems analysis itself, as well as in the uses for which they employ it.

Lyndon H. LaRouche, Jr. is one of this century's outstanding thinkers. A frequent contributor to Fusion, *LaRouche has received worldwide recognition for the depth and originality of his work in economics, philosophy, and epistemology. LaRouche's work has also led to his being named by the Club of Rome and its cothinkers as the most dangerous opponent to Malthusian thinking. A founder of the Fusion Energy Foundation in 1974, LaRouche has been on the FEF board of directors since 1980.*

Notes

1. *Harmonies of the World* (1619), book V, trans. C.G. Wallis (Chicago: Encyclopaedia Britannica, 1952), books I and II, unpublished translation by Christopher White, Sylvia Barkley, and others; *Mysterium Cosmographicum* (1596), trans. A.M. Duncan (New York: Abaris Books, 1981); and *Astronomia Nova* (*New Astronomy*, 1969), no published translation.
2. Chiefly the *Monadology* (written 1714, printed 1720-21) and the *Leibniz-Clarke Correspondence* (1715-16), ed. H.G. Alexander (Manchester, Eng.: Manchester University Press, 1977), the leading philosophical interest of the writer's 14th and 15th years.
3. See Kepler, *Harmonies of the World* on acknowledgement of intellectual debts.
4. Ibid.
5. Apart from the evidence supplied by Voyager observations, Uwe Parpart has shown, by a few elementary calculations using data from standard astronomical tables, that Kepler's calculations stand up for the planets and moons today.
6. The internal musical interval of any orbit is defined by the ratio of the angular velocity (speed of turning around the Sun) at the closest point to the Sun, the perihelion, to that at the farthest point, the aphelion. The orbits of the asteroids vary widely, but the internal intervals cluster around two values. For example, the interval for Ceres is 0.729, for Vesta 0.700, for Juno 0.342, and for Pallas 0.382. These values are close to those that create the musical interval of an augmented fourth; that is, C to F#. This augmented fourth is known by musicians as the devil's interval because of its extremely unsettling, dissonant quality.
7. G.W. Leibniz, "Historia et Origo Calcui Differentialis."
8. Dr. Jonathan Tennenbaum presented part of his work on this construction of proof of the well-tempered system during proceedings of International Caucus of Labor Committees conference held in Mainz, West Germany, Nov. 5-7, 1981.
9. Work prepared for the Dec. 31, 1981 ICLC conference in New York City by Dr. Tennenbaum and his associates.
10. See N. Spannaus and C. White, *The Political Economy of the American Revolution* (New York: Campaigner Publications, 1977) and A. Salisbury, *The Civil War and the American System* (New York: Campaigner Publications, 1977).
11. See L. LaRouche, *Basic Economics for Conservative Democrats* (New York: New Benjamin Franklin House, 1980).
12. B. Russell and A.N. Whitehead, *Principia Mathematica*, 3 vols., 1910-13 (republished, New York: W.W. Norton, 1963).

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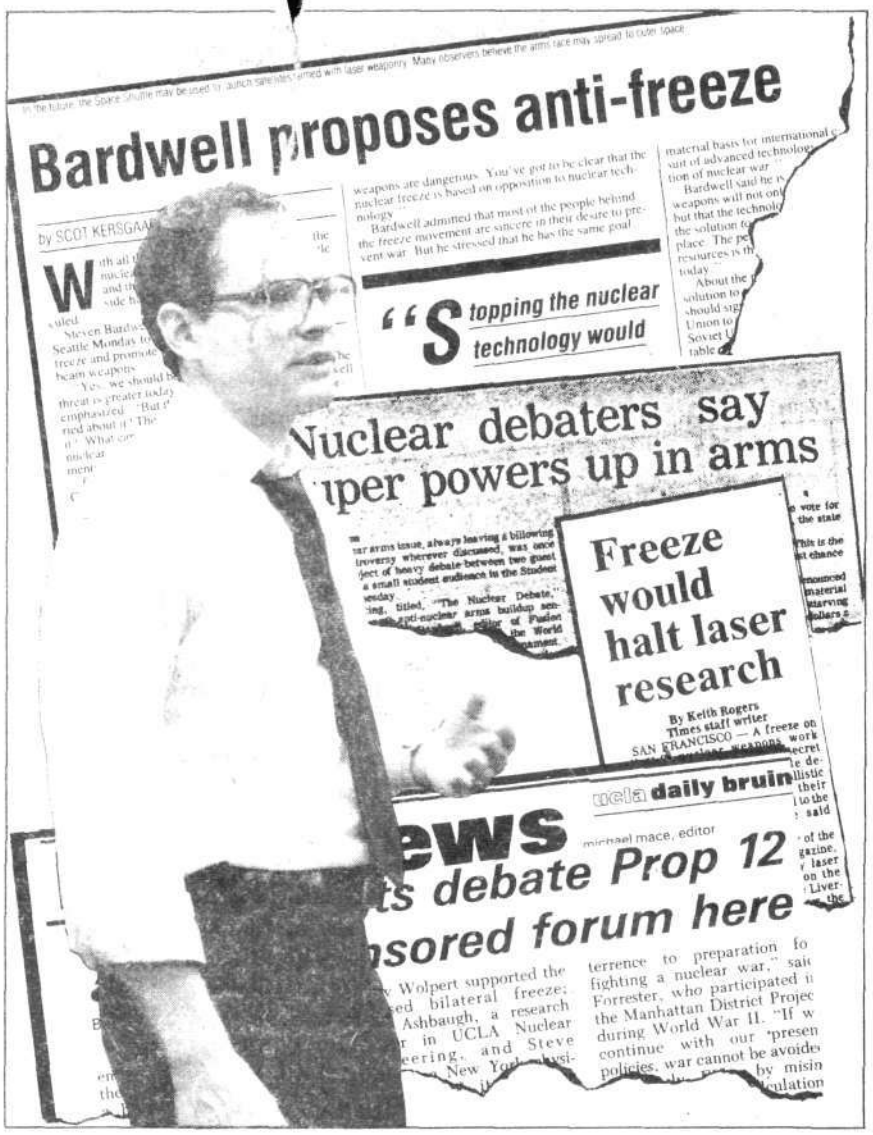

In This Issue

FEF MELTS 'NUCLEAR FREEZE' IN CALIFORNIA

A two-week tour by *Fusion* editor-in-chief Steven Bardwell just before the Nov. 2 elections exposed the "freeze movement" as a hoax and put the real issue up front: without advanced technology, there can be no world development.

Bardwell debated freeze leaders at campuses across the state and held many press conferences to explain (1) that born-again "peaceniks" like Robert McNamara are not really for peace, but for wars with conventional weapons to depopulate the Third World; and (2) that we can end the threat of nuclear war by developing energy beam weapons that can destroy nuclear missiles in mid-flight. Just these facts alone, Bardwell said, caused students to change their minds on the freeze, which won only by a narrow margin in the state instead of the expected landslide.

Bardwell's review of beam weapons—how they work and how soon we could have them—is adapted here from his comprehensive report on the subject.

Fusion editor Bardwell speaking in Los Angeles. Collage includes some of the press coverage of his California tour.

GEOMETRY AS THE 'LANGUAGE OF VISION'

Is the universe as we see it an adequate representation of the universe as it really is? In part two of "Systems Analysis: White Collar Genocide," Lyndon LaRouche answers this question using the method of Plato, Kepler, Cantor, and Riemann, and then discusses the application of this geometric approach to economic processes.

The key concept in understanding both the universe and economics is *negentropy*, the qualitative leaps in growth made possible by the introduction of new technologies that permit a society to support increasing rates of population growth. As LaRouche shows, this is a concept well understood by the American System economists like Alexander Hamilton and their philosophical predecessors.

Mary Gilbertson

A pedagogical museum developed by the Fusion Energy Foundation demonstrates the principles of causality and negentropy in the physical universe through a series of exhibits on the geometric organization of the universe. Here FEF staff member Bob Gallagher (right) describes one of the exhibits at an FEF seminar held at Columbia University Teachers College in May.