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21st CENTURY SCIENCE & TECHNOLOGY

Vol. 10, No. 2 Summer 1997

Features

The claims of human-caused global warming are not corroborated, even by the scientific studies on which they are supposedly based. Atmospheric scientist Hugh W. Ellsaesser reviews the scientific evidence, p. 61.

News

Departments

On the cover: Portrait of Georg Cantor by Christopher Sloan; cover design by Rosemary Moak.

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The Machine Tool Principle: The Transfinite in Practice

Understanding the philosophical issues that were the lifeblood of Gödel, Cantor, and Leibniz will determine whether we reverse the post-industrial tide of today's New Dark Age. The concept of the transfinite and, in particular, the transfinite nature of man's mind, is key. It is man's creativity that ensures that there can be no limits to growth, and it is man's continuing increase in the power of the creative process that has enabled mankind to progress from past dark ages to the 20th century.

This issue's cover story by Dino de Paoli, "Mathematics and the Paradoxical in Nature," discusses the Platonic method of the "positive paradox" from the standpoint of the work of Gödel and Cantor, and the relationship of both thinkers to the earlier ideas of Leibniz. De Paoli describes how the somewhat elusive ideas of Gödel and Cantor concerning the reflexive principle have been made clear in the modern writings of economist Lyndon LaRouche on physical economy. Like Gödel and Cantor, LaRouche is a Leibnizian, and it is his innovative work on the principles of physical economy that provides a concrete example of the actual physical force of creativity.

LaRouche's concept of technology puts the transfinite into practice. To Cantor's system of the aleph series, LaRouche has added the concept of this series as a transfinite transformation, a sequence of successive increases in potential population density. This means measuring progress by looking at the leaps in science and technology that have increased man's mastery over nature and man's productive power, and hence, have increased the number of people that a square kilometer of Earth's surface can potentially sustain.

Leibniz's conception of technology, which is the starting point for LaRouche's physical economy, comes to life in the story told by Philip Valenti, "Leibniz, Papin, and the Steam Engine." Valenti describes the philosophical basis for the work on the dynamics of the steam engine, in particular the goal of designing machines that would perform the work of many men, thus increasing man's mastery over nature.

The Machine Tool Principle

The driving force behind Leibniz and Papin's steam engine development is what LaRouche today calls the "Machine Tool Principle." He identifies the machine tool sector of an economy as the crucial transmission belt of scientific breakthroughs to applications in new technologies that improve products and increase the capital- and power-intensity of the economy. Combined with a classical humanist education, such economic growth through increased productivity, LaRouche says, leads to higher levels of development, and of creative reason in the individual.

The shares of various nations in world machine tool production over the past 30 years provide a kind of litmus test of the health and growth potential of each nation's economy. While the world share for the United States has fallen almost steadily between 1965 and 1995, Japan, South Korea, and Taiwan have continued to increase their share of world machine tool production (see figure).

In the same period, the physical economies of the industrialized nations, most especially the United States, have been characterized by an accelerating rate of decline (as opposed to the hyperbolic increase in financial and monetary aggregates). Neo-Malthusian, post-industrial policies—the opposite of the policies on which this nation was built—have turned this country into a cultural and economic rubble-field.

While U.S. policy makers today exhibit no understanding of the Machine Tool Principle or of how the shutdown

of strategic investment in scientific and technological progress is responsible for the accelerating contraction of the economy, many leaders in the developing sector see the relationship clearly. A May 7 symposium, "National Science and Technology Strategies in a Global Context," sponsored by the National Academy of Sciences in Washington, D.C., vividly made this point.

Korea's Science Driver

Dr. KunMo Chung, Ambassador-at-Large of the Atomic Energy Commission of South Korea, described how his nation has increased its per capita income from $80 per year 35 years ago, to more than $10,000 in 1995. Chung stressed that long-term thinking is crucial, and that bold strategies must be pursued, even if they are unpopular at first. "We know that science and technology are key for further development in the Republic of Korea. Our only tool is science and technology. We have few natural resources, and good human resources. This provides the motive power of our development."

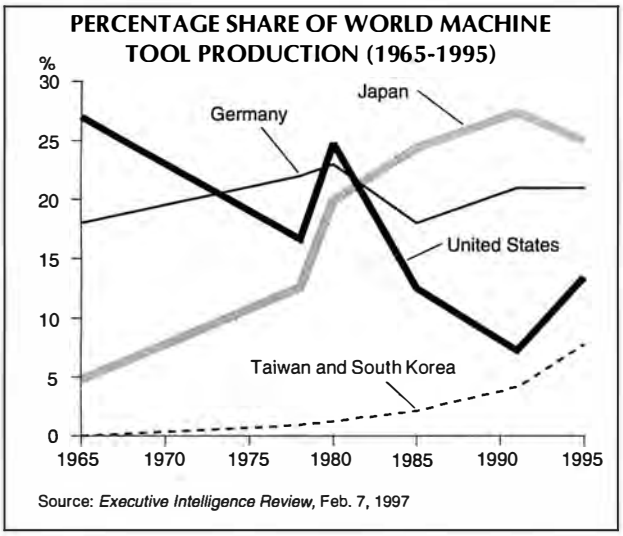
"In the 21st Century, we will develop new high technology areas," he stated, one of which will be the Korea Standard Nuclear Plant. People laughed at him in 1983, when he proposed a standardized plant design, he said, but after a 12-year development program, "now we are discussing exporting it to China and building it in North Korea, and we are designing plants."

In response to the frequent criticism that Korea quickly commercializes technologies that have been developed elsewhere, without doing the basic research, Chung reported on Korea's new science institution, the Korean Institute for Advanced Studies, which opened last year and held a workshop with American scientists for designing a superconducting fusion tokamak, a steady state machine to run 1,000 seconds at a time. "Practical people criticized our putting money into fusion," he said. "Fusion is complex, multi-disciplined R&D. Maybe we will have fusion 40 years from now. But we are an optimistic culture in Korea. We shouldn't count our pennies in [this kind of] project."

Chung reported on a new Korean law stipulating that 5 percent of the national budget will be in science and technology five years from now. (In the United States, federal investment in science and technology is about 4.5 percent of the national budget). He also pointed out that "the majority of Korean CEOs are scientists and engineers, not accountants and economists." It is, therefore, not surprising that South Korea has a growing machine tool capability, for application in increasingly science-intensive industries.

China: Large-scale Development

At the same symposium, Prof. Chen Zhang-Liang, vice president of Peking University and a member of China's Academy of Science and of the People's Congress, discussed the plans of this largest developing nation, stressing the concept of the science driver.



"People in many countries are concerned about whether China can feed its 1.2 billion people, and there have been books written about this," Zhang-Liang said. "In China we have 23 percent of the world's population and 7 percent of the cultivatable land. The challenge is that in 2025, we will have 1.5 billion people, with rapidly decreasing farmland, and severe water problems. China should be self-sufficient in food and modernize technology. For the past 5 to 10 years we have been investing in science and technology for agriculture, and reforming state companies."

Zhang-Liang emphasized the activities of the NSFC, which is similar to the U.S. National Science Foundation and funds basic research. NSFC is the fastest growing agency in the world, he said, and its funding is growing geometrically. In the priority field of agricultural biotechnology, he said, China is releasing the largest number of transgenic plants in the world, although the nation did not embark on this research until 1986.

The Chinese government is promoting research and development through special high tech economic zones, where new companies are started by university professors, similar to the way the Massachusetts Institute of Technology has functioned in New England. At Peking University, Zhang-Liang said, the teaching load is reduced for professors in order to allow them to "spin off" new companies. There are now 18 such companies established and owned by the university, which give back to the university their profits, amounting to one third of the university's budget.

Zhang-Liang noted that China "lost 15 years through the Cultural Revolution, a generation of scientists. . . . But by the late 1970s, there was a recovery in the number of scientists and engineers, and we sent students to the U.S. and Japan, and now there is a new generation. There are now 170,000 Chinese students in the United States. They would have a very big impact if they came back to China," he said.

With a growth rate of 10 percent in Gross Domestic Product, and a perspective of integrating its domestic economic development with those of like-minded nations, it is clear from Zhang-Liang's remarks that China intends to be well positioned to take the lead in the Great Projects along the old Silk Road, which will be the motor for worldwide development in the 21st century.

The challenge to the United States and other industrialized nations is to put the transfinite into practice—and join with Eurasia in developing the Great Projects to carry mankind forward into the 21st century.

Note to Readers

Carol White retired as editor-in-chief of *21st Century* in early 1997.

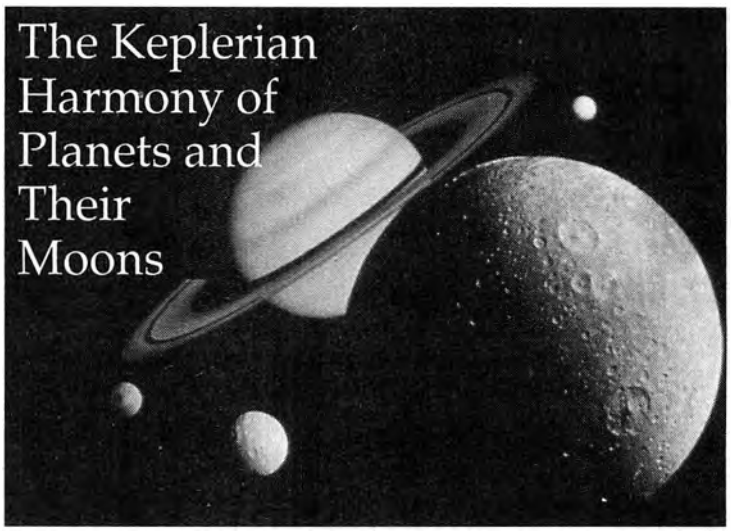
Letters

On Keplerian Harmony

To the Editor:

The article by Lothar Komp ["The Keplerian Harmony of Planets and their Moons," Spring 1997, p. 28] was especially interesting to me, since I had dealt with many of the same planetary relationships, including his treatment of Mercury and Venus. In looking at all of the remarkable relationships that become apparent as we delve, we recognize that these, while interesting and worthy of discussion, are but fingerprints of a higher lawfulness, whose discovery is still awaited.

The problem with these "items" is that they lack a universal binding principle, or "law," from which all of them are shown to follow, such as Kepler's three laws of planetary motion. Based on some new material which I have found, I believe that we are very near to such new planetary rules, which will not only make clear the *reason* for Kepler's laws, but give us several additional ones, including the determination of a planetary diameter and its sidereal rotation period from its axis and eccentricity.



Ultimately, we know that all parameters of a body need to be lawfully determined, including mass, inclination to the ecliptic, and so forth, since anything less would not be coherent with God's wisdom and lawfulness, and, therefore, not possible in this universe.

Concerning the interesting use of spirals to plot satellite systems, I know that this idea originated with an article in *21st Century* by Dr. Jonathan Tennenbaum some years ago. In it, he attempted to map the planets of the solar system onto one rotation of a logarithmic spiral, whereon non-arbitrary points were determined by the intersections of 12 evenly spaced radial lines extending from the spiral's center, the spaces between these lines being one-twelfth (or 30 degrees) of a single rotation, thereby representing the twelve-tone musical scale. Dr. Tennenbaum found that the positions of the planets fit quite closely where the musical notes would be.

I got an idea from my Canadian friend Benoit Chalifoux to try Tennenbaum's method on Jupiter's moons. He had been trying to map the Jovian system onto *one* rotation, using Tennenbaum's method. I noticed a constant in the ratios of Io/Europa and Europa/Callisto, three of the four large Jovian moons, which meant that a logarithmic spiral originating at Io and destinating at Callisto would hit Europa at exactly one-half rotation. Therefore, I took this spiral and extended it *several* rotations ("octaves") inward and outward to see what would result.

The result was delightful! Every known body in the Jovian system fit with this system to within approximately 98 or 99 percent. This included all of the moons, but also the rings—even the radius of Jupiter itself. Moreover, this arrangement divided the Jovian system into clearly distinct octaves. One result of this was that the two smallest of the four giant moons, Io and Europa, were in the first octave, while the two largest of the four big moons, Callisto and Ganymede, were in the second octave.

Komp's use of barred spirals may be a step forward from Tennenbaum's method, since it takes into account the diameter of the planet. However, it is still the case that we have not yet uncovered the universal lawfulness that makes all of these approximations work. When we do, far from having to completely throw out all of these delightful and beautiful systems, we will see, finally, why they *almost* work—but don't *quite* work, the reason being that they are but shadows of an even more beautiful system, whose discovery still awaits us, but which, we know, will overjoy us in its simplicity and beauty, being testimony, yet again, of God's wisdom.

Jeremy Batterson
Ridgefield Park, New Jersey

Solar Distances Corrected

To the Editor:

On page 32 in Figure 5 [of Lothar Komp's article, "The Keplerian Harmony of Planets and their Moons," Spring 1997] "distances in solar diameters" should read "radii" instead of "diameters." The same is true for Figure 6 on page 33.

I retired from Pacific Telephone, as a Senior Engineer in 1978, after 32 years. Although astronomy is not my hobby, I've always been fascinated by Bode's geometric array of planetary distances from the Sun.

So it was of great interest to learn that Johann Daniel Titius, a theology professor, was first, and that Johann Elert Bode, director of the Berlin Observatory, claimed the idea. I shall now forever refer to it as the Titius-Bode Rule as does Lothar Komp in his wonderful and amazing article.

I am very impressed by your magazine and look forward to each issue.

Svein E. Mikkelsen
Edina, Minn.

A Mercurial Correction

To the Editor:

Congratulations on a most excellent article, "The Keplerian Harmony of Plan-

ets and their Moons" by Lothar Komp! There is a small error on pages 39-40, where the period of Mercury is given as 87,969 days, and its axial rotation as 58,646 days (instead of 87.969 and 58.646). Perhaps the error occurred in translation, since in the European system, decimals are indicated by commas, rather than periods.

On the other hand, if Mercury's period really is 87,969 days, perhaps that explains why I have never succeeded in seeing it!

Susan Welsh
Leesburg, Va.

The Physical Basis of the Geometry of Moons

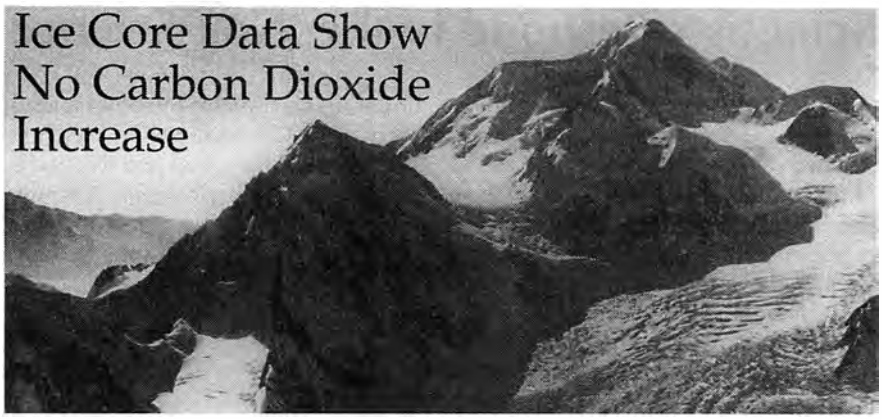
The advance represented in Lothar Komp's article is the introduction of a metric of spiral action, that is, of a metric of a *physically possible* basis for the existence of the systems of moons, in place of the Titius-Bode linearity.

Komp treats the diameter of a planet as a key parameter in determining the spacing of its moons. Are even better results obtained in determining the spacings by using instead the distance from the center of the planet to the center of the first moon? Since the governing concept here is that moon systems share the geometry of barred spiral galaxies, this parameter would make more physical sense.

And what if one constructs two spiral arms, with identical rates of growth, from the ends of this "bar" that has the planet on one end and the first moon on the other, in the manner of barred spiral galaxies?

Alternatively, what happens if one uses a longer bar, that runs from the center of the nearest moon to the center of the next-nearest moon at opposition, acknowledging the planet as the "nucleus of the galaxy," and constructs two spiral arms? These proposals are aimed at making the "bar" a physical entity, instead of a merely mathematical quantity. But it is also necessary to remember, that the physical geometry by which the orbital distances were produced, might not be marked off in a way that is so conveniently visible today.

David Cherry
Associate Editor
21st Century



We're in a Little Ice Age!

To the Editor:

I agree with Dr. Zbigniew Jaworowski ["Another Global Warming Fraud Exposed: Ice Core Data Show No Carbon Dioxide Increase," Spring 1997, p. 42] that we are headed into another major glaciation. Temperatures have declined by 5°C in the Northwest Territories of Canada since the Climatic Optimum, 6,000 years ago, according to the Colorado Arctic and Alpine Institute.

However, it is my view that we are already in this Holocene Interglacial, about two-thirds of the way into another Little Ice Age, like the Maunder Minimum, because, according to all the Scandinavian Meteorological Institutes, temperatures have declined by 1 degree from the mid-century to 1990; with other proxy data now the decline may be still lower.

Our current snowpack in the Cascade Mountains this last winter was 185 percent of normal. "Normal" is a 30-year running average. We saw record low temperatures last winter, as well as record snowfall and record flooding in the Dakotas and Minnesota. Due to the quasi-biennial polar oscillation cycle, the polar vortex should once again expand down the East Coast this coming fall and winter, giving record low temperatures and snowfall, as in the winter before last.

We are even now having some symptoms similar to those of the end of the Eemian Interglacial, 115,000 years ago, as described by G. Woillard, in the classic palynology paper in 1979, entitled "Abrupt End of the Last Interglacial s.s. in Northeast France," *Nature,* Vol. 281, pp. 558-562. The end of the Eemian was obscured by a massive drought, as hardwoods died in 75 to 150 years, and *Abies genera* firs died in only 20 years. Currently dutch elms are dying, as well as oaks, in the Midwest, as well as many species of trees in the far west, likely for similar reasons.

Europe this last winter saw extremely cold weather, with the Thames and Holland canals freezing over, as in the Maunder Minimum, described by Prof. H.H. Lamb in Chapter 12 of his book *Climate, History, and the Modern World.* The two-year cycle was strong then, too.

Jack Sauers, geologist
Seattle, Wash.

Scientists Respond to the 'Non-Science of Global Warming'

Dr. Robert Stevenson, whose article, "An Oceanographer Looks at the Non-Science of Global Warming," appeared in the Winter 1996-1997 issue of 21st Century *magazine, received a great many comments from scientists around the world who are concerned, as he is, about the abandonment of science in the debate over global warming. He has made his open letter to colleagues and some of their responses available to* 21st Century, *because of the importance of the issues involved for the future of science.*

Dr. Stevenson's Letter

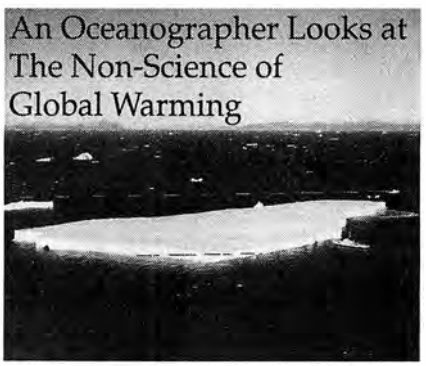
Dear colleagues and friends:

I am sending you the Winter 1996-1997 edition of *21st Century Science & Technology,* in which you'll note my paper on the "Non-Science of Global Warming." After reading the paper, I hope you will become enthused and active in the defense of honorable scientific research.

My first peer-reviewed paper was in 1947, co-authored with U.S. Grant IV, my major professor at UCLA. I could have published before 1947, but in 1942 I joined the U.S. Army Air Force to "save the world for democracy"; with an encore during the Korean Conflict. Since then, I've published annually papers, books, training manuals, and classified oceanography tactical documents for the Navy, and became an expert in space oceanography.

My professors were all from the great American universities of the early 20th century; Harvard, Chicago, Illinois, Cal/Berkeley, Stanford. Each practiced the principle of personal "honor." Scientific honor codes were not explicitly taught in my classes, but were learned by example. Of course, about 99 percent of fellow students then were veterans of World War II in whom honor had been thoroughly indoctrinated. It was enhanced by our professors, and all of us understood "dishonor." Such conduct simply was not tolerated; by student or professor.

During my career, as professor, science and institution director, oceanographer with the Office of Naval Research, and as Secretary General of the International Association for the Physical Sciences of the Oceans (IAPSO), I met thousands of scientists, read and listened to uncountable scientific papers, attended hundreds of scientific meetings and workshops, national and international, and reviewed hundreds of research proposals. The science ranged from excellent to mundane; the papers, books, and monographs, the same. Through it all, I watched the tremendous growth in our knowledge of geophysics, and the dynamics of the atmosphere, the oceans, and the solid Earth. It has been exhilarating to be part of this greatest of all possible adventures.



In all these years, I never recognized any fraudulent or deliberately dishonorable scientific conduct—until 1989. It was then, as Secretary General/IAPSO, that I began to hear about anthropogenic "global warming" and "ozone depletion." At first, I considered these "doomsday scenarios" just the usual idiotic bleating of radical environmental NGOs [nongovernmental organizations]. Then came the extraordinary, non-scientific Rio Summit in 1992! In the following years, I observed "scientists" associated with, and supporting, the Intergovernmental Panel on Climate Change (IPCC), World Meteorological Organization (WMO), and United Nations Environmental Program (UNEP) practice dishonest and, therefore, dishonorable science. It seemed, too, that much of the scientific community had lost its intoleration of dishonorable scientific conduct. Personal pragmatism appeared to replace honor, especially amongst those scientists supported by government funding.

Science is the anchor of rationality for our civilization. It cannot serve this purpose if dishonorable conduct is common and tolerated. Such conduct must be eliminated! True scientists and their scientific institutions must stand up and be counted.

Dr. Robert E. Stevenson
Del Mar, Calif.

Aksel Wiin-Nielsen
Graested, Denmark

Thank you very much for sending me a copy of your paper, "An Oceanographer looks at the Non-Science of Global Warming.". . . I have read it with great interest.

From my present base as a professor (now emeritus) at the University of Copenhagen, I have done what I could to throw some light on the same matters through the last decade. I have published papers (in Danish) in the journal of the Danish Meteorological Society called *Vejret* (The Weather) trying (in vain) to influence the position of Denmark's Meteorological Institute in the IPCC work. Rather critical comments were submitted as one of the many reviewers of IPCC (1990), but since my remarks were totally neglected, I asked at that time to be removed from the review process. . . .

In Denmark, we pay a CO_2 and an SO_2 tax. They are simply added to the electricity bill. Adding these two taxes to the common sales tax, the electricity expenses are increased by 167 percent. In general, you do not hear many complaints about these taxes simply because the environmental activists have won the battle and convinced everybody that doomsday is near. I find it totally unacceptable that my grandchildren are indoctrinated already in the lower grades to believe that most of their rather flat homeland will disappear under the surface of the ocean in a few decades! I am just quoting the teachers' instruction book.

To counteract these developments I have recently published an elementary textbook (*Climate Problems* in Danish), co-authored by my daughter, who is a staff meteorologist at the Danish Defense Command, and aimed at first- and second-year college students. The reason is of course that we need to re-educate the young students to take the normal critical scientific attitude. . . .

As a former Secretary General of the World Meteorological Organization (1979-1983), I look with some dismay on the role of this organization and the U.N. Environmental Programme in the whole IPCC affair. But since I am *persona non grata* at the WMO Secretariat I can do nothing about it.

Paul Scully-Power
Sydney, Australia

Thanks for sending me a copy of the *21st Century* magazine. It is a very good article that needs/requires that it be published in other journals and periodicals so that the scientific community and the general popular community can be exposed to the ideas in it. . . .

I . . . start from the premise that nature is inherently nonlinear. Once you accept that, it is blatantly obvious that any modelling of nature is today rather limited either in accuracy or extent. . . We therefore probably need to consider a series of nonlinear balances inherent in nature if we are to ever understand nature and its embedded balancing mechanisms.

Dr. Scully-Power, an oceanographer for 19 years at the Naval Underwater Center, New London, Conn., flew on the Space Shuttle (STS-41G) in Oct. 1984. He is now chief executive officer of Zylotech Corp., Sydney, Australia.

Ye Longfei
Guangzhou, China

It is exhilarating to read your paper, "Non-Science of Global Warming." First I am happy to learn that you work so well now after you resigned from IAPSO. Second, this is so important not only just in science.

It is well known very certainly that about 3,000 years ago, elephants were even commonly employed for agricultural labor in northern China. This agrees well with [the view] that the Earth is going on the way to an ice age as predicted by long-term statistics.

Dr. Ye works at the South China Sea Institute of Oceanology of the Chinese Academy of Sciences.

Alfred H. Pekarek
Englewood, Colorado

I am constantly amazed by the volume of hard data that conclusively argues against global warming. The use of the paper tiger, global warming, as justification for the global social engineering being proposed is nothing short of fraudulent.

Dr. Pekarek is a consulting geologist in the field of oil and gas exploration.

Michael Gadsden
Aberdeen, Scotland

I was glad to be on your mailing list for "The Non-Science of Global Warming." I found myself, not for the first time, in full sympathy with your rant. . . .

All this, Bob, is to say that you are not alone. And long may that continue to be!

Dr. Gadsden is professor of physics at the University of Aberdeen and secretary general emeritus of the International Association for Geomagnetism and Aeronomy.

Yuli D. Chashechkin
Moscow, Russia

Again everybody can recognize the lion from his claws. Thank you very much for your message and magazine with impressive paper which I have read with great pleasure. . . . It is my pleasure to let you know that physicists who are not involved in climatic problems are still continuing their routine work. By the way, in one of them we describe the possible mechanism (linear!) of direct interaction of large and small scales motions without any vortex cascade.

Dr. Chashechkin works at the Institute for Problems in Mechanics of the Russian Academy of Sciences.

Anna Ginzburg
Moscow, Russia

Yesterday I received and read your paper in *21st Century*. My congratulations! Important problem, good argumented paper in polemic style. I did not imagine that [such] evident disregard of scientific results is possible in such a progressive country as America. It will be interesting, if your paper, which gives the total information on the global "warming" problem, will change the situation.

Ginzburg is an oceanographer at the Institute of Oceanology of the Russian Academy of Sciences, Moscow, Russia.

Peter Dietze
Langensendelbach, Germany

. . . I am glad to be able to contact another active contrarian. From science journalist Holger Heuseler, I got an excellent article from you, translated into German to be published here. . . .

Dr. Dietze is an electrical engineer at Siemens. For 10 years he studied the global warming debate privately and independently, and, with others, presented a new global carbon model in Leipzig in November 1995 at the congress of the European Academy for Environmental Affairs.

Gunther Krause
Bremerhaven, Germany

Thank you very much for your exciting article on "The Non-Science of Global Warming." Next door to my office resides the secretary of a German Federal Council on "global environmental issues," who will distribute copies to its prominent members. I have also handed out copies to our department leaders, and I am looking forward to reactions.

I like your article very much and also your treatise on the scientific honor codes and their violations in recent times. I share your views, and I am really looking forward to the response of the powerful international organizations to the criticism of a brave and well-known scientist!

Prof. Dr. Krause, of the Alfred Wegener Institute in Bremerhaven, is a deputy secretary general emeritus of IAPSO.

Bob Dale
San Diego, Calif.

. . . Really, your article should be required reading in *all* science classes. A young sixth grader wrote to me for an interview on "global warming" and how it will affect flying. The boy wants to be a pilot. So, I explained how an airplane handles differently on hot days and cold days—*and* there was much evidence to support *"Non* global warming." I sent him a copy of your article and suggested it might be interesting to do his science fair project using some of *your* information rather than just accepting global warming as a "done deal."

Bob Dale is the long-time weatherman on the San Diego NBC-TV affiliate.

EMERGENCY MEASURES NEEDED:

'Feed North Korea Now'

The Schiller Institute issued an emergency plan of action June 13, to end the starvation in North Korea, and appealed to the United States, the European Commission, and other nations to immediately ship 1.8 million tons of grain to North Korea. More than 50 percent of North Korea's 24 million people are nearing death from starvation.

At a June 16 press conference in Los Angeles, Schiller Institute head Helga Zepp-LaRouche called on President Clinton to urge Japan, Australia, and Thailand to use their strategic reserves to supply North Korea, so that the food could get there in days, not weeks. The Schiller Institute, she said, was asking Clinton to raise the issue at the upcoming G-8 summit meeting in Denver, of the United States and the European Union resupplying countries that sent their reserves to North Korea. Any delay is criminal, she stressed. To argue that this relief will only help the military, is morally criminal and unacceptable.

The Schiller statement reports on the visits of humanitarian organizations and U.S. Congressmen to North Korea that document the vast extent of the famine. Whereas in most famines, the poor die early, in North Korea the paltry food stocks are being shared equally by the entire population, in tiny 100-gram-a-day rations. Therefore, the entire population of North Korea is growing weaker and weaker, and when the dying begins, it will be too late.

Beyond the food crisis, the statement reports, North Korea's entire economy is nearing paralysis, as malnutrition grinds workplaces to a halt and all available import cash goes to pay for food.

The Schiller Institute's plan outlines food sources, logistics for food delivery, and the agricultural mobilization necessary, and calls for an end to the World Trade Organization provisions that restrict nations in their efforts to protect and increase their agricultural production. It also attacks the Malthusian policy of using food as a political weapon.

For more information, contact the Schiller Institute, P.O. Box 20204, Washington, D.C. 20041, (202) 322-7889.

The Lightning Rod

My dear Friends:

I have not written here in some time, being occupied with other matters and, frankly, having decided that so much of today's history resembles even the most outlandlish items I had mentioned in this column in the past that readers would be quite bored. However, in going through my papers, I came across a remarkable account that I thought should interest even the most jaded: To wit, some 1726 correspondence from one Captain Gulliver, kindly forwarded to me by Jonathan Swift.

Now, this Captain Gulliver, in the course of his seafaring journeys, visited many odd places, which he describes very oddly, as you may know.* The particular journey to catch my attention was made to a quite rundown metropolis known as Lagado. As Gulliver describes it, this area was ruled by a group of persons who wanted to put "all arts, sciences, languages, and mechanics upon a new foot."

Well, that's not necessarily a bad idea, if the old foot was rotten, but unfortunately, the "new foot" that Gulliver describes bears a pungent resemblance to the green foot, so to speak, with which today's radical environmentalists are stomping around. As Gulliver tells it, the projects associated with this new foot didn't work, " and in the meantime, the whole country lies miserably waste, the houses in ruins, and the people without food or clothes."

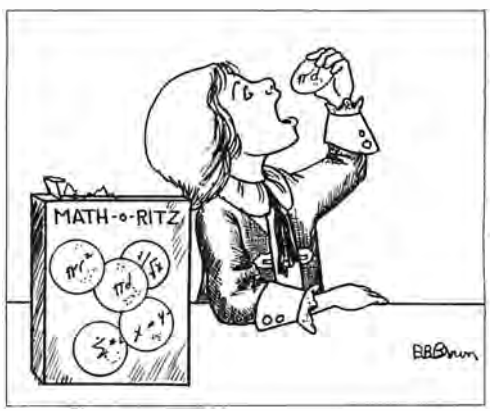
Gulliver, a great admirer of projects, visited the Grand Academy of Lagado for several days, and described his tour and meetings with "projectors" in some detail. I feel certain, although Gulliver's account dates back nearly 300 years, that it is the metaphorical model for many of today's environmental radicals, whose projects, under the banner of "saving the world," are destroying it. Gulliver writes:

Sunbeams

"The first man I saw was of a meagre aspect, with sooty hands and face, his hair and beard long, ragged, and singed in several places. His clothes, shirt, and skin were all of the same colour. He had been eight years upon a project for extracting sun-beams out of cucumbers, which were to be put into vials hermetically sealed, and let out to warm the air in raw inclement summers. He told me that he did not doubt in eight years more he should be able to supply the Governor's gardens with sunshine at a reasonable rate; but he complained that his stock was low, and entreated me to give him something as an encouragement to ingenuity, especially since this had been a very dear season for cucumbers. I made him a small present, for my lord had furnished me with money on purpose, because he knew their practice of begging from all who go to see them.

"I went into another chamber, but was ready to hasten back, being almost overcome with a horrible stink. My conductor pressed me forward, conjuring me in a whisper to give no offence, which would be highly resented, and therefore I durst not so much as stop my nose. The projector of this cell was the most ancient student of the Academy; his face and beard were of a pale yellow; his hands and clothes daubed over with filth. . . .

"His employment from his first coming into the Academy, was an operation to reduce human excrement to its original food, by separating the several



parts, removing the tincture which it receives from the gall, making the odour exhale, and scumming off the saliva. He had a weekly allowance from the society, of a vessel filled with human ordure. . . .

"There was a most ingenious architect who had contrived a new method for building houses, by beginning at the roof and working downwards to the foundation, which he justified to me by the like practice of those two prudent insects, the bee and the spider.

". . . In another apartment I was highly pleased with a projector, who had found a device of ploughing the ground with hogs, to save the charges of ploughs, cattle, and labour.

Natural Labour

"The method is this: in an acre of ground you bury, at six inches distance and eight deep, a quantity of acorns, dates, chestnuts, and other mast or vegetables whereof those animals are fondest; then you drive six hundred or more of them into the field, where in a few days they will root up the whole ground in search of their food, and make it fit for sowing, at the same time manuring it with their dung. It is true, upon experiment they found the charge and trouble very great, and they had little or no crop. However, it is not doubted that this invention may be capable of great improvement."

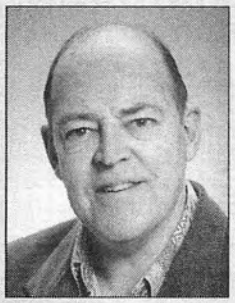
Well, dear readers, I am certain that many of you will find even this brief selection from 1735 of use in your evaluations of some of today's academies, and I commend to you as well Gulliver's writings on the "speculative" departments of the Legado Academy, in particular, the mathematical school. The ingenious method of learning here required pupils to ingest thin wafers on which the math was written using cephalic ink, which, with proper diet, was said to imprint itself on the brain. How such a measure succeeded, I leave to the reader to ponder.

I remain,
Yr. Obedient Servant

Notes

* Jonathan Swift's 1735 satire, *Gulliver's Travels*, has been reprinted in several editions.

The Bunkification of Physics Today


James E. Corley

by Thomas E. Phipps, Jr.

Dr. Phipps, a retired physicist, describes himself as a certified heretic in the field of modern theoretical physics. He recently carried out experimental work to verify the existence of the Ampère longitudinal force. His viewpoint is a response to a recent article in Physics Today *by Edward Witten,[1] a professor of physics at the Institute for Advanced Study in Princeton. Witten is the inventor of string theory, and has been dubbed by the media, the "new Einstein." As Phipps commented in submitting this viewpoint, "I do not think it is 'safe' for practical people to let the theorists go their way to perdition unimpeded."*

Professor Witten's panoramic survey[1] of modern theoretical physics calls for a Luddite response, which (as a certified heretic[2]) I feel qualified to supply. The basic point in question is: Are bad ideas made better by combining, symmetrizing, and concatenating them? We start from an idea, "spacetime symmetry," which is bunk, but at least postulationally consistent and physically comprehensible bunk (in that all cooordinates are "bosonic," that is, they homogeneously obey the same *c*-number postulates of commutativity). Then we (speculatively) build this into a "supersymmetry," which is (bunk)^2 (in that now not all coordinates are *c*-numbers but some of them are "fermionic." Thus, some, but not all, obey a non-commutative *q*-number postulate system; so "coordinate" postulational homogeneity and any connection to measurability or operational definability are dropped.

Next, we parlay this into string theory, which is (bunk)^3, inasmuch as it gives rise to supersymmetry plus general relativity (the higher bunkification of the original spacetime symmetry bunk), plus non-Abelian gauge theory (the bunk that stands in the way of any understanding of sub-nuclear dynamics). Blessed with six (five plus one) versions of string theory, we then proceed to muck-up quantum mechanics, our last feeble link to reality, by touting (bunk)^4, an "M-matrix theory" generative of all six. Can it be doubted that if there exists a (bunk)^5 level of physical description, our stout Cortez will find the words to render it beautiful in the eyes of his colleagues, as they stand silent upon a peak in Darien?

So, this is physics at the end of the 20th century: thus far, the modern dabblers in Newton's ocean. Is it possible that the young are fooled? It would seem so—those of them not gifted by nature with the wits to steer clear of physics altogether.

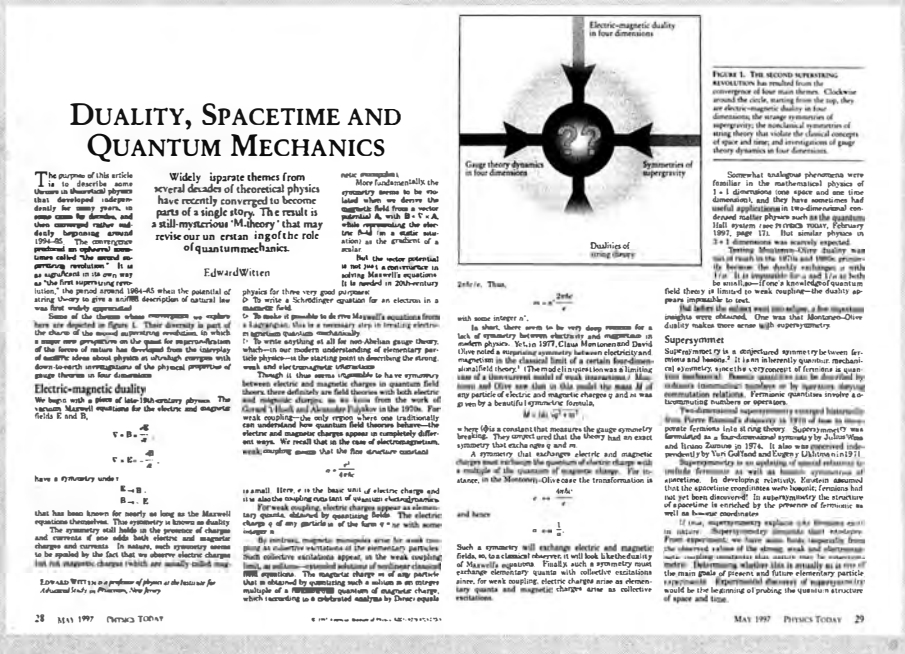
Let us now stand back from this and see what it means on the level of grand strategy for theoretical physics. Suppose, as I am freely willing to concede, that 99 percent of what I have just said is itself bunk. If even 1 percent is correct, so that embedded among the "truths" of modern physics there lurks a single atom of falsehood, then the method of concatenating previous theories espoused by Admiral of the Ocean Sea Witten and crew, is certain to amplify and transmogrify that error, "clinching" it and making it irreversible, barring the trauma of "scientific revolution."

Band-aid Physics

How many generations of symmetrizing and concatenating of even the smallest error will be required to render the resulting "physics" pure nonsense? To put correction beyond the reach of imagination, hence beyond the help of revolution? Obviously, not many. In other words, the current strategy is not bulletproof. It

does not fail safe; it quickly produces a "physics" that (although by definition "beautiful" in the eyes of authoritative consensus) is neither structurally robust nor happy in its tummy . . . a physics constituted of conceptual band-aids, apotheosized into Great Band-Aids in the Sky with Diamonds, beneath which original wounds continue to fester.

Is there a better strategy? Obviously, any that emphasized pluralism of basic presuppositions would be immeasurably safer. Let me put it more strongly: Pluralism recommends itself not merely as a prescription for avoiding danger (for "danger" suggests fun and a possibility of escape); it is essential for avoiding the statistical *certainty* of ultimate disaster for physics (not a "theory of everything" but a dead-end of everything theoretical—the perpetual grinding of water in a mortar, with an all-powerful priesthood in sole control of the pestle).



DUALITY, SPACETIME AND QUANTUM MECHANICS

Widely separate themes from several decades of theoretical physics have recently converged to become parts of a single story. The result is a still-mysterious "M-theory" that may revise our understanding of the role of quantum mechanics.

Edward Witten

Electric-magnetic duality in four dimensions

Gauge theory dynamics in four dimensions

Symmetries of supergravity

Dualities of string theory

Witten's article in Physics Today *weaves together four major themes in theoretical physics into what he calls a "second superstring revolution."*

Indeed, it is my opinion that the "ultimate" disaster is practically upon us already. For academic physicists have consistently scorned pluralism in purest Bolshevik style, throughout the second half of this century, and have taught little beyond one evolving "party line." The current lack of alternative pathways is the direct result of physical journal editorial policies, deliberately crafted to exclude deviant ideas. And it is academic physicists who have set those policies and have enforced them as referees. The gleeful killing of theoretical alternatives has been a tradition of this century's scientists, beginning with the rejection of Weber's action-at-a-distance electrodynamics in favor of Maxwell's field theory. Contrast the successful strategy that produced the A-bomb: Alternatives were deliberately fostered, not until a rival proved competent, but until each was given full opportunity to demonstrate its own incompetence.

Spacetime Symmetry

Finally, in order not to leave the reader with an impression of criminal insanity on my part, let me give the justification for my original contention that spacetime symmetry is (as Henry Ford said of history) "the bunk." Spacetime symmetry (like all of special relativity theory) is simply Maxwell's equations writ large. It arises from the symmetrical presence of partial differential operators $\left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}, \frac{\partial}{\partial ct}\right)$ in Maxwell's equations. The latter revered equations, as they appear on the sweatshirts of sophomores, are invariant under no known coordinate transformation. Heinrich Hertz saw this as a flaw, which he corrected[3] at first order, by substituting a total time derivative for the partial one,

$$\frac{\partial}{\partial t} \rightarrow \frac{d}{dt} = \mathbf{v}_d \bullet \nabla + \frac{\partial}{\partial t},$$

and by a trivial adjustment of the source terms. The resulting equations of vacuum electromagnetism were rigorously *invariant* at first order under the Galilean transformation. This destroyed spacetime symmetry at the source, since the space partial derivatives were no longer mathematically symmetrical with the total time derivative.

Hertz's discovery of an invariant covering theory of Maxwell's equations was ignored by the dominant Maxwellians. Professor Witten speaks of physics as being possibly "developed on thousands of planets throughout our universe." He sorts these *Gedanken* planets into eight classes, according to the order in which they might develop three fancy ideas that appeal to him as "great." I suggest this reveals a coruscatingly brilliant lack of imagination regarding the scope of alternative physical theory. Might not one of those thousands go the pathway of invariance rather than covariance? Is it entirely certain that all conceivable physicists in the universe prefer *ersatz* (covariance) to *echt* [genuine] (invariance)? Are all imaginable planets Disneylands of hype? All insufferably the same? Or are such spectacular stuntings of the imagination possibly unique to Earthmen?

Sad to say, all modern field theory has its roots in Maxwell's noninvariant special case of Hertz's equations. Thus the Spanish castles upon castles built by the Wittens of this world look back historically to their founding upon a dungheap. Although violence is no cure for human ills, allow me to be at least violently ill.

Notes

1. E. Witten, 1997. "Duality, Spacetime, and Quantum Mechanics," *Physics Today*, Vol. 50, p. 28 (May).
2. T.E. Phipps, Jr., 1986. *Heretical Verities: Mathematical Themes in Physical Description* (Urbana, Ill.: Classic Non-fiction Library).
3. H.R. Hertz, 1962. *Electrical Waves* (New York: Dover), Chapt. 14.

Drastic Changes Needed in Science

by Dr. Alan Hale

Dr. Alan Hale, the co-discoverer of Comet Hale-Bopp, is the director of the Southwest Institute for Space Research, in New Mexico. The 39-year-old astronomer graduated from the U.S. Naval Academy in 1980, and earned his Ph.D. in astronomy in 1992 from New Mexico State University at Las Cruces.

Hale's statement was sent as an "open letter, to the scientists of my generation" via electronic mail, to friends and colleagues, April 17.

I am Alan Hale, the co-discoverer of Comet Hale-Bopp, which, as I'm sure you're aware, is getting a tremendous amount of media attention at this time. As I'm sure is true for many of you, I was inspired by the scientific discoveries and events taking place during my childhood to pursue a career in science, only to find, after completing the rigors of undergraduate and graduate school, that the opportunities for us to have a career in science are limited at best and are what I usually describe as "abysmal."

Based upon my own experiences, and those of you with whom I have discussed this issue, my personal feeling is that, unless there are some pretty drastic changes in the way that our society approaches science and treats those of us who have devoted our lives to making some of our own contributions, there is no way that I can, with a clear conscience, encourage present-day students to pursue a career in science.

It really pains me a great deal to say something like that, but I feel so strongly about this that I have publicly made this statement at almost every opportunity I have been given. I am trying to use the media attention that is currently being focussed upon me to raise awareness of this state of affairs, and perhaps start to effect those changes that will allow me to convey a more positive message to the next generation.

So far, I'm sensing a certain reluctance among the media to discuss this issue, as they seem far more interested in items which I consider to be irrelevant and unimportant. But I intend to keep hammering away at this, and I'd like to believe that eventually some are going to sit up and take notice.

I am also attempting to schedule meetings with some of our government leaders, to see if I can at least get some acknowledgment from Washington that this is a problem that needs to be dealt with.

Gary Cervo

Comet Hale-Bopp

'Horror Stories' Requested

My reason for writing to you is to ask your help. I know that I'm not alone in being frustrated about the current prospects for pursuing any kind of decent career within science, and I'm quite sure that many of you have "horror stories" about your searches for decent employment that are quite similar to my own. I'd like to hear them.

"Unless there are some pretty drastic changes in the way that our society approaches science . . . there is no way that I can encourage present-day students to pursue a career in science."

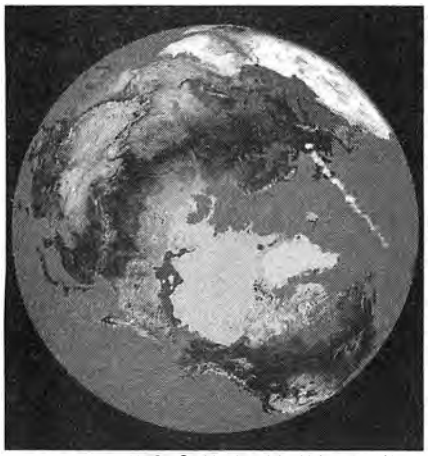
I'd especially like to hear from those of you who are on your second or third or fourth post-doc, or who have left the field as a result of the employment situation, or who have experienced severe personal difficulties (for example, break-up of a marriage, and so on). I realize that some of these might be painful to discuss, but I'd like to show that we are not a bunch of impersonal statistics, but that we're human beings trying to make an honest living and perhaps make a contribution or two to society while we're at it.

Speaking of statistics, though, if you received any information about the numbers of applicants to some of the positions you applied to—which was often a three-digit number in my case—I'd like to hear that, too.

Please e-mail your stories to me at ahale@nmsu.edu, with a subject line of "horror stories" or something like that. Please let me know if you would prefer to remain anonymous when I share these stories with the press and the government. Also, please pass this message on to any of your friends and colleagues who might be interested in sharing their stories with me, and keep in mind that I would like to receive stories from as many scientific disciplines as possible. (Because of the amount of e-mail traffic I'm receiving these days, along with everything else that's going on, I probably won't be able to acknowledge each message individually.)

Thank you for your time, and I hope to hear from you. Perhaps, with the opportunity we have before us right now, we have the chance to make a difference.

NEWS BRIEFS



NASA Goddard and the University of Iowa

Computer enhanced, time-lapse image in ultraviolet light of an icy comet breaking up, between 15,000 and 5,000 miles above Earth, Sept. 26, 1996.

POLAR SATELLITE IMAGES SHOW SNOWY COMETS HITTING EARTH

Thousands of snowy comets, weighing 20 to 40 tons each, fall on Earth every day, Dr. Louis Frank, a plasma physicist at the University of Iowa, told a May 28 press conference at the American Geophysical Union spring meeting in Baltimore. Frank presented a series of breathtakingly beautiful images of objects streaking toward Earth and breaking up. The camera system employed, designed by Frank, was lofted into nearly polar orbit aboard the POLAR satellite early last year, and takes images at both visible and far-ultraviolet wavelengths. Since then, Frank and his colleagues have obtained so many images of white streaks that even his harshest critics have been forced to agree that his ice comet theory has merit.

Frank ignited a storm of controversy in the scientific community when he first published his ice comet theory in April 1986. He proposed a comet influx to explain the thousands of "holes" in ultraviolet images obtained by an earlier satellite, Dynamics Explorer I. This satellite, launched into polar orbit in mid-1981, carried a camera designed by Frank to investigate the nonvisible light emissions from Earth. As Frank noted in his 1990 book, *The Big Splash,* "I was driving a bulldozer through dozens of the neatly planted fields of science and everyone was upset."

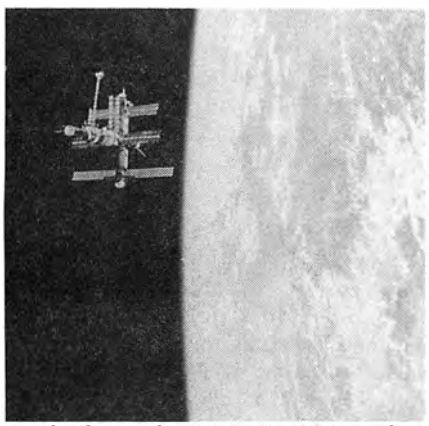
An article about Frank and his theory, "Great Heavenly Balls of Ice," appeared in the Fall 1995 issue of *21st Century.*

'NATURE PARKS' SHOULD REPLACE BORDERS, WIRTH TELLS MILITARY

The national borders of Central and South America should be replaced by nature parks under armed guards, Timothy Wirth, U.S. State Department Undersecretary for Global Affairs, told the "Western Hemisphere Environmental Security Conference," June 3-4, in Miami. Wirth was the featured speaker at the conference, which was cosponsored by the U.S. Army Southern Command and the Defense Department's Deputy Undersecretary for Environmental Security. According to a report on the conference in Brazil's *O Globo* daily, June 5, some 300 military officers from Ibero-America were lectured by Pentagon officials on how they should become "ecological warriors."

FREEMAN SPEAKS AT AIAA WASHINGTON MEETING ON SPACE HISTORY

21st Century Associate Editor Marsha Freeman addressed a special history symposium at the annual meeting of the American Institute of Aeronautics and Astronautics on May 6, on the history of space exploration and the idea of time reversal—the understanding that a concept of the future can determine the present and the causal effect of the past. Freeman pointed out that the optimism of President Kennedy's Apollo announcement in May 1961 mobilized the nation to do great deeds. Similarly, it was their plans for future manned space exploration that allowed the German space pioneers to weather the Depression, the Nazi regime, and work for the U.S. Army, while never abandoning their dream to land men on the Moon. It is that optimism about the future, Freeman said, that is needed today for our nation to be mobilized to accomplish great projects.



©MCMXCVII Imax Corporation and Lockheed Martin Corp.

A scene from the IMAX film Mission to Mir, showing the space station Mir crossing the Earth's limb. The Mir was filmed by a remote camera mounted on the Space Shuttle Discovery.

INTERNATIONAL SPACE STATION ASSEMBLY TO BE FILMED BY IMAX

NASA has signed a contract with the Imax Corporation to produce a documentary film of the in-orbit assembly of the international space station, which will begin next year. The space station is scheduled to be completed by 2002. NASA Administrator Dan Goldin said, when he announced the project, "Our astronauts have said that previous Imax films are the closest thing to actually being in space. Capturing the assembly of the International Space Station in this realistic and compelling format will help NASA share this experience with the public."

On May 20, the Air & Space Museum in Washington, D.C., premiered the fourth

Imax film about the space program, *Mission to Mir*. Film footage taken by the astronauts, combined with historical footage, tells the story of the relationship between the American and Russian space programs from the beginning of the space age during the Cold War, through the ongoing joint Space Shuttle/Mir docking missions. *Mission to Mir* will appear in 150 Imax theaters in 22 countries this fall. The Imax space films have been viewed by more than 60 million people in 22 countries.

NEWEST U.S. RESEARCH VESSEL, *ATLANTIS*, TO SET SAIL THIS SUMMER

The newest U.S. ocean-exploring ship, Atlantis, a 274-foot vessel designed for deep-sea research, will set sail this summer equipped with the most sophisticated oceanographic research instruments available: precision navigation, bottom mapping and satellite telecommunications systems, and several deep submergence vehicles. (The most famous of these is the submersible *Alvin*, which surveyed the wreck of the sunken ocean liner *Titanic* in 1986.) *Atlantis*, which is funded by the U.S. Navy and administered by the Woods Hole Oceanographic Institution, was on display in New York and Washington in May, with its array of research devices.

One *Atlantis* project will use sound waves at several frequencies to characterize the reverberations from different types of plankton. Although scientists had assumed that echoes from plankton were the same for organisms of same size, it was found to be untrue, and new techniques for estimating size and biomass will be tested.

A future issue of *21st Century* will include a review of the *Atlantis* mission and its technologies.

Woods Hole Oceanographic Institution

The capabilities of Atlantis will make it possible for scientists to survey a wide area and zero in on features of interest on the same cruise.

FIRST MIRROR FOR MT. GRAHAM TELESCOPE REQUIRED TOPPING UP

After three months of cooling, the rotating furnace containing the world's first 8.4-meter monolith mirror, at the Steward Observatory Mirror Laboratory, University of Arizona, was opened April 2. It is the first of two identical, spincast mirrors for the Large Binocular Telescope on Mt. Graham. From video images taken through small ports, it was already known that the mold had sprung leaks at the bottom of the tub walls. But it was discovered on April 2 that an estimated 3 tons of glass had leaked out. Only 2 tons of extra glass had been included to allow in advance for such leaks. As a result, the faceplate (upper surface) was thinner than the planned 36 mm. With more glass chunks added, the mirror was softened by being slowly reheated to about 700°C. The upper surface was then flash-heated on June 10 to 1,180° with 40 kW of power from the lid heaters, to melt and fuse the new glass to the rest of the mirror. The three-month cooling and annealing process is now under way.

IN MEMORIAM: SUSAN P. JOHNSON (1944-1997)

Susan P. Johnson, whose translations from German have often graced the pages of *21st Century*, died April 22, after an 11-month battle with a malignant brain tumor. In 1996, she collaborated with *21st Century*'s imprisoned associate editor, Laurence Hecht, to render the first English translations of Wilhelm Weber's first memoir, "Electrodynamic Determinations of Measure"; of Carl F. Gauss's first treatise on magnetism, "The Intensity of the Earth's Magnetic Force Reduced to Absolute Measure"; and the 1856 report of the Weber-Kohlrausch experiment. Her translation of "Gödel, Cantor, and Leibniz: Mathematics and the Paradoxical in Nature," by Dino de Paoli, appears in this issue.

Susan was a woman of many talents—editing and writing, training and leading a chorus, and tough political combat. She dedicated her life to the fight for truth and worked with the LaRouche political movement from 1968. Her devotion to truth and the high standards she set for herself intellectually were—and still are—an inspiration. We will miss her greatly.

We *Can* Feed the World!

A review of new technologies for agriculture—and what's slowing their implementation.

by Colin Lowry

China announced in April that it plans to use advanced agricultural technologies to become self-sufficient in food by the mid-2000s, *and* to produce enough food for export—a policy that underlines the fact that feeding a growing world population is a question of political will. The report by the Chinese Academy of Sciences lays out an ambitious program of modernizing agricultural infrastructure and increasing research in biotechnology, with an emphasis on the basic genetic technology that is related to improving crops. In coordination with this research effort, the report suggests the training of millions of farmers in rural vocational schools in the use of advanced technology on the farm to increase production.

China's crash program in agriculture occurs in parallel with its vast industrial and infrastructure projects, like the Three Gorges Dam, which will make the water and power available for large-scale irrigation and modern farming.

As China has reiterated, despite the shrill warnings of Malthusians (like WorldWatch's Lester Brown), that there will be mass starvation because of an allegedly overpopulated Earth, the history of agriculture shows that man can increase his population density and at the same time increase his supply of food. China's new agricultural policy echoes the approach of the "Green Revolution" of the 1960s, but with a far greater potential to feed its people and increase the rate of economic growth.

The Green Revolution

The Green Revolution in agriculture, which began in the 1960s, doubled the yield of major crops such as wheat and rice, by developing new hybrid varieties that produced higher yields. This concentrated effort in agricultural research produced new disease- and pest-resistant crop varieties which allowed many developing-sector nations to be able to feed their people and avoid famines. The successes of the "Green Revolution" show that an even broader use of modern technology in agriculture today, and the accompanying development of infrastructure, could easily provide enough food for double the current world population.

For example, in Asia, in 1960, the average yield of rice per hectare was about 1 to 2 tons, planting native varieties and using traditional farming methods. Most native rice varieties have tall weak stems, and are susceptible to damage by insects and disease. The first widely used hybrid rice developed by scientists at the International Rice Research Institute (IRRI) in the Philippines, was a sturdy, short plant with better resistance to some pests. This new hybrid doubled the rice yield, and responded well to nitrogen fertilizers. However, this hybrid was not resistant to several viruses, and bacterial blight, which broke out in the late 1960s and early 1970s in many Asian countries.

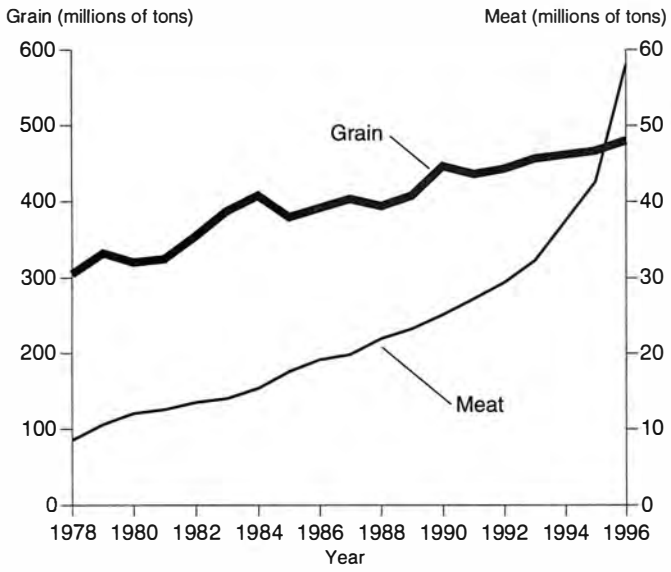
The IRRI scientists responded to this challenge by developing another rice hybrid that was resistant to many viruses, bacterial blights, and insects, with shorter growth duration. This hybrid became the most widely planted variety in the world, and brought rice yields per hectare to new highs, while saving farmers money by reducing the need for pesticides.

The large-scale adoption of improved farming techniques, along with the use of the new high yield rice hybrids, had dramatic effects in many Asian nations (see table). In India, rice production increased from 46 million tons in 1966 to 122 million tons in 1995. Indonesia used to be one of the largest rice importers in the 1970s; its rice production increased from 12 million tons in 1966 to 47 million tons in 1994, and the country is now self-sufficient.

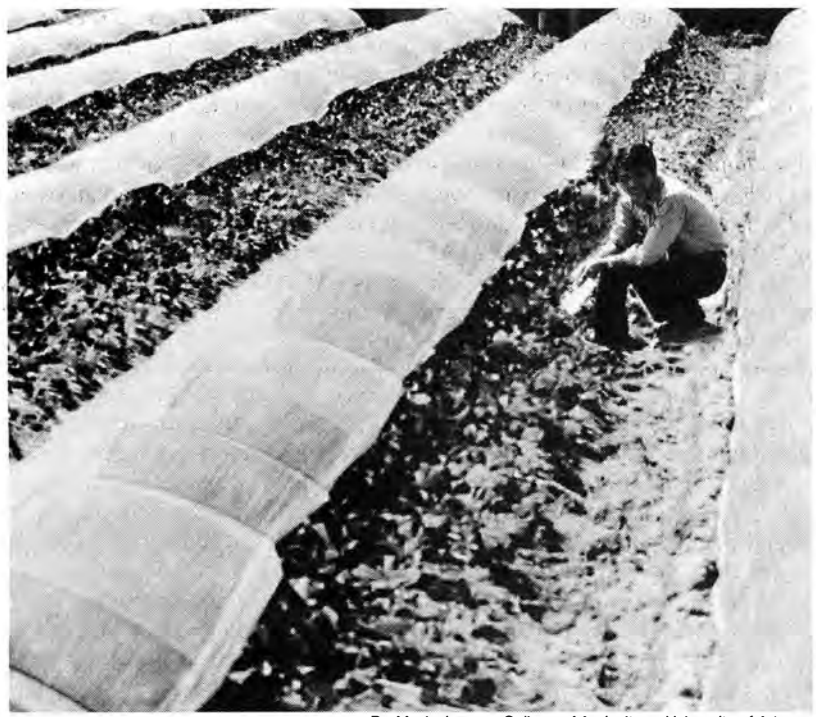
Wheat Yield Also Increased

Similar gains were made in increasing the yield of wheat. The high-yield dwarf Mexican wheat developed with funding from the Rockefeller Foundation by Nobel laureate Norman Borlaug, was modified by scientists at the Indian Agricultural Research Institute, who developed hybrids more suited to India. They crossed the Mexican wheat to Indian varieties, which changed the grain color from red to amber, and created a hybrid superior in yield to its parent varieties. These new wheat varieties helped India increase wheat production from 12 million tons in 1964, to 42 million tons in 1983. These new high-yield varieties spread throughout Asia, and by the mid 1980s, more than 50 percent of the wheat area was planted with high-yield varieties.

The policy of making the new discoveries in hybrid plants and improved farming methods available to the public sector was key to the success of the Green Revolution. The IRRI made all of its new rice varieties freely available, and distributed breeding lines to many nations every year. The agricultural research programs of rice-growing nations worked together with the IRRI, sharing information on plant genetics, and coordinating field experiments. In the case of wheat, the coordination of privately funded research centers with strong national research programs produced better crop varieties that were put into the



GRAIN AND MEAT PRODUCTION IN CHINA (1978-1996)



Dr. Merle Jensen, College of Agriculture, University of Arizona

Field research trials on the use of plastic covering and mulches to increase crop yields in China. China now leads the world in the use of plastic mulch.

widest use through the public sector.

The philosophy of the Green Revolution was that of the American System of agriculture, as described below. Ironically, this successful American System of agricultural growth is now being strangled by cartels in the name of the "free market."

Biotechnology Today

The basic research in genetics and DNA transfer technology of the last two decades has provided agriculture new tools for even greater food production potential. New genetic technologies have made it possible to integrate specific genes for resistance to disease, or to insects, into plants that come from different plant species, or even from bacteria.

With the older breeding techniques, it was possible to make hybrid plants only by crossing different varieties of the same species. Now, it is possible to create *transgenic* plants, which contain genes from an unrelated organism. This new technology is causing a revolution in new approaches to controlling insects, crop diseases, and improved plant characteristics. Now a resistance to viruses or bacterial blights that is identified in plant species unrelated to crops, can be transferred genetically to crops.

The driving force behind most basic agriculture research in the United States is the U.S. Department of Agriculture (USDA), which funds and operates public-sector research. Many of the recent discoveries in agricultural science are the result of research carried out under USDA direction.

The ability to make transgenic plants has led to a new USDA strategy for controlling crop-destroying pests. For example, scientists recently identified a protein produced by a bacterium, that causes worms and caterpillars to stop eating. They integrated this bacterial gene into corn and cotton, and the resulting transgenic plants resist the corn borer and other caterpillars, without using any added pesticides. The new corn, called Bt corn, introduced in 1995, could save farmers more than $1 billion in damages to the corn crop and pesticide costs each year. Unfortunately, however, the Bt corn is patented and licensed by private companies, which will limit its use, especially in developing sector nations.

New genetic technologies have also allowed scientists to engineer crops for specific characteristics. For example, new soybean varieties are being produced that have more protein content, or less saturated fats. Many other crops can be nutritionally improved using these techniques.

Specific characteristics can also enhance plant resistance to disease, or to poor soil conditions. For example, USDA scientists have been studying how fungal infections grow on the leaves of wheat plants. They found that the smooth leaf surface commonly found in most wheat aids fungal growth, so they engineered a wheat plant to have a hairy leaf surface that would resist the fungus. USDA sci-

entists also have developed varieties of wheat and rice that can tolerate poor soil conditions, such as deficiencies in zinc and other minerals.

Another aspect of research is how to rotate crops so that the soil is fertilized, not depleted of nutrients. USDA research has developed legume varieties that fix nitrogen from the air, and deposit increased amounts of nitrogen in the soil, reducing the need for nitrogen fertilizer use on the next crop.

There are many crop pests for which pesticides are the only effective means of control. USDA research has been trying to develop methods to reduce pesticide amounts while maintaining pest control. One of these methods involves incorporating pesticide into starch granules, which then stick to the plant leaves very efficiently. This technique uses 99 percent less total pesticide, which achieves pest control that is better than 100 times more pesticide used alone.

More Food on Less Land

Although the gains in rice production made throughout Asia during the last three decades are impressive, the amount of land available for rice production has decreased. Scientists at the IRRI, led by Dr. Gurdev S. Khush, are developing even higher-yield rice varieties to meet the challenge of growing more food on less land. Using breeding and genetic engineering, they have created an entirely new type of rice plant to be released by the turn of the century. The new rice type produces more biomass per hectare, with an increased percentage of grain—a 20 to 25 percent higher yield. Current high yield rice can produce 18 to 20 tons of biomass per hectare, with 50 percent of that being grain.

The new "super rice" produces 21 tons of biomass per hectare, with 60 percent of that being grain, giving it a 12.0 to 12.5 tons of rice per hectare yield. "Super rice" will be released at the turn of the century, after disease- and insect-resistance genes are incorporated into it.

Khush stressed that research must continue to meet the challenges ahead. "We cannot rest on our laurels," he said.

What Stops New Technologies?

The advanced technologies to easily feed the world already exist, so what is stopping them from being used? While the media has prominently featured the radical environmentalists who block the use of new technology, such as genetic engineering, not so well known are the practices of the food cartels, which are restricting the use and research of biotechnology for the public good under the guise of "free market" policies. By patenting genetically engineered seed, plants, and the techniques to create them, the cartels not only can restrict their use, but also can block the government from conducting research in areas in which the cartels hold broad patents.

There are several recent legal means that are used by the cartels to control new technologies in agriculture. The most powerful is the industrial plant patent, which has existed since 1985, when the patent office ruled that genetically modified plants could qualify for this strong form of patent protection. This type of patent can be used to lock up new high-yield crop varieties; it does not allow any exemptions for research or for use by farmers, without a license from the cartel company.

Much of the success of the "Green Revolution" resulted from the fact that discoveries made by scientists in the public or private sector were made readily available to the public. Today, the cartels' increasing control over agricultural research makes it very difficult for new discoveries to be widely distributed for the public good. In most cases, the cartel companies hold patents and licenses on any new discovery that could produce higher crop yields.

In contrast, in the 1960s, new hybrid seeds, or advanced farming techniques developed by government-funded research within the USDA, were directly and freely released to individual farmers and breeders, and no one could then

INCREASES IN RICE OUTPUT, 1967-1969 TO 1991-1993

Nation*	Rice production (million tons/year) 1967-69	1991-93	Percent increase in production	Total area planted to rice 1992 (million hectares)	Percentage of area planted to modern varieties
China	97.6	185.3	90%	32.4	100
India	58.9	110.8	88	42.0	66
Indonesia	18.2	46.7	157	10.6	77
Bangladesh	17.2	27.3	59	10.1	51
Vietnam	8.8	21.0	138	6.7	80
Thailand	12.4	18.6	50	9.5	68
Myanmar	7.9	14.5	84	4.7	50
Japan	18.6	11.7	−37	2.1	100
Brazil	6.6	9.8	48	4.7	23
Philippines	4.8	9.4	96	3.2	94
U.S.A.	4.3	7.6	77	1.3	100
South Korea	5.0	7.0	40	1.2	100
Egypt	2.5	3.7	48	0.5	100

Source: Adapted from Gurdev S. Khush, "Modern Varieties—Their Real Contribution to Food Supply and Equity," pp. 275-284, *GeoJournal*, March 1995.

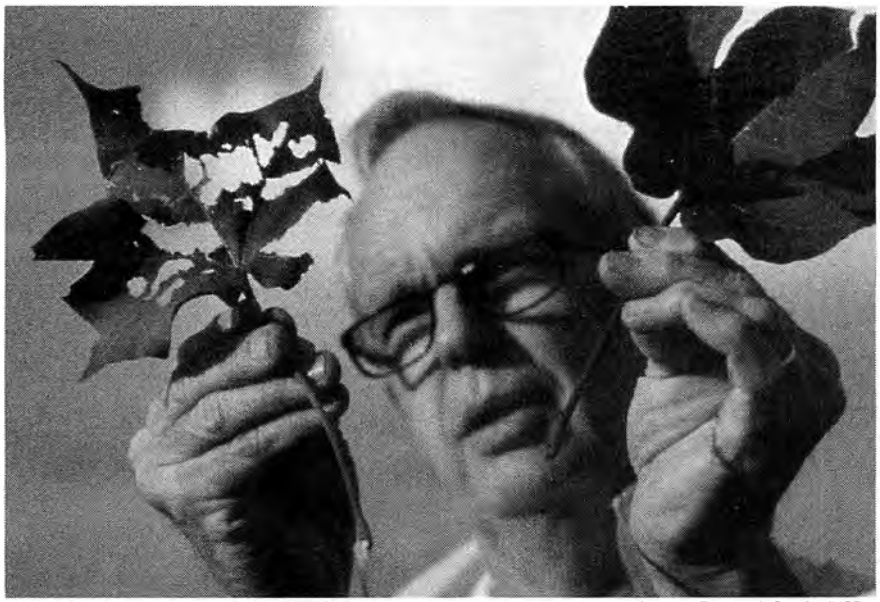
Notes
* Countries are ranked by volume of rice output, annual average, 1991-1993.

Dr. Gurdev Singh Khush

Technology Development Is Key

"We need to invest today in the future of our children and grandchildren. It is our foremost responsibility to develop the technologies which will help produce enough food for more and more people," Dr. Khush said when he received the 1996 World Food Prize.

Khush's work on developing high-yield rice varieties at the International Rice Research Institute was instrumental in the doubling of rice production worldwide since 1966. The introduction of new rice varieties that produced two to three times more yield helped many Asian nations to avoid famine during the 1960s and 1970s.



Agricultural Research Service/USDA

An ARS scientist compares an insect-ravaged cotton leaf from a control variety with one that has been genetically engineered with a protective gene from the bacteria Bacillus thuringiensis.

Agricultural Research Service/USDA

An entomologist checks the adhesion of starch granules containing an insecticide to a leaf surface.

patent any of these discoveries to stop others from using it. The advent of the industrial plant patent in 1985, and the changes to the Plant Variety Protection Act in 1994, however, made it impossible for the USDA to freely release its new discoveries to the public.

Since 1985, the USDA must license and sell the right to any new plant variety it comes up with to the highest bidding company. In this "free market" system, the largest and most powerful companies stand in the way of the widespread use of public-sector discoveries, and controls who gets access to new technology.

Over the past 10 years, because of budget cuts, the Agricultural Research Service has had to fund new projects through cooperative agreements with private companies, which now make up the majority of these agreements. (In the past, most of these agreements were with governments of developing-sector nations.) The private companies provide part of the funding for a short-term project, which usually ends up producing a patentable new plant variety or technique.

The companies retain the exclusive marketing rights of any discoveries made during these research projects, so often discoveries made by government scientists end up in the exclusive control of the cartels. If the cartels patent the technology, they can then restrict the government scientists from continuing research in the area those scientists pioneered.

Cartel Restrictions

A few years ago Monsanto was granted wide patents on all genetically engineered cotton and soybeans. This decision by the patent office caused USDA researchers to drop projects in these areas, and instead try to "invent around" the patents. These particular patents were subsequently restricted through a legal battle, but the long-term damage to government research programs has already been done.

Another case is the new Bt corn that resists pests. The patent on this variety prohibits anyone, including government researchers, from doing research using Bt corn without a license from the company.

The new plant patents and the Plant Variety Protection Act are also being used by the cartels to restrict farmers' rights. The Plant Variety Protection Act, amended in 1994 to meet GATT (General Agreement on Trade and Tariffs) standards, denies farmers the right to exchange or sell any protected or patented seed. However, many of the plant patents go even further, prohibiting the farmer from saving seed to replant, allowing inspection teams onto his farm to enforce patents, and dictating what chemicals he can use on his crops. The farmers must also pay large licensing fees, in addition to the cost of these new patented seeds, just to access the technology. This new system is squeezing the independent farmer into bankruptcy, forcing him under the control of the cartel companies if he wants to use genetically engineered seeds that would give higher crop yields.

The 1994 GATT agreements also have provisions whereby developing-sector

nations must recognize the patents and intellectual property protection held by foreign companies on plants and other living organisms. This gives the cartels the ability to deny developing-sector nations access to advanced agricultural biotechnology, and provides enforcement of their patent rights by the World Trade Organization.

Cargill in India

For example, Cargill has been pushing hard for intellectual property rights for its seeds in India. Cargill was marketing sunflower seeds promising high yields, but refused to submit seed samples to the Indian Government Seed Bank, as required by law, claiming this would violate their private property rights. When these seeds were grown by local farmers, the yields were disastrously low, sparking a protest against

Increasing Yields with Precision Farming

by Marsha Freeman

For two decades, farmers have had access to data and images from Earth-orbiting satellites, enabling them to monitor the health and growth of crops. Satellite remote sensing can provide information regarding stress on plants, such as weeds, pest infestations, and water, either too much or too little. Farmers have been able to use water inventory data to estimate spring and summer water resources from projecting winter snow melt runoff, and see their entire land under cultivation from space.

The biggest shortcoming of the currently-operating Landsat remote sensing system is the resolution of the images, which is 30 meters (about 90 feet), and the temporal resolution, which is one image of the same spot about every two weeks. Farmers need to survey the health of crops more often, and to discern features smaller than 90 feet.

To aid in this effort, new satellite systems, specially designed for agricultural applications, are being planned. One of these, by Resource21 in Colorado, will consist of four multispectral satellites with a resolution of 10 meters, and global coverage twice weekly.

With the availability of the Global Positioning System (GPS) satellites since 1989, a new tool has been added to the farmer's capabilities, which allows him to locate any features in his field very precisely, giving him an extremely detailed and variegated view of his growing area.

A Defense Spin-off

The GPS system was proposed by the Navy to be able to give precise navigational information to submarines, but was developed by the Department of Defense for use by all branches of the military. The constellation of 24 satellites allows a user to locate his position within a few meters, anywhere in the world, 24 hours a day, and it has been made available for civilian use. The system is being used by commercial ships and surface transporters, surveyers, hydrographers and all manner of mappers, raw materials producers, the fishing industry, search and rescue teams, and many others, in addition to farmers.

At the Agricultural Research Service's Soil Tilth Laboratory in Ames, Iowa, Thomas Colvin has been experimenting with GPS applications in agriculture to work toward what is described as precision farming.

A farmer knows through experience that yields are different for the same crop in different areas of a field. Using a receiver for a signal from the Global Positioning System satellites, a farmer can now identify the spot where he is at any time, within about 20 feet. He can place that spot on a map of his field, and map out where there should be additional treatments of fertilizer, pesticides, other chemicals, or water if the land is irrigated, according to what he has observed. Rather than a gross application of resources to an entire crop area, selective treatment in precise areas is possible.

Rockwell International

Agronomist Phil Cochran of Paris, Illinois, examines corn root conditions after harvest. Above his head can be seen a GPS receiver, which allows Cochran to produce a site-specific map of yield data, to aid in the next growing season.

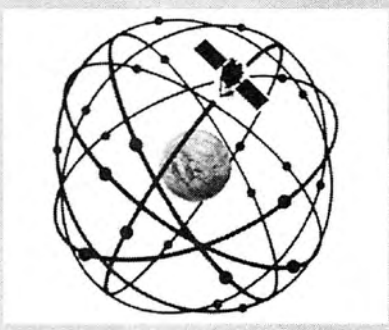
Colvin is interested in the development of sensors to be placed on farm machinery, and on satellites, that could take automated measurements that would describe basic crop and soil characteristics and, using the GPS navigational data, make a precise map of the farmer's field. Then, each time the farmer crosses his field with his tractor, or a couple of times a week using remote sensing data, he can produce an updated map of his crops.

Cargill and its support of the GATT agreements, in which some farmers burned the files and seed samples of the local Cargill office in 1992.

A Break with the 'American System'

The current cartel policy is the opposite of that of the "Green Revolution"—

Continued on page 21



GE Astro Space

The Global Positioning System is comprised of a constellation of 24 satellites in crossing orbits. They provide multi-satellite coverage, 24 hours a day, for every location on the Earth.

According to *@g-Innovator* magazine, last year there were more than 5,000 GPS receivers on combines. This compares to 300 GPS receivers in use on farms in 1993. One thing that could hold back further use of the technology is the near-ruin financial conditions of many independent farmers.

Removing Guesswork

Reducing the amount of chemicals in areas of the field where they are not needed does more than save the farmer money. According to Colvin, over-fertilization of some crops, such as potatoes and sugar beets, can degrade the quality of the produce. Practicing precision farming, the farmer may even be able to vary the number of seeds that are planted, maximizing his effort, based on soil fertility. The Agricultural Research Service is now studying how the farmer will be able to use historical data about small areas of his field to try to help determine in advance how to treat each site.

Colvin stated in a 1992 article that eventually, farming using satellites "should take much of the guesswork, except for weather variables, out of farming."

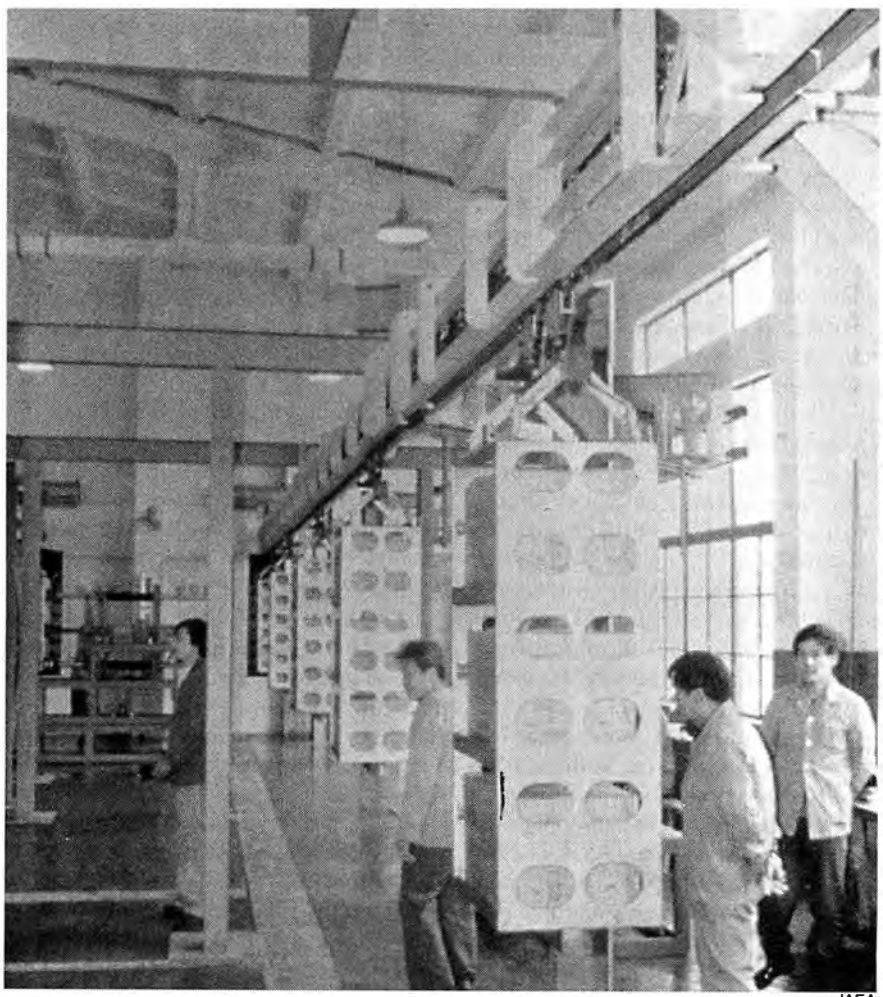
IRRADIATION PROCESSING

Increasing the Quantity and Quality Of the Food Supply

by Marjorie Mazel Hecht

Any nation that is serious about improving the quantity and quality of food for its population will develop a capability to use food irradiation technology in the 21st century. Low dose irradiation, using the high-frequency energy from X-rays, gamma rays, or accelerated electrons, can disinfest fruit and vegetables and lengthen their shelf life, delay the sprouting of potatoes and onions, and destroy or reduce pathogens like salmonella in meat, poultry, or fish.

In developing countries, where 50 percent or more of the harvest is routinely lost to insects, rodents, mold, or fungi, a relatively small investment in food irradiation technology can mean the difference between whether crops are eaten by the people whose lives depend on them—or by other species. In the United States, food irradiation could alleviate the situation of food-borne illnesses, which now claim 10,000 lives a year and billions of dollars in lost work



IAEA

A food irradiation facility in China, where cartons of apples are being conveyed to the cobalt-60 source for processing.

time and medical treatment. Estimates are that 20 million persons suffer from food-borne illnesses yearly in the United States.

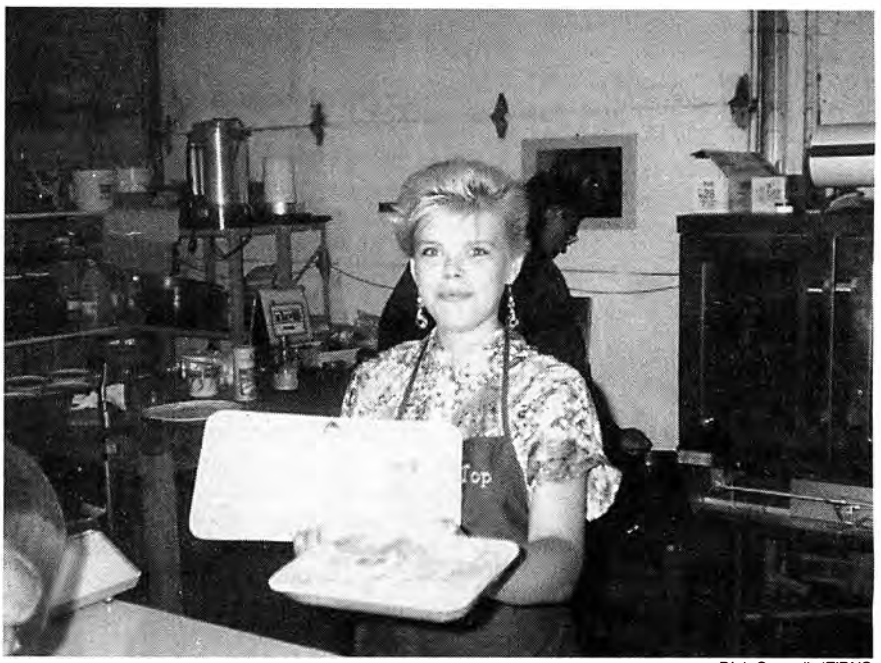
Although food irradiation technology was pioneered in the United States just after World War II, other countries are now taking the lead in using the technology. China, for example, has integrated food irradiation into its ambitious plans for expanding food production, irradiating apples, cereal grains, cooked meat products, dried fruits, garlic, potatoes, rice, and spices.

Thoroughly Tested

By 1970, the U.S. Atomic Energy Commission had already labeled food irradiation as "more thoroughly tested than any other method of food preservation." Today, more than 25 years later, there is an impressive worldwide research base (30,000 references) for food irradiation, covering all aspects of safety and wholesomeness for a wide range of produce, grains, fish, meats, and poultry. Forty nations have approved the use of irradiation processing for a wide variety of food products; current products on the market range from irradiated fermented pork sausage (Nham) in Thailand, to Camembert cheese in France, to irradiated potatoes in Japan, to irradiated meals for astronauts and hospital patients in the United States.

Food irradiation uses the ionizing energy from a decaying radioactive isotope, like cobalt-60, to penetrate inside solid particles and kill microorganisms by breaking down the cell walls or destroying the metabolic pathways of the organism so that its cells die. There is no radioactivity induced in the processed food. The chemical reactions caused by the very-short-wavelength gamma rays do not involve the atomic nuclei of the food, and therefore the atomic structures in the food molecules are not changed.

The reduction of microorganisms caused by the ionizing radiation depends on the dose absorbed, which is controlled by varying the amount of irradiation applied and the length of exposure of the food product. U.S. and international regulatory agencies have determined specific minimum irradiation levels for various food products to kill microbes, bacteria, insects, insect larvae, parasites, or molds. At higher levels all pathogens and viruses can be eliminated, thereby sterilizing the food.



Dick Connelly/EIRNS

Some of the first irradiated poultry on sale in the United States at Carrot Top, a market in suburban Chicago. The poultry was processed at the Vindicator plant in Florida (now Food Technology, Inc.).

After 50 years of research, scientists have perfected the dose levels and conditions for various foods, so that the color, taste, texture, odor, or nutritional quality of the foods are not affected. (There are a few exceptions to this—some dairy products, for example—for which irradiation processing is not recommended.)

The Food and Drug Administration, responsible for assessing the safety of food irradiation, concluded that the difference between irradiated and nonirradiated foods is so small as to make the foods indistinguishable in respect to safety. All the major international organizations responsible for food and food safety have enthusiastically supported the technology, as have the major scientific organizations.

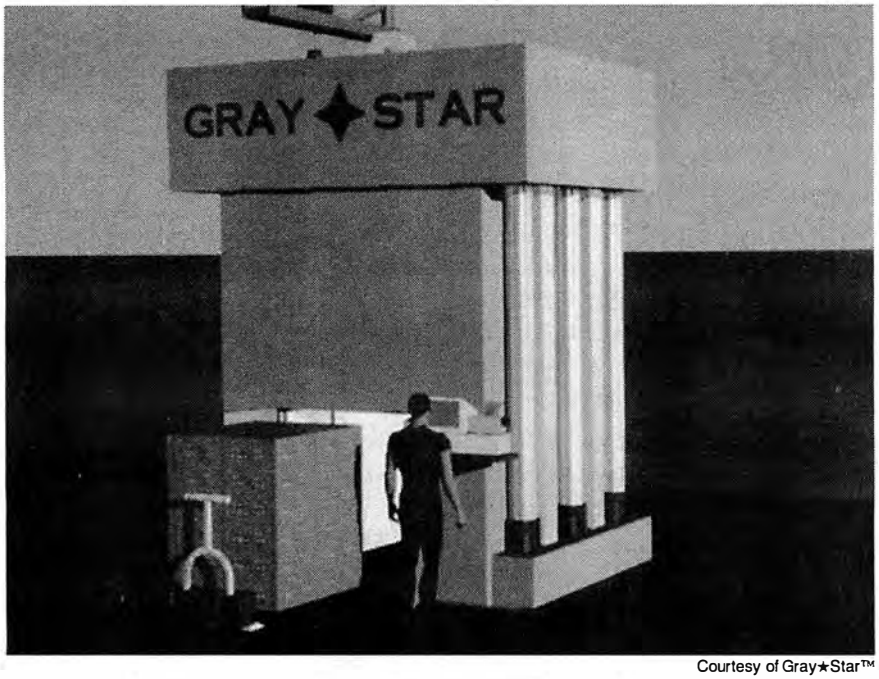
Consumers have also shown their approval—by buying irradiated products. In the United States, for example, test marketing of irradiated papayas, strawberries, and mangoes showed overwhelmingly that U.S. consumers preferred to buy the irradiated products and would even pay a little more for the quality. The advantage of irradiation for disinfestation is especially important in fruits and vegetables, which can be picked riper and then be treated, giving the consumer a better tasting product. (The available alternatives for tropical fruits, for example, are a hot-dip treatment or a month-long cold storage, both of which do not enhance flavor or quality.)

The development of food irradiation was slowed down from the bright hopes of the Atoms for Peace project in the late 1950s and early 1960s, by the anti-industrial counterculture launched as a reaction to the scientific renaissance begun by the Apollo program and the civilian nuclear power program. Today, the opposition to food irradiation comes from a small group of anti-nuclear activists, who churn out lying propaganda and use extortion and intimidation to stop food-processing companies from using the technology.

But times are changing. The demand for pathogen-free food is growing, new food irradiation plants are being built in the United States, and a county council in Hawaii just approved funds for an irradiator for tropical fruit.

An Innovative Irradiator Design

Most irradiation facilities, including those in the United States that sterilize medical supplies, use cobalt-60 as the radiation source, submerged in a well of water and shielded by 6 to 8 feet of concrete. The product moves around the source in containers, supported by rails.



Courtesy of Gray★Star™

An artist's illustration of the Gray✦Star™ *on a plant floor, with a pallet ready to be loaded in for irradiation.*

Each centralized facility must be licensed by the regulatory agencies, and the operators must be highly trained and licensed.

The latest commercial irradiator design is radically different—it is a modular, prefabricated, transportable, self-contained, dry storage unit that uses cesium-137 as the radiation source. Called the Gray✦Star™, it is designed to be transported to existing food-processing or packing plants, where it can be installed singly, or in as many units as necessary to keep up with the plant's output. The product, therefore, does not have to be transported to a centralized facility, thus cutting the cost of the process. No special facility need be built; the unit is installed in a pit dug in the floor of the processing plant.

The Gray✦Star™ chamber accommodates a standard pallet (40 inches by 48 inches) of produce, so that no stacking or reconfiguring is necessary for the product. The entire pallet goes into the irradiator, stays the required amount of time to receive the appropriate dose, and then comes out of the chamber. (Poultry might take 1/2 hour; produce 6 minutes, for example.) Each unit can handle 10,000 pounds of produce per hour, and the pallet can remain under refrigeration during the process.

Unlike traditional irradiators, the Gray✦Star™ does not require highly trained personnel to operate it. The steel chamber that contains the cesium-137 is a sealed box, the outer dimensions of which are 8.5 × 10.5 × 12 feet. The box is placed below ground. When the pallet of produce is inside the above-ground closed chamber, the panels containing the cesium source move up and surround the pallet on four sides. The innovative control systems of the Gray✦Star™ make it an inherently safe unit, which can be accessed and monitored remotely via a satellite data-link phone system.

Because the self-contained irradiation unit will be pre-fabricated, the installation can be done in a day, once the site is prepared, and operation can begin. The unit will be preapproved; the regulatory agency just has to know who is in charge and how it was installed. This alone will make a big difference in making the technology accessible for industrial users.

Suitable for Developing Countries

The Gray✦Star™ was designed by a father-and-son team in New Jersey, Russell N. and Martin H. Stein, who have 54 years of experience in the food irradiation field between them. The units will cost approximately $1.5 million each, and according to Martin Stein, will be very suitable for developing countries, because they are easy to ship, "reasonably easy" to operate, and do not require a special centralized facility.

Stein estimates that processing meat and poultry will cost about 2 cents per pound, while irradiating produce will cost less than 1 cent per pound.

Right now, the U.S. Nuclear Regulatory Commission is reviewing the design for licensing, and the Department of Agriculture is preparing to test a commercial prototype, to confirm the predicted uniformity of dose, among other things. The USDA's Dr. Donald Thayer, who has carried out much of the U.S. food irradiation research, is enthusiastic about the project, and its potential for rapidly expanding the use of irradiation.

Six Gray✦Star™ units are on order, and more are expected.

Feed the World

Continued from page 19

and of the United States in the past. When the Department of Agriculture was set up in 1862, its purpose included the duty "to procure, propagate, and distribute among the people new and valuable seeds and plants." The USDA distributed new seed varieties directly to farmers from the 1890s until 1923, under the free seed program, which resulted in the increased diversity of cultivated crops.

The first Plant Patent Act of 1930, applied only to flowers and ornamental plants, and prohibited the patenting of any food crop, recognizing that such patents would threaten the food supply. The current patents on food crop seeds and advanced technologies that give the cartels monopolies over the use of new discoveries would not be tolerated, if the courts considered the common good of the nation to be of primary importance.

Chief Justice John Marshall, in 1823, overturned patents and monopolies that limited the use of the steam engine, that violated the Constitution's authority to "promote the progress of science and useful arts," arguing that monopolies denied the nation the benefits of new discoveries. If the United States is to take a leading role in creating new scientific discoveries to feed the world's population, the nation must return to the outlook of Chief Justice John Marshall.

GÖDEL, CANTOR, AND LEIBNIZ

Mathematics And the Paradoxical In Nature

Only the "positive paradox," as a method of creative thinking, can solve fundamental metaphysical questions and profound paradoxes.

by Dino de Paoli

Melancholia I., an engraving by Albrecht Dürer, depicts the human spirit in its striving for truth, surrounded by representations of its creations.

This is the second part of the author's study of the mathematician Georg Cantor, and presents a further analysis of the importance of Cantor's notion of the absolute series of transfinites.[1]

In order to understand the significance of Cantor's work, it is essential to examine it in the context of the work of his famous predecessor, Gottfried Wilhelm Leibniz, and his immediate successor, Kurt Gödel. What is the thread connecting Leibniz, Cantor, and Gödel? The author shows that all three scientists, using Leibniz's method as their point of departure, polemically prove that the effort to reduce human reason to a closed formal system must necessarily lead to

paradoxes. All three intensively occupied themselves with the question of the "ontological proof of God" and showed that only the method of "the positive paradox," wielded as a method of creative thinking, offers an approach to solving fundamental metaphysical questions and profound paradoxes in mathematics.

This article first appeared in the German-language cultural quarterly, Ibykus, *in April 1993, and was translated into English by Susan P. Johnson.*

If any 20th-century mathematician ought to be considered the intellectual heir of Georg Cantor, it is Kurt Gödel. There exist only a few scattered philosophical reflections by Gödel, assembled by his biographer Hao Wang. Yet despite Wang's efforts to make Gödel's philosophical and theological ideas available, Wang himself says that he did not understand them.[2] A deeper study of Gödel's mathematical writings, especially his commentaries on what are usually considered Cantor's "crazy" hypotheses about theology, philosophy, and physics, gives the reader a sense of the issues with which both Cantor and Gödel were wrestling.

In particular, I will investigate why Gödel became so interested in the "ontological proof of God." In my view, the formal outline known as his "proof of God" is of very secondary significance. The actual proof was contained in his life's work, where he confirmed Cantor's answer to the question of "the Absolute," by proving that "positive qualitative creative changes" are *necessary.* Gödel showed that "contradictions" are not simply Kantian antinomies, but can carry within them a *positive* notion of truth; they can only be solved creatively, through a necessary transition to a higher level of thinking.

Gödel demonstrated that the necessity and lawfulness of these "transitions" are a reflexive property,[3] which derives from the *existence* of Cantor's Absolute, or from the "absolute impossibility of a complete *linearization."* To use a metaphor: He speaks of the Absolute with a capital *A,* and also of the "absolute limit to linearization" with a small *a,* indicating a fundamental difference, but also a fundamental similarity, comparable to the paradox in Plato's *Parmenides* dialogue. The reflexivity of the Absolute is functional at every point, although to different degrees, which means, as Gödel successfully established, that no Russellian "dead points" exist in our universe.

The difficulty in all this has to do with a prevailing misconception about the actual origin of the "ontological proof." Theology investigates the "knowability" of God for human beings; that is, theology is an essential science which has to be conducted with "a full heart, a clear/pure mind, and one's whole self." Theology seeks *what is necessary* in how man thinks, knows, and discovers. That means it is "subjective," and in the effort to make God "knowable," it must proceed from an "internal image." In order not to fall into pure subjectivity, however, theology must develop a "necessary" transition in its mode of thinking, as illustrated by the beautiful prayer of St. Anselm and his *argumento unico* for God's existence,[4] which should not be confused with formal logic.

Can the existence of God be proven by means of Aristotelian logic? The Cartesians think so, and René Descartes's (1596-1650) formulation is considered the official "ontological proof." *That* is the proof demolished by Immanuel Kant (1724-1804), who aimed his destructive rage against a lifeless corpse. He fought and vanquished a nonexistent ghost, and then declared that it is impossible to prove God's existence.[5] And so, today, the debate has been reduced to Cartesians versus Kantians.

Institute for Advanced Study Archives/ Princeton University Gödel Papers

Kurt Gödel with his student and biographer, Hao Wang, in March 1972.

In any university today, Gödel's work is a mandatory reference point for mathematics students, and in the fields of logic and information theory, as well as mathematics, he has become a sacred cow. But insofar as he is made into an object of super-specialization, the actual philosophical implications of his work are difficult to grasp, even though they are indispensable for mapping the human thought process. Here we attempt to shed light on those implications, on precisely the aspects of Gödel's ideas which Wang found "strange," and which are only understood through an acquaintance with the essentials of Leibniz, on whom Gödel built his work.

Gödel's Life and Accomplishment

Gödel was born in 1906 in Brünn, in the Moravian part of the Austro-Hungarian Empire. His mother was Lutheran, his father Catholic. As for his own religious convictions—according to his wife, he read the Bible in bed on Sundays—he wrote in 1974: "Baptized Lutheran (but not member of any religious congregation). My belief is *theistic,* not pantheistic, following Leibniz rather than Spinoza" [emphasis in original].

At the age of 14, he taught himself mathematics. Two years later, he began to study Kant. Yet, he wrote in 1974: "the greatest philosophical influence on me came from Leibniz." Wang reports, "He says that his philosophy agrees, in its general features, with (the metaphysical system of) the monadology of Leibniz."

In 1924, Gödel began to study mathematics and physics at the University of Vienna under Professor Furtwängler, cousin of the great conductor. Here he also joined the Vienna Circle under Rudolf Carnap for two years. Yet he maintained a highly critical attitude toward its positivist philosophy, and indeed, it was at this time that he began to develop "a strong antipathy toward Aristotle, toward empiricism and materialism . . . and felt drawn toward Platonic realism." In a later comment on this period, Gödel wrote:

> I don't consider my work "a facet of the intellectual atmosphere of the early 20th century," but rather the opposite. It is true that my interest in the foundation of mathematics was aroused by the 'Vienna Circle,' but the philosophical consequences of my results, as well as the heuristic principles leading to them, are anything but positivist or empiricist.

In 1928-1929, Gödel studied David Hilbert's mathematical work and wrote his now-famous dissertation, "On the Completeness of the Calculus of Logic." It was during this period that he developed the deep interest in Leibniz which culminated in three years of immersion in Leibniz's work, in 1943-1946. In 1930, he received his doctoral degree, and in 1931, he published what would become his 1932 habilitation thesis,

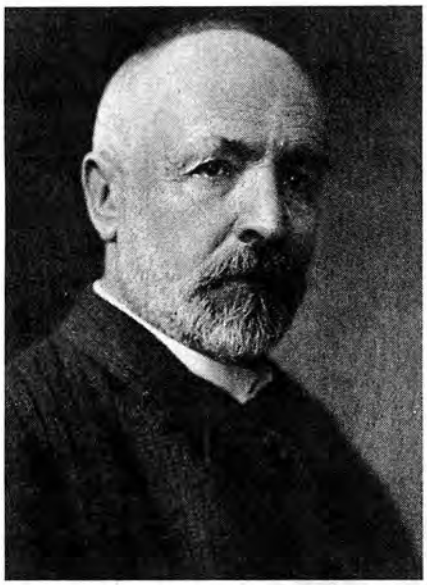
However, patristic writers had already shown that no Aristotelian proof of necessary existence can be given, yet there is a Platonic solution: the method of "positive paradox," expressed in the statement, "*I know* that I do not know." The effort to reduce the whole debate to Kant versus Descartes excludes the thought and method of a crucial thinker who is indispensable for solving the question: Gottfried Wilhelm Leibniz.

Cantor and Gödel rediscovered Leibniz and the method of positive paradox, a method which becomes even clearer in Lyndon H. LaRouche, Jr.'s essay "On the Subject of God," which addresses the same problem.[6] What links Gödel, Cantor, and LaRouche to each other is, on the one hand, their roots in Leibniz, and, on the other hand, their original interest in, and then strong rejection of, Kant. Of the three, LaRouche has grasped Leibniz most profoundly. Thus he was able to reach conclusions which some consider diversionary, but which represent a solution—in fact a "formal" solution—to the efforts of Cantor and Gödel: He has defined a function for nonlinear transformations, in the form of his function for physical economy.

This physical-economic function serves as a sort of "golden bridge," as Cantor always called it, between science and theology. LaRouche developed a "Science of Christian Economy" in which the reflexive principle of Gödel and Cantor is given content as the physical, social, and moral reflection of the *imago viva Dei* principle, the idea of man in the living image of God. Without LaRouche's elaboration, the goals of Cantor and Gödel would remain mysterious, even to serious, honest scientists. Of course, it takes a bit of courage to pursue the implications of their work. The reality is that all three of these thinkers have been subjected to frantic slanders and sabotage attempts. Cantor spoke in passing of the destructive role of "satanic and Freemasonic networks," which some dismiss as Cantor's "paranoid side," a term also applied to Gödel.

But let us now look at Gödel himself.

"For most people Gödel's life and work are like a remote and esoteric landscape that is attractive but hard to reach," wrote his biographer Hao Wang.



Georg Cantor

Gottfried Leibniz

Lyndon H. LaRouche, Jr.

"What links Gödel, Cantor, and LaRouche to each other is, on the one hand, their roots in Leibniz, and, on the other hand, their original interest in, and then strong rejection of, Kant."

"On Formally Undecidable Propositions of *Principia Mathematica* and Related Systems," which led him to his major breakthrough. Between 1933 and 1938, he taught as a university lecturer in Vienna.

Let us consider the significance of Gödel's results at this very early stage. Roughly speaking, he had proven the following theorem:

> Given a suitable formal system L [a deductive lattice], there are undecidable propositions in L; that is, propositions F such that neither F nor not-F is provable in it. Then if L is consistent it is incomplete and incompletable. But as F and not-F express contradictory sentences, one of them must express a true sentence. So there will be a proposition of L which expresses a true sentence, but nevertheless is not provable in L.

In other words, working within formal logic, Gödel is able to prove that any formal language, no matter how much one tries to make it narrow and precise, that is, consistent, will necessarily lead at some point to contradiction and inconsistency—to a paradox. Therefore, the effort to construct restricted logical systems or languages with the sole aim of avoiding anomalies, ambiguities, and so forth, as Bertrand Russell, Ludwig Wittgenstein, and the Vienna Circle were attempting to do, is condemned to failure from the outset. The human mind possesses exactly that quality which is *irreducible* to any type of language which seeks to exclude ambiguities, anomalies, and metaphors. Gödel's complicated procedure for the proof may simply be characterized for our purposes by noting that it is inspired by Georg Cantor's diagonal method.[7]

To use an image: The problem of anomalies is like the appearance of dissonances in music, or the incommensurability of the diagonal of the square with the sides. It is like believing that "water" is the sole principle of the universe, and then suddenly being presented with a piece of ice whose existence or truth-content cannot be proven inside the parameters of the deductive "water" lattice.

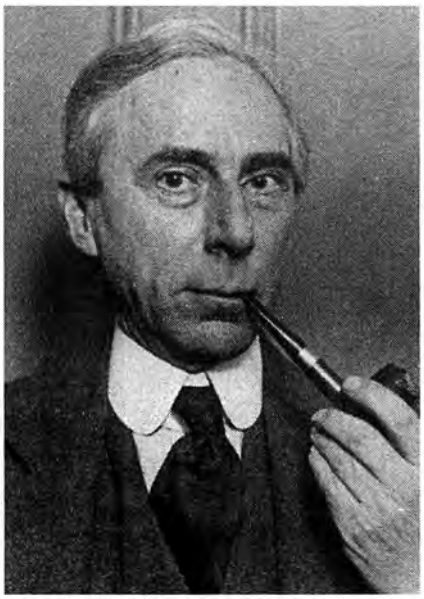
But there is a still more important point in Gödel's theorem. The issue is not simply that closed, formal systems are doomed to generate some form of paradox, anomaly, or undecidability crisis. What we have here is a "true statement," a real existence, whose truth nevertheless appears impossible to prove inside the original system. Thus the original system is not complete; it is part of a more comprehensive form of reality. Let me repeat this point, because it is essential: We have reached a situation where *truth* and *consistency* cannot be considered *equal,* but nevertheless they are still *coherent.*

An "undecidable" existence in one manifold, that is, an existence which within that system would lead to so-called Kant-Russell antinomies, paralogisms, or paradoxes, is nevertheless a *true* existence. That means that an anomaly is not always a simple "negation." It also has a positive value, indicating something higher, which demands a nonlinear evolution of the process of thinking. Let us take a sometimes abused but classic example of evolutionary and non-evolutionary paradox. In the 1930s, the famous physicist Paul Dirac developed a new hypothesis, from which it was deduced that the world would disappear within a microsecond. But it did not. So he had to change the premises which had led to the contradiction. Soon he arrived at a new paradox: the existence of "negative energies" and "anti-particles," never before seen or conceived of. This time he let the paradox stand, forcing changes in established theories. A few years later, such particles were discovered as real existences with real effects in the world.

The psychological impact of the young Gödel's discoveries becomes clear when his cultural milieu is examined. The time is 1930. Europe is going toward the so-called New Or-

der. The dominant cultural paradigm is defined by the "big names," Russell, Wittgenstein, and the Vienna Circle, who have arrogantly decreed that metaphysics and theology can be eliminated as "ambiguous" sciences, now that the human mind, through simple "facts" and strict terminologies, can obtain complete control over knowledge, truth, and falsity. Their bible is Russell's and Whitehead's *Principia Mathematica.* Now a young student comes on the scene and, *from the inside,* brings down the whole house of cards at one stroke.

In 1930, the stock markets have collapsed, panic is spreading. In quantum mechanics, "uncertainty" has already appeared, and now it is spreading within the realm of the queen of the exact sciences, Aristotelian logic. The elites respond with their old trick: a move away from Aristotelian formalism, toward Aristotelian irrationalism, in the form of Heidegger's existentialism, Theosophy, gnosticism, Nazism. As soon as Gödel has demolished logical positivism, he is forced to battle with the post-modernism of Karl Popper, the father of latter-day radical relativistic subjectivism.



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Bertrand Russell

The Charles Babbage Institute Reprint Series

Alan Turing

Gödel's discoveries were a devastating attack on the Aristotelian formalism of Bertrand Russell and the Vienna Circle, as well as on post-modern irrationalism and the modernist, mechanistic outlook of Alan Turing.

Thus, starting in 1935, Gödel was fighting on two fronts: combatting the "modernists," the mechanistic outlook of Alan Turing, and later Norbert Wiener and his cothinkers, while attacking the "post-modernists" and "free-market" ideologues who rejected the notion of "function" or causality in science, economics, and history.

We will now focus on this question of the evolution of ideas.

Gödel's Transfinite Functions

As we have seen, paradoxes can have a *positive* effect, if their solution is defined by means of an evolutionary "transition" into a higher ordering. Clearly, music does not consist solely of dissonances, but instead they become contributory elements of counterpoint, so that the excitement of a composition includes the creative resolution of dissonances. Gödel writes:

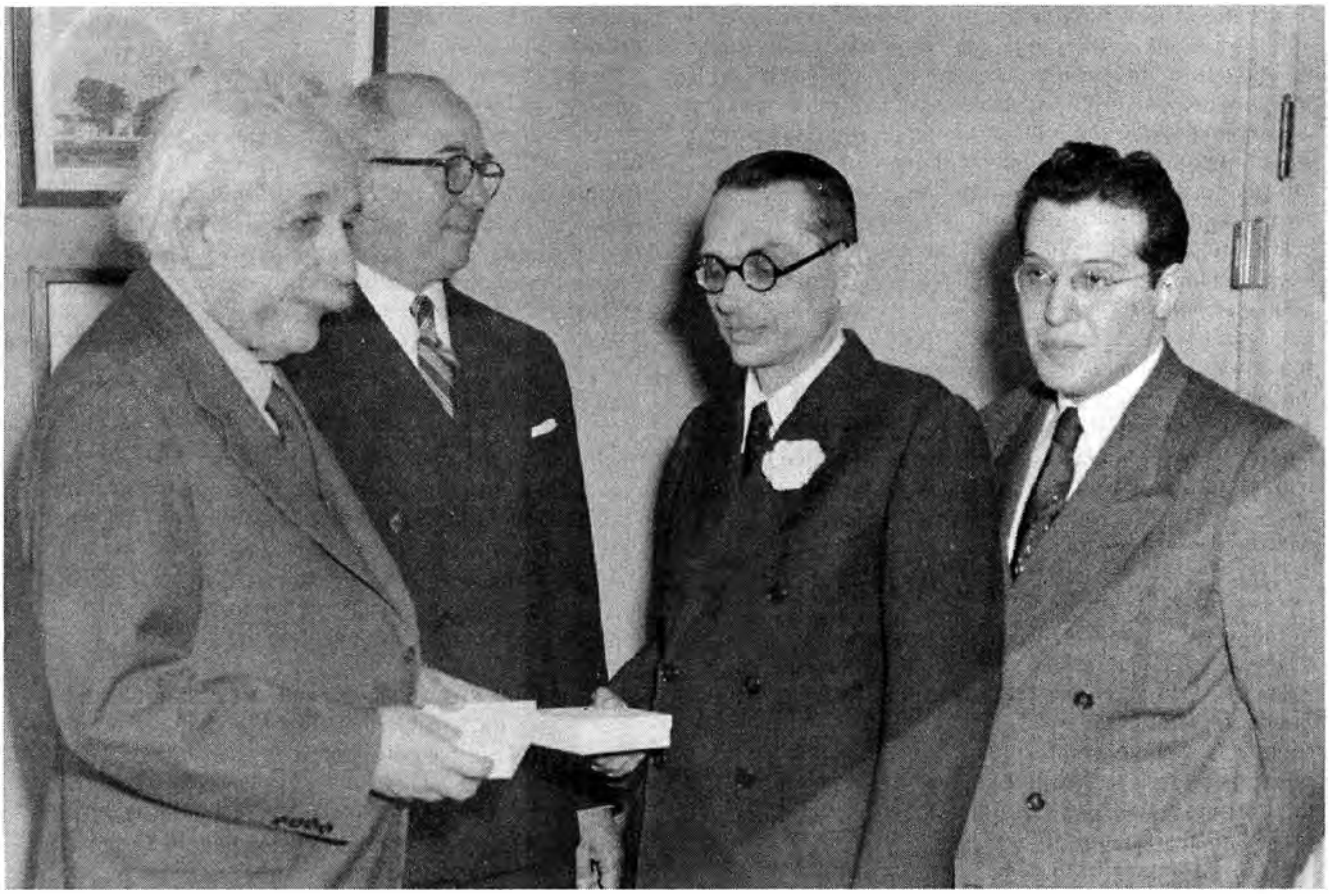
> The true reason for the incompleteness inherent in *all* formal systems of mathematics is that the formation of higher types can be continued into the transfinite, while in any formal system, at most only an enumerable number of them are available. For *it can be shown that the undecidable propositions constructed here become decidable whenever appropriate higher types are added* . . . an analogous situation prevails for the axiom system of the set theory [*Werke* I, p. 181, note 48a].

Returning to the concept of the transfinite in another letter, Gödel comments on why others had missed what he had been able to see:

> This blindness (or prejudice) on the part of logicians . . . lies in a widespread lack of the requisite basic epistemological attitude toward meta-mathematics as well as toward non-finitary thinking [Cantorian transfinite]. . . . [A]dmitting "meaningless" transfinite elements into meta-mathematics [seemed] inconsistent with the very idea of this science prevailing at the time . . . [which attributed meaning] solely to propositions which speak of concrete and finite objects. . . .I may add that in particular my conception of . . . transfinite reasoning was fundamental to my other work in logic as well. Finally, it should be noted that the heuristic principle of my construction of undecidability . . . in the formal systems of mathematics is the transfinite concept of "objective mathematical truth" as opposed to that of "demonstrability." . . . [A]gain the use of this transfinite concept has the possibility of leading to finite, provable results . . . to general theorems of existence . . . in consistent formal systems.

And in an article in which Gödel seeks to define a function for evolutionary processes:

> The process of extension can be iterated into the transfinite. Thus there cannot be any formalism which comprises all these steps [this is aimed against Turing], but this does not preclude that all these steps (or at least all those which introduce something new into the domain) could be described and brought together in *some non-constructive way.* . . . [T]he successive extension can best be represented by a stronger and stronger axiom of infinity [nested transfinites]. . . . [A]n axiom of infinity is a proposition which *has a certain decidable formal*



Alan Richards/Courtesy of the Archives of the Institute for Advanced Study

Gödel emigrated to the United States in 1940, working at Princeton University. Here, he receives the Einstein Prize in March 1951. With him (from left) are Albert Einstein, Lewis Strauss, and Julian Schwinger.

> *structure and which in addition is true.* . . .The simplest way is to *take the* [transfinite] *ordinals themselves as primitive terms.* I would think that definability in terms of ordinals, even if it is not an adequate formulation for comprehensibility by our minds, is at least an adequate formulation in an absolute sense for the property of "being formed in accordance with a law," as opposed to "being formed by a random choice of elements" [*Werke* II, pp. 151-152].

Here Gödel clearly indicates the direction of his thinking. The minimal elements of our universe are not "finite points," material or logical. The building-blocks of the universe are "transfinite." We shall see that this means that they are elementary quanta of action. The paradoxes and the need to reach higher levels do not appear, so to speak, only at the end of the road, when people start talking about God. If that were the case, then Russell, Turing, et al. could apply their motto: "Fine, keep your God for Sundays, but we don't need Him during normal working hours!"

Gödel has underscored the fact that the "paradox" of God's existence, or of Cantor's Absolute, is *efficiently* present at each moment, not simply as punishment through the emergence of crises and antinomies, but also in the joy of discovery and resolution.

With this in mind, it should be clear why Gödel devoted three years to studying Leibniz. The key to this effort was Leibniz's *Monadology*. Before we examine this subject more closely, let us briefly finish Gödel's biography.

After the Nazis annexed Austria in 1940, Gödel emigrated to the United States. At Princeton University, he developed a close friendship with Albert Einstein. In 1944, he wrote his paper titled, "Russell's Mathematical Logic," in which he attacks Russell's view that "Classes exist only as many . . . but not as one," classes are "meaningless symbols," and transfinites are "just a manner of speaking." In this paper, Gödel further emphasizes the need to carry forward Leibniz's project for a *characteristica universalis,* and quotes him: " 'so that humanity would have a new kind of instrument increasing the power of reason far more than any optical instrument has ever aided the power of vision' " (*Werke* II, p. 140).

During these years Gödel also worked on Cantor's continuum hypothesis, and on relativity theory, developing solutions to the equations in which the universe is rotating, which need not be discussed here. In 1970, apparently for the first time, he circulated some informal reflection on Leibniz's formal attempts at a proof of the existence of God. Gödel died in 1978.

Gödel and Leibniz

Let us now see whether we can make sense of Gödel's "strange" interests. It is obvious that, in order to reject mech-

anistic theories of the human mind, Gödel had to grapple with the question of why mind, or, better stated, why the human being, is different from both animals and machines. He had already stated that his own work "had not established any boundaries for the powers of human reason, but rather for the possibilities of pure formalism in mathematics" (*Werke* I, p. 369), and furthermore, that "reason, when it is used, is not static but constantly self-developing" (*Werke* II, p. 306).

It is against the background of this conviction that Gödel, according to Wang, began to say:

> I believe that there is much more reason in religion, though not in the churches, than one commonly believes, but we . . . were brought up from early youth to a prejudgment against it through the school, the poor religious teaching, through books and personal experiences.

Wang also relates:

> Given my lack of familiarity with (and interest in) theology, Gödel rarely talked to me about it, but did say that to study philosophy, I should know something about rational theology.

And Gödel would have added: "It is when religion is given up as beyond the reach of reason that philosophy loses one of its principal unifying principles."

Wang continues:

> Gödel did propose a proof of the existence of God, argue for a next world, and suggest taking God as one of the primitive concepts of metaphysics. . . . [C]entral to his thinking was the predominant (or even exclusive) importance that he attributed to the individual soul or person. . . . According to him, if you know yourself, you know everything.

Failing to grasp this direction in Gödel's thought, Wang also seems not to fully understand why Gödel

> appears to wish to continue from where Newton and Leibniz left off and to believe that the historical course after the 17th century has regressed rather than progressed, except for the increase in information. . . . [Gödel] is not satisfied with Newton's understanding of the physical concepts, but wishes to continue Leibniz's attempt to analyze the concepts deeper so that the physical concepts of physics are merged with the truly primitive concepts of metaphysics. Hence, in particular, he is not satisfied with Kant's "metaphysical foundations" of (Newtonian rather than Leibnizian) physics. . . . Gödel was in favor of a richer concept of force (than Newton's), that belongs, as with Leibniz, to the fundamental discipline of metaphysics.

Wang also cites Gödel's opposition to Kant from the standpoint that Kant played a crucial role in "separating religion into an 'irrational' domain." By doing so, Kant split up many branches of knowledge, dissociating art from science and philosophy, and so on.

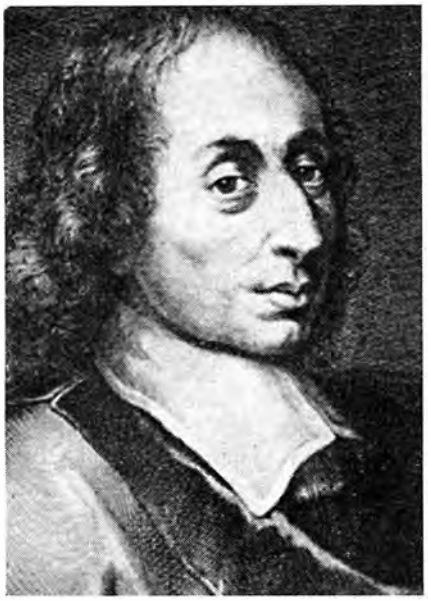
Gödel's thinking thus becomes quite clear and coherent, reflecting the insights which had produced his earliest breakthrough. Gödel is interested in theology, beyond what is usually considered religion; he is particularly interested in Leibnizian theology, not because it could produce miracles in mathematics, but because Leibniz makes intelligible a method of discovering fundamental problems, just as Cantor did not link the Absolute to God simply in order to make our arrogant academics nervous.

Leibniz wrote, in a 1678 letter to Countess Elizabeth of Pfalz, replying to a question about Descartes's ontological proof of the existence of God:

> Your highness knows that there is nothing more trite today than demonstrations of God's existence; I observe that it is almost like proofs for squaring the circle and per-petual motion. The greenest student of mathematics and of mechanics lays claim to these sublime problems . . . which, in my opinion, are the fruits of all our studies, since they constitute the foundation of our greatest hopes. . . .
>
> As for myself, I cherished mathematics only because I found in it the traces of the art *of invention in general;* and it seems to me that I discovered, in the end, that Descartes himself had not yet penetrated the mystery of this great science. . . .I claim that there is yet another analysis in geometry which is completely different from the analysis of [François] Viète and of Descartes. . . .
>
> I have recognized that metaphysics is scarcely different from the true logic, that is, from the art of invention in general; for, in fact, metaphysics is natural theology, and the same God who is the source of all goods is also the principle of all knowledge. This is because the idea of God contains within it absolute being, that is, what is simple in our thoughts, from which everything we think draws its origin. Descartes did not go about it in this way. . . .
>
> [F]or now it is sufficient for me to note that the foundation of my [universal] characteristic is also the foundation of the demonstration of God's existence. For simple thoughts are the elements of the characteristic and simple forms are the source of things. . . [*Philosophical Essays,* pp. 235-237, 240; emphasis in the original].

In 1679, in the article on *analysis situs* in which Leibniz developed the crucial notion of topological quantitative measurement beyond algebra, based on the concept of similarity, as opposed to algebraic equalities, Leibniz discusses Platonic ideas or "forms":

> In addition to quantity, figures in general also include quality or *form*. . . .The theory of similarity, or of forms, lies beyond mathematics and must be sought in metaphysics. . . .
>
> The true reason that geometricians have not made enough use of a theory of similarity is, I think, this. They did not have any general concept of it which was sufficiently distinct. . . .This is a fault of philosophers, who are



Blaise Pascal, 1623-1662

René Descartes, 1596-1650

Bibliothèque Nationale

Immanuel Kant, 1724-1804

Pascal's theology was an important influence on both Cantor and Leibniz. The opposing philosophy and mathematics was represented by both Descartes and Kant, neither of whom understood the concept of the transcendental.

usually content . . . with vague definitions. . . . Thus it is not enough to designate objects as similar whose *form* is the same, unless a general concept of form is further given . . . [Author's translation].[8]

In a letter to Queen Sophie Charlotte of Prussia, around 1702, Leibniz writes:

> Thus, what the ancient Platonists have remarked is very true, and very worthy of consideration, that the existence of intelligible things, and particularly of this I who thinks and is called mind or soul, is incomparably more certain than the existence of sensible things. . . . This conception of *being* and *truth* is, therefore, found in this I and in the understanding, rather than in the external senses and in the perception of sensible and material things outside of us. . . . [In the self] we find the *force of the conclusions* of reasoning, which are part of what is called the *natural light*. . . . [I]t is generally true that we know *necessary truths* only by this natural light, and not at all by the experiences of the senses. . . . This consideration [singularities in geometry and experimental science] also shows that there is *an inborn light within us.* For since the senses and induction can never teach us truths that are fully universal, nor what is absolutely necessary, but only what is, and what is found in particular examples, and since, nonetheless, we know some universal and necessary truths in the sciences, a privilege we have over the beasts, it follows that we have derived these necessary truths, in part, from what is within us. Thus one can lead a child to them in the way Socrates did, by simple questions [*Philosophical Essays,* pp. 189, 191; emphasis in original].

In the preface to his *New Essays on Human Understanding,* Leibniz writes:

> . . . I believe with Plato and even with the Schoolmen, and with all those who find this meaning in the passage of St. Paul (Romans 2:15) where he states that the law of God is written in our hearts. The Stoics call these principles *Prolepses,* that is, fundamental assumptions, or what is taken as agreed in advance. Mathematicians call them *common notions*. . . . Modern philosophers give them other fine names . . . [such as] living fires, or flashes of light. . . [*Philosophical Essays,* p. 292; emphasis in original].

Kurt Gödel remarks in his paper on Bertrand Russell:

> Furthermore, Leibniz explained repeatedly that his theory [of the *characteristica universalis*], however rudimentary it might be, was the origin of all his mathematical discoveries, which even Poincaré would have to acknowledge as sufficient proof of its fruitfulness. [*Werke* I, p. 141]

Now we have begun to recognize what Leibniz discovered, and why Gödel sought to grasp it. Something more should be added, however. While he was in Paris, Leibniz had taken up the work of Blaise Pascal (1623-1662), who at that time was leading the opposition to the Cartesians in every field of study. Leibniz never concealed Pascal's influence on his own work, and Cantor too had a very affirmative attitude toward Pascal. Therefore we will take a brief look at Pascal's "theology," because it was as important to Leibniz as Pascal's accomplishments in geometry.

Pascal is often wrongly associated with the so-called fideists,

or with existential pessimists such as Heidegger and Barth. To prove the case, the famous sentence in his *Pensées* is always quoted: "The eternal silence of these infinite spaces frightens me."

But let us put this excerpt in the larger context of his writings:

> Pensée 348: It is not in space that I must seek my dignity, but from the ordering of my thinking. . . . As space, the universe grasps me and swallows me up like a point; by means of reason, I grasp the universe.
>
> 527: The knowledge of God without knowledge of our impoverishment generates arrogance. The knowledge of our impoverishment without knowledge of God generates despair. The knowledge of Jesus Christ constitutes the center ground, because there we find both God and our impoverishment.
>
> 267: The last step of reason is to recognize that there is an infinity of things which surpass it. Reason is but weak if it does not go far enough to know this.
>
> 270: Saint Augustine—Reason would never submit if it did not judge that there are occasions when it must submit. It is then proper for it to submit when it judges that it must submit.

This is not pessimism, but an unsolvable paradox for all Aristotelians. This means to really grasp that Socrates did not simply say, "I do not know," but "*I know* that I do not know." And Nicholas of Cusa did not simply say "ignorance," but "*learned* ignorance."

In Paris, in the course of debating Pascal's ideas about geometry, Leibniz developed his notion of transcendental functions, a concept crucial both to mathematics and to the "ontological proof," and published it in 1675 in his paper "*De vera proportione circuli*." Leibniz calls "transcendental" most of the curves which bypass Cartesian algebra, that is, non-algebraic curves, but which can nevertheless be made intelligible by means of new mathematical tools.

Most of the functions or numbers of this type are related to the problem of "squaring the circle": The impossibility of squaring the circle takes the form of an infinite process or series. Leibniz is the first to concentrate, not on the infinite per se, in an attempt to exhaust a series, but on the discovery of some inner law subsuming the paradox. With his functions, we are able to define, not equalities, but coherent relations.

Leibniz declared:

> If we consider the totality of the series, even if it is infinite, as long as it is defined by some law of progression . . . then we can conceive of it as a totality, even if it cannot be expressed by a simple number [referring to Cartesian numbers].

Transcendental numbers or functions represent this kind of "unity of multiplicities." The same concept plays a crucial role in Leibniz's *Monadology*.

Thus we see that the actual opposition to Descartes in both philosophy and mathematics is not Kant, but Pascal and Leibniz. Kant would essentially accept Descartes's arguments against Leibniz; neither Kant nor Descartes understood the notion of real number, or of the transcendental form of intelligible existence. Let us summarize the difference between Leibniz on the one hand, and Kant and Descartes on the other, by means of an imaginary dialogue:

> *Descartes:* The only metric we have for existence is a linear algebra corresponding to finite objects in space. Nevertheless, I can think of an *infinite polygon,* therefore it exists.
>
> *Kant:* I agree with Monsieur Descartes about the metric, but in order to say that the infinite polygon exists, you have to construct it as a finite object in space, which is impossible. So it does not exist.
>
> *Leibniz:* Gentlemen, the *maximum* polygon is intrinsically self-contradictory. Each time you try to construct one, first of all, it will be finite, and secondly, I can immediately construct one with more sides. The problem is actually your "metric." The maximum of a polygon does exist: It exists as a *non-polygon,* namely, a *circle.* And this is of a higher type. Any reductive attempt to linearize the circle *will create antinomies.*

Friedrich Schiller, too, replied to Kant's philosophy with a paradox. In the third act of Schiller's play *Don Carlos,* the Marquis of Posa says:

> Look around
> Upon his splendid universe. On freedom
> Hath it been founded. . . .
> Freethinkers see the *splendors,* yet not Him.
> Wherefore a God? they say, the world suffices
> Unto itself. And Christians' reverence
> Hath never rendered Him a greater praise
> Than this freethinker's blasphemy.

On the opposing side, Bertrand Russell uses Kant against Leibniz. In 1900, Russell wrote *The Philosophy of Leibniz,* whose only aim is to try to ridicule and misrepresent Leibniz's theology and metaphysics. Specifically, Russell focusses his attack on Leibniz's "ontological proof," essentially repeating Kant's arguments. Fifty-seven years later, in his *Why I Am Not a Christian,* Russell screeches against "a Catholic dogma," referring to the ontological proof.

The First Vatican Council and Cantor's Work

In 1869, amid grave turmoil in Europe, Pope Pius IX convened the First Vatican Council, the first general council of the Church in 300 years. I am in no position to judge all the questions involved in this council. Yet it is clear that its occurrence stirred quite an uproar around the world, especially in the ranks of international Freemasonry, which, according to official accounts, called a "counter-Council" in Naples, bringing together not only Giuseppe Garibaldi and Victor Hugo, but the entire Jacobin network of Lord Palmerston's agent Giuseppe Mazzini.

It was precisely this council that adopted the Dogmatic Constitution *Dei filius* (*De fide catholica,* 1870), which affirmed that God can also be known (*conceptio*) by man with the aid of *reason.* A weighty role in this doctrinal formulation was played by J.B. Cardinal Franzelin, who later helped to shape the social policy of Pope Leo XIII, and conducted a cor-

respondence of great profundity with Georg Cantor.[9] With *Dei Filius,* the Catholic Church was responding to the materialists and the fideists, both of whom denied any connection between reason and faith.

Catholic teaching thus declares that our limited mode of language can indeed attain to God, but because of His absolute transcendentality, we cannot comprehend what He is, rather what He is not, and how other existences relate to Him.[10]

How does all this bear on Cantor's work? His letter to the French mathematician Charles Hermite of Jan. 22, 1894, is instructive:

> I thank Almighty God that he has maintained your strength to enrich, with the constant freshness of youth, my beloved mathematics (*mon premier amour*) by means of highly significant new investigations and results. . . . For it has now been more than 20 years—since the Vatican Council—that in the intellectual sphere, mathematics is no longer my soul's only love, and still less its essential one. Metaphysics and theology, I will openly confess, have taken hold of my soul to such a degree that I have comparatively little time left for my first flame. If things had gone as I wished 15 years ago, I would have been given . . . a greater field of activity in mathematics, perchance at the university, and I would perhaps have had no worse success there than Fuchs, Klein, and others. Now I simply thank God, the infinitely wise and good, that He has forever denied me the fulfillment of these wishes, for thus has he constrained me to serve Him and his holy Roman Catholic Church, through a deeper search into theology, better than I could have been able to do, in accordance with my weak mathematical talents, by means of the exclusive pursuit of mathematics. Thus my thoroughly *irenic,* universal, and cosmopolitan activity has extended mainly in two directions: first, I exert an influence upon the clergy, with whom I have the closest of friendships, acting according to this pledge: "You are my teachers in religion and theology, I your grateful son and pupil; it is subject solely to you and your good will that I become your teacher in secular science and thus build a golden bridge of conciliation from you to us and from us to you." Secondly, I have recourse to the circle of educated laymen (without zealotry, free of ostentation, with the requisite discrimination, prudence, and good sense, in order to dissuade them from the prevailing errors of skepticism, atheism, materialism, positivism, pantheism, et cetera, and lead them by degrees back to the *theism* which alone is compatible with reason. That mere churchless theism does not suffice, I know perfectly well; my weak powers do not allow me to go further on my own, the rest I leave to the disposition of all-bountiful Providence [*Briefe,* 139].

Their Name Is Pius, Books for Libraries Press

The First Vatican Council, convened in 1869 by Pope Pius IX, adopted a doctrinal formulation that affirmed that God can be known by man with the aid of Reason. One of the architects of this conception was J.B. Cardinal Franzelin, whose correspondence with Georg Cantor is noted here.

And two years later, on Feb. 11, 1896, Cantor wrote to Hermite:

> Some two years ago, you complained in one of your letters to me about the pernicious effectiveness of the *Freemasons,* and about how even *satanic cults* were flourishing in France. At the time I deliberately did not answer you on this point (although all these things were well known to me), because, I think, my studies relating to this subject had not yet produced a definite conclusion. You are completely right to see in *Freemasonry* the strongest and greatest danger to the Church and human society; therefore, along with many others, I have dedicated myself for many years to this subject, among many others, and in particular I am well acquainted with the French configurations of this monster. Several weeks ago, toward the end of 1895, the "Labarum" world league was founded. . . . The question is now whether we will be able to reach the essential goal, namely, the total annihilation of the vital principle of Freemasonry in all its colorations. This goal, however, is the reason why I have probed and studied this dragon down to the core of its black-blooded heart, in which effort I believe I had been guided and encouraged by God's grace [*Briefe,* 153].

Attention should be called, not only to Cantor's reference to the Vatican Council, but also to his use of the word "irenic," a term associated with Leibniz's project of reunifying the Christian churches. In this context, a comment on Kant in a Sept. 19, 1911, letter from Cantor to Bertrand Russell is of interest:

. . .I am quite an adversary of Old Kant, who in my eyes has done much harm and mischief to philosophy, even to mankind; as you easily see by the most perverted development of metaphysics in all that followed him, as in Fichte, Schelling, Hegel, Herbart, Schopenhauer, Hartmann, Nietzsche, etc. etc., on to this very day. I never could understand how . . . reasonable people . . . could follow yonder sophistical philistine, who was so bad a mathematician [*Briefe,* 181].[11]

Now let us examine how Cantor further developed Leibniz's work on transcendental functions.

Cantor's Notion of an Absolute Function

What is a number?

Cantor says that all his work is based on "the *extension* of the concept of number," which in effect means that his point of departure is Leibniz's transcendental numbers. For Cantor, "number" is essentially the same as "conscious concept." It is an object of our thinking. And like all real concepts, it contains within it a paradox. Keeping in mind that Cantor frequently uses the term *Menge,* usually translated "set," for "number," let us begin with the following statement:

By a number, I generally understand every multiplicity which can be thought of as one, i.e., any totality of definite elements which by means of a law can be bound up into a whole, and I believe that in this I am defining something which is related to the Platonic ἐιδος [*eidos*] or ἰδέα [*idea*]. . . [*Gesammelte Abhandlungen,* 204].

Cantor also emphasizes that Euclid's concept of number, as expressed in Book VII, has the same content: "A number is an aggregate of unities." Let us pursue the tracks of these "unities." In the *Monadology,* Leibniz says:

The passing state which involves and represents a multitude in the unity or in the simple substance is nothing other than what we call *perception,* which should be distinguished from apperception, or consciousness, as will be evident in what follows. This is where the Cartesians have failed badly, since they took no account of the perceptions that we do not apperceive. . . [*Philosophical Essays,* p. 214, §14; emphasis in the original].

Bernhard Riemann, Cantor's predecessor, says, in one of what Wang might call his "strange" moments:

With every simple thought, something enduring, substantial, enters our souls. This substantiality appears to us indeed as a *unity,* yet (insofar as it is the expression of something spatially and temporally extended) it seems to contain an internal manifold; hence I call it a "thought-mass." All thinking is, accordingly, the formation of new thought-masses. The thought-masses entering the soul appear to us as mental images. . . .[12]

We see, then, that even if their terminology differs, Cantor, Riemann, and Leibniz have in mind the same idea. Cantor makes use of another of Leibniz's insights to communicate a fuller sense of his new transfinite numbers. Number, Cantor says, is

a *true unity* [*monas*], because in it a multiplicity and manifoldness of units is united. . . .The addition of units, however, can never serve as the definition of a number. . . .This proves that number, achieved through a single act of abstraction, can only be explained as an organic unity of units.

In Cantor's German, plays on "Ein" are evident:

eine *wahre Einheit* [*monas*], weil in ihr eine Vielheit und Mannigfaltigkeit von *Einsen einheitlich* verbunden ist. . . . Die Addition von Einsen kann aber niemals zur Definition einer Zahl dienen. . . . Dies beweist, dass die Zahl, durch einen einzigen Abstraktionsakt gewonnen, nur als organische Einheit von Einsen zu erklären ist. . . [*Gesammelte Abhandlungen* 380-1].

In other locations, Cantor develops this metaphor and speaks of numbers as "organisms," in the sense of a living cell or monad. Cantor's mathematics is, so to speak, mapping the phenomenon of "bringing unities to life" in the domains of nature and the intellect. In 1885, he writes:

In accord with Leibniz, I call the *simple* elements of nature, out of whose combination in a certain sense *matter* emerges, *monads* or *unities* [there follow two references to Leibniz] . . . I proceed from the view, in which I think I find myself in agreement with modern physics, that *two different, specific, mutually interacting substances,* and accordingly also *two* different classes of monads, are to be juxtaposed as the basis: . . . the corporeal *monads* and the aether *monads*. . . .

From this standpoint arises, as the *first question* . . . which *powers* those two substances have, taking into consideration their elements. . . . [I]n this connection I had already formed the *hypothesis* years ago that the *power* of the *corporeal substance* is what I call the first power in my investigations, while on the other hand, the *power* of the *aether substance* is the *second* power [*Gesammelte Abhandlungen* 275-276].

We will soon see what is meant by "power," but let us first look at the whole picture Cantor has in mind:

The actual infinite [can be] differentiated according to *three* relations: *first,* so far as it is realized in the highest perfection, in fully independent existence outside the world, in God, where I call it the *absolute infinite* or *Absolute; secondly,* insofar as it is represented in the contingent world of creatures; *thirdly,* so far as it can be grasped by thought as mathematical magnitude, number, or type of ordering, *in abstracto.* In the two latter relations . . . I call it the transfinite and counterpose it with the utmost strictness to the Absolute [*Gesammelte Abhandlungen* 378].

Compare Cantor with Aristotle: Cantor's universe is composed of an Absolute and an array of transfinites. Aristotle's universe is composed of an Absolute and an array of objects and linear changes. The difference is that in Cantor, there is a reflexivity between the absolute Creator and the human and natural creations; in Aristotle, there is none. For man, the Aristotelian gods are thus as good as dead.

In Cantor, there is a reflexivity between the absolute Creator and the human and natural creations; in Aristotle, there is none. For man, the Aristotelian gods are thus as good as dead.

The Unity of One and Many

Cantor makes another important clarification:

(1) Assume two modes of changes:

(a) the first class, or first process of generation. This is a linear or formal-deductive algebraic *type* of change.

(b) the second class, or second process of generation. This is a nonlinear, qualitative, creative, transfinite, transcendental *type* of change. Plato refers to it as "the coming-into-being resulting from those measurings that are attained with the aid of the limit" (*Philebus,* 26d).

(2) Specify the Platonic-Leibnizian principle "What bounds is higher than what is bounded." Cantor says specifically:

> If we begin by taking a set or aggregate which has the power of the first class, and give its elements *any* sort of determinate succession, so that it becomes "well-ordered," then its number [*Anzahl*] is always a definite number [*Zahl*] of the *second* number class . . . [*Gesammelte Abhandlungen* 169].

Here *Anzahl* means "unity," the transfinite *ordinal number* which bounds a "well-ordered succession," the "Many." As a thought-object, as a number, it is an element with a higher power than the elements it orders, and in reality it determines their existence in the form of an *ordered* Many, or ordered progression.

The important thing to make clear is that Cantor takes such "transfinite ordinals," "unities of multiplicities," "thought-objects," transcendental numbers, *Anzahlen,* and so forth, as the *minimum* elements of his universe. As we have seen in the case of Gödel, then Leibniz, and now Cantor, the irreducible elements of our universe, the "unit measure," are *creative acts,* or actual monads. Linear change, the realm of the "Many," is ultimately a *subsumed aspect* of this creative activity. And thus we can define the transfinite ordinal essentially as a *quantum of creativity.*

The Alephs and the Concept of 'Power'

This leads us directly to the notion of "power," which stems from Leibniz's *analysis situs.* The question is how to measure species of qualitative changes. Cantor first made a formal demonstration that only "transcendental" changes can increase the power of a series, and lead to the next higher power. But even qualitative changes can become constant or repetitive in their ordering principle, and will not lead of their own necessity to a higher power. Cantor calls this first power $\aleph_0$ (aleph-0).

This identifies the species or *type* of qualitative changes which defines, for instance, all the physical transcendental functions of Leibniz. Here we see the richness of the very first, null-power level. Its elements are the first sort of creative acts or monads.

Then, if we want to go further, as we must, we have to consciously grasp the underlying principle of that type of change, the "power" of the first domain, so that we can transform it. We can create new species of functions, new types of ordinals, which will be of a higher power, $\aleph_1$

Mathematically, on this level we find, for example, the non-analytical functions. We can also characterize the $\aleph_1$ power by saying that it is a changed mode of thinking.

In his formal mathematics, Cantor ended his description with $\aleph_1$ Yet he generalized the process so as to be able to think in terms of a universal series of alephs of higher and higher power. It is sometimes assumed that the series simply progresses from $\aleph_1$ to $\aleph_2$, $\aleph_3$, $\aleph_4$, and so on, as "the change of the change of the change. . . ." We had better stop right there.

This is one of the most common misunderstandings. It reflects a psychological outlook which leads to all the formalist absurdities of Russell and others. The progression is not a simple "and so on and so forth." That approach usually means that we are *linearizing* development, as if we had already found the constant of the process.

Then what does Cantor mean by the aleph series? In order to get a precise image, we cannot approach it as "the thinking of the thinking of the thinking." We have to look at our historical development as the human species, what man has and has not accomplished. Consider the species as one human being, born a long time ago, and still living; let's call him "humanity."

Now, investigate how humanity has had to change his mode of thinking, how he has had to *increase the power* of his creative process, in order to survive. Consider how he did it, and what happened when he did not succeed. Consider, also, the fact that each time a creative act succeeded, it was accomplished by actual individuals like us. Look at other living species, at types of energy. Now we can begin to understand what Cantor had in mind with the universal aleph series.

Cantor himself discovered what happens when one attempts to linearize a discontinuous series of changes. In a letter to David Hilbert of Sept. 26, 1897, referring to a discovery he had made two years earlier, two years before the so-called Zermelo Paradox, he wrote:

> The totality of all alephs is namely of a kind which cannot be conceived of as a determinate well-defined complete set. Were this the case, an aleph of *definite* magnitude would be a successor to this totality, which would accordingly *belong* to this totality (as an element), while it also would *not belong,* which would be a contradiction. . . . Many years ago I assigned the term "absolute infinite" to *totalities* that we cannot conceive

as "sets" (of which the totality of all alephs is an example, as was demonstrated above), and sharply differentiated them from the *transfinite numbers* [*Briefe,* No. 156, pp. 388-389].

Cantor wrote again to Hilbert, who had difficulty understanding the concept, on Oct. 2, 1897:

> You overlook the fact, however, that I . . . have continued to use the predicate "complete," and stated:
>
> *Theorem:* "The totality of all alephs cannot be conceived of as [a] determinate and *at the same time complete* set."
>
> Herein we see the *punctum saliens* [salient point]. . . .
>
> It is only necessary to understand the term "complete" in the right way. [*Briefe,* No. 156, p. 390]

On May 9, 1899, he wrote to Hilbert that from now on, "complete" would mean the same thing as "consistent" [*Briefe,* No. 160, p. 399].[13]

The 'Absolute'

Cantor recognized that the paradox arose from the effort to linearize, indeed, to nullify, a process whose minimum element, as we saw earlier, is nothing other than a type of creative activity, that is, an aleph. He did not conclude, however, that the solution would be to eliminate creativity, or render it completely unintelligible, as Russell and Poincaré later proposed to do. Based on his knowledge of theology and philosophy, Cantor realized that, from the *necessary existence* of creative activity, from its lawful ordering, it was possible to *indirectly* establish the existence of a higher type of unity—as he had done in his first encounter with transcendental functions.

Now, try to imagine for a minute that you are a *conscious* polygon which must continuously increase the number of its sides, and see whether you can discover that there is a Maximum, but not a maximum polygon. The existence of this Absolute is reflexive, in the sense that it paradoxically guarantees the impossibility of complete linearization from any point of departure, or, conversely, proves the necessity of higher types of creative evolutionary acts.

American Institute of Physics/Emilio Segrè Visual Archives

Mathematicians, such as David Hilbert, had difficulty understanding Cantor's concept of the aleph series.

Writing to Richard Dedekind on July 28 and Aug. 3, 1899, Cantor gives a long formal justification for this. The conclusion, in summary, is that the system of all alephs, that is, the system of all transfinite cardinal numbers, forms an "inconsistent absolute infinite [well-ordered] sequence" [*Briefe,* Nos. 162 and 163, pp. 405-411].

Which means:

(a) It is *well-ordered:* the quality and necessity of the transitions, the transformations, point to the existence of an *absolute* ordinal number, a unity, a maximum of higher powers.

(b) It is *inconsistent,* meaning that the maximum ordinal in the series cannot be an aleph. There is no maximum aleph. The series are unlimited.

(c) That inconsistency, that impossibility of a maximum aleph, at the same time also defines the quality and necessity of evolution to the next higher aleph, to higher modes of existence.

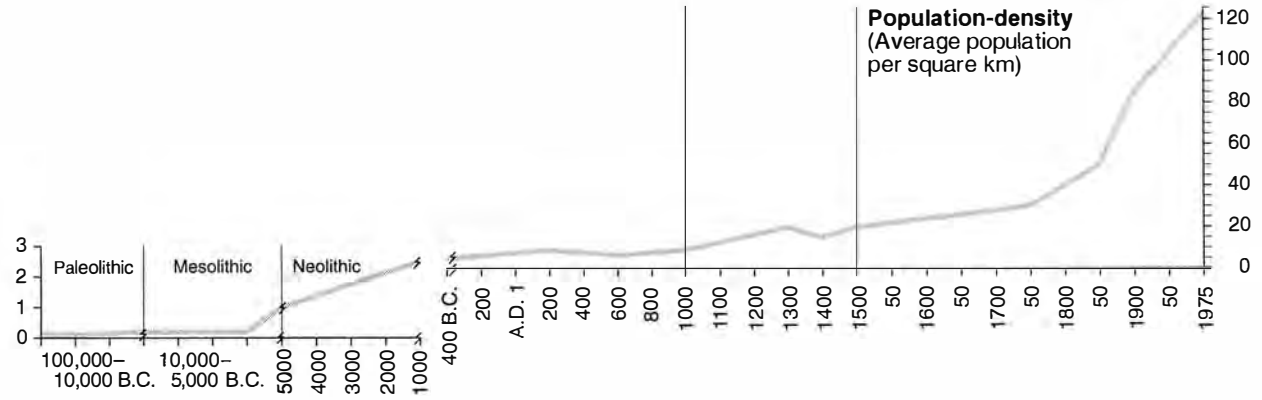
Look back at Leibniz's *Monadology:*

> Since this substance is a sufficient reason *for* all this diversity, which is utterly interconnected, *there is only one God, and this God is sufficient* [*Philosophical Essays,* p. 218, §39; emphasis in the original].

Gödel showed the absurdity of any attempt to avoid the paradox of the reflexivity of the evolutionary "inconsistencies," and after he realized the implications, he developed his "strange" interest in Leibniz. As we said at the beginning, it must be emphasized that because of the nonexistence of formal mathematical solutions, the "choice" of the ordering, and the determination of its necessity, require a comprehension of the creative act as a real existent, as a physical force. This, I think, is why Gödel began to take an interest in "Leibnizian forces"; however, he never arrived at Leibniz's science of technology.

LaRouche's comment on Cantor's alephs is pertinent here:

> The crucial added feature . . . is this writer's definition of that series as a sequence of successive increases in *potential population density.* This addition leads to solution of hitherto perplexing problems in the physical-economic functional definition of the Leibnizian term, *technology.* That, in turn, defines a quality of



POPULATION-DENSITY IN EUROPE, 100,000 B.C. TO 1975
(Average population per square km)

LaRouche has given a unique physical significance to the concept of Cantor's alephs by defining that series as a sequence of successive increases in potential population density. *As LaRouche writes, "This addition leads to solution of hitherto perplexing problems in the physical-economic functional definition of the Leibnizian term,* technology." *Depicted here is economic growth as a function of man's increasing mastery over nature, reflected in the increase in population density.*

process in which Cantor's alephs acquire a unique physical significance.[14]

That is how we can give far greater content to an otherwise rather cold, formal Absolute.

And in order not to leave "Old Kant" in peace, I would like to conclude with a joke that Plato might have made about him:

Kant considered himself "enlightened," or "illuminated." Now, everyone knows that actors on an illuminated stage have some difficulty seeing each other, and when they look out into the theater, they see nothing at all. We, the poor spectators in the shadows, not only clearly see the "illuminated ones," but we can even see, though vaguely, certain persons beyond the stage.

Dino de Paoli, based in Hannover, Germany, has written widely on the history of science, especially the role of Leonardo da Vinci. Sponsored by the Schiller Institute, he has presented a series of lectures on Cantor and the transfinite to university audiences in Europe.

Notes

1. The first part appeared in *21st Century*, Summer 1991, p. 43, "A Refutation of Artificial Intelligence: Georg Cantor's Contribution to the Study of Human Mind."
2. Hao Wang, 1988. *Reflections on Kurt Gödel* (Cambridge, Mass.: MIT Press). Most of the biographical information on Gödel referred to here comes from this work.
3. By "reflexive," I mean the quality which Cantor demonstrated for the transfinite ordinal numbers, namely, that the part reflects the attributes of the whole. With reference to the Absolute, we shall see, through Gödel's proof, that the "inconsistency" discovered by Cantor in an all-encompassing absolute unity holds true for any theoretical lattice of theorems, and indeed in an everywhere "dense" way, because the inconsistency itself is present in every arbitrarily small "interval" of the lattice.
4. Anselm of Canterbury (1033-1109), *Fides querene intellectum* and *Proslogion*.
5. Kant, in his *Critique of Pure Reason*, rejected all forms of theology based on reason. In the *Critique of Practical Reason*, however, he attempted to demonstrate the existence of a supreme God. At that point, precisely in order to prove the existence of a however-constituted "God-like Maximum," Kant is compelled to apply just the "transcendental" method which he had rejected. He made the best of a bad job by replacing moral laws with ethical ones, and Gödel accurately accuses him of paying mere lip service to religion.
6. Lyndon H. LaRouche, Jr., 1993. "On the Subject of God," *Fidelio*, (Spring), pp. 17-48.
7. See the author's "A Refutation of Artificial Intelligence: Georg Cantor's Contribution to the Study of Human Mind" (Note 1 above) and, among other textbook treatments of Cantor's proof, William Dunham, *Journey Through Genius—The Great Theorems of Mathematics* (New York: John Wiley & Sons, 1990).
8. Leibniz's paper "On Analysis Situs," is included in Gottfried Wilhelm Leibniz, *Philosophical Papers and Letters*, edited by Leroy E. Loemker, 2nd edition (Norwell, Mass.: Kluwer Academic Publishers, 1969), pp. 254-258.
9. De Paoli, "A Refutation of Artificial Intelligence" (Note 1 above), pp. 50-51. The entirety of the Cantor-Franzelin correspondence was published for the first time in English in "On the Theory of the Transfinite," *Fidelio*, Fall 1994, pp. 98-106.
10. The idea is expressed in the *Catechism of the Catholic Church* (Vatican City: Libreria Editrice Vaticana, 1994), §43, quoting Thomas Aquinas, among others.
11. While Johann Friedrich Herbart (1776-1841) was at first an adherent of Leibniz and Schiller (and in this vein influenced Bernhard Riemann), he later turned against them.
12. Bernhard Riemann, "On Psychology and Metaphysics," in his "Philosophical Fragments." The first English translation of the "Philosophical Fragments" in their entirety appears in *21st Century*, Winter 1995-1996, pp. 50-62.
13. Ironically, Hilbert failed to understand precisely this point.
14. Lyndon H. LaRouche, Jr., 1993. "On the Subject of God" (Note 6 above), p. 38.

A Note on Sources

Cantor's works are cited from *Gesammelte Abhandlungen* (Collected Treatises), edited by Ernst Zermelo, Berlin, 1932.

Cantor's letters are cited from *Briefe* (Letters), edited by Herbert Meschkowski and Winfried Nilson (Berlin: Springer-Verlag, 1991).

Gödel's writings are cited from the two volumes of the German edition (*Werke*). An English edition in several volumes is in the process of being published (*Collected Works*, edited by Solomon Feferman, et al., New York: Oxford University Press, 1986-).

Citations from Leibniz, unless otherwise identified, are found in *Philosophical Essays*, edited and translated by Roger Ariew and Daniel Garber (Indianapolis: Hackett Publishing Co., 1989).

In quotations, words in square brackets have been supplied by the author.

A CASE STUDY OF SABOTAGE
BY THE BRITISH ROYAL SOCIETY

Leibniz, Papin, And the Steam Engine

by Philip Valenti

The Newtonians delayed steam power 100 years by suppressing the technology and the Leibnizian conceptions behind it.

Corbis-Bettmann

The early history of the invention of the steam engine shows, without doubt, that the British Royal Society, including Isaac Newton personally, prevented the industrial and naval applications of steam power for nearly 100 years. In fact, the Royal Society was so intent on burying Denis Papin's 1690 invention of a paddlewheel-driven steamship, worked out in collaboration with Gottfried Wilhelm Leibniz, that it stole his work, and created a mythical story of how two British "Newtonian" heroes, Savery and Newcomen, invented the steam engine, for the sole purpose of raising water from coal mines—a myth that still persists in history books today.

As we shall demonstrate, Leibniz and Papin developed the steam engine based upon a scientific hypothesis concerning the nature of the Universe, elaborated by Leibniz in such metaphysical writings as his *Monadology*. This case study shows how modern technology emerged as a result of a purely philosophical conception, as opposed to Newton's logical/empirical ideology and his hatred of all hypotheses (other than his own). This fact is what the British Royal Society, and its modern epigones, have sought to suppress.

The French Academy of Sciences

The project of discovering and perfecting a new source of power, capable of effecting a dramatic human advance, was first initiated as a directed national effort by Jean-Baptiste Colbert (1619-1683), the minister of the young French King Louis XIV. In 1666, Colbert established the Academy of Sciences at Paris for this purpose, recruiting the Dutch scientist Christiaan Huygens (1629-1695) as its first president. Huygens's proposed 1666 program included "research into the power of gunpowder of which a small portion is enclosed in a very thick iron or copper case. Research also into the power of water converted by fire into steam," as well as experiments with vacuum pumps, wind-powered engines, and the communication of force by the collision of bodies.

In 1672, Huygens acquired two young students and collaborators: German diplomat Gottfried Wilhelm Leibniz (1646-1714), and Denis Papin (1647-1712?), a medical doctor introduced into the Academy by Madame Colbert. Within a year, Huygens and his new colleagues had successfully modified the von Guerike air pump into an engine capable of transforming the force of exploding gunpowder into useful work.

Huygens proposed to create a vacuum within a cylinder under a piston, by exploding a charge of gunpowder at the cylinder's base (Figure 1). After the air was expelled through two valves fitted with leather collars, the collars collapsed, preventing air from reentering the cylinder. The pressure of the atmosphere then pushed the piston downwards, into the cylinder, the motion of the piston being applied to perform work.

After successfully demonstrating a model gunpowder engine to Colbert, Huygens wrote:

> The violent action of the powder is by this discovery restricted to a movement which limits itself as does that of a great weight. And not only can it serve all purposes to which weight is applied, but also in most cases where man or animal power is needed, such as that it could be applied to raise great stones for building, to erect obelisks, to raise water for fountains or to work mills to grind grain. . . . It can also be used as a very powerful projector of such a nature that it would be possible by this means to construct weapons which would discharge cannon balls, great arrows, and bomb shells. . . . And, unlike the artillery of today these engines would be easy to transport, because in this discovery lightness is combined with power.
>
> This last characteristic is very important, and by this means permits the discovery of new kinds of vehicles on land and water.
>
> And although it may sound contradictory, it seems not impossible to devise some vehicle to move through the air. . . .

An 1883 illustration depicting Denis Papin attempting to sail his steam-powered boat on the River Weser, assailed by fearful boatmen and shippers in 1707.

While Papin advanced Huygens's work with improved engineering designs, Leibniz proceeded, in deliberate fashion, to discover and develop the science of dynamics, and its mathematical tool, the calculus.

Leibniz wrote that in his youth, he freed himself from "the yoke of Aristotle," rejecting scholasticism in favor of the mate-

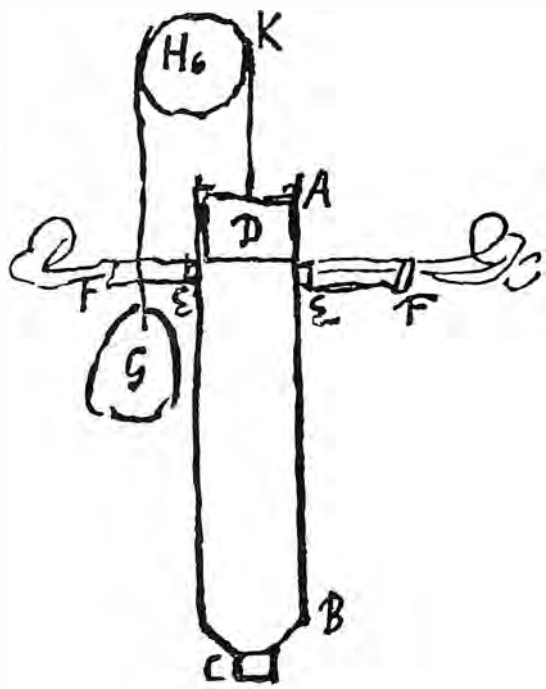


Figure 1
HUYGENS'S GUNPOWDER DEVICE
Christiaan Huygens designed this earliest internal combustion engine in 1673, using a charge of gunpowder to create a vacuum in a cylinder under a piston. While Huygens's device relied on mere atmospheric pressure to perform work, Leibniz anticipated the modern high-powered engine by proposing to harness the direct force of exploding gunpowder or alcohol, as well as high-pressure steam.

rialist notion of "atoms and the void." Accepting Descartes's notion of matter as mere passive "extension," Leibniz attempted to work out a complete physical theory in his 1670 *New Physical Hypotheses.* However, he found that the assumption of a passive, inert matter, whose essence consists in merely taking up space, resulted in absurdities.

Consider the case, he wrote, of a small body, *A,* moving in a straight line with velocity *V.* Suppose that *A* encounters a much larger body, *B,* at rest. Leibniz concluded, that because there is nothing in the concept of mere extension to account for inertia, the body *A* will carry the body *B* along with it, without losing any of its velocity:

> This is a consequence which is entirely *irreconcilable with experiments.* . . . All of this shows that there is in matter something else than the purely Geometrical, that is, than just extension and bare change. And in considering the matter closely, we perceive that we must add to them some *higher or metaphysical notion, namely, that of substance, action, and force* [emphasis in original].

As opposed to the Newtonian dogma of "hard atoms," interacting in the "vacuum" of empty space, Leibniz proposed to study the supposedly "impenetrable" interior of things (much as 20th-century scientists have explored the interior of the atom), thus leading to the discovery of new and greater sources of power.

This project led Leibniz to discover the grounds for universal progress, and the basis for a new science—*dynamics.* For Leibniz, matter cannot be divided linearly, like marks on a ruler, but rather in a manner suggestive of the Riemannian conception of nested manifolds, or "worlds within worlds." Thus, Leibniz develops his own concept of "infinite divisibility" in the *Monadology:*

> Each portion of matter is not only divisible *ad infinitum,* as the ancients recognized, but also each part is actually endlessly subdivided into parts, of which each has some motion of its own; otherwise it would be impossible for each portion of matter to express the whole universe.
>
> 66. Whence we see that there is a world of creatures, of living beings, of animals, of entelechies, of souls, in the smallest particle of matter.
>
> 67. Each portion of matter may be conceived of as a garden full of plants, and as a pond full of fishes. But each branch of the plant, each member of the animal, each drop of its humors is also such a garden or such a pond.
>
> 68. And although the earth and air which lies between the plants of the garden, or the water between the fish of the pond, is neither plant nor fish, they yet contain more of them, but for the most part so tiny as to be imperceptible to us.
>
> 69. Therefore there is nothing fallow, nothing sterile, nothing dead in the universe, no chaos, no confusion except in appearance. . . .

Such an endless subdivision, Leibniz said, can account for the "perpetual and very free progress of the whole universe":

> Even if many substances have already reached great perfection, nevertheless on account of the infinite divisibility of the continuum, there always remain in the depths of things slumbering parts which must yet be awakened and become greater and better, and, in a word, attain a better culture. And hence *progress never comes to an end* [emphasis added].

The Development of Dynamics

Equipped with a matter containing unlimited resources ("slumbering parts which must yet be awakened"), Leibniz transcended the science of mechanics that had dominated Western thinking since Archimedes. Where mechanics pertained to the passive effects of ancient machines—the lever, pulley, inclined plane, and so on—dynamics was conceived as the science of the active, living force *(vis viva,* or kinetic energy) of "violent actions," such as the explosion of gunpowder, and rapid expansion of high pressure steam:

> The ancients, so far as is known, had conceived only a science of inactive force, which is commonly referred to as Mechanics, dealing with the lever, the windlass, the inclined plane pertinent to the wedge and screw though there is discussion of the equilibrium of fluids and of similar problems; only the effort or resistance of bodies, and not the impetus they have acquired through their action, is discussed. . . .
>
> For I here refer not to any effect, but to one produced by a force which completely expends itself and may therefore be called violent; such is not the case with a heavy body moving on a perfectly horizontal plane and constantly preserving the same force; this is a harmless sort of effect, so to speak, which we can also calculate by our method, but it is not the one we wish to consider now.

Since it is limited to the study of "harmless sorts of effects," mechanics considers the total absolute force of bodies acted upon by the ancient machines, as directly proportional to the acquired velocity, or $F = mv$. In contrast, Leibniz considered the equivalence of the kinetic energy of a heavy body falling from a given height (violent action), to the work required to raise it to that height, and determined that the live force of a body in motion is directly proportional to the *square* of the velocity; that is, $F: mv^2$.

Leibniz's practical goal became to harness the most violent actions, for the purpose of advancing the material conditions of man. By applying the law of the conservation of *vis viva* to maximize the conversion of the kinetic energy of such actions into useful work, Leibniz envisioned mastering the direct force of explosions to power ships, carriages, airplanes, and factories. In contrast, how could a scientific establishment possibly invent anything useful while insisting, as the British Royal Society did throughout this period, that one's preference between measuring force by mv or mv^2 is simply a matter of personal taste, the consequence of a mere semantic quibble?

From the beginning of his study of the matter, Leibniz had insisted on the practical implications of his dynamics, particularly the issue of mv^2 versus mv, for the construction of machines and the perfection of technology.

He wrote in 1695:

> These things are not worthless to consider, nor are they quibblings over words, for they are of the greatest importance in comparing machines and motions. For example, if power is obtained from water or animals or from some other cause, by which a weight of 100 pounds is kept in constant motion so that within a fourth of a minute it can be made to complete a circle of 30 feet diameter, but someone else maintains that a weight of 200 pounds can in the same time complete half the circle with less expenditure of power, his calculation seems to yield a gain; but you ought to know that you are being deceived and getting only half the power. . . .

By 1675, the impact of the reactionary shift in the policies of Louis XIV, which began with the French invasion of Holland in 1672, reached Colbert's Academy. The result was a forced exodus of Protestant scientists. Leibniz left Paris, reluctantly, to accept a post as librarian in Hanover, while Papin left for England.

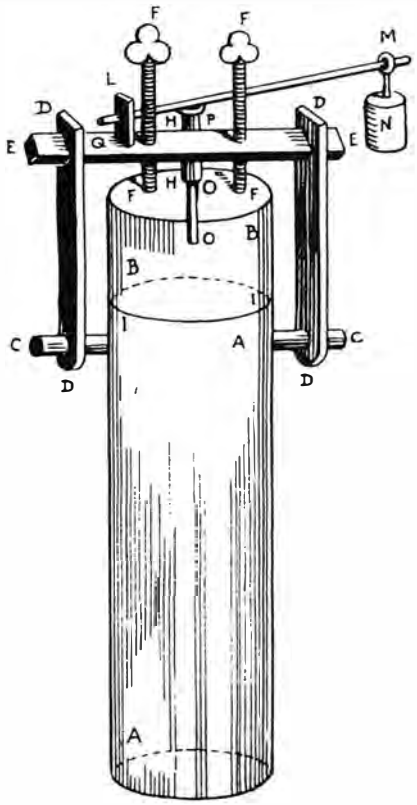


Figure 2
PAPIN'S DIGESTER

Papin wrote a lengthy cookbook for 17th century housewives, explaining the operation of his 1680 invention, the steam pressure cooker, or "digester." In addition to helping to "relieve poverty," which was Papin's purpose, the digester enabled science for the first time to safely control pressures many times ordinary atmospheric pressure. Papin accomplished this breakthrough by inventing the adjustable safety valve, installed at the top of the cooker.

Papin's Early Inventions

By 1680, Papin had made a major breakthrough toward controlling highly compressed steam, in the form of his "New Digester for softening Bones, etc.," a steam pressure cooker. This device consisted of a cylinder with thick walls (as prescribed by Huygens in his 1666 program), in which was enclosed water along with bones, tough meat, and so forth. The whole device was then placed on a fire to cook (Figure 2).

Although Papin's immediate motive was, as he wrote to Huygens, "to relieve poverty, and to get wholesome and agreeable foods from things that we ordinarily reject as useless," his digester was also a major advance toward the steam engine, because of a totally new feature—the safety valve. This allowed Papin safely to contain pressure many times that of the atmosphere and greater than any pressure previously controlled, limited only by the strength of the cylinder.

In 1687, Papin unveiled a new invention to transmit power pneumatically, in order to develop a means of spreading industrialization to areas where water power was not available. Papin proposed erecting two sets of pumps: one set operated

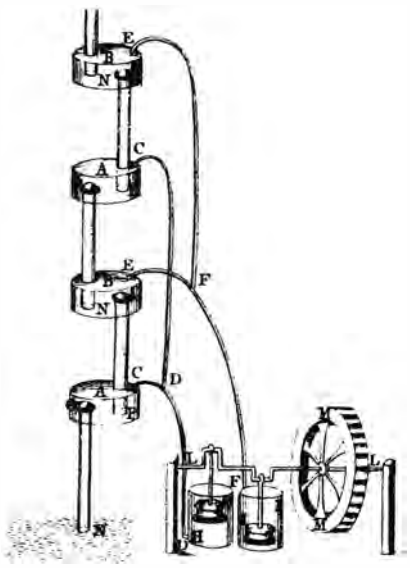


Figure 3
PAPIN'S PNEUMATIC FOUNTAIN

In 1687, Papin illustrated the operation of his pneumatic pump by constructing a model fountain. Water was raised by the alternate suction and pressure exerted by a pair of air pumps. Papin enclosed his model in a container, allowing his Royal Society colleagues to observe the water spouting at the top, but concealing its internal mechanism, and he then challenged the Royal Fellows to guess at its design. The Royal Fellows failed to solve Papin's puzzle, and were especially embarrassed because they had all earlier agreed that the pneumatic transmission of power was impossible. Papin found himself suddenly friendless in London and decided to leave for Germany later that year.

by a water wheel, connected by airtight pipes to another set, which was placed in a neighboring town or suburb. Power would be transmitted by the alternate suction and pressure exerted by the first set of pumps (Figure 3). This idea was hotly opposed in the British Royal Society, and Papin left England to accept a chair of mathematics at the University of Marburg in Hesse, bordering Hanover.

In 1690, Papin published an historic article in the *Acta Eruditorum* of Leipzig, "A New Method of Obtaining Very Great Moving Powers at Small Cost," where he proposed using the power of expanding steam to operate a piston/cylinder engine. In the new invention, steam replaced the gunpowder charge of Huygens's cylinder, creating a more complete vacuum under the piston, and thereby taking advantage of the full force of atmospheric pressure (Figure 4).

Papin's concept was appropriated *in toto* in the Newcomen engine more than 20 years later. However, although Papin mentioned in passing the utility of his invention to "draw water or ore from mines," his article featured a lengthy and detailed discussion of the application of steam power to propelling ships equipped with paddlewheels:

> So, no doubt, oars fixed into an axis could be most conveniently driven round by my tubes, by having the rods of the pistons fitted with teeth, which would force round small wheels, toothed in like manner, fastened to the axis of the paddles. It would only be requisite that three or four tubes should be applied to the same axis, by which means its motion could be continued without interruption [Figure 5].

Papin recognized the problem inherent in such atmospheric engines. Because the source of power is not the steam itself, but the pressure of the atmosphere, the only means of increasing power is to increase the diameter of the cylinders:

> The principal difficulty, therefore, consists in finding the manufactory for easily making very large tubes. . . . And for preparing that, this new machine ought to supply no small inducement, in as much as it very clearly shows that such very large tubes can be most advantageously employed for several important purposes.

The Leibniz-Papin Collaboration

Papin began to tackle the problem of "making very large tubes," by studying the means of refining ores more efficiently, and of manufacturing cylinders with appropriately smooth surfaces; that is, to create the appropriate *machine tools,* which would allow him to realize his ideas. This led him to the invention of an improved furnace capable of reaching higher temperatures with a more efficient consumption of fuel. Papin used another of his inventions, the Hessian bellows, to generate a forceful down-draft in his furnace, thereby eliminating smoke and allowing a complete burn (Figure 6).

By 1695, Papin had adapted this hotter furnace to the rapid production of high-pressure steam, by constructing the furnace so that the fire surrounded the water, allowing the maximum surface area of water to be heated directly.

With this discovery, Papin was prepared to initiate a qualitative technological advance—not a linear extrapolation from his 1690 results, such as building larger atmospheric engines, but a proposal to directly harness the violent force of the expanding steam.

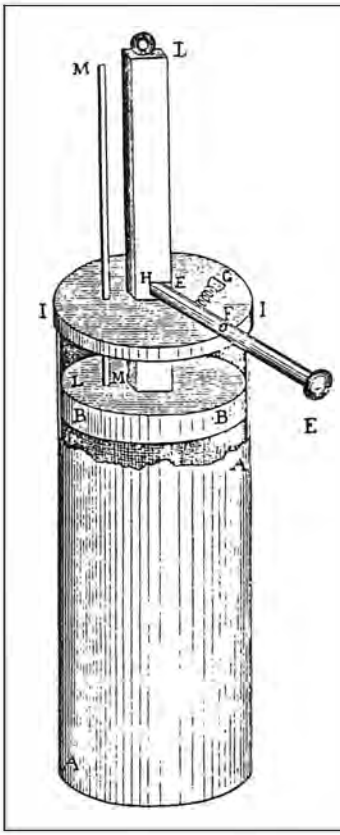


Figure 4
PAPIN'S 1690 ENGINE
The first steam engine using a piston and cylinder was invented by Papin in 1690. Papin proposed to use steam instead of gunpowder to create a vacuum under a piston. Although Papin suggested a means of applying the force of his engine to operate a paddlewheel boat, he realized that the power of an atmospheric steam engine was strictly limited by the diameter of its cylinder.

In a letter dated April 10, 1698, Papin apologized to Leibniz for not having written sooner, and explained that a new project, commissioned by his employer, the Landgrave of Hesse, had taken up most of his time:

> Monsgr. le Landgrave formed a new plan, very worthy of a great Prince, to attempt to discover where the salt in salty springs comes from. To reach the bottom of this, it would be very advantageous to be able to easily draw out a great quantity of water to a considerable height. I've made many tests to try to usefully employ the force of fire to this task; some succeeded so well that I was persuaded that this force could be applied to things much more important than raising water. Consequently, I've given myself totally to this work, knowing the great difficulties always to be met with in such enterprises and which can't be overcome without an extraordinary diligence. I'm presently having a new furnace built, of which I've spoken to you before. . . . I'm building it simply to make certain large retorts of forged iron, which will be very useful to produce the great effects that I expect from the force of fire. For this furnace, I've also built a large Hessian bellows more perfect than those I've made before. And thus one thing leads to another. . . .

In his reply four days later, Leibniz asked if Papin's method of raising water

is based on the principle of rarefaction which you published before, or if it is based on some other principle; I also have a thought about it, but I want to make a little test of it in order to consult you on its performance.

Here is Papin's historic answer, dated July 25, 1698:

> The method in which I now use fire to raise water rests always on the principle of the rarefaction of water. But I now use a much easier method than that which I published. And furthermore besides using suction, I also use the force of the pressure which water exerts on other bodies when it expands. *These effects are not bounded, as in the case of suction.* So, I am convinced that this discovery if used in the proper fashion will be most useful. . . . For myself, I believe that this invention can be used for many other things besides raising water. I've made a little model of a carriage which is moved forward by this force: And in my furnace, it shows the expected result. But I think that the unevenness and bends in large roads will make the full use of this discovery very difficult for land vehicles; but in regard to travel by water I would flatter myself to reach this goal quickly enough if I could find more support than is now the case . . . . It gave me much joy to find that you also have some plans to put the moving force of fire to use, and I strongly hope that the little test you told me of succeeded to your satisfaction [emphasis added].

Leibniz's concern, however, was much greater than simply using the "force of fire" to propel ships and carriages. He saw in Papin's work the unique experiment capable of irrefutably establishing the truth of his dynamical science, as well as advancing that science, by the process of applying its principles to the measurement of the thermodynamic efficiency of Papin's machines. This is the "little test" referred to in the letters above.

Leibniz wrote to Papin, on July 29, 1698:

> I understand very well that the force of expanding water will do much more than air pressure will do when the steam is condensed, and this is exactly what I have thought as well in regard to gunpowder. . . . But in regard to water the strain of its expansion will be less violent, [so] it would be good to see if there aren't other fluids which would be even better than water. But water has the advantage that it costs nothing, and is available everywhere. *My plan would be to do a test to discover if expanding water can usefully raise more than a column of air.* But I lack workers here, and I'm too distracted. . . . But I'm now very glad to find out that you've already made the relevant experiment, and that therefore you

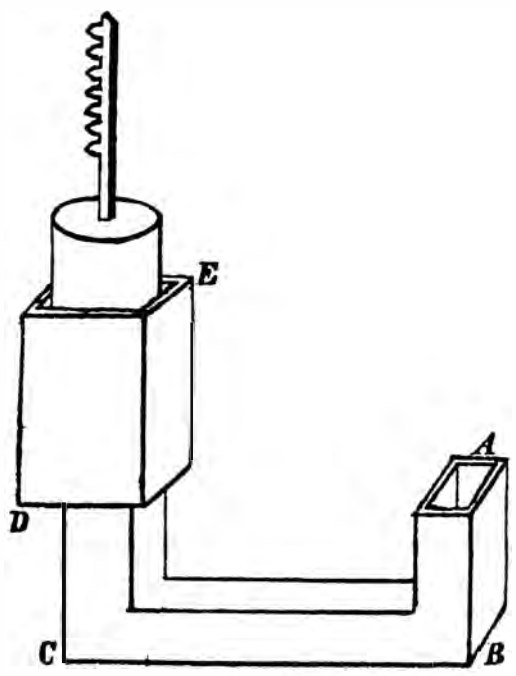


Figure 5
PISTON WITH TEETH FOR USE WITH PADDLEWHEEL

In his 1690 treatise proposing an atmospheric steam engine using a piston and cylinder, Papin described how his engine could be used to rotate the axle of a paddlewheel and "propel ships against the wind." The teeth of the piston rod would engage a toothed axle as atmospheric pressure forced the piston down toward the bottom of the cylinder. Papin explained, "It would only be requisite that three or four tubes should be applied to the same axis, by which means its motion could be continued without interruption.

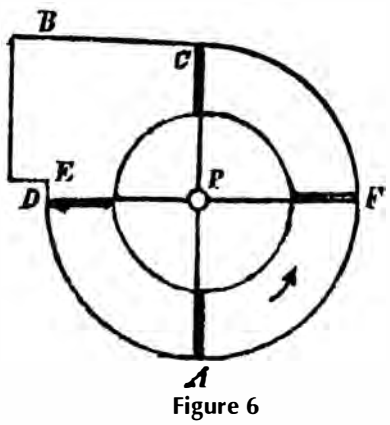


Figure 6
HESSIAN BELLOWS

Papin tackled the problem of manufacturing larger cylinders for his atmospheric steam engine by first inventing a hotter and more efficient furnace to improve the reduction of ores. This furnace utilized a down-draft generated by his Hessian bellows, which allowed a continuous, forceful stream of air to feed the burning fuel. At Leibniz's prompting, Papin applied his hotter furnace to the rapid production of high-pressure steam. This led Papin to abandon the effort merely to scale up his atmospheric engine and instead to begin the crucial project of harnessing the "unbounded" energy of high-pressure steam.

know approximately what *the force of the steam is relative to the heat and to time* [emphasis added].

Papin replied with a progress report on the construction of his engine, promising that once it was completed:

> I will try also to make observations on *the degree of heat [chaleur] required to make a given effect with a given quantity of water.* But up to the present all that I've been able to do, by the expansion of the steam, is to raise water to 70 feet, and to observe that a small increase in the degree of heat is capable of greatly augmenting the magnitude of the effect. And this convinces me, that if these machines are perfected so that very great degrees of heat can be used, one will be able to create a greater effect with a pound of water than with a pound of gunpowder [emphasis added].

Vis viva Versus Mechanics

Consider the implications of the Papin-Leibniz discussion once the word *effect* is translated to the modern term *work.* Both Leibniz and Papin agreed that the useful work performed by a heat engine, was to be measured by the height to which it could raise a given quantity of water. In his dynamics, Leibniz had used the example of the equivalence of the work required to raise a heavy body a given height, to the *vis viva* acquired by the body in falling from that height. Whereas, in the case of the falling body, the *vis viva* is measured by the body's velocity, Leibniz proposed to measure the *vis viva* of expanding steam by its temperature. Applying the principle of the conservation of *vis viva,* Leibniz developed the following sort of relationship:

> *vis viva* consumed by machine =
> useful work (height a given quantity of water is raised) +
> heat lost in overcoming friction +
> heat lost to superfluous cooling + [other inefficiencies].

With this sort of analysis, Leibniz was prepared to compare the thermodynamic efficiencies of heat engines by measuring "the degree of heat required to make a given effect." This also led him to the formulation of his unique experiment: demonstrating that steam can "raise more than a column of air"; that is, that the direct power of expanding steam is greater than mere atmospheric pressure.

Consider the case of Papin's 1690 steam engine. Here, the atmospheric pressure alone, considered as a "column of air" resting on the cylinder, is responsible for the motion of the piston. The role of the expanding steam is simply to raise the piston back to the top of the cylinder; that is, in Leibniz's phrase, "to raise a column of air." Then, the condensed steam leaves a vacuum in the cylinder, and atmospheric pressure pushes the piston downward once again.

Leibniz proposed to demonstrate that the direct force of expanding steam, unlike mere suction, is *unbounded,* that it can "raise more than a column of air" (Aug. 28, 1698):

> There is nothing which merits development more than the force of expansion [*la dilation*]; if one objects that expanded water can do no more than raise a cylinder of air, and that the stronger it [steam] is, the higher it [cylinder of air] is raised, and that therefore it is sufficient to use the weight of the falling cylinder—I reply that this higher elevation requires more time, allowing the steam to gradually cool, than *a quicker elevation of a heavier weight.* Thus, either force is lost, or more fire must be used [emphasis added].

Clearly at issue in this "little test," is the validity of the mechanical world view, that threatened to impose itself on emerging technology. Was steam power to be constrained to act passively, slowly pushing and pulling weights like some grotesque Rube Goldberg type of lever or pulley, or was it to be freed in all its "violence"—maximum *vis viva*—to effect a qualitative human advance?

From this dynamical point of view, in fact, Leibniz was by no means convinced that expanding steam was the optimum source of power for the new technology. For him, even expanding steam was not sufficiently violent or rapid *in its action,* compared, for example, to exploding gunpowder or, as he suggests elsewhere, to the combustion of alcohol. He argued as well for further work in applying the force of highly compressed air, pointing out its advantages for building lighter and more portable engines for vehicles.

The Savery Hoax

Despite the publicity given to Papin's invention, the British Parliament awarded an exclusive patent for "Raising Water by the Impellent Force of Fire" to one Thomas Savery, variously described as a "sea captain" and a "military engineer." The terms of the patent meant that any steam-powered device Papin might invent in England would come under the control of Savery.

Although news of Savery's patent reached Germany by 1699, it was not until 1704 that Leibniz, via "Hanoverian envoys" in London, was able to acquire some sort of description of Savery's device. Leibniz forwarded a sketch of the English "engine" to Papin, along with an evaluation of its capabilities. Based on further intelligence reports from his envoys, Leibniz concluded that Savery's device could not work in full size.

Savery's "engine" consists of a chamber connected by a pipe to a source of water below, and by another pipe to a separate boiler. Steam enters the chamber from the boiler; cold water is poured on the chamber, condensing the steam, thus creating a vacuum and drawing water up the pipe from below. The steam enters the chamber again, this time for the purpose of pushing the raised water out of the chamber, and up another pipe. The steam is then forced to condense once again, creating a vacuum, and sucking more water up from below, renewing the cycle (Figure 7).

For Leibniz and Papin, study of Savery's design provided a unique opportunity to apply and improve their new thermodynamic principles, because Savery was proposing precisely the sort of containment of steam power—within the conceptual and technological boundaries of mechanics—against which Leibniz had warned.

Papin wrote to Leibniz, July 23, 1705, describing experiments in which he had discovered that, using Savery's design, an increase in the temperature of the steam actually resulted in a *decrease* of the work performed:

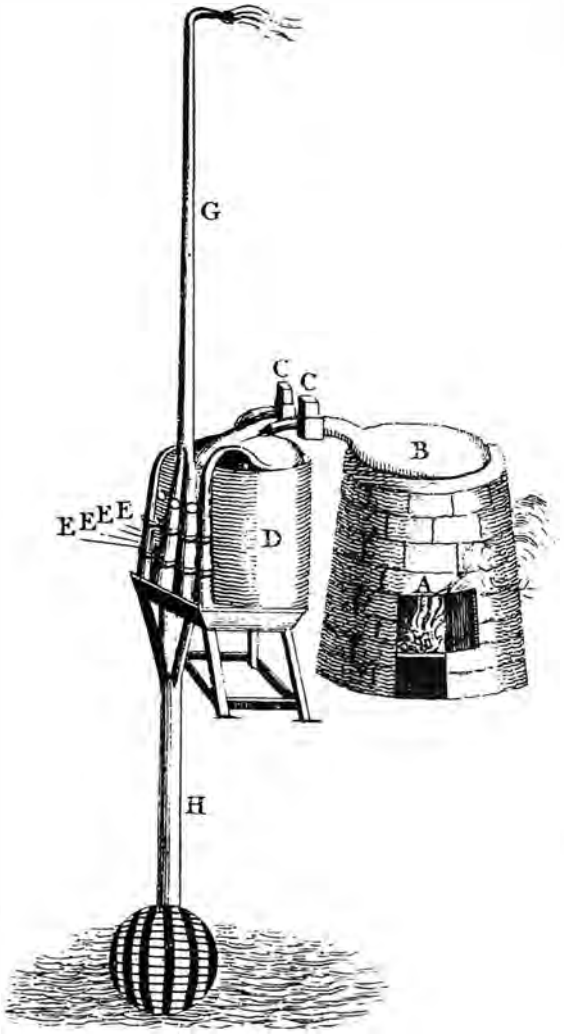


Figure 7
THE SAVERY ENGINE

In 1699, Thomas Savery was granted an exclusive patent by the English Parliament covering all conceivable "fire engines," despite the fact that his contraption did not work in full size. Savery claimed otherwise, insisting, for example, that hot steam would not condense upon encountering the cold water in the main chamber of his "engine." Savery further insisted that no engine using a piston and cylinder could ever work because of friction. Nevertheless, Savery's design was guarded as an English state secret, until Leibniz's spies succeeded in smuggling the blueprints to Hanover in 1704.

Source: Abraham Wolf, *A History of Science, Technology, and Philosophy in the 16th and 17th Centuries* (New York: The Macmillan Co., 1935)

I am persuaded that it will be useless to try to push water to great heights by the immediate pressure of steam: Because when the expanded steam strongly applies itself against the cold water, as is necessary to make it rise to a great height, it isn't possible to conserve the force of the steam; but it is immediately condensed by the coldness of the water. And the hotter the steam is, the more it violently pushes the valve, in such a way that the valve, being pushed as well by the spring which is behind, causes the water to become very agitated. The water thus agitated is much more likely to cool off a lot of steam, than when its surface remains smooth. Thus, I firmly believe that this is the reason which makes the elevation of the water decrease when the heat increases. . . .

I therefore believe that the best is to do it so that the steam doesn't directly touch the water, but that it pushes it only by the mediation of a piston which is quickly heated, and which consequently only condenses a little steam. And the surface of the piston which touches the steam always stays the same, the new steam which frequently reaches it, easily maintains it in a degree of heat all the more great as the steam is hot. Thus, there is no fear that the machine's effect will fail to be augmented in proportion to the increase in heat. Experiment has well confirmed my conjecture. . . .

And the more I go forward, the more I wonder at how a small quantity of wood is capable of furnishing such force. . . . But . . . it would be desirable to work at that with more heat than made [now]: seeing principally that the use of this invention isn't limited to raising water, but that it could be applied very well to vehicles and to many other things where force is needed.

Leibniz fully approved of Papin's successful application of his thermodynamics, and advised him not to take Savery's claims of success too seriously. He wrote on Aug. 15, 1705:

> I am delighted that your fire engine advances so well, because when it is brought to perfection, I consider that it will be very useful. Also, it would be a mere trifle if only one-third of the expense would be saved, as the English author believed, since this advantage would be easily absorbed by other inconveniences which such a great alteration of machines would attract. It is very reasonable also to believe that too diffuse steam applied directly to cold water will condense and lose its force. Consequently, it is better to keep them self-contained [*renfermees*].

According to the British Royal Society myth, this sort of reasoning about the steam engine was not supposed to have occurred until about 1769, when James Watt recognized the problem of loss of force because of superfluous cooling of the steam, and invented a separate condenser. Watt was motivated in this invention by the knowledge that the Newcomen engine would operate much more efficiently, if its cylinder was kept constantly hot, while the condenser was kept constantly cold; that is, "it is better to keep them [steam and cold water] self-contained."

In effect, Savery proposed to doom steam to play the role of the ancient horse-driven windlass (hoist) and pulley, slowly pulling water up one pipe and pushing it out of another, with one significant difference—Savery's "fire engine" was much more expensive.

Savery's fraud was recognized as such by crafty miners, and his engine was used mostly to raise water for the fountains of wealthy aristocrats. As even the British historian Abraham

Wolf admits, "It was costly and dangerous, so the mine owners stuck to horses."

Savery included an interesting comment on ships in his second chapter, "Of the Uses That This Engine May Be Applied Unto," indicating that it apparently had been made clear in England that the authorities would frown on any drastic technological advance in this area. As the American Robert Fulton later understood, a successful steamship could be the greatest threat to continued Anglo-Dutch commercial and naval superiority.

Savery fearfully noted,

> 5. I believe it may be made very useful to ships, but I dare not meddle with that matter, and leave it to the judgment of those who are the best judges of maritime affairs.

A few pages later, he added,

> As for fixing the engine in ships, when they may be thought probably useful, I question not but we may find conveniency enough for fixing them.

These two timid passages apparently constitute the totality of published British commentary on the steamship during most of the 1700s! Meanwhile, Leibniz had become fully committed to seeing a steam-powered vehicle perfected and built within his lifetime—whether a steam boat, a steam carriage, or an airplane. But while Savery and his colleagues could obstruct science at their leisure in the relative peace and quiet of Gresham College, Leibniz and Papin struggled to advance science as rapidly as possible, living in the direct line of march of an invading French army.

War Pressures

Leibniz had barely dissuaded Papin, pressured by the war situation, from accepting a Royal Society invitation to take up his old post as curator of experiments—an offer made to him, interestingly enough, just after Parliament had granted Savery his exclusive patent in 1699. If Papin had gone to England at that point, all of his experiments in steam power would have come under Savery's legal control.

The situation was so unsettled in Germany that Papin was afraid to visit Leibniz in Hanover, for fear that his family would be caught alone in a French attack. He concluded that no continued scientific progress would be possible without an end to the war. He wrote to Leibniz in 1702, describing his experiments with a ballistic air pump capable of throwing "a weight of 2 pounds to a distance of 40 feet," and designed eventually "to facilitate the capture of the strongest positions." Papin argued that this invention not only would help bring peace, but also would be the best enticement for princes and generals to support further research into steam technology.

After a year of strenuous efforts to interest the leaders of the anti-French alliance in his invention, Papin reported to Leibniz, on Feb. 25, 1704,

> It has been possible since then to receive a reply neither from England nor from Holland; therefore all that I can conclude is that there is only some secret reason why no one wants to accept my proposal.

Leibniz continued to maintain friendly pressure on Papin throughout 1704, insisting that he resume research into applying violent force (particularly that of gunpowder) to the propulsion of ships and to carriages, if not to airplanes. Leibniz argued that such a breakthrough would have the greatest world strategical impact:

> Yet I would well counsel [you], Monsieur, to undertake more considerable things which would force everyone to give their approbation and would truly change the state of things. The two items of binding together the pneumatic machine and gunpowder and applying the force of fire to vehicles would truly be of this nature.

Papin finally agreed, and in a letter March 13, 1704, he revealed that he had already built a model paddlewheel boat "which can carry about 4,000 pounds," and that he had developed a complete theory of rowing, "which can also be applied to land vehicles."

By January 1705, Papin had received Leibniz's sketch of Savery's engine. Of course, this had the expected effect on Papin's thinking, as well as on the attitude of the Landgrave of Hesse, who took a renewed interest in Papin's work. In March, a newly self-confident Papin wrote to Leibniz:

> I can assure you that, the more I go forward, the more I find reason to think highly of this invention which, in theory, *may augment the powers of man to infinity;* but in practice I believe I can say without exaggeration, that *one man by this means will be able to do as much as 100 others can do without it.* All that I've done up until now has only been to discover the characteristics of this machine and the different symptoms to which it may be subject [a reference to the analysis of the thermodynamic efficiency of Savery's device discussed above]. But Monseigneur, from now on, wants to apply it to some real use, and his Highness gave me the honor of commanding me to apply this force to turn a mill to grind wheat. . . . And if, after the mill, we can proceed to apply this invention to ships [*voitures par eau*], I would believe this discovery incomparably more useful than finding longitudes on the ocean, which has been sought for so long.

By the end of 1706, Papin's experiments had convinced him of the explosive strategic potential of steam technology:

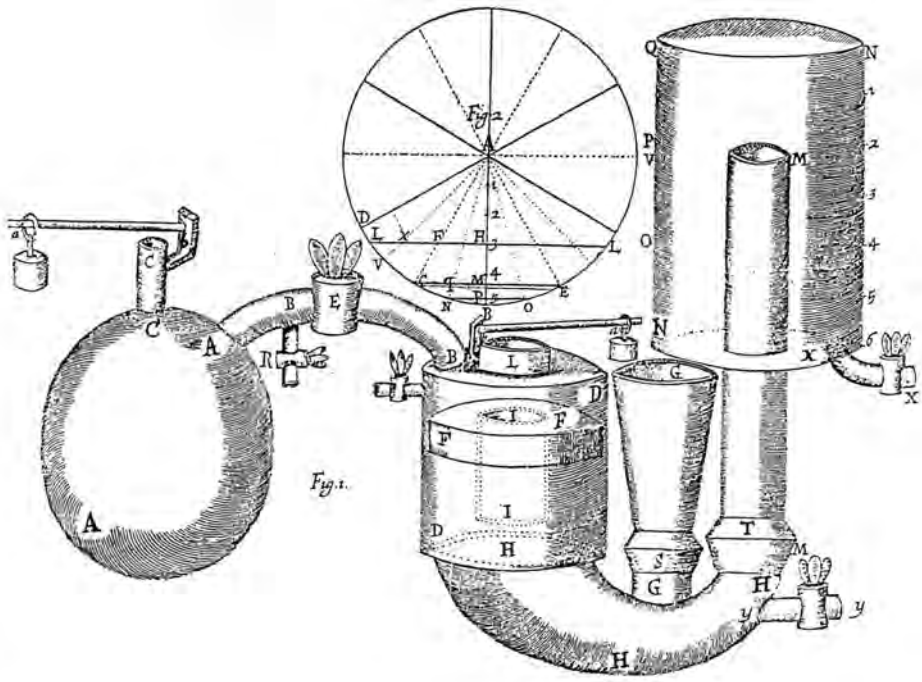
> Yet it's a great shame that the things from which the Public could derive such considerable usefulness aren't impelled by heat. Because the advantages which this invention could furnish for seagoing vessels alone, without counting those of land vehicles, would be incomparably greater than all expected from the transmutation of metals.

A Genuine Steam Engine

What Papin achieved within two years of receiving Leibniz's sketch of the Savery device, was a genuine, direct-action steam engine, capable of being immediately applied to ships.

Figure 8
PAPIN'S 1707
STEAM ENGINE

Papin invented and successfully operated the world's first direct-action steam engine, publishing the results of his experiments in 1707. Papin had also developed a theoretical approach to the construction of ships and to the method of rowing. His study of rowing led him to consider means of maximizing the conversion of energy from a paddle into the forward propulsion of a vessel. He had already constructed a working model paddlewheel boat, based on these principles in 1704. Therefore, by 1708, Papin was prepared to combine his steam engine and his paddlewheeler and build the world's first steamboat—100 years before Fulton.



Papin's engine successfully incorporated the dynamical innovations of 40 years of research, which began with the project initiated by Huygens in Colbert's Academy. This achievement is fully documented in Papin's 1707 treatise, "New Method of Raising Water by the Force of Fire," published in Latin and French at Cassel. (This booklet is available today in select university libraries because someone in France had foresight, in 1914, to reprint 250 copies of it.)

Papin's engine, shown in Figure 8, works as follows, with each step representing an innovation as a result of dynamical considerations. The engine is to be situated such that there is a constant flow of water into the pipe *G*. In this way, the water to be pumped enters the cylinder *DD* through *H;* the piston *FF* is then raised to the top of the cylinder by the weight of the water.

(1) The copper vessel *AA,* which Papin calls the retort, is totally enclosed in a furnace, not shown. The furnace is designed to allow the fire to completely surround the retort, with precautions made to guarantee minimum loss of heat to the outside air.

(2) The retort is supplied with a safety valve *ab* to allow a maximum controlled increase in steam pressure. The robinet, or spigot, *E,* is opened, allowing the high-pressure steam to rush into the cylinder.

(3) The opening *L* and the receptacle *II* are provided to allow insertion of hot irons, in order to increase the violence of the steam, which is allowed to reach a controlled maximum with attention to the second safety valve *ab*.

(4) The fulminating, expanding steam acts directly against the cold water through the mediation of the piston *FF,* arranged so that the surface of the piston encountering the steam remains hot, while the opposite surface remains relatively cold. The action of the steam on the piston forces the water out through *H* and up through the valve *T* into the closed vessel *NN*. As *NN* fills with water, the air within *NN* is compressed.

(5) The compression of the air in *NN* is allowed to increase, until the robinet at the lower right of the vessel is opened, allowing the raised water to exit forcefully through pipe *XX*.

(6) The resulting high-velocity jet of water encounters an improved paddlewheel, designed according to Papin's Figure 2 (shown here in Figure 8). Papin's figure illustrates the advantages of adding blades to a mill wheel, in order to more completely convert the energy of high velocity water into rotative motion.

With this design, technology entered a new, dynamic universe. In a certain sense, it represents a transition, in that modern thermodynamic principles are applied to the ancient task of turning a water wheel. However, Papin intended immediately to apply his new engine to power the model paddlewheel boat, which he had constructed three years earlier.

In the preface to his 1707 treatise, Papin gives Leibniz full credit for providing the necessary impetus to advance his experiments. In particular, Papin cites two crucial junctures—the 1698 discussions on harnessing the direct force of steam, versus mere atmospheric pressure, and the 1705 description of Savery's device, which Leibniz's spies procured in London.

The quality of analysis in the treatise also shows the effect of Leibniz's firm theoretical commitment to "live force," combined with Papin's repeated experimental vindications of Leibniz's dynamics over the past 40 years. Papin concludes the first chapter, describing the furnace enclosing the retort:

Chronology: Steam Power Versus the Royal Society

1666: Louis XIV's Minister Jean Baptiste Colbert establishes the Academy of Sciences, appointing the Dutch scientist Christiaan Huygens as the Academy's president. Huygens's program includes "research into the power of water converted by fire into steam."

1672: Papin and Leibniz join the Academy.

1673: Huygens successfully demonstrates his gunpowder-fueled engine, suggesting that his invention "permits the discovery of new kinds of vehicles on land and water. And although it may sound contradictory it seems not impossible to devise some vehicle to move through the air."

1675: Leibniz completes his development of the differential calculus. Anti-Colbert factions force Papin, Leibniz, and, later, Huygens to leave France.

1680: In London, Papin continues research into control of high pressure steam; he invents the steam pressure cooker and safety valve.

1687: Papin proposes the pneumatic transmission of power from water wheels near rivers to remote regions in order to facilitate the rapid spread of industrialization.

1690: The Steam Age begins with Papin's invention of the atmospheric steam engine; Papin proposes its application to powering a paddlewheel-driven ship.

1692: Papin and Leibniz begin intensive correspondence.

1695: Papin publishes a summary of his inventions, including the Hessian bellows, an improved furnace designed to multiply efficiency, the pumping of mines using the pneumatic transmission of power, the atmospheric steam engine, and the "plunging boat" (submarine).

1697: Papin's summary is reviewed in the *Philosophical Transactions* of the British Royal Society and circulated throughout England.

1698: Papin constructs a steam-powered atmospheric pump. Leibniz and Papin begin the project of harnessing the direct force of high pressure steam; Papin constructs "a little model of a carriage that is moved forward by this force."

1699: Thomas Savery is awarded an exclusive patent for the "fire engine" by the English Parliament.

1704: "Hanoverian envoys" to London smuggle Savery's blueprints back into Germany; Leibniz concludes that Savery's design could not work in full size.

1707: Papin publishes a complete account of his direct-action steam engine, and tests it successfully against Savery's design.

1708: In London, Papin proposes that the Royal Society allocate 15 pounds sterling to allow him to construct his engine "and to fit it so that it may be applied for the moving of ships. This Engine may be tried for an hour and more, together with some other made after the Saveryan method." Royal Society president-for-life, Isaac Newton, backed by Savery, rejects Papin's proposal.

1708-1712: The Royal Society appropriates Papin's researches without remuneration.

1712: Papin "disappears." The first Newcomen engine, limited to pumping water from flooded mines, is erected.

1807: American artist, inventor, and diplomat Robert Fulton achieves the world's first commercially successful steamship voyage with his Hudson River paddlewheeler, *The Clermont*. Fulton proposes that his inventions, including the submarine and the torpedo, be applied forthwith to destroy the "monstrous government" of England.

5. The reason which obliges us to have such a great care to augment and conserve the heat [chaleur] is because it is the heat which makes all the moving force in this machine. Because otherwise in ordinary pumps it is animals, rivers, the wind, or some other thing of this nature which employs their force in order to drive the piston in the pump and expel the water; here, it is only the heated steam in the retort *AA* which travels with violence through the pipe *ABB* whenever the robinet *E* is opened, and goes to press the piston in the pump *DD*. And the force of this steam is even greater, the more we give it a higher degree of heat.

In chapter 3, Papin comments on the "means to augment the effect of the machine":

2. The augmentation of effect of which I have just spoken [that is, increasing the diameter of the pipes, and so on] is a little thing in comparison to that which could be obtained in augmenting the pressure in the retort *AA:* Because that of which I've spoken until now in order to impel [pousser] the water to 64 or 65 feet, is equivalent to only two times the ordinary pressure of air: But it's certain that the pressure may be made much greater yet; with digesters or machines to cook bones, which weren't at all completely enclosed in their furnace, as is the retort *M* here, I sometimes achieved pressures equivalent to 11 times the pressure of air. Thus, one may boldly say that the retort, being as well heated as it is, and with the aid of hot irons enclosed in the pump *DD,* that pressures may be created much more than 6 times greater than that necessary to impel water to a height of 64 feet: and in such a case *one man could create almost as much of an effect as 500 others who have only those inventions used up to the present.*

As for Savery's design, Papin describes in detail, in chapter 5, how the Savery device was inferior to his own, "in order that there be no misjudgment in the choice that will be made between Mr. Savery's machine and this one." First, Papin notes, that since the retort *M* is "completely in the fire, it can be heated much more promptly and at less cost than the two vessels that Mr. Savery calls boillers."

Second, Papin notes that his piston system ensures that the "steam loses none or very little of its force," compared to the condensation that occurs in the Savery device. Third, Papin

describes his improvement that "allows the water to enter by its own weight into the pump *DD*, and not by suction" and writes, "without this correction, the inconveniences of which I've spoken about in this section would be enough to render the machine completely useless." Fourth, Papin notes the improvement of introducing hot irons to increase the "violence" of the steam. Then, "in order to incontestably prove that the piston *FF* is necessary to raise water to any considerable height," Papin reports that Savery's method completely failed to pump water

> into air which had been a bit compressed. . . . Instead, a good effect is always created with the piston, even if the resistance of the compressed air in *NN* is 10 or 12 times greater than that which was impenetrable without the help of the piston.

Leibniz wasted no time in beginning the process of improving Papin's design. In his last published letter to Papin, Feb. 7, 1707, Leibniz not only suggested that the engine be made completely self-acting, and thus more appropriate to moving vehicles, but also proposed practical means of still further increasing the thermodynamic efficiency of the engine by the ingenious use of the so-called waste heat:

> I maintain that for stationary machines or for seagoing vessels, it will be difficult to make anything better along similar lines. . . .
>
> I have a thought that perhaps will not displease you, which is to efficiently use the still-hot steam which leaves the pump when the piston is pushed up. Because it would be a great shame to lose it entirely. I imagine that in leaving it yet has much heat, and enough force to issue forth despite the outside air. . . . Then to make good use here of heat, otherwise superfluous, and at the same time of compressed air, in a manner which perhaps has never been used, I would make a sort of mantle or case *ZZ* around your vessel *QN*, partly filled with compressed air; and within this case I would let the steam enter in such a way that before it streams powerfully into the open air it would be between the case and the vessel. And while it warms this vessel it would as a result contribute towards the work of the compressed air contained therein. I believe that this will be a redoubling of the force. . . . and thus a mediocre vessel *QN* would make a much greater effect. Because it is already certain that heat gives as much force to ordinary air as does compression, and the same heat would give double or triple to compressed air. . . . The continual passage of hot steam would make this vessel extremely hot, almost as if it had been placed on a fire.
>
> I have always had the thought that a great effect could be made and much force placed in a small volume by means of air strongly compressed and then heated. This would be of great use for machines which must be portable.
>
> To say nothing of the superfluous heat of the furnace and the smoke which emerges from it which can be similarly useful among other ways by heating the water of the funnel *G* and of the tube *H* in order that the coldness of this water harms less of the heat in the pump *D* or in the vessel *QN*. . . . Furthermore, I have no doubt that you could, if you so desired, easily arrange that the robinets *E* and *n* are alternately open and closed by the machine, without having to use a man for this.

The 'Newton-Leibniz Controversy'

Although Leibniz and Papin had succeeded in bringing modern dynamical technology into being, making possible the industrial transformation of society, they were working within an increasingly aversive environment. Leibniz's persistent international efforts on behalf of a "Grand Design"—an alliance of sovereign nations for economic development through scientific and technological progress—had brought him into increasing conflict with his employer, George Ludwig, the Elector of Hanover (and future British King, George I).

Whereas George Ludwig was in the pay of the British financial oligarchy, based in the City of London, his mother, the brilliant Electress Sophie, was Leibniz's dedicated philosophical protégé. Until her untimely death in 1714, Sophie was next in line to become Queen of England! The massive Royal Society attack against Leibniz, which erupted in 1711, on the false charge of plagiarism of the calculus from Newton, was a politically motivated slander campaign, designed to destroy Leibniz's influence in England. Yet, the influence of Leibniz's ideas grew on the European continent and, significantly, in America as well. (See "The Anti-Newtonian Roots of the American Revolution," *Executive Intelligence Review,* Dec. 1, 1995.)

During this period, even before the publication of his treatise, Papin had reported a sharp escalation in harassment by his unnamed enemies in Hesse. As a result, the relative tranquility of London again became attractive to him, and he resolved to go to England to demonstrate before the Court and the Royal Society the incontestable superiority of his steam engine over Savery's device.

Papin's plan was to travel to London in his paddlewheel boat, rowing it by conventional means up the Weser River, through Hanover to Bremen, and across the North Sea. Once in London, with his model boat and with sufficient means to build an adequate steam pump, Papin planned to operate the world's first steam-driven ship and navigate it up the River Thames. In fact, the main reason which Papin gave to the Landgrave for his desire to leave for London, was that only such a seaport had sufficient depth to apply his engine to a ship.

In a letter to Leibniz, Sept. 15, 1707, Papin reported on the first successful test of his paddlewheeler:

> At present I will tell you that the experiment of my boat was made and that it succeeded in the manner that I had hoped of it. The force of the river's current was such a little thing in comparison to the force of my oars that it was difficult to recognize that it went faster in descending the current than in climbing it. Monseigneur had the goodness to testify to me of his satisfaction in having seen such a good effect. I am persuaded that if God gives me the grace to arrive safely in London and to make vessels there of this new construction which have enough depth to apply the fire engine to give movement

to oars, I am persuaded, I say, that we may produce those effects which will appear incredible to those who will not see them.

In the same letter, Papin renewed a request to Leibniz to help obtain the required permission from the Elector of Hanover for passage up the Weser. Leibniz could expect no cooperation from George, but he tried to intervene with his friends among local magistrates along the river. However, Papin got no further than Munden before encountering the ignorant opposition of the Boatmen's Guild, no doubt incited by elements of George's Court. Leibniz received the following report from an official of Munden, Sept. 27, 1707:

> Having been informed by the Doctor Papin, who, coming from Cassel, passed by this town the day before yesterday, that you are presently to be found in this Court [Berlin], I give myself the honor to advise you, Sir, that this poor man of medicine, who gave me your letter of recommendation for London, had the misfortune to lose here his little machine of a paddlewheel vessel . . . the Boatmen of this town having had the insolence to stop him and to take from him the fruit of his toil, with which he thought to introduce himself before the Queen of England. . . .

Despite the tragic encounter with this "mob of boatmen," Papin continued on to London, only to encounter an even more vicious mob—the British Royal Society, at the time headed by president-for-life, Isaac Newton, and by Newton's secretary Hans Sloane.

Royal Antiscience

When he arrived in England, Papin presented a copy of his treatise to the Royal Society, along with the following proposal, recorded in the *Royal Society Register,* Feb. 11, 1708:

> *Proposition by Dr. Papin, concerning a new invented boat to be rowed by oars, moved with heat:*
>
> It is certain that [it] is a thing of a great consequence to be able to apply the force of fire to save the labour of man; so that the Parliament of England granted, some years ago, a patent to Esquire Savery, for an Engine he had invented for that purpose; and His Highness Charles, Landgrave of Hesse, has also caused several costly experiments to be made for the same design. But the thing may be done several ways, and the machine tryed at Cassel differs from the other in several particulars, which may afford a great difference in the quantity of the effect. It will be good, therefore, to find out clearly what can be done best in that matter, that those which will work about it may surely know the best way they are to choose. I am fully persuaded that Esquire Savery is so well minded for the public good, that he will desire as much as any body that this may be done.
>
> I do therefore offer, with all dutyfull respect, to make here an Engine, after the same manner that has been practised at Cassel, and to fit it so that it may be applied for the *moving of ships.* This Engine may be tryed for an hour and more, together with some other made after the Saveryan method. The quantity of the effect should be computed both by the quantity of water driven out of each machine, and by the height the said water could ascend to . . . .
>
> I wish I were in a condition to make the said Cassellian Engine at my own charges; but the state of my affairs does not [allow] me to undertake it, unless the Royal Society be pleased to bear the expense of the Vessel called *Retort* in the description printed at Cassel; but after that I will lay out what is necessary for the rest, and I will be content to lose that expense, in case the contrivance of the Landgrave of Cassel doth not as much again as that of Esquire Savery; but in case the effect be such as I promise it, I do humbly beg that my expense, time, and pains, may be paid, and I reckon this to amount to 15 pounds sterling. If the Royal Society be pleased to honour me with their commands upon such conditions, the first thing to be done is to let me see the place where the Machine must be set, and I will work for it with all possible diligence and I hope the effect will yet be much greater than I have said [emphasis in original].

By 1708, the Royal Society had all but abandoned even the pretense of scientific inquiry, and so, its attitude toward Papin's proposal (as well as others) for real technological advance was predictably negative. In Papin's case, the repeated mention of the name Leibniz in his treatise was sufficient to trigger Royal Society killer instincts.

The *Transactions of the Newcomen Society,* Vol. 17 (1936-1937), contain a succinct account of the fate of Papin's proposition:

> Papin, then at Cassel, submitted with his paper, a request for 15 guineas to carry out experiments, but the Royal Society, like our own, did not hand out 15 guineas at a time. Instead, the matter was referred to Savery in 1708, and in his letter of criticism turning down Papin's design there is a passage in which he damned the cylinder and piston, saying it was impossible to make the latter work because the friction would be too great!

Papin then argued for his proposal before Newton himself, who rejected it on the pretext that it would *cost too much.* Papin was then stranded in England without any means of support, completely at the mercy of Newton, Sloane, and Savery, whose exclusive patent covering all conceivable "fire engines" was still in effect. Papin's 1707 "Proposition" was thus the last heard of any practical plan for a steamship or for early application of steam power, besides pumping mines, until the intervention of Benjamin Franklin's networks in England, later in the century.

No record remains of Papin's subsequent activity in England besides a mere seven letters to Sloane, mostly repeated requests for money to carry out a variety of experiments. In his last letter to Sloane, Jan. 23, 1712, Papin complained that a number of his inventions presented before the Royal Society had deliberately not been registered under his name:

> So there are at least six of my papers that have been read in the meetings of the Royal Society and are not

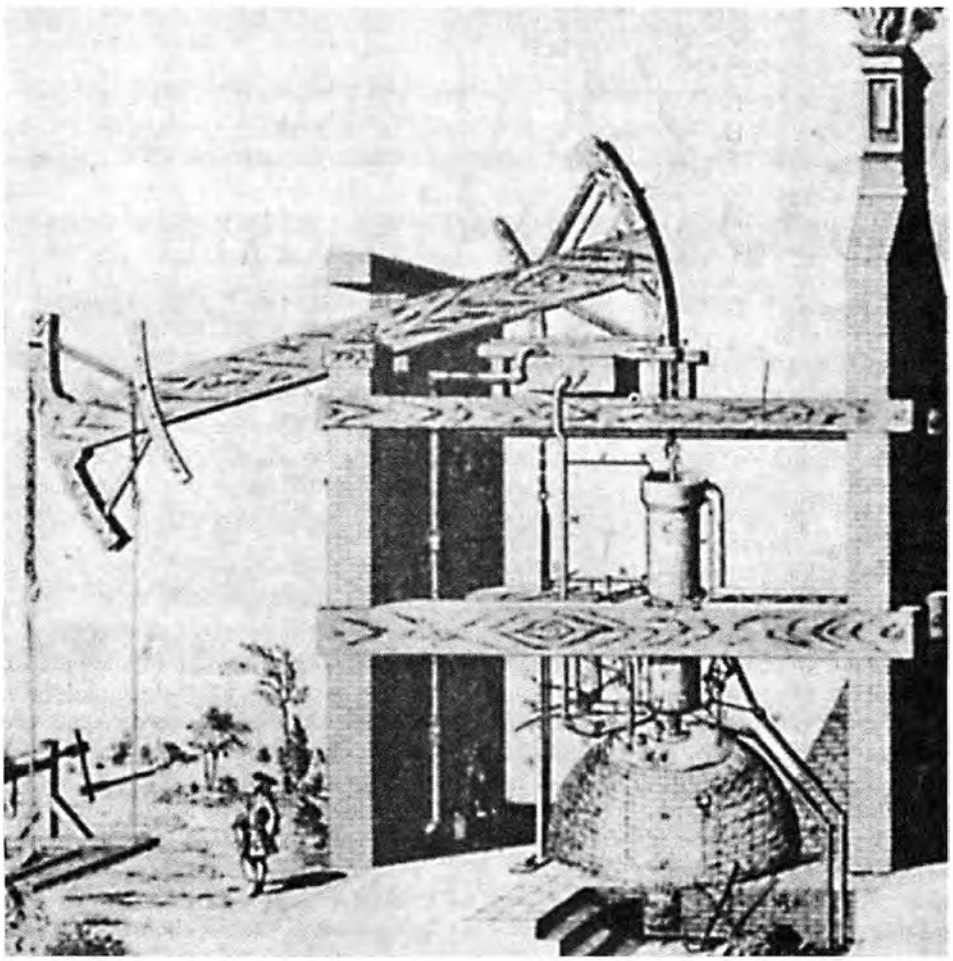


Figure 9
NEWCOMEN'S ENGINE

British historical tradition maintains that Denis Papin mysteriously "drifted into obscurity" in England in 1712. That same year, the ironmonger Thomas Newcomen allegedly erected his first engine, limited to pumping water from mines. British historians insist that Newcomen acted entirely alone and that he had no contact whatsoever with any scientist or scientific principles, his work being based exclusively on trial and error.

Newcomen published nothing, his exact date of birth and educational background are unknown, and no one knows what he looked like, because none of his contemporaries painted or sketched his portrait. His only extant writings are a few scraps of personal letters to his relatives.

mentioned in the Register. Certainly, Sir, I am in a sad case, since, even by doing good, I draw enemies upon me. Yet for all that I fear nothing because I rely upon God Almighty.

The Newcomen Fraud

In 1712, Papin apparently vanished without a trace—not even a death notice. That same year, as the witchhunt against Leibniz was reaching frenzied heights in England, Thomas Newcomen suddenly appeared to build his fabled fire engine, "near Dudley Castle."

In Newcomen's atavistic design, steam enters a cylinder under a piston from a separate boiler (Figure 9). Cold water is poured over the cylinder or is sprayed inside of it, condensing the steam and creating a vacuum; the piston is forced downwards by atmospheric pressure. In turn, a piston rod pulls down one end of a balance beam, which operates an ordinary mine pump, attached to the other end of the beam and placed down a mine shaft. Steam reenters the cylinder, merely counterbalancing atmospheric pressure; the piston is then raised back to the top of the cylinder by the weight of the water pump apparatus, and the cycle is repeated.

Compared to the level of conception and design achieved by Papin, Newcomen's "exotic lever" is manifestly primitive, and a great step backwards. Not only is the force of the engine limited to mere atmospheric pressure, and the design limited to raising water from mines, but Newcomen still insisted on alternately cooling off and heating up the same cylinder, wasting tremendous amounts of steam, and consuming massive quantities of coal. For this reason, his engine was used mainly by the owners of the coal mines themselves, who could afford the fuel.

The calculated result was a near 100-year containment of steam technology, which was overcome only by the intervention of Leibniz's intellectual heirs in America.

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WILHELM WEBER'S 'APHORISMS'

On the Hypotheses of Temporal Ordering

The first English translation of posthumously published fragments by Wilhelm Weber, concerning an anti-linear concept of time, with introductory comments by the translator.

TRANSLATOR'S NOTE

Prior to the Enlightenment, it had been the ancient knowledge of mankind, that the lawful relationship of events in the real Universe, is entirely contrary to the assumption of a simple linear (chronological) form of temporal ordering of the Universe, of the sort typified by the kinematic physics of Paolo Sarpi and Galileo Galilei.[1] The latter pretends to represent reality as a linearly ordered series of moments (layers of "now") of the quality of sense perceptions, in such a way that each moment is supposed to represent the sole "cause" of its successor in the series. This monstrous concoction was a prime target of G.W.F. Leibniz's efforts in the 17th and early 18th centuries, and in particular of his pedagogy concerning the necessary existence of monads.

We know, for example, that the demonstrable, powerful influence which certain past events exert upon the present course of history, has nothing to do with their apparent temporal proximity to, or distance from, the present epoch, whether measured in years, centuries, or millennia. Similarly, at times, individuals and whole populations may be so gripped by the anticipation of great events in the future (and perhaps even beyond their own lifetimes), that other, more immediate motivations fade into insignificance.

Above all, we can demonstrate, that the progress of Man's increasing mastery of the Universe obeys a transfinite, not a linear ordering, and that the action of higher hypothesis, generates arrays of events, which from a simple-chronological standpoint must pose insoluble paradoxes. Similarly, the quality of *agapé* acts, as if above time, throughout history; and all generations past, present and future rejoice together in it, as if at a single luminous point.

Courtesy of Göttingen Tourist Office

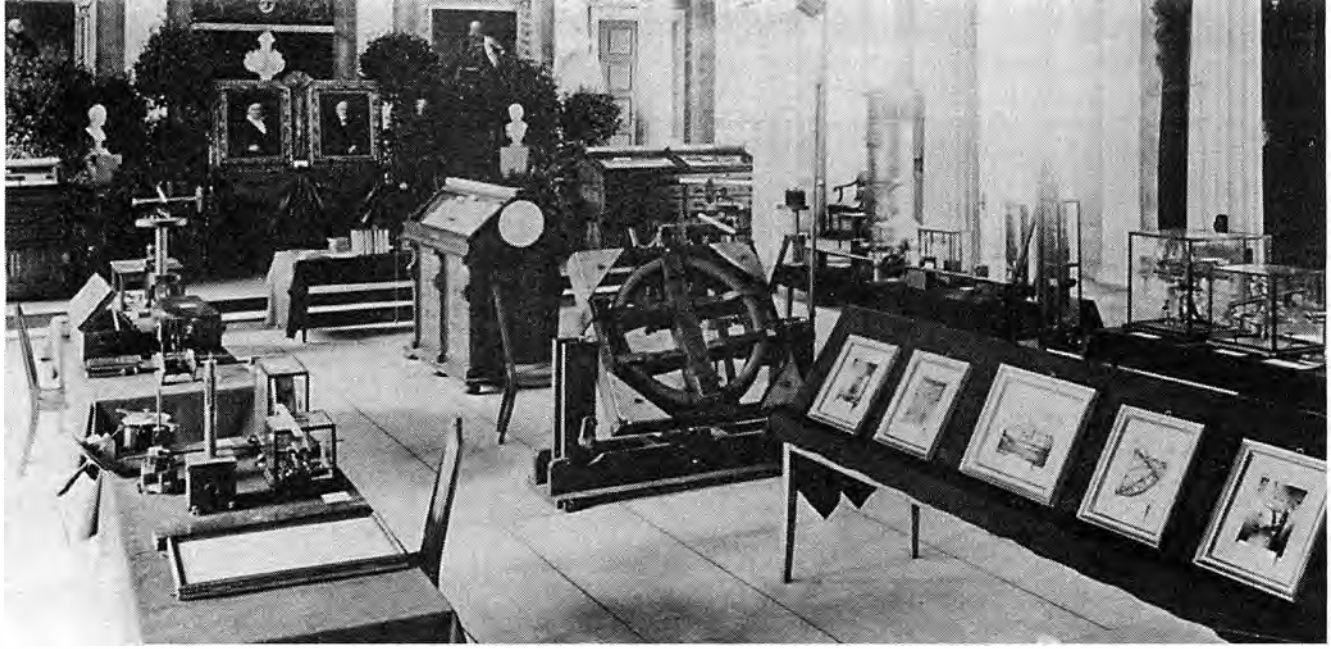
Wilhelm Weber (1804-1891), from the statue of Weber and Gauss at Göttingen University.

This anti-linear ordering of human history, is obviously a function of *ideas,* and reflects that aspect of reality—more than the proverbial 99.9999 percent—that is only graspable *within* the creative processes of individual minds, and absolutely cannot be represented ("from the outside," as it were) by formal methods of the sort typified by mathematical physics as presently understood.

Thus, the Enlightenment's imposition of kinematic, percussive notions of causality upon physical science—and, spreading out from there, upon virtually every domain of culture—aimed not only to wipe out the achievements of the Renaissance, but implicitly also to reverse the first steps of wisdom which launched the human race upon its earliest phases of upward-sweeping development on this planet.

Common textbook mythology has it, that it was Albert Einstein, with his Special and General Relativity Theory, who finally overturned the Galilean-Newtonian notion of absolute, simple-linearly ordered time within physics itself. Actually, Einstein was neither the first to attack Galileo and Newton on this point, nor did his attack really address the essential issue, which lies in the significance of *ideas* and the axiomatic inability of formal-mathematical methods, as presently understood, to represent the most essential aspects of the ordering of reality. This issue did emerge, in a limited but rather powerful way, in the earlier work of Carl Gauss, Wilhelm Weber, and Bernhard Riemann.

The feature of Wilhelm Weber's electrodynamic hypothesis, which provoked the greatest outcry from Hermann Helmholtz, Lord Kelvin, et al., was Weber's demonstration, that the apparent interaction between electric charges depends, not only upon their relative position, but also upon the relative velocity,



Courtesy of the George August Physics Institute at Göttingen University

An exhibit honoring Gauss and Weber in June 1899 at Göttingen University. Portraits of the scientists (in background) are surrounded by their experimental apparatus and illustrations of their experiments.

and even acceleration, of the charges—or, in a word, upon their state of motion. Paradoxically, however, the *physical efficiency* of a state of motion necessarily implies the existence of something beyond the mathematician's "frozen slice" of time: namely, a unitary process of becoming which must necessarily embrace a *multitude* of states, and therefore (apparently) a definite, non-vanishing quantum of action encompassing at least a portion of the past and future of the process. Weber's investigations demonstrated various facets of the same singularity, including the existence of a critical length and critical velocity, defying the assumptions of axiomatic continuity and linearity in the small.

Weber's student Bernhard Riemann, in his posthumously published manuscript on "New Mathematical Principles of Natural Philosophy,"[2] "found on March 1, 1853" (and in some other fragments among writings unpublished at his death), made an early attempt to frame an anti-entropic physics referenced *explicitly* to the process of creative mentation ("Erzeugung von Geistesmassen"), and in which the *content* of past events can exert an *unmediated* influence on the present course of a process.

Riemann's reflections on this matter were certainly influenced by his ongoing cooperation with Weber on electrodynamics, and by the considerations leading (at Gauss's instigation) to Riemann's 1854 dissertation on the "Hypotheses Which Underlie Geometry," as well as his 1858 paper on retarded potential—where the issue of an anti-linear temporal ordering, and of a sort of "memory" manifested even by inorganic physical processes, is implicitly addressed. Obviously, Riemann's thoughts on this were also closely related to his study of evolution and the organization of living processes generally, including the physiology of the brain.

Unfortunately, the doors opened wide by Weber's implied demonstration of a memory function in electrodynamic processes, were slammed shut again, thanks to the efforts of Maxwell, Helmholtz, and others to explain away the effect of retarded potential in terms of mechanistic, kinematic propagation of waves in a Cartesian form of ether. This operation is a direct precursor to the later information theory, insofar as it aimed to bury the crucial distinction between memory in the proper sense (explicable only on the basis of metaphor), and mere storage of information in the form of scratches on a Cartesian *tabula rasa*.

Weber's 'Aphorisms'

All of this was evident to me long before the moment when I ran across a remarkable item from the posthumous papers of Wilhelm Weber,[3] published at the end of his collected works. Entitled "Aphorisms," these short philosophical notes quite clearly reflect Weber's discussions with Riemann (although they may have been written much later) and confirm my sense of the kinds of things which must be understood "between the lines" in the work of the Gauss-Weber-Riemann circle on electrodynamics and related topics.

The "Aphorisms" must be read as a single whole. At first glance, Weber's statements below might be read as favoring a kind of dualism between a physical world and a mental world. However, we should not overlook the unmistakable irony in Weber's remarks, and the implied, rather devastating refutation of the objectivist, Enlightenment concept of the physical world (sometimes referred to as the "Körperwelt" or hypothesized kinematic world of discrete objects moving in a space characterized by simple continuity).

On the other hand, Weber seems to have overlooked the act of hypothesizing which underlies any notion of number—something well known to Plato and Nicholas of Cusa, and highlighted, of course, in Georg Cantor's work.

—Jonathan Tennenbaum

Notes

1. For Sarpi and Galileo, see "How Hobbes's Mathematics Misshaped Modern History," by Lyndon H. LaRouche, Jr., in *21st Century*, Spring 1996, and, paired with it, "Paolo Sarpi and the Fraud of the Enlightenment: Why 'Standard Classroom Mathematics' Makes People Stupid," by Jonathan Tennenbaum.
2. Found in Riemann's "Philosophical Fragments," of which a translation appears in *21st Century*, Winter 1995-1996, pp. 50-62. See pp. 58-60.
3. Wilhelm Eduard Weber, 1892-1894. *Werke.* 6 vols. (Berlin: J. Springer).

Aphorisms

by Wilhelm Weber

Among the categories Number, Space, and Time, *Number* alone belongs to pure logic or pure science, while Space already contains something hypothetical or derived from visual imagination (for example, the Euclidean hypothesis of the theory of parallels, and in addition, the concepts of left and right, which cannot be defined by logic). The case of *Time* is surely similar to that of *Space*. According to the conception of Time, which we have framed for the *physical world,* the relationship between past, present, and future assuredly also contains a hypothetical element, which has no absolute validity for the *mental world* (for the world of thoughts, and emphatically for thinking itself).

When we conceptualize the world in the framework of Number, Space, Time, Motion, etc., the assumption of continuity and simplicity of motion (that no object can simultaneously carry out two different motions) is essential to the relationships so framed.

This framework is no longer adequate, when we extend and expand our thinking to the world of mental processes and to Divinity.

The motion of thought cannot be subjected to the same limitations of continuity and simplicity, as we do for a physical motion (which would mean that no thinking being could have two thoughts at the same time). The possibility of reaching a conclusion, requires having three propositions present in the mind at once.

According to the first framework, the one conceived for the physical world, the present is really nothing at all, namely a mere boundary between past and future, without any content of its own.

In the mental world, the present contains consciousness, which has a significant content (including all memory). In the mental domain, therefore, the present is something real, and is not merely the boundary between past and future; it has a real content.

Without consciousness as the content of the present, there could be no mental life, and for the Divinity, the content of the present, existing in consciousness, must in fact be infinitely extended.

Such a content, however, requires time; in mental life, the present, being filled with consciousness, is no mere boundary between past and future, but is a *boundary layer* between past and future; it is a real element of time.

In the Divinity, the consciousness-filled present must be infinitely extended.

A Divinity, which were assumed to exist only in the present, insofar as the present is understood in the manner assumed for the physical world (where the present is merely a boundary between past and future)—that is, a present which were understood to have existed in the past and which still has to achieve existence in the future—were only an empty notion or a mere illusion.

Our power of thought, our power of sensation and our power of memory, are like a sum loaned to us, which we must produce with. We create a world of cognition, which stands in a wondrous relation to our sensations. Thereby we learn to value the "loan" extended to us, to honor and trust the one who gave that loan. This conceptual world, formed in connection with our sensations, embraces also a conception of ourselves, which, however, is confined, through our notion of our birth and our death, to the interval of time between those events. Although this world of cognition contains many notions—including notions of the time before our birth and after our death—of these notions none is of ourselves. As long as we

live, we work with the loan granted to us, and continually strive to perfect and to complete our world of cognition; but, what we have already achieved, suffices, that we be filled with the loftiest appreciation of the loan, and the highest trust in the one who gave it; and especially the confidence, that He, who granted that loan, will continue to care for us. Upon this trust is based our conviction, that the true ordering of the world, exceeds by far the ordering of our cognitive world.

When material entities, which are separated from each other spatially and temporally, interact with one another, then the reason for this interaction lies in the nature of both together *as a single whole.* The mutually dependent parts of this *whole* exist in different points of space and time. If there exist *material* entities, which as *wholes* cannot be confined to a single point in space and time, then this holds all the more for spiritual entities.

Granted to us are our powers of sensation, thought, and memory. We thereby gain not only a world of thoughts, but also a hypothesized world, where the material and the mental stand in causal connection. This causal connection leads to a final cause—God. The possibility of a deeper insight into the How and Why seems not to be given through the faculties of sensation and thought. A hypothesized world in causal ordering, which were based, not on a final cause, but only on many final causes—the properties of all things in space—would be confined to the hypothesized world of physical bodies; all that which *thinks,* is excluded from that domain, and thereby we would exclude also any *explanation* of the hypothesized world of physical bodies *(Körperwelt).* For, a world of physical bodies might exist, without it being thought.

In descriptive natural science (including chemistry) a relationship, given through a law, is accepted as an *explanation,* without having located the *reason* for the law in the nature of the hypothesized entity, not to speak of the reason for all sensation and thought.

BIOGRAPHICAL APPENDIX

Wilhelm Weber: Giant of 19th Century Physics

Wilhelm Weber

Wilhelm Eduard Weber (1804-1891) was born in the German city of Wittenberg. He was educated in science with the help of his older brother, Ernst Heinrich Weber, and physicist E.F. Chladni, a boarder in the same house as the Webers. The political climate of the household was shaped by the ideas of Friedrich Schiller and the American Revolution.

The brothers carried out independent, pioneering research on water waves, constructing the world's first experimental wave tank. Wilhelm went on to earn an advanced degree at the University of Halle through work on the acoustics of musical instruments.

Introduced by Alexander von Humboldt, he joined world-famous mathematician and astronomer Carl Friedrich Gauss at Göttingen University in 1831, where the two began pioneering researches in magnetism and electricity. Gauss's historic paper, "The Intensity of the Earth's Magnetic Force Reduced to Absolute Measure," which set the standard for all modern physical researches, and was the first to introduce the concept that all physical measurements be derivable from measure of *length, mass,* and *time,* was the first fruit of this collaboration. Weber was removed from his professorship at Göttingen University between 1837 and 1848 for his involvement in republican political activities.

Weber conceived the idea of adapting the precision instrument developed for the magnetic studies, the magnetometer, for electrical researches. By means of the new instrument he called an electrodynamometer, Weber experimentally verified, with a high degree of precision, the laws of electrodynamics established by André-Marie Ampère in Paris in the 1820s. This he reported in his famous first memoir, "Electrodynamic Determinations of Measure," published in 1845.

Ampère's electrical law had polarized the scientific world, by showing that the force of interaction between any two very small segments of two current-carrying wires was not only proportional to the inverse square of their distance of separation (and thus in conformity with Newton's formulation for gravitation, and with the recently established electrostatic and mag-

netic laws), *but was also dependent on the relative directions of the currents.* Weber's generalization of the fundamental electrodynamic law (which subsumed the phenomena of induction, not known to Ampère), described the pairwise interaction between electrical particles, presumed to be travelling in the wire—what would today be called *conduction electrons.* In Weber's new formulation, the electrostatic law (dependent solely on the inverse square of distance) is modified for moving charges, so as to be dependent on the relative velocity and acceleration of the charges.

This fruitful new formulation, subsequently confirmed and elaborated by the most careful experimental researches, led Weber over the following decades to deep and advanced insights into the atomic structure of matter. As early as 1870, he was able to envision, and describe with mathematical precision, the charged atomic nucleus and orbiting electrons, a model usually attributed to Rutherford and Bohr's work of four decades later. In 1870, Weber also arrived at the modern formulation for the *classical electron radius* (e^2/mc^2), decades before the values for charge and mass of the electron could be empirically determined. Weber's conception, based on his fundamental electrodynamic law, regarded this value as a *critical length,* below which the ordinary *repulsion* of like charges would change into an *attraction.* It applied to like charges of either sign, and thus would subsume the nuclear binding energy (strong force) under the electrodynamic law.

Another fundamental concept, not recognized in today's textbook physics, emerged from Weber's 1854 experiment, carried out at Göttingen jointly with the physicist Rudolf Kohlrausch. Its purpose was to determine the value of the Weber constant, *c,* which appeared as a critical limiting velocity in his electrodynamic law. The relationship of this constant to the velocity of light, *in vacuo,* was anticipated by Bernhard Riemann, who also assisted in the 1854 experiment. Riemann's theory of the retarded potential (the finite rate of propagation of the potential between two particles separated in space) derives from this work, and much predated Maxwell's speculations on the subject. Weber elaborated on aspects of this idea in an important 1878 memoir on the "Energie der Wechselwirkung" (Energy of Interaction). Here he argued against a simplification of the concept of energy that was under way at the time, by asserting that relative motion changed the internal state of objects, not merely their external relations, an idea which goes back to Leibniz.

In a handwritten manuscript from the 1880s on the subject of gravitation, published after his death, Weber hypothesized the construction of the periodic table according to the electrical charges of the elements, and discussed approaches to deriving the gravitational force from electrodynamic considerations. An attempt to advance that aspect of Weber's work was pursued by the brilliant Swiss physicist Walter Ritz (1878-1909), and is reported in his paper, "La Gravitation" (*Scientia,* Vol. 1, April 1909). Ritz there attempts an explanation of phenomena, treated unsatisfactorily in Einstein's Special Relativity Theory, by a unification of Weber's electrodynamic conception with Riemann's theory of the retarded propagation of potential.

—Laurence Hecht

Note

For more on the development of Weber's electrodynamic theory, see Laurence Hecht, "The Atomic Science Textbooks Don't Teach: The Significance of the 1845 Gauss-Weber Correspondence," *21st Century*, Fall 1996, pp. 22-43. On the Ampère law and modern experimentation, see Dr. Rémi Saumont, "The Battle over the Laws of Electrodynamics," *21st Century*, Spring 1997, pp. 53-60.

INTERVIEW WITH DR. SADAO HATTORI

Using Low-dose Radiation for Cancer Suppression and Vitalization

Dr. Hattori is the Vice President in charge of Nuclear Energy of Japan's Central Research Institute of the Electric Power Industry (CRIEPI). He directs Japan's research program on the effects of low-dose radiation, conducted at 14 universities. A 1959 graduate of Tokyo Institute of Technology with a master's degree in nuclear engineering, Hattori received his Ph.D. from the University of Tokyo with a thesis on the risk assessment of nuclear energy. He has been a guest professor at Tokyo Institute of Technology and at the Nagoya Institute of Technology, and he has held his present position at CRIEPI since 1989.

Hattori was interviewed by managing editor Marjorie Mazel Hecht in April 1997.

Question: Japan now has a unique and wide-ranging program of research into the health effects of low-dose radiation. How did the program get started?

In 1984, I came across an amazing paper on hormesis by Dr. T.D. Luckey in the December 1982 issue of the journal *Health Physics.* I sent a copy of Luckey's paper to F. Cutler and J. Taylor, the president and vice president of the Electric Power Research Institute (EPRI) in December 1984, asking them how they could explain what Luckey reported. They then decided to evaluate Luckey's paper.

In August 1985, there was a conference in San Francisco, called the Oakland meeting—the first radiation hormesis international conference. After this conference, EPRI answered my letter, saying that Luckey's paper was interesting and scientifically accurate—but not the full story. EPRI decided to fund some research activities on this at the University of California at Los Angeles, UCLA, under Professor Mackinodan. EPRI asked him in 1986 to do some tests to confirm radiation hormesis.

Meanwhile, in Japan, we formed a group to study the hormesis papers cited by Luckey, checking the data with specialists. After a few years of study, we initiated our radiation research program in 1988. We formed a committee, including many university professors, and specialists in the medical and biological fields. We then decided to perform some animal tests, which began in 1989.

This stimulated many people in the concerned fields in Japan. Many specialists were interested in this, and they asked me to do some research. Gradually, after being asked by many, many people, I was obliged to expand my activities, based on this interest. Our program expanded, so that now we work with 14 universities on medical activities.

Question: What are the dimensions of your budget for this research?

Well, I have to explain how Japanese universities work. The universities are mainly funded by the government, and medical research is funded by the Health Ministry. There is much active medical research ongoing, some privately funded. So, all I had to do is to add some small amount to the ongoing programs where researchers agreed to do some radiation hormesis research. For example, one professor in one university might be working with several people in a project already; so I would pay perhaps $10,000 or $20,000 for the hormesis research.

Question: Because the research institution was already supported.

Yes, completely. Salaries, the facilities, the equipment—I didn't need to pay for that. So it was quite easy to work with the universities. However, our budget has become larger recently; it's now about $700,000 yearly.

Question: What are the main areas you are investigating?

There are three major areas.

Number one is the immune system, immune stimulation to suppress cancer, work with the tumor suppression gene p53. This is an exciting field stimulated by Professor Sakamoto, who is doing cancer therapy in a hospital, and Professor Onishi, who is doing the p53 research.

The second area is rejuvenation, or vitalization of the bodies of mammals by low-level radiation. For example, vitalization of the essential activities such as membrane permeability of brain cells; suppression of diabetes; SOD or superoxide dismutase, which suppresses oxidation of cell tissues by free radicals, so we can keep ourselves young; and the important activity of sodium-postassium pumping through cell membranes, the in-and-out movements, which can be driven by Na^+K^+APTase (an enzyme essential for cell activities).

This work is mainly done by Dr. Yamaoka of our institute. He is working with many professors of many universities now. And, additionally, Professor Yamada is interested in the modulation of psychological stress, mental stress—how you can keep high tension down using low-level radiation. This also, we understand, comes under rejuvenation or vitalization.

The third area is adaptive response. Now, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) admitted that low-level radiation stimulated DNA repair activity, and if the damage is too severe, apoptosis activities are stimulated. This is a very interesting field now in nuclear medicine.

Question: So, these are the three major areas of research at the 14 universities.

Yes, and there are some other univer-

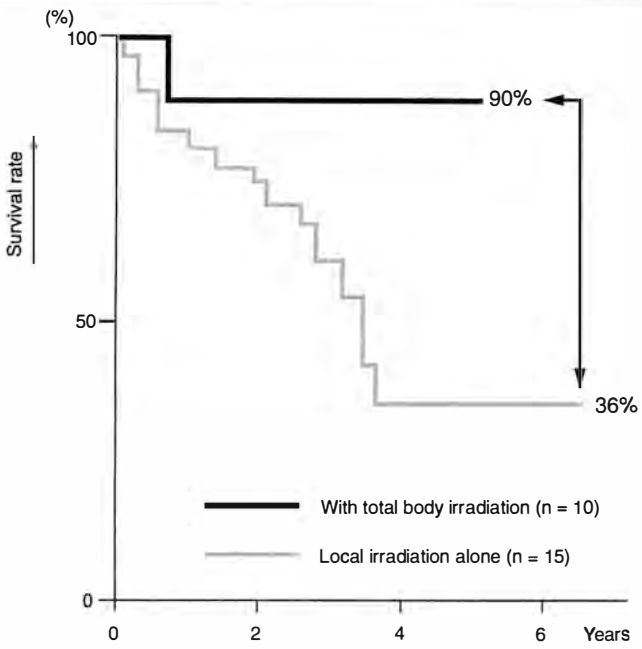


Figure 1
SURVIVAL RATES OF NON-HODGKIN'S LYMPHOMA PATIENTS WITH AND WITHOUT TOTAL BODY IRRADIATION

Lymphoma patients who were given a total body irradiation of 10 centigray by X-ray, three times a week, in addition to the standard local high dose irradiation treatment, had a 90 percent 6-year survival rate. The control group, which received only the local high-dose treatment, had a 36 percent 6 year survival rate.

Source: Dr. K. Sakamoto, Tohoku University

sities now asking to join our research program.

Question: What are the most important results you have seen over the past decade?

Most important, I think, are Professor Sakamoto's amazing results for human cancer suppression, treating lymphoma patients, and also saving the lives of some people with liver cancer. It was amazing. However, this radiation effect may be effective only with certain persons, depending on certain biological characteristics. They have found this by analyzing the immune system response of many patients.

I also think that Dr. Yamaoka's results with rejuvenation are amazing. If you look at the many natural radon springs around the world, such as Bad Gastein in Austria, however, they are applying only a primitive state of radiation treatment. By doing some research and analyzing the optimum exposure, we could produce further excellent effects. We have to find the optimum exposure to revitalize people.

Blood substance	Control	14-18 kilobequerels of radon
Insulin (μU/ml)	4.3 ± 0.4	8.5 ± 1.8
Glucose-6-phosphate dehydrogenase (IU/37°C)	1.9 ± 0.2	2.6 ± 0.3
Blood glucose (mg/dl)	218 ± 21	191 ± 19

Figure 2
EFFECT OF RADON INHALATION ON DIABETES-ASSOCIATED SUBSTANCES OF RABBIT BLOOD

Rabbits who inhaled radon for 90 minutes at a dose of 14 to 18 kilobequerels had increased levels of insulin and glucose-6-phosphate dehydrogenase, and lowered blood glucose levels.

Source: Dr. K. Yamaoka, et al., CRIEPI, Okayama University

Question: There are also data from experiments to control diabetes and hypertension using just one low-dose treatment a month. Has this work and the rejuvenation work been done only with rats and mice and other animals, or have you begun work with human beings?

No, no, just animals. I really wish to begin so, but it is impossible under this social common sense formulated by ICRP (International Commission on Radiation Protection).

Question: And what about the cancer treatment? Given the success at treating human lymphoma patients with total body low-level radiation, are there plans to establish this as a standard course of treatment in Japan?

No. Let me explain why. Japan is strictly following the ICRP regulations and recommendations. The Japanese government decided to strictly control Japanese society—they do not allow or permit human experimentation with radiation. This is an ICRP-regulated country.

Question: So how did you then treat the lymphoma and liver cancer patients? Were these exceptions?

Professor Sakamoto explained to these patients, who were all in the hopeless category, that there were no further medical methods which could save them, but that he thought the radiation might help. These patients then were eager to be included in the experiments with radiation. Sakamoto had to find the private funds to do this. There was no government support, nor support from the hospital. He had to use private money to save these patients.

Question: But given the results, which are really astounding in terms of the increase in longevity—

Amazing, but regulations are regulations; they are not life-saving. It's very cruel. Professor Sakamoto is almost mad about it.

Question: Well, what can be done?

We need worldwide activity to change the law. The ICRP controls all the activities in Japan. It's impossible to make

exceptions to save human lives. Regulations are regulations. I think this is a terrible situation. I hope to extend these programs to human beings, but it is impossible now—

Question: Given the current ICRP regulations—

Yes, and the public perception shaped by the ICRP regulations. The Japanese people are ignorant about this. They think radiation is terrible.

Question: Here in the United States we also don't do these experiments, but there is a procedure for establishing experimental protocols with new treatments for cancer, for example, especially with people for whom there is no other hope.

It is the same in Japan, but these are special cases.

Question: Is it possible to expand the number of special cases?

If certain funds and authorizations were given, Prof. Sakamoto has to find private money, which is difficult.

Question: Most people are startled to learn that the survivors of Hiroshima and Nagasaki who had low exposure to nuclear radiation are living longer than those in the Japanese population who had no radiation exposure. How do you explain this?

These are very exciting data, but very difficult to explain. Professor Sohei Kondo, a very famous professor in Japan and a most excellent analytical researcher, even he himself cannot explain to me why this is the case. It is very difficult to explain. For example, we have many animal experiments with radiation hormesis: We apply a certain dose—for example 10 centigray, or 15 centigray. However, that kind of wonderful, positive effect with animals does not remain throughout their lifetime.

For example, Dr. Yamaoka found that these positive effects could be kept for two months or so, but they cannot confirm or understand how the effects could remain throughout one's life, with only one exposure, as these survivors experienced.

Question: So with the animal experiments, the protective effect of the radiation also requires periodical exposures?

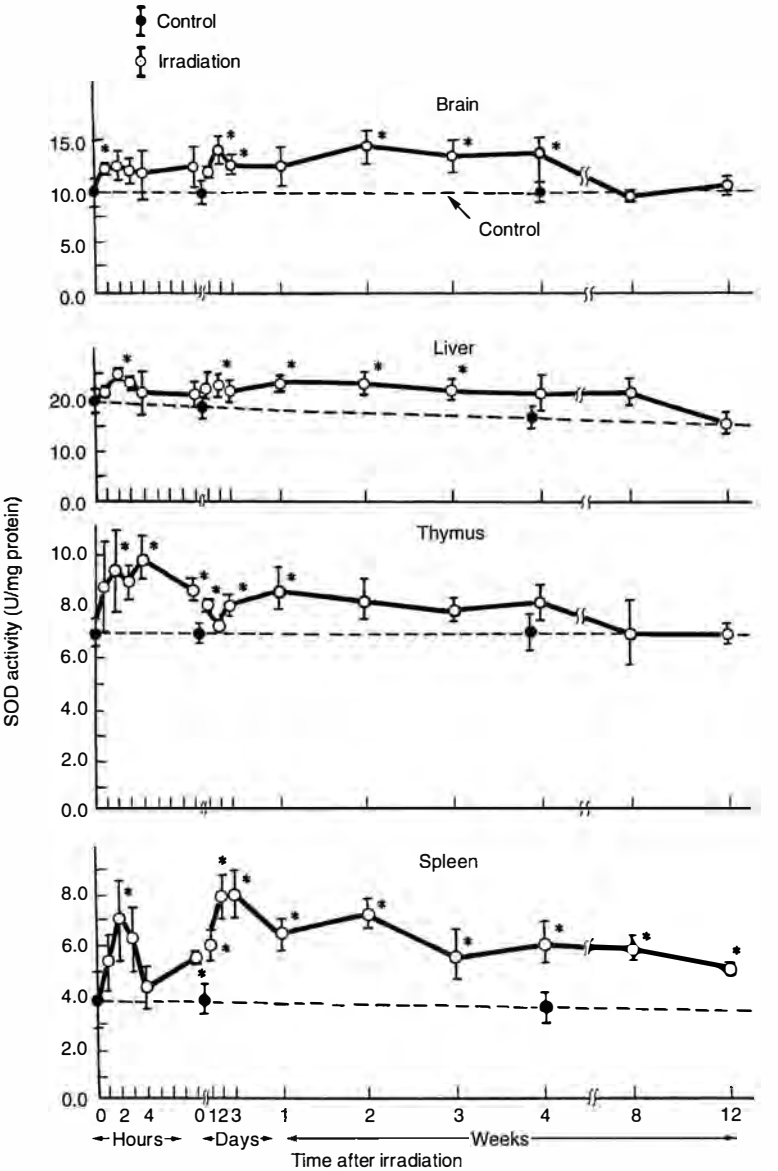


Figure 3
CHANGES IN SOD ACTIVITY IN THE ORGANS OF RATS OVER TIME, AFTER LOW-DOSE IRRADIATION

Low-dose (0.25 gray) irradiation fostered an increase in SOD (superoxide dismutase) activities, which suppress oxidation of cell tissues by free radicals, in various rat organs. The effects of one irradiation continued for up to 8 to 12 weeks.

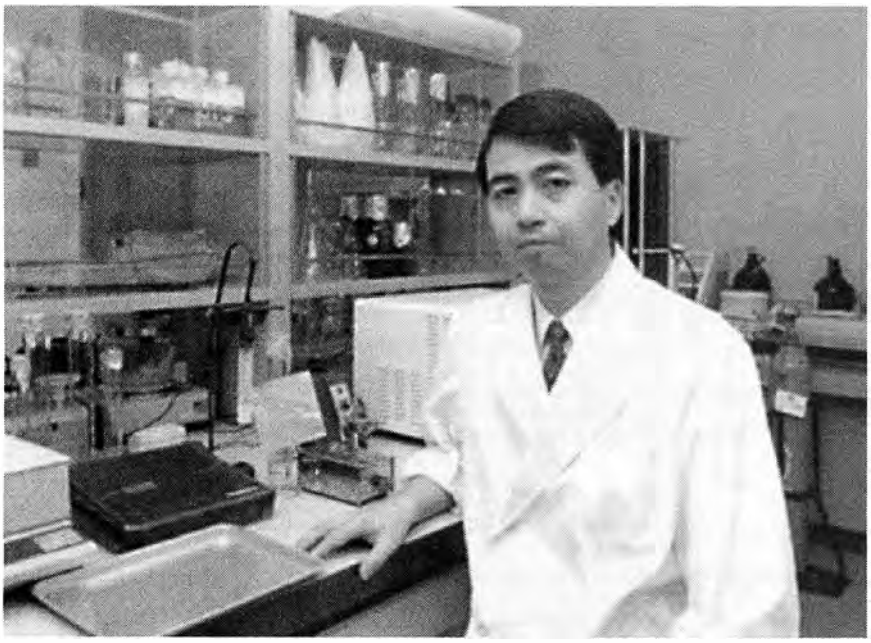
Source: Dr. K. Yamaoka, CRIEPI

Yes, the results in animals do not remain for so many years. So, this result in the Hiroshima and Nagasaki survivors has to be a subject for further research.

Question: Could it be the age of the people when they were exposed.

Yes, it may be age dependent, but there are many complicated issues to be analyzed. I cannot now explain why there is such a beneficial effect all through their lives, with only one exposure.

Question : How do you account for some of the results you are seeing? What do you think is going on at the cell level? Are there differing hypotheses as to what is going on?



Dr. K. Yamaoka in his lab at CRIEPI.

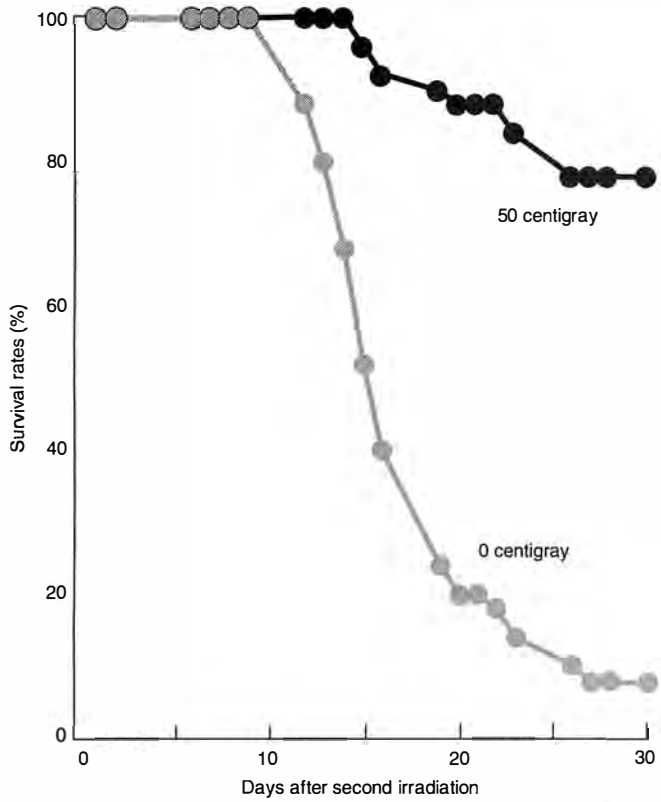


Figure 4
PROTECTIVE EFFECT OF LOW-DOSE IRRADIATION FOR MICE WHO THEN RECEIVE A HIGH-DOSE IRRADIATION

Mice irradiated with a low-dose (50 centigray) two weeks before a second, high-dose irradiation (7.4 gray), had much better survival rates (top line) than the control group, which did not receive the low-dose irradiation.

Source: Prof. Yonezawa, Osaka Prefecture University and Mr. Misonah, CRIEPI

I'll try to explain this simply. Ionizing radiation enters the cell and makes ions, electrons, and elevates the state of oxygen, and elevates the state of electron circulation around the atom. It makes a chemically active situation, even with water molecules. Hydrogen, oxygen, and other molecules and proteins are influenced by this activity.

Now, all cells hope to make some enzyme proteins and are waiting for certain stimulations in order to do so. So the radiation stimulates the production of these good enzymes. All cell activities want to go in a beneficial direction for the body; that is the fundamental intention. So the radiation stimulation creates all sorts of good activities: gene formulations, gene repairs, and apoptosis if it is needed. Everything can be explained by this stimulation. There is also some overlap phenomena helped by some other stimulation such as heat shock.

I'm not a specialist in the medical field, but I think this is an easy way to look at this.

Question: So it stimulates the normal cell reactions.

Yes, making electrons, ions, and excited states of atoms, good chemical reactions in a beneficial direction. You can formulate some helpful enzymes and proteins to go in better direction.

Question: There is now an international campaign to change the standards for radiation exposure away from their linear, no-threshold basis to standards that reflect the reality of the hormesis effect. Can you comment on this?

I think this is a wonderful activity, for all human beings around the world, to save mankind. Not only is nuclear energy needed as clean energy, but also we need the use of radiation to save many lives of people, vitalizing people who are sick. We could have so many health centers that would be applying low-level radiation, even in the kind of protocols you mentioned. But now these things are completely prohibited by the ICRP influence. We have to change the law to save people.

Question: I think that changing the radiation standards would help to do that, because now when you say "radiation," you get a negative reaction, and that's what also has to change.

Yes, it is a complete misunderstanding.

Question: To your knowledge, is similar research going on in other countries?

I have just a little knowledge about this. In northeast China, in Chanchung Norman-Bethune Medical University, Dr. Liu is conducting radiation research activities. He established a radiation hormesis research institute several years ago. He is eagerly doing experiments, especially on the immune system stimulation.

In Russia, in some universities, they are doing a little research, but without enough money. Also in Canada. And in France, there is very old information from 1940; France originated radiation stimulation for life vitalization. In the United Kingdom, Professor Potten at Manchester University has emphasized very low level radiation stimulation to produce good apoptosis activities to keep the small intestine well.

Question: But I think that the Japanese program is the largest in the world. What directions would you like the Japanese program to take in the next decade?

I think I have to look for some individuals to set up a foundation, not just CRIEPI—our institute is not enough. Our president, Mr. Yoda, recently suggested to me that we need to ask certain individuals to form a large research foundation for radiation hormesis, to save people. We have to explain to people the necessity for this and the true story of radiation hormesis to save many people. CRIEPI is not a research institute with a mission to save mankind. It's an electric power institute of which nuclear is just one division; hormesis is a very small part of this division, and thus limited.

Many people are now interested in this, but with ICRP and government controls, they are hesitating. So, it is not easy now. . . .

As you commented, we need low-level radiation as a standard course of treatment in Japan, to save people's lives. But everything is controlled by the ICRP and its influence on the public.

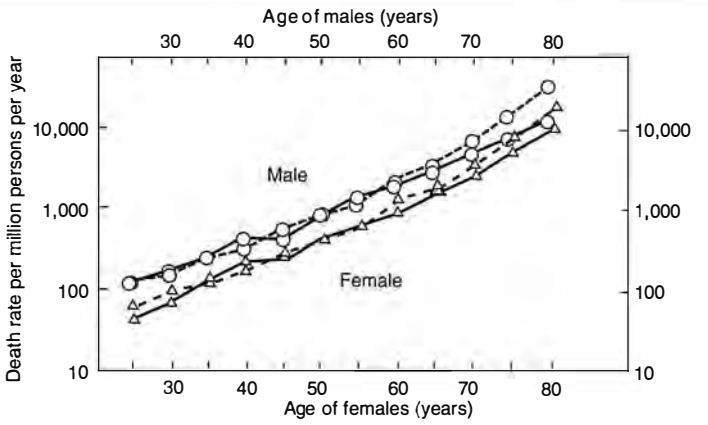


Figure 5
LIFESPAN OF ATOMIC-BOMB SURVIVORS
Residents of Nagasaki who were not exposed to the atomic bomb radiation have higher death rates after age 55 than those who were exposed. The dotted line is the non-exposed population; the solid line is the exposed population.

Source: Mine et al., 1981. "The Current Mortality Rates of A-Bomb Survivors in Nagasaki City," *Japan Journal of Public Health*, Vol. 28, pp. 337-342

Question: What would you suggest for the United States?

Well, every kind of innovative activity to change the world and such old-fashioned laws, all kinds of such activities in recent scientific history, have been done in the United States. So, I ask you, the people of the United States, to please save mankind.

Question: We have a big job to do, to get the United States to be interested in this. I think it's well worth making the effort. Maybe it can be a joint effort, with Japan and with other countries that have done this research, like China, as well.

In 20 years, China might be the leading country in the world.

Question: And the United States has to wake up. . . .

Yes, you have to wake up your country.

Cloning: Medical Spin-offs and A Challenge to Old Assumptions

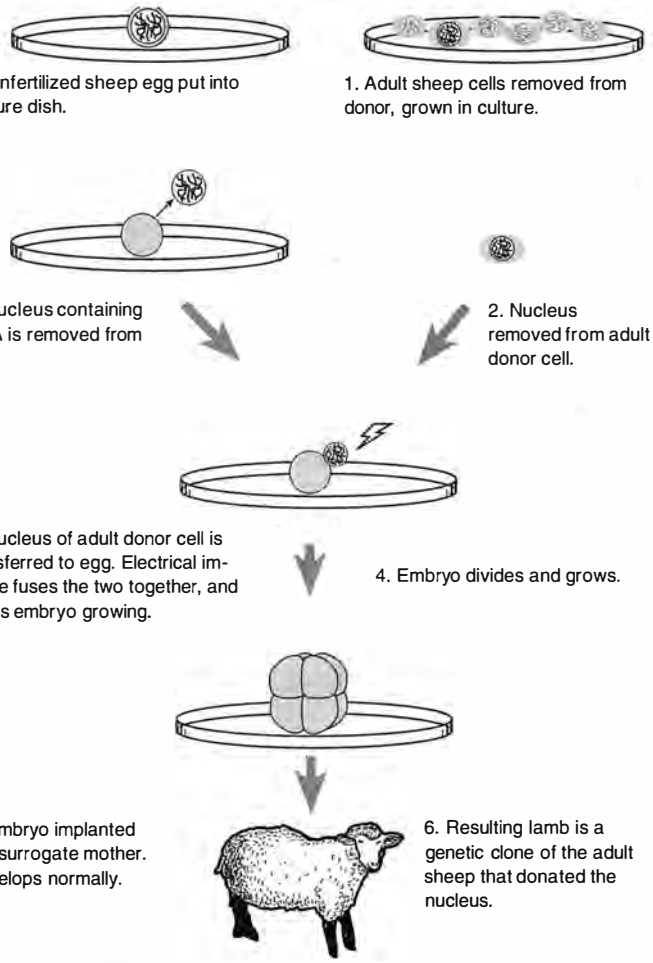
by Colin Lowry

The successful experiment which produced the now famous cloned sheep, Dolly, has opened up exciting new possibilities in medical research, and has challenged a fundamental assumption in biology: the idea that adult differentiated cells have had their DNA conformation permanently changed.

The new cloning technique involves the transfer of the nucleus containing the DNA from an adult cell into an unfertilized egg that has had its nucleus removed. The procedure developed by Dr. Ian Wilmut, and his team at the Roslin Institute in Scotland, produced a newborn sheep that is genetically identical to the adult animal that donated the cell nucleus. The adult animal cells are grown

in culture, and chemically treated so that they exit the growth phase of the cell cycle and enter a quiescent state. This is important to the success of the technique, as the donor cell is put into a metabolic state very similar to the unfertilized egg. It is thought that this will cause the DNA to adopt a conformation that will respond to the proteins in the egg that regulate genes in development.

The egg has its nucleus removed, and the donor cell is then fused to the egg using a small electric charge, which also stimulates the cycle of cell division and growth. The adult nucleus, under control of the proteins in the egg, will provide the necessary genetic information for the development of a new individual. Once the embryo has reached sufficient size, it is transferred to a surrogate mother, where it develops, and is born in the normal fashion.



THE CLONING TECHNIQUE THAT PRODUCED DOLLY

Life-saving Spin-offs

The hysteria generated in the popular press that linked Dolly to the possibility of human cloning, was designed to shift the emphasis away from the important benefits to medicine, agriculture, and basic research that the discovery will produce.

The key point is that the new technology will save lives. It is important here to understand the distinction between the policy question of the use of science, and the fact that evil people might come into control of such a technology. But to fight the evil application of a technology, you must fight the evil people, not fight the technology, or ban it. In fact, to be duped into opposing the scientific discovery would be helping the very evil purposes to which the person objects, by denying society the beneficial use of that discovery.

Here are some of the benefits of the ability to create cloned animals from cultured cells: In the short term, researchers will be able to produce human therapeutic proteins (such as insulin) in transgenic animals, which will be much easier, more precise, and faster than current methods. Transgenic animals (those which contain genes from other species) are currently created by injecting DNA constructs into early embryo cells. The foreign DNA is correctly integrated into the animal's genome at very low percentages, and the resulting animals that are born must be tested for the presence of the DNA construct.

The new cloning technique would allow the process of foreign DNA integration to be performed in cell culture at much higher efficiencies, and cells expressing the new DNA could be selected and used to clone animals. Many therapeutic proteins such as blood clotting factors, or specific drugs for treating diseases like cystic fibrosis, can be made in transgenic animals.

The cloning technique also offers the chance to create animal models of human diseases. For example, animals could be developed that contain the genetic defect for the disease cystic fibrosis, and potential treatments could be tried on these transgenic animals. The ability to make genetic changes in animal cells, and study the effects of these changes in the development of the animal would provide insight into gene function and regulation.

This would also benefit agriculture, as an understanding of genetic regulation and the ability to alter it could make it possible to develop cows that produce more milk, or cattle that are more resistant to disease.

Perhaps most dramatic, the cloning discovery could provide part of the long-term solution to the severe shortage of human donor organs available for transplantation. The major problem in transplanting organs is the immune system response that attacks and rejects foreign tissue. Basic research has provided a partial picture of how immune cells recognize foreign tissue by reading the proteins present on the surface of the tissue. Scientists currently are using this knowledge to introduce human surface protein genes into animals, so that their organs could be used for transplantation into humans without rejection by the immune system.

The application of the cloning technique in this area would make it possible to produce enough transgenic animal organs to save the lives of the thousands who die each year waiting for an organ to become available.

Fundamental Assumptions Challenged

The breakthrough in cloning has challenged a fundamental assumption in biology, and has prompted a new

Continued on page 67

What Man-Induced Climate Change?

The claims of human-caused global warming are not corroborated, even by the scientific studies on which they are supposedly based.

by Hugh W. Ellsaesser, Ph.D.

The key statement from the 1995 report of the Intergovernmental Panel on Climate Change (IPCC), the group responsible for the science behind the global treaty on climate, is as follows: "The balance of evidence suggests that there is a discernible human influence on global climate."

This pronouncement has been most frequently supported, both in Section 8 of the IPCC 1995 report, and in *Science* magazine (Kerr 1995a and b), by references to Hegerl et al. (1994), Mitchell et al. (1995), and Santer et al. (1995 and 1996). An analysis of these referenced articles, however, shows that the cited studies do *not* support the IPCC's suggestion.

This article summarizes the relevant material from the cited studies, and the evidence that the spatial pattern of the 0.5°C warming of the past century has steadfastly disagreed with that predicted by climate models, in that it has not been amplified in polar regions, and it has not led to higher maximum temperatures.

At the outset, it should be noted that additional greenhouse warming is just what we need to prevent or delay the next glacial cycle. By current understanding, the Holocene, our current period of interglacial climate, is due to end, and a period of 90,000 years of cooling is due to begin—taking us back to conditions of the last glacial period about 18,000 years ago, when the temperature was 5° to 7°C cooler than now (Figure 1). Why don't we ever hear the argument that additional greenhouse warming is just what we need to prevent or delay the next glacial cycle?

The Hegerl et al. Report

Hegerl et al., in a report published by the Max Planck Institute for Meteorology in Hamburg in 1994, used two, long-term climate model runs to obtain an estimate of the natural variability of surface temperature. Using this as an estimate of natural climate variability, Hegerl et al. concluded that the warming observed over the period of record exceeds natural variability and is therefore unnatural, or forced.

In their words: ". . . under the caveat that we have correctly estimated natural [climate] variability [from models] . . . [our] conclusion that a significant warming has been observed can be given with some confidence. . . . However, we caution that we cannot yet decide if the observed abnormal [non-natural] warming in the last few decades can be uniquely attributed to anthropogenic greenhouse gas forcing."

Hegerl et al. (1994) thus specifically deny the very point for which their report is cited by the IPCC.

Hegerl et al. (1994) was cited in the 1995 IPCC report, Section 8, as: Hegerl et al. (1996), *J. Climate* (in press), but no record could be found of the 1996 reference having been published.

The Little Ice Age Factor

Use of this report to suggest "a discernible human influence on global climate" also directly conflicts with the statements from the IPCC's 1990 report concerning the Little Ice Age, which occurred circa 1450-1850. The IPCC writes: "The Little Ice Age, in particular, involved global climate changes of comparable magnitude to the warming of the last century. It is possible that some of the warming since the 19th century may reflect the cessation of Little Ice Age conditions" (IPCC 1990, p. 233).

Further, the same report notes, "The size of the observed warming is broadly consistent with predictions of climate models, but it is also of the same magnitude as natural climate variability" (IPCC90, p. xii).

The 1995 IPCC report contains nothing to suggest that these earlier statements are no longer valid .

During the Little Ice Age, the rivers of London, St. Petersberg, and Moscow froze solid enough to hold public fairs; the Nordic colony in Greenland perished, and many farms and villages in Scandinavia and Switzerland had to be abandoned because of glacier advances. By present estimates, we have moved about halfway from the coldness of the Little Ice Age to the warmth of the preceeding Medieval Climatic Optimum, circa 900-1300, when the Norse were able to colonize Greenland and to explore Labrador.

The Mitchell et al. Study

Mitchell et al., writing in *Nature* magazine in 1995, used the British Meteorological Office Hadley Center's advanced climate model to run three experiments, starting from 1860: a control with constant CO_2; an experiment known as GHG, with CO_2 increasing, as recorded historically to 1990 (+ 2.5 watts per square meter at this time, and at 1 percent/year thereafter); and an experiment known as SUL, with both CO_2 and sulfate aerosol increasing, as recorded historically until 1990 (-0.6 W/m^2 at this time) and thereafter following the IPCC scenario designated IS92a in the IPCC 1992 report.

Results were given in decadal averages of GHG and SUL, minus control and centered spatial (on the map) correlations for each decade, between the model experiments and the observed temperature anomalies. (The global means are subtracted from each map before the correlations so that the correlation pattern shows only the predicted change versus the observed change.) The decadal correlations are reproduced in Figure 2.

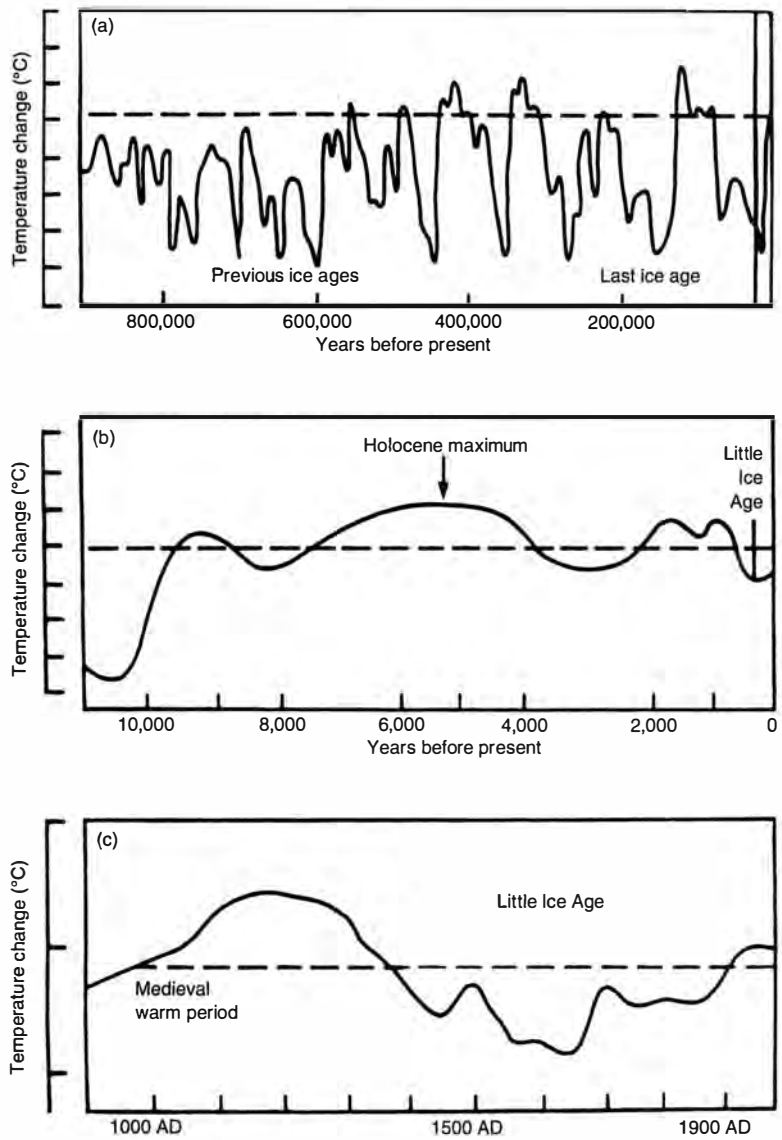


Figure 1
RECONSTRUCTION OF THE EARTH'S CLIMATE OVER THE MOST RECENT 850,000 YEARS

A long-range view of climate indicates that the Holocene, our current period of interglacial climate, is due to end and a period of 90,000 years of cooling is due to begin, taking us back to temperatures 5° to 7°C cooler than those of the present. This schematic shows the mean global temperature for the past million years (a), and in more detail for the past 10,000 years (b), and the past 1,000 years (c). There were at least three cyclic warmings and coolings in the past 10,000 years, lasting about 2,500 years each. The dashed line represents conditions near the beginning of the 20th century.

Source: IPCC, 1990, Figure 7.1

The GHG experiment gave correlations exceeding 0.2 in the 1870s, 1880s, and 1950s. The other decades were near or below zero. For the SUL experiment, the correlations varied about zero through the 1960s, and rose to about 0.275 for the 1970s, and 0.3 for the 1980s. That is, the strongest upward trend was from the 1960s to the 1970s—essentially the same period in which Santer et al. (1995) (see below) found the strongest upward trend.

However, the use of non-overlapping decadal means (where there is only one point mapped for each decade), averaged out both the negative correlations of 1945-1955 and the rapid drop in correlations after 1985, as shown by Santer et al. (1995).

The *Nature* article by Mitchell et al. (1995) described these results as follows: "For the decades since 1950, the magnitude of the pattern correlation between SUL and the observations increases steadily, rising above the 10 percent significance level in the two most recent decades. This recent trend is consistent with what could also be an emerging greenhouse gas/sulphate aerosol signal in the observations."

No claim was made in this article that an anthropogenic climate change signal had been identified in the observational data.

The Santer et al. Experiment

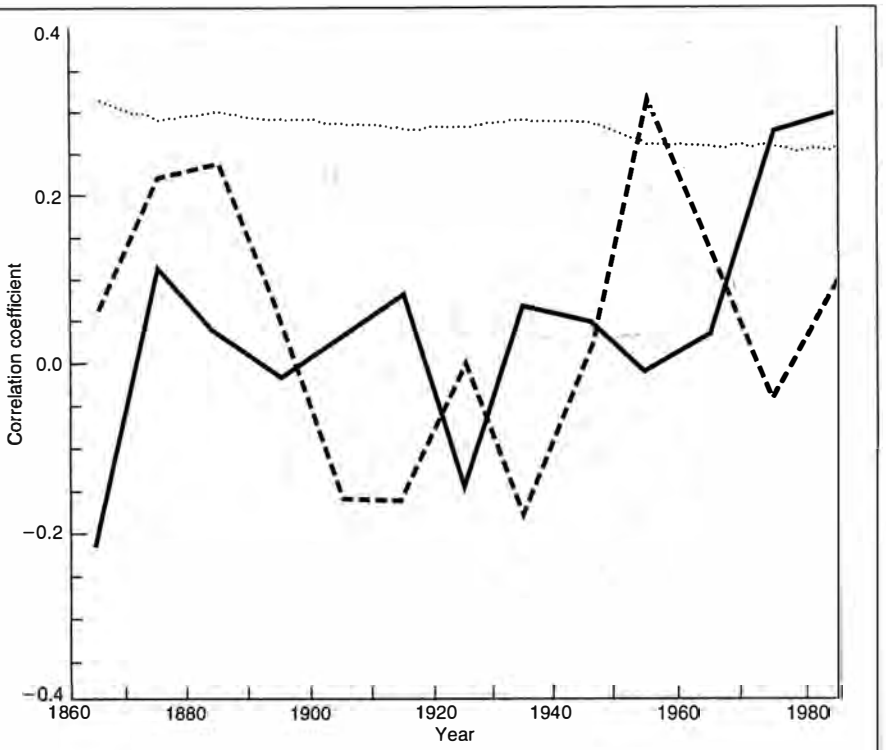
Santer et al., in a 1995 report published by Lawrence Livermore National Laboratory, compared the model integrations (extended) of Taylor and Penner (as published in *Nature* in 1994), with an updated version of the observational data series of Jones et al., published in conference proceedings on global warming by Elsevier in 1991.

Four equilibrium integrations were performed: a control run (designated CTL) with nominal pre-industrial CO_2 at 275 parts per million volume (ppmv); a sulfate-only run (designated S) with near-present-day anthropogenic sulfur emissions, 78 teragrams of sulfur per year, providing a forcing of -0.95 W/m^2, and pre-industrial CO_2; a CO_2-only run (designated as C) with no sulfur emissions and nominal present-day CO_2 (345 ppmv, providing a forcing of 1.26 W/m^2) and a combined run (designated SC) with near-present-day CO_2 and sulfur emissions.

In the analysis, a 13-year filter was passed over the 1854-1993 observational data series to produce smoother values. (In other words, the data were smoothed, by taking a 13-year weighted mean, where the center point carries more weight than the distant points.) These results were then subtracted from those of a reference year, normally 1954, in order to produce seasonal and annual mean temperature change maps for the period

Figure 2
CORRELATION OF SIMULATED AND OBSERVED TEMPERATURE CHANGES RELATIVE TO THE 1860-1990 MEAN

The spatial correlation between simulated and observed decadal temperature changes is shown relative to the 1860-1990 mean. The dashed line is the GHG experiment, which had CO_2 increasing as recorded historically to 1990. The solid line is the SUL experiment, which had both CO_2 and sulfate aerosol increasing, as recorded historically until 1990. The dotted line gives the 10 percent level of significance, which varies with data coverage. Note that the normally *used 5 percent level of significance would be well above the correlation curves. Mitchell et al. make no claim that an anthropogenic climate change signal had been identified in the observational data.*



1910 to 1993. These temperature changes were then correlated, year-by-year, with the change patterns predicted by the model. These were constructed by averaging the last 20 years of each model run and subtracting the control run from each of the three perturbed runs.

The correlations computed were of two types: a centered (or pattern) correlation, designated as *R(t),* in which the global mean is first subtracted from the respective fields each year; and an uncentered (or trend) correlation, designated as *C(t),* in which global means are not removed. (If the global means are removed from each field, then the mean becomes zero, before the correlation is made.) Note also that the data coverage in the reference year, t_0, also served as a grid mask, to determine which observational grid points were included in the correlations.

The stated strategy was "to search for a long-term, positive trend in the pattern correlation statistic, which would indicate an increasing expression of the [model-predicted] signal in the observations."

The Santer Results

Santer et al., writing in *Climate Dynamics* (1995b), found their best results in the summer and fall data: "Our results indicate that over the last 50 years, in summer [June-July-August] and fall [Sept.-Oct.-Nov.], observed patterns of near-surface temperature change show increasing similarity to the model-simulated response to combined sulfate aerosol/CO_2 forcing." Their fall combined sulfate-CO_2 *R(t)* results, selected for display in their Figure 10, are reproduced here as the solid curve in Figure 3; the dashed curve is their comparable S (sulfate-only) *R(t)* curve.

Note the following:

(a) The observed temperature change pattern becomes increasingly dissimilar to the combined, sulfate-CO_2 experiment-predicted change, from the 1910 starting point until 1945—that is, *R(t)* drops from +0.2 to −0.12. The dissimilarity became even greater over this period for the sulfate-only experiment.

(b) The rise in *R(t),* or "increasing similarity" between observed and predicted temperature change patterns, is essentially restricted to the period 1945-1970, and the bulk of this merely returns the similarity to its initial 1910 value; from 1970 to 1993, the *R(t)* linear trends for both the sulfate-only and the sulfate-CO_2, are negative.

(c) Even if the positive linear trends for 1945-1993 are accepted as "increasing similarity" between observed and predicted temperature changes, it must be admitted that the addition of carbon dioxide degraded the response, compared to the sulfate-only experiment in this best case. Thus, as pointed out by a report published by the Marshall Institute (1996), if this is evidence of "a discernible human influence on global climate," it is a result of sulfate aerosol alone and is not due to carbon dioxide.

Interpreting Experimental Results

In the updated analysis by Jones et al. (1991), as shown here by Figure 4(a), the Northern Hemisphere becomes warmer than the Southern Hemisphere after about 1920, and reaches a maximum temperature difference circa 1950. After 1950, this temperature difference decreases; then it reverses, and, in about 1970, the Southern Hemisphere reaches a maximum in warmth over the Northern Hemisphere.

This difference in hemispheric temperature then decreases, returns to about the same value circa 1985, and then decreases rapidly to the end of the record. As noted in the IPCC's 1992 report: "The difference in mean decadal anomaly changed markedly between 1946-1955 and 1971-1980 corresponding to a relative warming of the Southern Hemisphere compared to the Northern of nearly 0.3°C between these decades. This relative warmth of the Southern

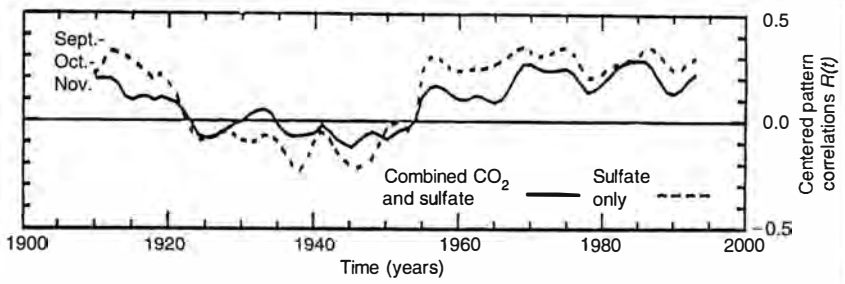


Figure 3
OBSERVED VS. MODEL-SIMULATED PATTERNS OF NEAR-SURFACE TEMPERATURE CHANGE (1900-1993)

Centered pattern correlations [R(t)] between model and observed near-surface temperature changes for fall (Sept.-Oct.-Nov.). Model changes are taken from the combined CO_2 and sulfate aerosol experiments (solid line) and sulfate-only experiments (dashed line). Note that the addition of CO_2 reduces both the correlation and its upward trend after 1945. In other words, CO_2 degrades the results.

Source: Adapted from Figures 7 and 8 of Santer et al., 1995

Hemisphere was greatest around 1975-1980 and the mean difference in anomalies in the last five years has returned to near zero" (IPCC 1992, pp. 146-7).

Anthropogenic sulfur emissions are concentrated in the Northern Hemisphere. Thus, their primary effect in the models, as shown by the two experiments cited above, is to cool the Northern Hemisphere relative to the Southern Hemisphere. Because the analyses of both experiments are based primarily on centered correlations of spatial patterns (with the global means removed) of model-predicted and observed temperature change fields, it is no surprise that the correlation statistics for both the sulfate-only and the combined experiments show marked positive trends from 1950 to 1970. This is the period in which the observed hemispheric temperature difference reversed, and the Northern Hemisphere became colder than the Southern Hemisphere in the Jones et al. analyses.

The important question is the *cause* of this reversal in hemispheric temperature difference. Was it the result of man's emissions of sulfur, which apparently increased about two-fold between 1950 and 1990 (according to Mitchell et al., 1995)? If so, why did the relative cooling of the Northern Hemisphere stop in 1970, and rapidly reverse itself after 1985?

The pronounced Arctic warming observed in the 1920s and 1930s, noted by Scherhag (1939), and statistically isolated by Mann and Park (1994), is a more likely cause of the Northern Hemisphere being warmer than the Southern Hemisphere until 1950. (The winter temperature in Spitsbergen, for example, warmed by 12°C.) Stocker and Mysak (1992), Mann and Park (1994), and others have related the Arctic warming to a century-scale variability in deep-water production in the North Atlantic.

The fading away of the Arctic warming during 1940-1960, could be expected to reduce this difference to zero, but would it reverse it? The colder isopleths moving toward the equator, out of the Arctic, circa 1970 (see Figure 7.12b in the IPCC 1990 report) suggest that it

An Anthropogenic Signal in the Temperature Record

The question of whether a man-induced climate change has been identified in the temperature record can be answered with a confident "no." But there is one point that should be mentioned. There was an abrupt drop in ship temperatures of about 0.35°C, circa 1901-1905, with no immediate recovery, as pointed out in Ellsaesser et al. (1986). This drop is almost certainly an artifact—that is, man-induced.

As noted by Ellsaesser et al. (1986), this abrupt cooling of ship temperatures occurred at a time of transition from sailing ships to steam ships—a transition made more abrupt by the rapid increase in total shipping at the time. A cooling would be expected for this transition. On sailing ships, stormy periods are generally colder than normal and all hands are busy, so fewer weather observations are recorded. Under becalmed conditions, which are generally warmer than normal, there is little to do, so weather observations were regularly recorded. With steam ships, this selectivity disappeared.

Note how little this behavior is reflected in the land-only temperature curves in Figures 4(b) and (c). This abrupt drop is clearly evident even in the smoothed analyses of Figures 4(d) and (e), and is still more evident in the most recent update of the NMAT (nighttime marine air temperature) data series of Parker et al. (1996), shown in Figure 5.

As stated by the IPCC in its 1990 report: "Smoothed night global marine air temperature showed the largest apparent change around 1900, with a maximum [observed decadal] cooling of 0.32°C between 1898 and 1908, though this value is very uncertain." No one has yet suggested a credible explanation for this perturbation that would provide a basis for correcting the record.

This hiatus in the ship observational record has very definitely placed an anthropogenic signal (non-climatic, insofar as can now be determined) in the hemispheric and global temperature records. The combination of these ship records, without correction, with the land record, has moved the coldest period of the observational record from the early 1880s into the early 1900s, as can be seen by comparing the land-and-sea curves of Figure 4(a) with the land-only curves in Figures 4(b) and (c).

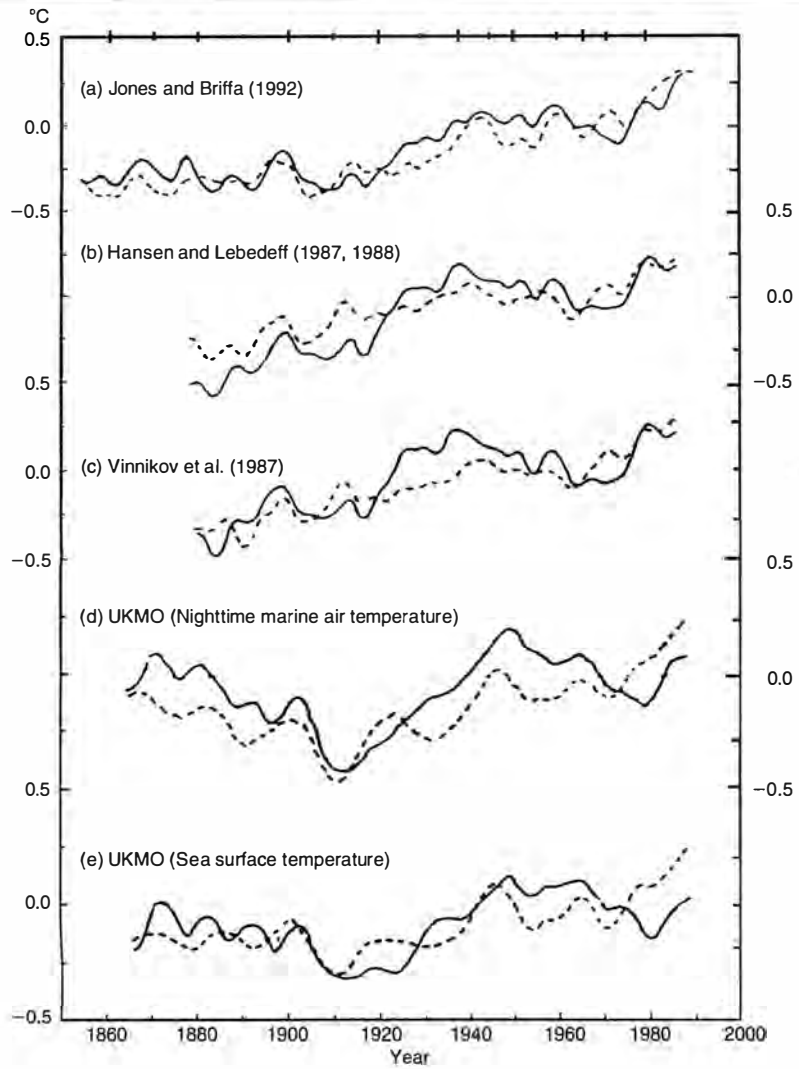


Figure 4
COMPARISON OF VARIOUS NORTHERN AND SOUTHERN HEMISPHERE MEAN SURFACE TEMPERATURE CURVES (1860-1990)

Comparisons of Northern Hemisphere (solid) and Southern Hemisphere (dashed) smoothed mean surface temperature curves as compiled by the sources noted. Since the pattern correlations of both Mitchell et al. (Figure 2) and Santer et al. (Figure 3) depend on how far the Southern Hemisphere curve lies above the Northern Hemisphere curve, their results would vary greatly with the observational data set used.

did. Thus, we have one indication that the increasing trends in *R(t)* from 1950 to 1970 is, therefore, also an artifact, caused by the waning of the Arctic warming, rather than by any effect of man-induced sulfate aerosols on mean hemispheric temperatures.

From the differences in the relative hemispheric temperatures shown by the different analyses in Figure 4, we have another indication that these results may simply be an artifact, resulting from the data analyses being inadequate to define hemispheric temperatures relative to each other.

The results of Mitchell et al. (1995) and Santer et al. (1995) would appear to have been stronger if they had used one of the ship data series in Figures 4(d) and (e) for verification of their models.

Further Evidence

There are several additional points that must be weighed in the "balance of evidence," to use the IPCC's term:

(a) Any attribution scenario attempting to explain the evolution of hemispheric temperature differences over this period, 1950-1970, in the Jones et al. (1991) analysis has to invoke a large variability caused by natural but unknown forcing functions, because it has to reverse itself twice after 1950. As soon as such natural variability is admitted, it cannot be eliminated as the cause of all the variability, leaving none to be attributed to anthropogenic forcing.

(b) All combined sulfate-CO_2 experiments, including the Mitchell et al. (1995) experiment with a full ocean model, have shown strong polar amplification of the temperature change response. In both these studies, the areas of largest temperature change were eliminated by the observed data masks, and therefore did not affect the computed correlations.

Because the satellite data show that these large, predicted polar temperature changes have failed to appear, these areas would have seriously degraded the correlations of these studies if they had been included. As shown in Table 3 of Santer et al. (1995), the annual mean *R(t)* between the sulfate only and the combined sulfate-CO_2 cases is 0.10 for the full field, and 0.60 when the observed data mask is used. For the CO_2 and combined sulfate-CO_2 correlation, *R(t)* is 0.63 for the full field, and 0.01 with the data mask.

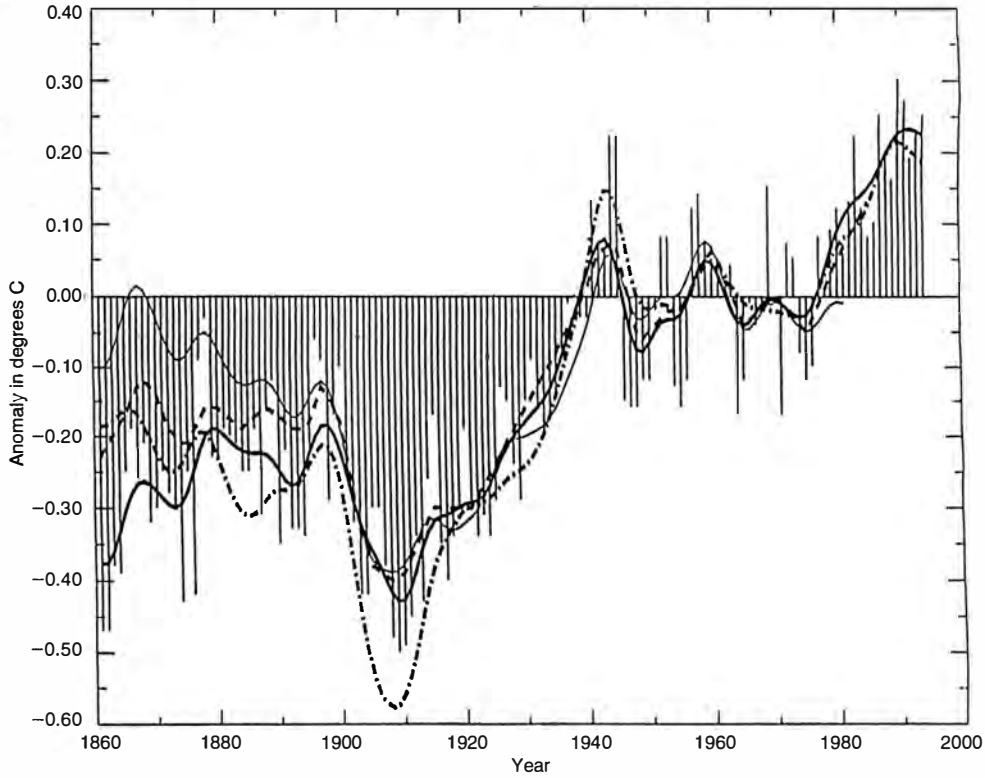
Obviously, inclusion or omission of the areas of polar amplified model responses can make or break the correlation.

(c) Observational data show that the sulfate content of air over the Arctic is highly seasonal, being greatest in late winter and spring. Also, this sulfate, in the form of Arctic haze, "forces a warming of the Arctic atmosphere," according to Shaw (1995), and thus should amplify rather than negate greenhouse warming in the Arctic.

(d) Jones's (1994) latest update of the land-only data reduced the Southern Hemisphere trend since 1861 by about 0.2°C. The new trends in degrees Celsius per century are Northern Hemisphere 0.47, and Southern Hemisphere 0.26, for 1861-90; and Northern Hemisphere 0.56, and Southern Hemisphere 0.47, for 1901-1990. Because the effects of both sulfate aerosol and CO_2 are calculated to be greater over land than sea, this would further reduce observational support for these combined model results.

Figure 5
GLOBAL ANOMALIES OF SMOOTHED SURFACE SHIP TEMPERATURES (1860-1994)

Four sets of data are combined in the figure. The light solid line is from Folland et al. (1984). The light dashed line is from Bottomley et al. (1990); the Folland and Parker (1995) corrections to this are shown in the heavy solid line and in the annual bars. The dash-dot smoothed curve is nighttime marine atmospheric temperature (NMAT) from Parker et al. (1995). Note how all of the ship data, and particularly the NMAT data, show the abrupt 1900-1903 cooling, with delayed recovery, even after smoothing.



Conclusions

From this analysis, I conclude that the only suggestion of a human influence on climate is the warming of the past century. This warming itself is significantly less than predicted, its time evolution does not match that of the rise in CO_2, and its spatial pattern in latitude and altitude does not match the fingerprint given by current climate models. Furthermore, recovery from the Little Ice Age provides a natural, and no more controversial, explanation for the warming observed to date.

It would appear that the IPCC 1995 statement—". . . the balance of evidence suggests that there is a discernible human influence on climate"—was studiously crafted to induce the media to broadcast to the citizens and policy makers of the world a message that few, if any, of the researchers on whose work it was based, are yet willing to defend before the scientific community.

As Santer et al. (1995) stated: "We have not shown conclusively that the signal identified can be attributed to the unique cause of anthropogenic sulfate aerosols and CO_2."

After publication of the IPCC 1995 report, J.T. Houghton, the chairman of the IPCC, stated (1996) that neither the IPCC nor anyone "who is informed is claiming certainty of detection or attribution."

My conclusion is that the question of whether a man-induced climate change has been identified in the temperature record can be answered with a confident "no."[1]

Hugh W. Ellsaesser, an atmospheric scientist, is a member of the scientific advisory board of 21st Century. *He retired from the U.S. Air Force after 20 years as an Air Weather Service Officer, and from the Lawrence Livermore National Laboratory after 23 years of atmospheric and climate research.*

Notes

1. A recent article in *Science* magazine by Richard Kerr, titled "Greenhouse Forecasting Still Cloudy," appears to say that my conclusion is now generally accepted.

Acknowledgments

Helpful comments from J.T. Houghton, R. Jastrow, M.E. Mann, P.J. Michaels, B.D. Santer, F.S. Singer, K.E. Taylor, and H. Van Loon are gratefully acknowledged. This work was performed at the Lawrence Livermore National Laboratory under the auspices of the U.S. Department of Energy under Contract W-7405-Eng-48.

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Cloning

Continued from page 60

perspective in gene regulation research. It was previously believed that adult differentiated cells have had their DNA conformation permanently changed, making them unable to direct the developmental program needed to produce a new individual. Although all cells of the body (except germ cells) contain the same DNA sequences, as cells become specialized into types, certain genes are activated and others inactivated, resulting in different DNA conformations.

These changes to the DNA are now known to be reversible through the success of the cloning experiment.

Colin Lowry

Scientist Ian Wilmut (third from left) at the U.S. Senate hearings on cloning March 12, with Sen. Tom Harkin (D-Iowa), Sen. Bill Frist (R.-Tenn.), and Sen. Ted Kennedy (D-Mass.). The hearings were held to discuss the benefits of cloning—and the media coverage that linked the breakthrough to scare stories about human cloning. Wilmut stressed that the motivation for the research was its potential for helping improve the treatment of human disease.

Embryonic cells are totipotent, meaning that they have the ability to differentiate into all the different cell types present in the body, while cells that have already developed into a specific type no longer have this ability. The study of how this process of differentiation occurs at the genetic regulation level, may make it possible to re-program an adult cell to return to an embryonic state. This would have a tremendous impact on the treatment of injury and disease, because cells could be de-differentiated, genetic defects corrected, and then the cells could be directed to grow back into their specialized type. This approach could make it possible to regenerate damaged tissue.

The cloning experiment has also put a focus on how the newly formed embryo directs its own development. In an unfertilized egg, almost all of the genes are inactive at the point before fertilization. Once fertilized, it must activate its genes in the correct sequence, temporally and spatially. In different species, the time of activation differs for the new zygotic genome (normally, the sum of the genes from the sperm and egg).

In the sheep, the zygotic genome is not activated until after three rounds of cell division, at the eight-cell stage. This may be important to the success of the cloning experiment, as this gives the egg proteins time to get the new genome ready for activation, in a process called chromatin remodelling. Chromatin is the organized mixture of proteins and DNA that make up chromosomes.

In the case of Dolly, the adult chromatin has to have the adult patterns erased, and the embryonic conformations have to be initiated, in order for the necessary genes to be activated in development. This process involves the enzymatic modification of the proteins that package the DNA into specific structural conformations in chromosomes, and the regulation of this process in the development of the embryo is mainly unknown.

The difference between the mouse and the sheep embryo in terms of when the new zygotic genome is activated helps answer the question of why all previous attempts to clone mice have failed. In the mouse, the zygotic genome is activated after only one cell division, at the two-cell stage, which may not allow enough time for an adult nucleus to be successfully remodelled. Species that quickly activate the zygotic genome may not be able to be cloned until the process of nuclear remodelling is better understood, and scientists can remodel adult nuclei before transferring them to the egg.

Since the announcement of the cloning success, other scientists have renewed efforts to clone other animals such as cows and pigs. Basic research in biology has been pushed to examine fundamental questions in development and gene regulation, which will undoubtedly enrich our understanding of living processes, and provide many useful applications in medicine and agriculture for years to come.

Phytoremediation: Weeding Out Waste

by Mark Wilsey

Removing heavy metals and radioactive waste from soil or water is a particularly troublesome decontamination problem. The challenge is to find more effective means of separating a teaspoon of toxic material from a ton of soil or water.

It is well known that plants extract from the soil what they need to grow, and horticulturists are able to monitor the levels of these nutrients in the soil to ensure healthly crops. There are many plants, however, that will take up signifcant amounts of heavy metals, in addition to taking up nutrients, and researchers are currently looking at ways to use growing plants to remove unwanted materials—such as radioactive isotopes—from soil and water. The process is called phytoremediation (*phyto-* comes from the Greek word for plant).

Waste Treatment *Plants*

A few years ago, Dr. Scott Cunningham, a scientist at the Du Pont Company, was testing the level of lead contamination around a Du Pont chemical plant in New Jersey when he discovered that the level of lead in the ragweed plants he tested was much higher than that in the soil in which the ragweed was growing. Spurred by this finding, Cunningham and his co-workers set up a small plot on the plant grounds to monitor how much lead the weeds were soaking up. After four months of growth, the ragweed showed lead concentrations as high as 8,000 ppm (parts per million), while the lead concentration in the surrounding soil was only 1,000 ppm.

Plants, such as ragweed, that can build up high concentrations of metals in their cells are called "hyperaccumulators." They can absorb orders of magnitude more metal than other plants, and survive in soils in which most other plants could not. In some cases, the metal absorbed can make up more than 2 percent of the plant's dry weight. There are hundreds of plants that have demonstrated this ability for more than a dozen metals, such as arsenic, copper, and beryllium. Indian mustard, for example, will take up selenium and chromium; Alpine pennycrest will take up zinc and cadmium.

Courtesy of Phytotech

A Phytotech scientist measures the radioactivity level at the Chernobyl pond selected for rhizofiltration. In the background is the nuclear power plant.

After it has grown and absorbed the contaminant, the plant is harvested. It then can be dried, burned, turned into compost, or be safely disposed of in other ways. The expectation is that after several growing seasons, phytoremediation will be able to reduce the metal content of the soil under treatment to a tolerable level.

It is even possible, if desired, to smelt the metal from the ash, which contains 10 to 20 percent metal by weight. In fact, a couple of years ago, the U.S. Bureau of Mines conducted tests on nickel-rich soil in California, which indicated that the plant streptanthus could take up 50 to 100 pounds of nickel per acre.

Another application of phytoremediation under investigation deals with chemical contaminants. There are plants being studied that contain enzymes that can break down many of the chemical compounds commonly found in solvents, fertilizers, and munitions. Further research aims at enhancing the ability of these plants to deal with waste. To accomplish this, scientists will need to gain a better understanding of the reactions and mechanisms at work inside the plants. It may be possible, for example, to genetically alter a plant to tailor it to a specific application, or to give one plant a desired trait from another.

Radioactive Weeds

The U.S. government is now storing hundreds of millions of gallons of radioactive waste, primarly from its nuclear weapons programs. Treatment and storage would be greatly simplified if the radioactive components could be

Courtesy of Phytotech

Floating rhizofiltration systems at the Chernobyl pond. The sunflower plants were able to concentrate strontium-90 and cesium-137 up to 10,000 times.

separated from the rest of the waste, thus reducing by several-thousand-fold the sheer volume of this radioactive waste.

Dr. Paul Jackson, at the Los Alamos National Laboratory in New Mexico, has been experimenting with jimson weed as a means of separating out plutonium and other radionuclides in radioactive waste. The jimson weed is grown as a cell culture in tanks in the laboratory. The cells are collected, dried, and processed with other materials into a dry cake. This substance is then used as a filter for the nuclear waste.

Although the jimson weed cells are no longer alive after this process, they still absorb the radionuclides. The metals are bound up in the cell wall of the plant by a protein compound. Dr. Jackson is currently studying how this binding of the metal to the cell wall occurs.

Once the jimson-weed filter has collected the radioactive material, it becomes radioactive itself. However, this presents a physically much smaller problem to deal with.

The U.S. Department of Energy (DOE) has been working with Phytotech of Monmouth Junction, N.J., to develop other remediation techniques. Phytotech is one of a handful phytoremediation companies; others include Phytokinetics in Logan, Utah, and Applied Natural Sciences in Hamilton, Ohio.

Phytotech and the DOE are developing a process for treating contaminated water, called rhizofiltration (*rhizo-* comes from the Greek word for root). In this technology, sunflowers are grown hydroponically in low-level-radioactive water. Sunflowers, and some other plants, do not transport the metals they absorb up into their stems and leaves; instead, the metal accumulates in the plant roots. The advantage to this is that when the plant is harvested, its top can simply be discarded, because so little of the radionuclides are transported up into the stem, and its roots, which contain the radionuclides, can be disposed of separately.

In field tests at a DOE site in Ohio, rhizofiltration removed 99 percent of the uranium in the processed water: The water went from 350 ppb (parts per billion) to less than 5 ppb, which is the Environmental Protection Agency standard for drinking water.

Phytotech has also tested this method in the polluted ponds near the Chernobyl nuclear plant in Ukraine, at the site of the nuclear accident in 1986. The scientists grew sunflowers on a small raft at one pond. In a few days, the concentrations of radioactive cesium and strontium in the plants were thousands of times that of the water. In this way, the researchers were able to remove enough radioactive material from the ponds to make the water safe for irrigation and drinking.

Phytotech president Burt Ensley estimates that rhizofiltration could cost as little as 5 percent of the cost of conventional technologies for the same volume of water—$2 to $6 per 1,000 gallons, compared with $80 per 1,000 gallons for reverse osmosis. In regard to cleaning up soil, phytoremediation can also be much cheaper than traditional measures. Ensley states that compared with extraction methods, where the contaminated soil is simply trucked away to another location, phytoremediation would cost only one-fourth as much—although it would take three years to perform the job.

Looking Ahead

The DOE and International Business Communications cosponsored a conference in Washington, D.C., in 1996, with participants representing the wide interest in the subject, from university and industry researchers to government agencies.

Some of the issues facing the emerging phytoremediation community are to establish a scientific framework for phytoremediation to assure accurate results; to develop protocols for evaluating results; and to demonstrate that phytoremediation can meet regulatory requirements. There are likely to be instances in which phytoremediation will not work, and it is important to find both the limits of this technology and where it will be best suited.

Recently, the DOE announced a new program called Natural and Accelerated Bioremediation Research (NABIR), a 10-year, $417-million effort. (Bioremediation includes the use of microorganisms as well as plants for waste cleanup.) There is a large body of research focussing on microbes and their effectiveness in converting hydrocarbons and other chemicals into water and carbon dioxide for treating contaminated soil and water. Microbes have also been studied for their ability to take up heavy metals and radionuclides.

NABIR will include fundamental research as well as field tests. Part of the DOE's goal is to transfer this technology to the commercial sector over the next three to five years.

By one estimate, phytoremediation development is lagging behind microbial bioremediation by a couple of years, but the gap is narrowing. It is clear that although phytoremediation may still be in its infancy, it is growing like a weed.

CNN's Ted Turner Funds Earth First! Eco-vandals

by Frederick Greene

Heinz Ruckemann

Brought to you by CNN's Ted Turner: Scenes from the environmentalist training session at the YMCA's Camp Howdy in Belcarra Regional Park, British Columbia. Activists from Greenpeace, Friends of Clayoquot Sound, BearWatch, Forest Action

Canadian citizens were shocked to learn on British Columbia television news April 9, 1997, that Ted Turner, owner of Cable News Network (CNN), and his wife, Jane Fonda, were funding a training camp for eco-vandals in British Columbia's Belcarra Regional Park, including the transportation of youth from the United States into Canada to the camp. Funds from the Turner Foundation, which is directed by Fonda, were provided to sponsors of "training camps" in Canada for environmentalist actions against the timber industry.

Financial records show that the Turner Foundation funds various enviromental groups run by the admittedly eco-terrorist Earth First! (see below).

The activists at the training camp openly stated their willingness to break the law on behalf of "Mother Nature." Speaking to reporters at the Belcarra training camp on April 8, Greenpeace spokesman Tamara Stark promised a summer of protest to stop old-growth logging in 10 of British Columbia's watersheds. "If need be, I think the law of nature and the ongoing viability of the rainforests are far more important than breaking the law of the country," Stark declared.

Several groups from the United States and Canada have been protesting against the timber industry in both countries. The activists at the Belcarra gathering included about 60 members of Greenpeace, the Forest Action Network, Bear Watch, and Friends of Clayoquot Sound. The training was headed by the Earth First!'s Ruckus Society, based in Montana, which has been involved in numerous illegal activities in the United States. This is the third of a series of camps designed to train the youth of both countries to become involved in illegal forms of protest and other criminal acts.

The Money Links

It has been confirmed through financial records that much of the money used for training and protests comes directly from the Ecology Center of Missoula, Montana, which is run by the Earth First! leadership. According to an article in the Canadian magazine, *British Columbia Report* April 21, "A spokesman for the Ruckus Society told BCTV [British Columbia television] on April 9 that the Turner Foundation, established by American media mogul Ted Turner and directed by his activist wife, Jane Fonda, has provided funds to the group."

The Ruckus Society was founded by Mike Roselle, the cofounder of Earth First! and the current leader of the organization. Roselle has admitted on many occasions that he has committed many acts of terrorism, including the destruction of a U.S. Forest Service building and the sabotage of heavy equipment "that is being used to destroy the Earth."

Roselle's January 1995 article in *Earth First! Journal*, was a call to arms for his following to commit more criminal acts when he stated: "What we want now is nothing short of a revolution. F**k that crap you read in *Wild Earth* or *Confessions of an Eco-Warrior*. Monkey-wrenching is more than just sabotage and you're g**dam right it's revolutionary. This is jihad [holy war], pal. There are no innocent bystanders, because in these desperate hours bystanders are not innocent."

When asked about Roselle's comments, Mark Wexler, professor of applied ethics in British Columbia's Simon Fraser University faculty of business administration, commented: "Oh boy. To me, that's more like Londonderry, Hebron. That's like Oklahoma City bombing stuff. That's crazy talk."

Unabomber Links?

Although Roselle may not condone the actions of the Unabomber, there is a certain similarity to his justification of violence against individuals. And Unabomber suspect Theodore Kaczynski's connection to Earth First! has been

Heinz Ruckemann

Network, and People's Action for Threatened Habitat hold a press conference April 8, while others practice climbing and rappeling techniques.

established in a new book, *Ecoterror—The World of the Unabomber.*

The Unabomber himself commented concerning his murders, in his June 29, 1995, letter: "This is a message from FC, 553-23-4393. . . . Contrary to what the FBI has suggested, our bombing at the California Forestry Association was no way inspired by the Oklahoma City Bombing. We strongly deplore the kind of indiscriminate slaughter that occurred in the Oklahoma City event. We have no regret about the fact that our bomb blew up the 'wrong man,' Gilbert Murray, instead of William N. Dennison to whom it was addressed. Though Murray did not have Dennison's inflammatory style, he was pursuing the same goals, and he was pursuing them more effectively because of the very fact that he was not inflammatory."

Murray died April 24, 1995.

Turner's Eco-millions

Financial records show that the Turner Foundation funds several environmentalist activist groups, including the Ecology Center in Missoula, Montana. The Ecology Center is run by Earth First! leadership, including Mike Roselle. The center's 1995 tax records show a budget in 1995 in excess of $516,000, to which the Turner Foundation was a major contributor. More than 70 percent of that budget went to "Activist Coordination + Empowerment."

". . .I think the law of nature and the ongoing viability of the rainforests are far more important than breaking the law of the country."
—Tamara Stark, Greenpeace

Among the groups connected to Earth First! that received grants in 1995 from the center, are Gila Watch of Silver City, New Mexico, which received $13,000; the Southwest Center for Biological Diversity and the Greater Gila Biodiversity Project, both of Silver City, New Mexico; and New West Research of Santa Fe, New Mexico. (Gila Watch has worked for several years to put Kit and Sherry Laney of the Diamond Bar Ranch out of business. Apparently, the Diamond Bar Ranch is adjacent to the Turner ranch.)

Other Earth First!-connected groups to which the Turner Foundation has made grants are: Biodiversity Legal Foundation of Boulder Colo. (formerly the Earth First! Biodiversity Legal Foundation), Road-ROP of Houghton, Mont., Forest Guardians of New Mexico, the Native Forest Network (founded and run by Earth First! leadership), and Rainforest Action Network (founded by Earth First! and with Mike Roselle still on the board of directors). And there many others.

Eco-terrorism Chronology

North American Research, which tracks eco-terrorism, has compiled a list of more than 1,100 acts of domestic terrorism against ranchers, miners, loggers, hunters, recreationalists, McDonald's outlets, and many more. The February 1993 issue of *Earth First! Journal* advocated sabotage at McDonald's outlets, and since that time, dozens of them have been sabotaged.

A chronology of the most serious, recent acts of environmentalist terrorism includes:

- Sept. 4, 1996—Arson fire at the home of John Campbell, CEO of Pacific Lumber in Arcata, Calif.
- Oct. 29, 1996—Arson fire at the Detroit Ranger Station and the $5.7 million arson fire at the Oakridge Ranger Station in the Willamette National Forest, Oregon. An Earth First! offspring, the Earth Liberation Front (ELF), has taken credit for both fires.
- Nov. 9, 1996—A $400,000 arson fire at MacDonald's in West Jordan, Utah.
- Jan. 14, 1997—Arson fires at Burlington Coat Factory, and two department stores that sell furs in Broward County, Florida. An Animal Liberation Front publication claims responsibility for $20 million worth of sabotage.
- March 10, 1997—Investigators have confirmed that the explosion of six pipe bombs set a fire that resulted in about $1 million in damage to a Sandy, Utah, fur feed company.

Does Light Travel Faster in the Earth-Sextans Direction?

by David Cherry and Charles B. Stevens

Cosmological thinking today is dominated by the assumption that all large volumes of space are basically the same (that is, that the universe is homogeneous), and that the universe must look the same in all directions (that it is isotropic).[1] The universe is thought of as having little more order than is allowed for in gas theory, where the particles (galaxies in this case) obey statistical laws of randomness, instead of being thought of as *hylozoic,* having a predisposition toward life.

This is a far cry from the the thinking of Carl Gauss and Bernhard Riemann, 19th century scientists who walked in the footsteps of Leibniz. Indeed, why *should* the universe—in which life and even human thought and conscience are nurtured—be isotropic and homogeneous?[2]

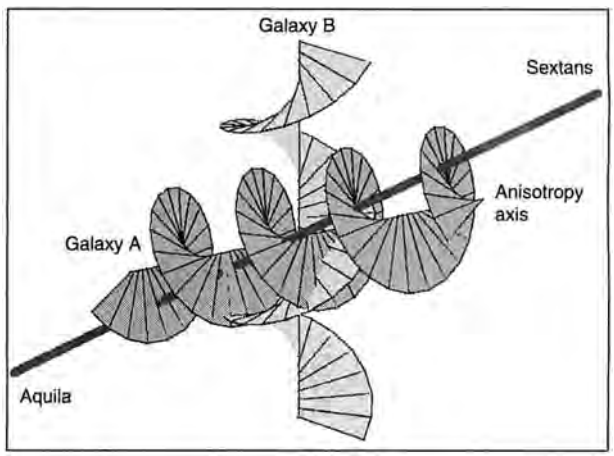
Now, two physicists have published a finding that challenges the assumption of isotropy. "Indication of Anisotropy in Electromagnetic Propagation over Cosmological Distances," by Borge Nodland and John Ralston, appeared in *Physical Review Letters* on April 21.[3] It indicates that the speed of light or other electromagnetic radiation travelling through the near-vacuum of space, is not a constant, but varies, depending on the direction in which it travels. They did not discover this by accident, but went looking for it.

If their finding is correct, light travels slightly faster in a direction defined by an axis running through Earth and the constellation Sextans. It travels increasingly slowly at increasing angles with this direction, and travels most slowly at about 90 degrees from it.

The Corkscrew Effect

It is better, however, to state the finding in terms of the behavior of plane-polarized radiation (Figure 1), rather than the speed of light as such, the latter being a derived conclusion: They find that the plane of polarization rotates slowly as light or radiowaves travel, even in the absence of electric or magnetic fields, and that the rate of rotation depends on the direction in which the light travels. If true, the implications for current cosmological dogma are, obviously, great.

Nodland did the study as his doctoral dissertation, beginning in 1993, under Ralston, professor of physics and astronomy at the University of Kansas. Nodland is now at the Laboratory for Laser Energetics at the University of Rochester.



Borge Nodland

Physicists Nodland and Ralston find an indication that the plane of polarization of polarized light rotates as it travels through space, even in the absence of a magnetic field, and that it rotates more rapidly in the directions of the constellations Sextans and Aquila. Here, the light from Galaxy A, as seen at Earth (at center of line running between Sextans and Aquila), rotates in a tighter corkscrew than the light from Galaxy B.

Their four-page paper gained strength from interchanges between the authors and six peer reviewers, who scrutinized it for nearly two years. Nodland and Ralston had also sought criticism from other physicists. In an interview, Ralston said, "I've talked to perhaps 50 physicists about this over the past two years, and I ask them, What do we do with this? We have this embarrassing phenomenon, and we can't make it go away." So the finding may not be knocked down with the kind of criticisms that some instant critics are offering. Nevertheless, Nodland and Ralston continue to be concerned that their result may simply arise from some systematic bias in the data.

The finding comes at a point at which astronomers are also facing a challenge to the assumption of homogeneity. They have to admit, that as they look on larger and larger scales, they continue to see structures that go to the limits—and presumably beyond the limits—of the largest observed scale. They find that galaxies are gathered in walls between voids, and there is even evidence of periodicity in the spacing of such walls.[4]

The Mystery

The starting point of Nodland and Ralston's inquiry was a mystery—well known to radio astronomers—concerning the plane-polarized radiowaves (synchrotron radiation) from galaxies. Nodland explained, in an interview: "It is known that the plane of polarization of such radiowaves rotates because of the Faraday effect," which is the influence on the radiowaves of charged particles and ions and magnetic fields between galaxies.

Continued on page 74

INTERVIEW WITH JOHN RALSTON

'Look For Things Not Explainable By Conventional Means'


Scott Harper

John Ralston, professor of physics and astronomy at the University of Kansas, was interviewed by David Cherry on April 25 and May 16. Ralston is the coauthor of the paper, "Indication of Anisotropy in Electromagnetic Propagation over Cosmological Distances."

Question: How is it that you came to direct your attention to the possibility of an anisotropy in the universe, and to this kind of measure?

Because it is observable. You see, many people have considered the possible interaction of light with some new physical forces, that there could be some funny business as light crosses the universe. But if you look at that critically, there is some doubt about understanding what the *sources* are doing. As you go back in time (or you go farther out in redshift—farther out in distance) the sources are different. You are not quite confident that you understand those sources.

So, if you look at anything that is just a function of distance, it could always be attributed to differences in the source populations. And in fact, for years, astronomers have said that this unexplained residual rotation in the radiowaves, could be because of the sources: that the older sources are just emitting in a different way.

Well, the whole scientific argument stops at that point because you run up against an unknown. But we realized that if you didn't look for that, but if you looked for a correlation with respect to angle on the sky, that that could not be caused by any differences in the source populations. Populations can't be dependent on their distribution on the sky. You see this is a very observable effect. If you hold your arms out at right angles, and there are objects in both directions at a redshift of 2, they are billions and billions or light years away from each other, and they don't know about each other. Sometimes, depending on the angle and redshift, people believe things are not even causally connected. If, on the other hand, you are stubborn, and you say, maybe there *is* interaction, then you have another awesome thought: How *did* they know about each other?

Even though a correlation on the dome of the sky is a highly unconventional thing to look for, once you find it, you are not going to have a conventional explanation. So it is all part of unconventional thinking. The philosophy is, if you find something that you could conventionally explain, then don't look. You have to look for things that could not be explained by conventional means. That's how we do it.

Our proposal is to say that the galaxies are emitting independently, but there is some space-time effect, which is causing an anisotropic effect. The space-time is like a medium, like a big crystal or something, and the response is there. That's actually legal in general covariance, as a concept, but it is very, very unconventional. It is an anisotropic cosmology, and then, since general relativity is a very well-studied theory and everything is very tight, you have to reconcile that with other aspects of the Big Bang model and work through it. And the answer is, I don't know what the results are.

The effect we find is small, incredibly small, one turn per 10 billion light years. But how big do you expect it to be, and how model-dependent are people's ideas about the Big Bang? How important is it that the 3° background is thermalized and features get smeared out as a result? These things have never been explored well enough. My feeling is that some anisotropic cosmologies might have to deal with the 3° background radiation, and face that issue, before they could be acceptable explanations for both the background radiation and the cosmological corkscrew effect.

Question: When you extrapolate the linear Faraday plots to $x = 0$, how is this extrapolation physically legitimate?

The business of extrapolating the plots was done by the astronomers to take out the effects of Faraday roation. It might not be obvious, but if you have data for some variable y going, such as $y = mx + b$, and you believe you understand the "mx" part, then the y-intercept b is everything not accounted for. In this case, x is the wavelength squared; the slope m is extracted from the data and called the Faraday measure, and is interpreted as measuring certain plasma properties summed up along the line of sight to the galaxy. The linear behavior was observed. But since there is no way to know the slope (Faraday measure) *a priori*, and it can be full of contamination from our own galaxy (the astronomers try to correct that anyway), we didn't use it.

The y-intercept b is supposed not to come from Faraday rotations, and used to be identified with the residual offset angle between the source axis and the polarization axis back at the source. But we reinterpreted the data to see if b could give us a signal of birefringence.

As you say, this method is not the same thing as actually measuring the data as wavelength goes to zero, which is the same as high frequency. The observations could go right up to visible or even ultraviolet. This would be really interesting to study, especially since the frequency dependence of our effect is unknown, outside the region we studied.

But there's a tendency for things not to be very much polarized at really high frequencies. Remember, most high-

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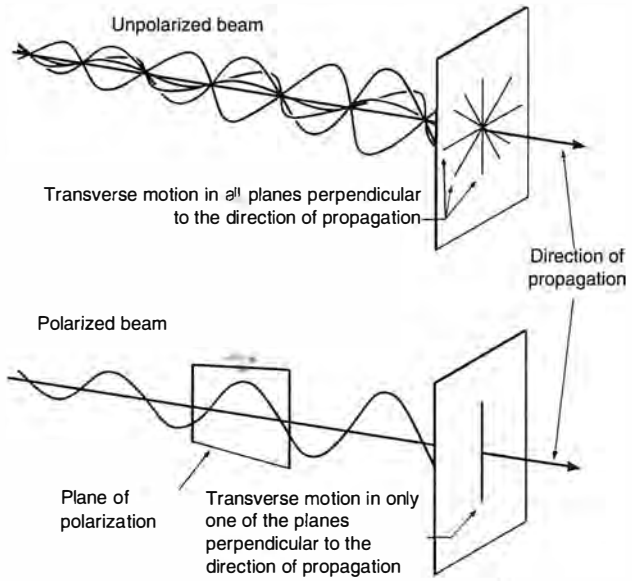

Figure 1
POLARIZED AND UNPOLARIZED ELECTROMAGNETIC WAVES

In an unpolarized beam, there is transverse wave motion in all directions at right angles to the direction of propagation (above). In a plane-polarized beam, there is transverse motion in only one of the planes at right angles to the direction of propagation (below).

Plane-polarization is a characteristic of synchrotron radiation from galaxies—radiation emitted by charged particles travelling at relativistic speeds as they move through strong magnetic fields. Relativistic speeds are speeds so great, that particle masses are measurably increased according to the energy-mass equivalence $e = mc^2$.

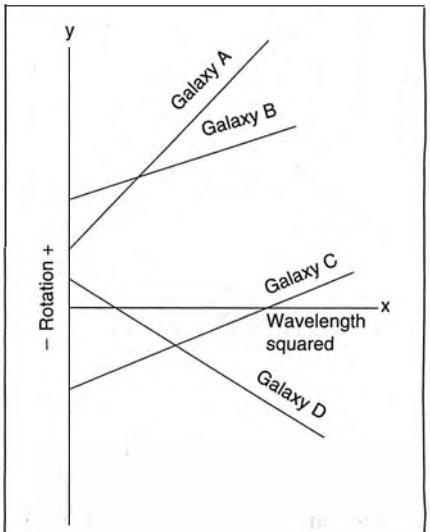

Figure 2
A FARADAY PLOT

As plane-polarized light leaves a galaxy, it may pass through a region of space in which there is a magnetic field, causing the plane of polarization to rotate. For a given galaxy, the amount of rotation varies according to the wavelength being observed. There is, in fact, a linear relationship between the square of the wavelengths, and the amounts of Faraday rotation.

Continued from page 72

"Astronomers use established physics for the Faraday effect, and indeed they observe, that the Faraday rotation is proportional to the square of the wavelength of the radiowaves. If, for a certain galaxy, you plot the amount of rotation along the *y*-axis, and then you have the squares of the observed wavelengths along the *x*-axis, you get points that show that the amount of rotation is linearly proportional to wavelength squared; you can make a straight line through those points. If you then extrapolate this line back to wavelength = 0, you get an intercept value on the *y*-axis" that is typically not equal to zero. This is what the authors mean by removing the Faraday rotation and finding a residual rotation "independent of wavelength," as they put it (Figure 2).

But there is no physical meaning to wavelength = 0, and no basis for assuming that the linearity remains as zero is approached—and a strong presumption against it. This indirect way of measuring a possible non-Faraday rotation has its problems. Still, we should ask how *y*-values at a short but observable wavelength would order the data. The intercept values at wavelength = 0, meaningless in themselves, may be the shadows of something real.

These Faraday plots have been published by radio astronomers since the 1960s. The non-Faraday rotation was thought to result from some difference in the emitting galaxies themselves, such as strong differences in their magnetic fields, or random fluctuations.

What Nodland and Ralston have done, is to suppose that the non-Faraday rotation might be an intrinsic property of the travel of light through space. They reduced the observed amounts of such rotation to *rates of rotation* by taking account of the different distances (actually the different redshifts) of the galaxies. They then asked the audacious question (audacious only from the standpoint of the current paradigm), whether the dif-

Continued on page 76

Figure 3
OPTICAL IMAGE OF AN ELLIPTICAL GALAXY

A nearly spherical galaxy, M49, in Virgo. Such galaxies have almost no dust or gas between their stars. Elliptical galaxies are ellipsoids, and have no spiral structure.

Continued from page 73

frequency emissions come from hot things, which are usually a lot smaller than the galaxy and not well correlated with its orientation. Still, there is a little data on visible light, and less on ultraviolet. As far as I know, there is not enough to do anything statistically valid, but maybe I am wrong.

The radiowaves, on the other hand, have been observed hundreds of times, and apparently come from big, big, coherent fields that have a chance to be correlated with the galaxy—at least, a correlation is observed. Right now, the astronomers are getting a lot of VLBI [Very Long Baseline Interferometry] radio data taken at about 10 times higher frequency and are eyeballing it, but it seems full of swirls and complexity to me, and we have not had a chance to look at the statistics.

Question: Do you ever think about the possibility that the Big Bang might be flawed even in some of its assumptions?

I am a pretty unconventional thinker. I am conservative in physics, but being conservative means you have to be unconventional, and you ask yourself novel questions. The evidence for the Big Bang itself, consists of *only* three pieces of really major data: the 3° background radiation, the Hubble expansion, and some conclusions about elemental abundances. Now those are consistent, and very nice, and I think it is about the best framework available. But I am the kind of person who thinks unconventional thoughts, and so I always keep an open mind. I would think that the conservative thing is to leave the Big Bang alone and find ways to tinker with it, either with a small anisotropy, or tinker with the electrodynamics, or tinker with a new particle.

Question: One of your predecessors in this field of investigation was P. Birch, who claimed, in a 1982 paper in *Nature*, that he had found evidence that the universe is rotating.

Yes. We cite Birch's paper [*Nature*, Vol. 298, p. 451]. Birch, an astronomer, noticed an empirical pattern in his numbers, that there was some kind of systematic tendency for the misalignment—the residual rotation—to seem to track an axis on the sky. He jumped to the conclusion that this had to do with the universe rotating underneath the light. The idea he had was, that as it travels from the galaxy to us, everything twirls underneath it, and that make the light look like *it* is turning.

Birch did not do his physics right, because he didn't appreciate that the farther the light travels, the more time it has to turn, so this effect has to be proportional to the distance. So he made a model which was that the angle went like the cosine of the angle on the sky, without distance as a factor. Birch publishes a paper in *Nature*, and it gets some attention. One group criticizes him saying he didn't do his statistics right. Another group redoes it, and finds his statistics are all right.

Then a third, high-powered group, real statistics experts, comes out, and they redid everything and said that he definitely had a highly significant result. Although he had done his statistics wrong, they said, they redid them themselves, and concluded, it's there—there's a signal. This last group is Kendall and Young, cited in our paper. All of those people are quoted in our paper. I learned all of this history by going backwards and forwards in the literature myself.

Then Philipp Kronberg weighs in, with Michael Bietenholz, and they redo the study, and *they* find that there is a signal, *but*—same paper, one paragraph later—they say, when we add more data, the signal goes away. What they added was a whole bunch of data which were all mixed up in distances, all randomly selected, and they didn't even have the redshift information on these sources. Now since Birch had not involved the distance in his hypothesis, it was a perfectly fine confrontation of his hypothesis in the formal sense. But if Birch found something—and it had to depend on distance, as is obvious from physics—then when people add another set that is all mixed up in distance, you wash the effect out. And this was never noticed or commented on, because Birch and all the other people were just responding to the question, Is there a dependence on the cosine of the angle?

Recently, people are asking again, could this effect [the Nodland-Ralston effect] be a sign of rotation, because that was Birch's original interpretation. And as far as I know, it *could* be, but the people who do Big Bang studies have a rather model-dependent way of calculating the vorticity among the black-body photons, which would be caused by rotation. They take a model of the universe turning, and from that they calculate the vorticity of the photons. The photons in the 3° background are very isotropic, and so they put a limit on the entire rotation of the universe. But there is an intermediate step, of associating the overall universe rotation with the vorticity, and you say, How general was that calculation, that association? And now there are some papers which say that was *not* very general, and it *could* be a universal rotation. And I am just agnostic. I don't know. It has to be studied.

So I believe, for example, that such a hypothesis would be chained to an exact dependence on the cosine of the angle on the sky. Every single source would have to go like the cosine of the angle—a universal phenomenon. So, if you have a big enough sample, where you can tell the difference between a pure cosine function and some patchy effect—seen here, but not there—then you can test that idea.

If, instead, the effect occurs in patches, it brings to the fore an idea that has been mentioned in the literature, that there might be domain walls of elementary particles, representing different vacuums. There could be one vacuum between here and a redshift of $z = 1$, and beyond, another vacuum. In between the two, energy and elementary particles are tied up and it mismatches and you have a little wall of elementary particle fields, and the light gets a twist when it comes through that wall.

Until one gets perhaps ten or a hundred times more data, we might not be able to resolve that question. But the question can be *asked*, and positive-minded scientists will say, that's what we ought to be doing, exploring these different possibilities. So I think we need 10,000 data points.

Question: Two Stanford professors emeritus of electrical engineering, Ronald Bracewell and Von Eshleman, have offered an interesting response to your finding. They note a near-coincidence between the axis you have defined and the direction of the anisotropy of the 3° cosmic background radiation. Both phenomena have the same depen-

Continued on page 76

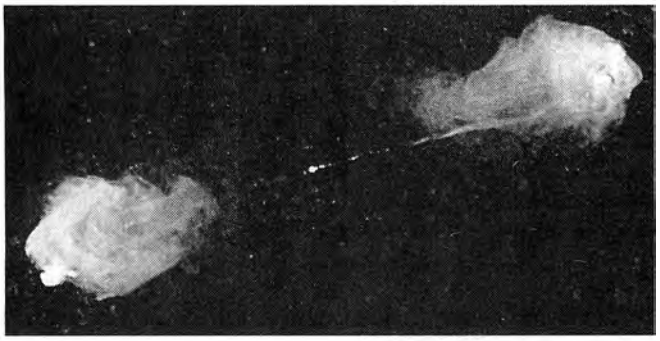

Figure 4
RADIOGRAPH OF A GIANT ELLIPTICAL GALAXY
The elliptical galaxy at the heart of radio source Cygnus A is the dot at the center. Powerful bipolar jets are producing lobes that are bright at the 6-cm radio wavelength, at which this image was formed.

Source: NRAO/ R. Perley, J. Dreher, and J.J. Cowan

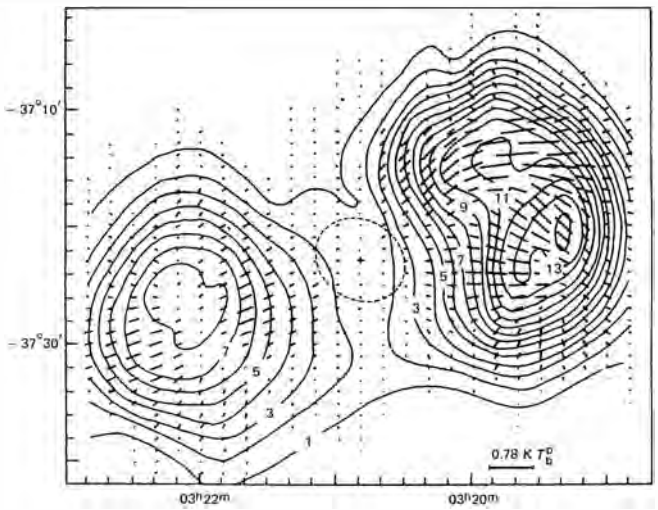

Figure 5
POLARIZATION VECTORS OF A RADIO GALAXY
Fornax A is another giant elliptical galaxy that emits radiowaves from two lobes. The galaxy itself is at the central cross. The whiskers are the observed radio polarization vectors. Brightness at the 6-cm wavelength is represented by contours. Nodland and Ralston used a single, overall measure of polarization for each galaxy.

Source: F.F. Gardner and W.B. Whiteoak, 1971, *Australian J. Phys.*, Vol. 29, p. 899

Continued from page 74
ferences in rotation rate depend upon the direction the radiowaves travel to reach us. It did not take many trials, according to Ralston, before they began to home in on the Earth-Sextans orientation as the one which ordered their sample of 160 galaxies. They employed Monte Carlo statistical simulations to test the significance of their result. Ralston says astronomers are developing data on additional galaxies, so the concept can be subjected to further test.

The Method of Hypothesis

This finding—even while it is still being scrutinized—presents a good opportunity for courageous scientists to call into question the entire formalist, reductionist dogma which has grown, like some terminal disease, to so completely dominate physics and astrophysics. How was it, after all, that isotropy came to be a standard assumption in cosmology?

That is, instead of maintaining mathematics as the arbiter and measure of truth, we must return to the method of Hypothesis of Plato, of Leibniz, and as evidenced by Bernhard Riemann's "On the Hypotheses Which Lie at the Foundations of Geometry."[5] For Riemann and Gauss, mathematics must be derived from physics in terms of the method of Hypothesis.

That method stipulates that the entirety of the accepted definitions, axioms, and postulates (that is to say, the prevailing Hypothesis itself, in the use of that term by Plato, Leibniz, and Riemann) is overthrown, when no theorem-lattice can be derived therefrom that is consistent with some newly discovered truth about nature. To have to change even a single axiom is to require a new Hypothesis, that is, a new act of creative reason.

As Lyndon LaRouche has repeatedly demonstrated in works such as *The Science of Christian Economy,* this central fulcrum of Gauss's and Riemann's work

Continued from page 75
dence on direction. Their paper, titled "The Nodland-Ralston Effect," submitted to *Physical Review Letters,* considers "the implications if the cause is the same as that of the anisotropy of the cosmic background radiation that results from solar motion" through the background.

I think their observation is very interesting—it is tantalizing. They haven't identified a physical mechanism yet. They are not the only ones to have done this. It has also been done by Rainer Kuehne, University of Wuppertal, Germany. There may also be others. I have tried to identify a physical mechanism to tie together the observation with some possible Lorentz transformation with respect to some rest frame, but I haven't been able to identify a mechanism.

But it is an interesting development. It seems to be a positive indication that what we have found is a real cosmological effect, because one can't get the effect we see in free space with ordinary relativity theory. It is ruled out. You don't get a rotation of the plane of polarization from motion relative to light. It doesn't work that way. But, there must be some cosmological effect *and* it must be tied up with relativity—some kinematic effect of relativity, which has not been identified.

Question: Three radio astronomers, John Wardle, Rick Perley, and Marshall Cohen, have authored what they consider a refutation of your finding, titled "Observational Evidence Against Birefringence over Cosmological Distances," and submitted it to *Physical Review Letters* on April 30. They have also posted it on the Internet. But they also took the extraordinary step of having a press release issued by the National Radio Astronomy Observatory to promote it the same day it was submitted.

I have seen the paper. They have some new sources, and they are looking at a slightly different variable, because they take little pieces of radio jets emerging from the galaxies or from quasars. We used the orientation of the axis of the entire galaxies. But it is some kind of measure. By subtracting 90° from their data, they believe they are looking at the intrinsic orientation of the magnetic field at the source. They sometimes make no correction for the Faraday effect, but they claim they don't have to. Thirteen of their quasars are listed in the paper they cite by Alan Bridle et al., but they omit some of the samples available in Bridle et al. They also just ignore the other kinds of galaxies with jets identified to emit at different angles. So there is evidently some strong data selection here.

Second, they have 16 unpublished quasar observations. If you put all of them in with the 160 galaxies, it doesn't seem to change anything. They set out to refute something they don't like. They have selected a handful of cases out of hundreds, and have written a paper saying this refutes Nodland and Ralston.

The astronomers are used to looking at the data they observe from Earth, and believing it represents the intrinsic emission from the source, because they didn't take it in the context of any cosmological effects. They think, when they look at the data, they are seeing the source directly. Then you have no possibility of allowing any cosmological effect.

On the other hand, the assignment of the number, which one would have from the trend of our statistical analysis, in this region, would be about pi over 2 rotations for these sources that have a redshift of order $z = 1$. Now you go back and you rotate all the vectors they have by pi/2. And you get in fact a very strong correlation between the orientation of the jet and the orientation of the polarization, as they claim. The things are correlated, but the question is, are you going to attribute that pi/2 to an intrinsic effect, back at the source, or, is it a cosmological effect?

The high resolution data from the Very Large Array (VLA) that Wardle, Perley, and Cohen work with, show all kinds of swirliness and scatter in these polarizations. So, since that stuff is scattered around, if you look at one particular source, and you say, well look, it doesn't fall on the curve predicted by Nodland and Ralston and that rules their idea out—that doesn't mean a thing. If you look at another source that *does* fall on our curve, that doesn't prove anything either.

So this business of selecting data, in order to confront a statistical argument, I think is similar to tobacco companies bringing out a 90-year-old cigarette smoker, and saying, look, cigarettes don't cause health problems. It is not a valid scientific response to what we found.

When Wardle, Perley and Cohen looked at the VLA data, they didn't do any statistics. (And concerning our data, they even say, "We shall not discuss the statistical or theoretical arguments in their paper.") But with the VLA data, they *could* make a response. They just have to do more work. It takes more than *one week.*

Essentially, the two-population hypothesis is being defended by some of the radio astronomers because that is what they have all relied upon for decades. However, it has no predictive power, because you don't know what the characteristics of the sources are, and you just interpret the data as intrinsic, and that's that. I think that finally it's going to sink in that the correlation on the dome of the sky—the element that is really observable—is not being addressed by these jet studies yet. But they have great potential.

has been all but buried.[6]

The fact is that Riemann constructs the foundations of his "Hypotheses" paper and his central concept of multiply extended magnitude—Riemann's "quantum" of action which Bertrand Russell so vociferously denounces in his *Foundations of Geometry*—on the hypothesis of Gauss that only spiral action is primary in the physical world, as that hypothesis is developed by Gauss in his papers on biquadratic residues. This is where Gauss develops his concept of the complex domain through generating the square root of minus 1—which had previously only been viewed as an algebraic abstraction—as a 90° right-handed spiral action. As Riemann notes, Gauss only hints at this, although, given the present context, the hypothesis is clear enough. Gauss writes:[7]

"This distinction between right and left is, once one has arbitrarily chosen forwards and backwards in the plane, and upward and downward in relation to the two sides of the plane, in and of itself completely determined, even though we are able to communicate our concept of this distinction to other persons only by referring to actually existing material objects."

Here, Gauss adds this clarifying note: "Kant already had made both of these remarks, but we cannot understand how this sharp-witted philosopher could see in the first remark a proof of his opinion that space is only a form of our external perception, when in fact the second remark proves the opposite, namely, that space must have a real meaning outside of our mode of perception."

Notes

1. A material, such as a crystal, that is isotropic, has the same index of refraction, the same dielectric constant, and so on, regardless of the angle at which it is measured.
2. For Riemann's exploration of this problem, for example, see his "Philosophical Fragments," translated in *21st Century*, Winter 1995-1996, pp. 50-62, Section I, and "The Mechanism of the Ear," translated in *Fusion*, (Sept.-Oct. 1984), pp. 31-38.
3. *Phys. Rev. Letters*, Vol. 78, No. 16, p. 3043.
4. A useful discussion of inhomogeneity is found in the interview with astronomer Margaret Geller, in Alan Lightman and Roberta Brawer, *Origins—The Lives and Worlds of Modern Cosmologists* (Cambridge: Harvard University Press, 1990), pp. 359-77.
5. Bernhard Riemann, 1854. "On the Hypotheses Which Lie at the Foundations of Geometry." An English translation appears in David E. Smith, ed., *A Source Book in Mathematics* (New York: Dover Publications, 1959), pp. 411-425. On the method of Hypothesis, see Riemann's explicit discussion in his "Philosophical Fragments," *21st Century*, Winter 1995-1996, pp. 50-62, Section II.
6. Lyndon H. LaRouche, Jr., 1991. *The Science of Christian Economy and Other Prison Writings* (Washington, D.C.: Schiller Institute), passim. And see especially his "Leibniz from Riemann's Standpoint," *Fidelio*, Fall 1996, and the section titled, "Riemann's Principle of Hypothesis," pp. 18-24.
7. Carl Gauss, 1825. "The Metaphysics of Complex Numbers," *21st Century*, Spring, 1990, pp. 60-63.

TECHNICAL COMMENTARY

Anisotropy of Light and the Positional Dependency of the Photon's Rest Mass

by B. A. Soldano

Dr. Benny Soldano is a member of the scientific advisory board of 21st Century *magazine.*

The recent isolation[1] of a minute anisotropy in the propagation of electromagnetic radiation over cosmological distances, one in conflict with the universal concept of isotropy, portends far-reaching consequences in the structure of physics. Based in part, on the assumption of gauge invariance and the validity of the equivalence principle,[2] Nodland and Ralston concluded that their results rule out the existence of a photon rest mass. Our analysis[3] suggests that gauge invariance is violated, and that a photon rest mass is one of its many consequences.

Operationally, the effects of non-equivalence can be embedded in the behavior of a photon rest mass whose terrestrial magnitude $m^*_{\gamma,\oplus} = 2.385 \times 10^{-17} evs$,[3] with $m^*_\gamma \rightarrow 0$ at astronomical distances relative to our terrestrial frame. This terrestrial photon rest mass is consistent with the Pound et al.[4] photon "weighing" experiment.

A positional-dependent rest mass of the photon m^*_γ consistent with the Nodland-Ralston[1] long-range mass scale, can be linked (Equation 1) to an invariant rest mass of the graviton [$m_{2\hbar} = 2.79 \times 10^{-34} evs$], through the latter's *indirect* decay into photons when mediated by $q\left(\frac{q^2}{\hbar c} = 14.6\right)$, the strong nucleonic charge, and that of the electron $\bar{e}$, via their *local* decay into photons. The thermo-coupling, Equation (1), reflects the isotropy of the emissivity of blackbody radiation.

$$m^*_\gamma \left[\bar{e}\,\frac{kT\lambda\,\max}{hc} q\right] \delta_{L,\gamma} = m_{2\hbar}\, q^2 \qquad \textbf{Eq. (1)}$$

On the Earth's surface, where $m^*_\gamma = 2.385 \times 10^{-17} evs$, $\delta_{L,\gamma} = 2.625 \times 10^{-15}$. The *rotational angle* $\delta_{L,\gamma}$ is also a non-equivalence terrestrial limit to the isotropy of light—one comparable to the limit set by the Hall-Brillet[5] modern version of the ether drift experiment.

The product, of the angle $\delta_{L,\gamma}$, which is composed solely of *macroscopic* terms, and the fractional difference between the solar and sidereal day—that is, 0.7155×10^{-17}—is comparable to one of Georgi's[6] *microscopic,* particle estimates of the magnitude of ΔCP associated with the axion.

The rotational or circular polarization nature of the local terrestrial term $\delta_{L,\gamma}$ is reaffirmed by the latter's relationship to the important $[(K_2^0 - K_1^0) = 3.49 \times 10^{-6} evs]$ mass split, Equation (2).

$$\left(\frac{K_2^0 - K_1^0}{K_2^0}\right) [\lambda_{\max\ energy} + \lambda_{\max\ no,\gamma}] \times \left(\frac{kT}{hc}\right) = \delta_{L,\gamma} \times 1.22 \qquad \textbf{Eq. (2)}$$

where the numeric 1.22 defines the first diffraction interference ring for light.

The sum of the blackbody wavelengths for maximum energy emissivity $\left[\frac{kT\lambda_{\max.\ energy}}{hc} = 0.201403\right]$, and the maxi-

INTERVIEW WITH PHILIPP KRONBERG

'There Is No Such Effect'

Radio astronomer Philipp Kronberg, professor of astronomy at the University of Toronto, developed some of the data on elliptical galaxies used in the study by Nodland and Ralston. Kronberg contends, however, that their finding has no basis, and one of his associates, Rick Perley, is a coauthor of a paper to that effect (see interview with Ralston). Kronberg was interviewed by David Cherry on May 10.

Question: What is your objection to the finding of Nodland and Ralston?

We have looked at extended radio sources at varying distances, usually associated with quasars, which means they are at great distances. We have compared the angle of the plane of polarization with the orientation of the source. It is a very simple thing to do. We found, as is already known from the literature, that there is a fairly tight coupling between the angle of polarization and the orientation of the source. This is contrary to the result that Nodland and Ralston claim for very distant sources. They claim that for increasingly distant sources, that alignment between the angle of polarization and the orientation of the source gets increasingly poor, due to a hypothetical fundamental physics effect which would break some symme-

mum for the number of photons emitted $\left[\frac{kT\lambda_\gamma}{hc} = 0.2550571\right]$ are required to achieve precise agreement with the term $[1.22 \times \delta_{L,\gamma}]$ in Equation (2).

The addition of isotropic, blackbody emissivity wavelengths inherent in Equation (2) is characteristic of a resonance process. In this regard, it has been demonstrated that many of the properties of blackbody systems can be accounted for by ascribing to them characteristics of two coupled nonlinear oscillators, a prerequisite for resonance. The conventional particle physics description of the strange K^0 meson system treats the K_2^0 and K_1^0 states as manifestations of *circular* polarization[7] similar to that of $\delta_{L,\gamma}$.

When the rotational, anisotropic angle $\delta_{L,\gamma}$ in Equation (1) is set equal to the 2π that defines the spin-one photon, $\left(\frac{\hbar}{2\pi}\right)$, the required photon mass $m_\gamma = 1 \times 10^{-32}$ *evs;* a magnitude precisely equal to the $\left[\frac{1\hbar c}{\Lambda_s}\right]$ mass scale estimate of the Nodland-Ralston's cosmological light anisotropy model.[1] Significantly, the ratio $\left(\frac{\delta_{L,\gamma}}{2\pi}\right)$, can be quantitatively related, Equation (3), to the local rest mass of the photon and a Hubble recessional constant $\Delta v_H = 80 \frac{Km}{\text{sec}} \times \frac{1}{mps}$.

$$\left(\frac{\delta_{L,\gamma}}{2\pi}\right) = \Delta v_H \frac{2\hbar}{m_\gamma^* c^2} e^{1.073} \qquad \textbf{Eq. (3)}$$

The de Sitter[8] exponential (1.073) in Equation (3), the ratio of the universe's radius of curvature relative to its initial radius of curvature, quantifies a universal spirality sensitive to both the expanding universe ΔV_H and the local photon rest mass m_γ^*. It defines that initial point wherein light waves will make one more circuit during the rest of eternity. Those starting later will never get around the universe, because no *causal* signal can reach them.

Gravitational anisotropy of light, when applied to the *interior* of the Earth, accounts for the key spectral factor (1.00078) required by Lanzerotti, et al.,[9] Equation (4), to quantitatively establish a *p* and *g* wave helioseismological link between the Earth and Sun, one involving the coherence of the near vacuum of the solar wind.

The agreement becomes exact when one takes account of the fact that the Earth is spinning as it orbits the Sun, thereby resulting in an additional minute eccentricity contribution. The eccentricity of the Earth is $= \sqrt{\frac{a^2 - c^2}{a^2}} = 0.08182$ where a is the Earth's major axis and c its minor axis. Simply dividing this eccentricity by the factor of 2π that cancels the photon's spin $\left(1\hbar = \frac{\hbar}{2\pi}\right)$, leads to the following precise agreement with the empirical Lanzerotti spectral factor at the Earth's surface, where $R_\oplus = 6.371 \times 10^8$ *cms.*

$$\left(e^{\frac{-m_\gamma^* c^2 \times R_\oplus}{1\hbar c}\left[1 + \sqrt{\frac{a^2 - c^2}{a^2}}\frac{1}{2\pi}\right]}\right) = \frac{1}{1.0007793826} \simeq \frac{1}{1.00078} \qquad \textbf{Eq. (4)}$$

Note that the precision of this agreement with the Lanzerotti spectral results represents an additional confirmation of both the existence, as well as the magnitude, of a *local* rest mass of the photon acting anisotropically.

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try in the propagation of the photons over large distances.

Question: What do you mean by the orientation of the source?

If you look at a quasar or a galaxy which is a strong radio source, many of them have a very long jet that emits radiowaves, which shoots out from the source, sometimes in both directions, and so the radio image is very elongated. And the radiation is usually highly polarized.

So what they are doing is very simply looking at the polarization direction—taking the overall polarization of the source—and comparing it with the orientation of the elongation. It doesn't really matter whether you do that, or whether you look in detail at the image of the source. The point is that for these very distant quasars, the polarization direction lines up almost exactly perpendicular to the direction of the long thin jets that go out of the galaxy nucleus or the quasar. So it is very easy to judge just by eye—you don't have to do a statistical test.

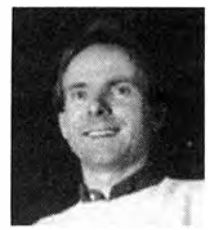
If you want to do a quick check, just go into the literature, not to our data necessarily, but to data reported by Colin Lonsdale, Miley, and Barthel, for example, in the *Astronomy and Astrophysics Supplement,* or in the *Astrophysical Journal Supplement.* There are two or three compilations of these images, with the polarization also reported in most cases. So you can just flip through the images and look at the sources that have a very large redshift—for which the effect claimed by Nodland and Ralston would be very strong—and you find that there is no such effect. You don't need a statistical method in this case to check their claim.

[Kronberg also mentioned these references, among others: Colin Lonsdale et al., 1993 (*Ap. J. Suppl.,* Vol. 87, p. 63); Peter D. Barthel et al., 1988 (*Astronomy and Astrophysics,* Vol. 73, p. 515); and Barthel, Tytler and Thompson, 1990 (*Astronomy and Astrophysics Suppl.,* Vol. 82, p. 339).]

There is nothing wrong with the data they have used, nor with the new data, but neither set shows any strong effect as they claim.

INTERVIEW WITH BORGE NODLAND

A Contradiction with Relativity Theory?



Borge Nodland's doctoral thesis led to his controversial paper, "Indication of Anisotropy in Electromagnetic Propagation over Cosmological Distances," with coauthor John Ralston. He has posted additional information and relevant papers at http://www.cc.rochester.edu/college/rtc/Borge/aniso.html. Nodland was interviewed by David Cherry on April 22.

Question: In your study, the essential data are a position on the sky for the galaxy, a redshift of the galaxy to indicate distance, and a *y*-intercept on the Faraday plot?

Yes, the data that we have consist of redshift measurements of elliptical galaxies, and declination and right ascension to pinpoint the galaxy on the sky. And then we have polarization data, which consisted of the orientation of the axis of the galaxy on the sky, and then the orientation of the polarization vector as observed at Earth.

Question: Presumably this study was done at radio wavelengths, and not visible wavelengths, because radio wavelengths are long, making greater precision possible.

And because the galaxies we looked at are synchrotron galaxies, which means that they emit radiowaves that are highly plane polarized. We had to look at galaxies that had plane-polarized emission.

Question: The sample of 160 galaxies—are they distributed over the entire sky?

Yes. But most of them are in the Northern Hemisphere, because most of the radio telescopes are in the Northern Hemisphere.

Question: Your proposed explanation likens the passage of light or radiowaves through space to their passage through a material medium.

The analogy is to the way plane-polarized light has its plane of polarization rotating as the light travels through an optically active material, like corn syrup, for example. In that case, you can find experimentally that the plane of polarization actually has rotated after the light has travelled through the corn syrup. You can show that this rotation is caused by the light—when it enters the corn syrup—being split up into two modes or two partial waves. Both partial waves travel in the same direction, but they travel with slightly different phase speeds, and that difference in phase speeds is generated by the corn syrup interacting with the light wave going through it. And the greater is the difference in phase speeds of the two partial waves, the more the amount of rotation will be, of the plane of polarization of the total wave, which is the sum of the two partial waves.

The analogy is not complete, however, because the phase speed difference is independent of the light's direction of travel through the corn syrup (the corn syrup is isotropic). So in our hypothetical explanation, we showed how an interaction between the electromagnetic field of the radiowaves and some new field, would cause *two partial waves* to travel along the same direction from a galaxy, but they would have slightly different speeds, and that this difference of speed would generate the amount of rotation needed to explain the data. The difference depends on the direction of travel (so that space exhibits an apparent anisotropy) and is so tiny that you couldn't detect it with an interferometer.

Question: Does the explanation you have offered put relativity in question?

Relativity basically assumes that space is the same in all directions, so on a conceptual level, there is a contradiction with relativity theory. Also, the interaction that we propose, that the radiowaves are split into two partial waves that have slightly different speeds in the vacuum of space, conflicts with the notion that the speed of light is a constant, which is a basic assumption in special relativity. But one could investigate how relativity could incorporate this effect. There is a small group of physicists that are looking at so-called anisotropic cosmological theories that are based on general relativity. Relativity is so general and broad, the effect could be explained within this framework.

Question: From your paper, it appears that radio astronomers have been puzzled by the variation in the Faraday plot *y*-intercepts for some time, what you are calling variation of the observed, wavelength-independent polarization orientations.

Yes. Some people, as we mentioned in our paper, have proposed a so-called two-population hypothesis to explain it. The authors of that paper propose that there are two groups of galaxies out there. These are elliptical galaxies, and they have a symmetry axis. The two-population hypothesis assumes that there is one group of galaxies that emit radiation with polarization approximately perpendicular to the axis of the galaxy, and another group that emit radiation with the polarization vector approximately parallel to the axis of the galaxy. The hypothesis, furthermore, assumes that the orientation of the emitted polarization vector is the same as that of the observed polarization vector, so that no rotation is occurring.

But the actual data show only that there might be a slight tendency toward observed angles around 90 and around 0 degrees. There are really many galaxies that have observed polarization orientations that make other angles. So we suggest another explanation, because if you use the hypothesis of different populations, you really need to assume that there are more than just two populations. You might need to assume that there are ten.

The explanation that we propose might put more order in the data, by assuming that the galaxies initially emit at some angle with respect to their axis of symmetry that is the same for all galaxies. It then explains the angles that we observe—those intercepts on the *y*-axis—as a non-Faraday, or wavelength-independent, rotation of the initial electric field of the wave, the amount of which depends upon the distance travelled and the direction of travel.

LEONARDO FOR YOUNG SCIENTISTS

Genius Can Be Taught!

by Susan Welsh

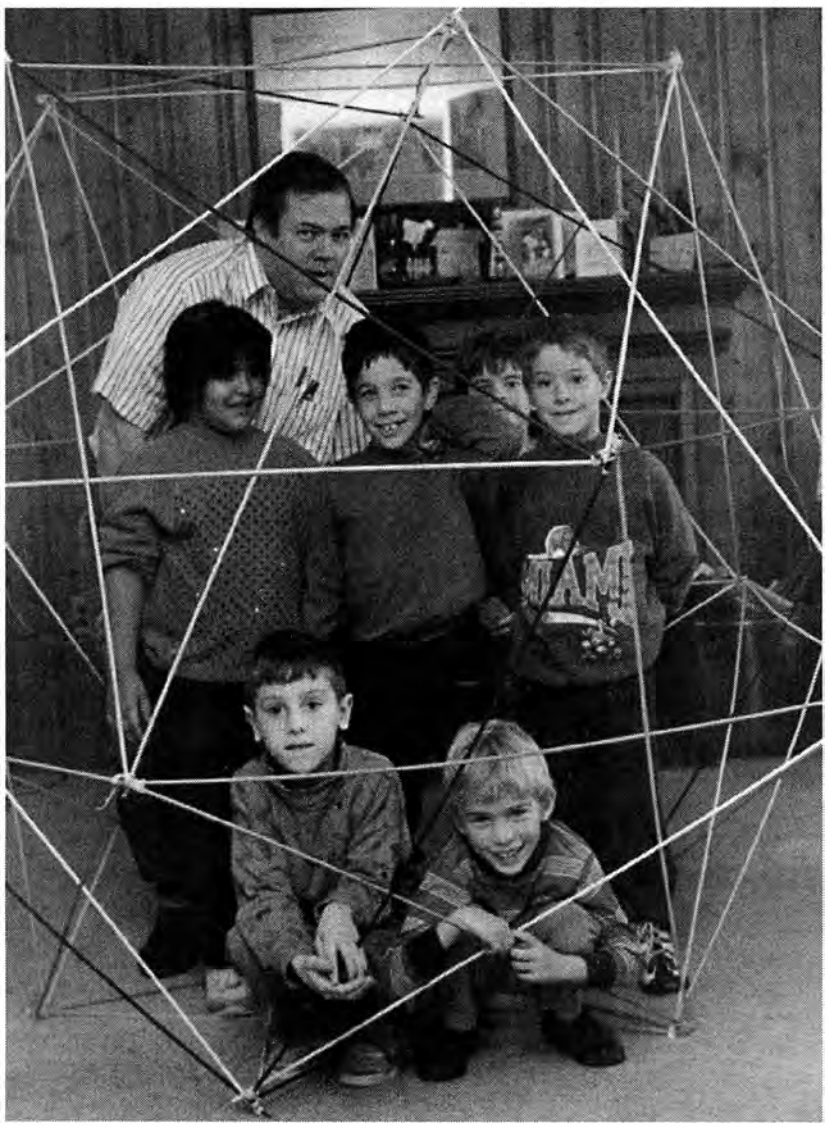
Leonardo da Vinci is a man who inspires awe in children who come to know him. "Smartest dude in world history," was how one teenager summed it up. Leonardo's passionate desire to understand the coherence of God's creation speaks to us very personally, five and a half centuries after his birth. His creativity seems to know no limits, infused, as it is, with the love of mankind and of all created things.

Is there some way that we can produce more geniuses, more Leonardos?

Economist Lyndon LaRouche, who is in some ways himself a "Leonardian," maintains that we can. In numerous published locations over the years,[1] LaRouche has called for a curriculum that emphasizes the re-creation, in the mind of the student, of some of the great original discoveries of world history. Only in this way, he insists, can the student actually come to *know,* rather than merely to become adept at regurgitating the contents of textbooks.

The point is not simply to replicate some of the important experiments of the history of science; it is rather to experience for oneself the process of discovery that led the creative thinkers of the past to leap from one domain of understanding—what LaRouche calls a "theorem lattice"—to a higher domain, based on the Platonic method of hypothesis-formation.

The Leonardo da Vinci Science Club in Leesburg, Virginia, undertook a modest pilot project to begin to develop such a pedagogy, from October 1996 through April 1997, in a series of weekly classes for six- and seven-year-olds. Hopefully the ideas presented here will prove helpful to parents involved in efforts to make up for the deficiencies of their local school systems, as well as to professional teachers. The basic concepts can be adapted and extended, for use with older children (with, naturally, a great deal of hard work on the part of the teacher!).



Richard Welsh/EIRNS

Members of the Leonardo da Vinci Science Club, with guest instructor Charles Stevens of 21st Century. *They have built a "dodecahedron fort," using dowels and rubber bands. Each face of the dodecahedron is a five-pointed star. The dowels are painted in five colors, and assembled in such a way that each color traces out a cube.*

Our main purpose at this stage, is to encourage the love of discovery that all children are born with, and to begin to channel it in directions that we know

will prove fruitful later on: the study of the physical geometry of nature and how it changes; and, understanding man's transformation of nature through science and technology, in the interest of the economic progress that provides the foundation for further discovery.

Why Leonardo?

Why choose Leonardo? In art classes at the local elementary schools, an entire year can go by, without Leonardo's name ever being mentioned. The Golden Renaissance of the 15th century, if it is discussed at all, may be dismissed as "a period," among other "periods." In this age of multi-culturalism, it is not politically correct to promote the work of Dead White European Males; so, the children learn about the arts and crafts of virtually every nook and cranny of the globe, and every epoch of history, *except* the Italy of the Golden Renaissance.

Yet, the age in which Leonardo lived (1452-1519), was the most important, positive inflection point in human history. Taking off from the revolutionary philosophical contributions of Cardinal Nicholas of Cusa, Leonardo and some of his leading contemporaries, such as Louis XI of France, took to heart the idea that man was created in the image of God; that the creative potential of every individual is a divine spark that, if kindled, will burst into flame. This was a decisive break with all previous history, in which at least 95 percent of the world's population lived in misery and backwardness. It meant the application of science and technology for the benefit of all mankind, making possible unheard-of economic progress and the rapid growth of population. It implied that every child deserved an education—a notion that was put into practice by the Brotherhood of the Common Life, the teaching order that took poor boys—orphans—off the street, and turned them into statesmen, scientists, and poets.

Stuart Lewis/EIRNS

At a party celebrating Leonardo's 545th birthday, children construct Platonic solids, using gumdrops and toothpicks. Platonic solids are those solids which can be inscribed within a sphere, such that each vertex (point) touches the inside of the sphere; all edges are of equal length, all faces are the same shape and size, and they come together at the vertices in the same way. There are five Platonic solids: the tetrahedron, the cube, the octahedron, the dodecahedron, and the icosahedron.

For the artist of the Renaissance—most especially Leonardo—the phony distinc-

Resources for Parents and Teachers

On Leonardo himself, a good introduction for ages 12 and up is Richard McLanathan's beautiful book *Leonardo da Vinci* (New York: Harry N. Abrams, Inc., 1990). A book long out of print, but well worth hunting for, is Margaret Cooper's *The Inventions of Leonardo da Vinci* (New York: The Macmillan Company, 1965), also for ages 12 and up. For adults, *The Unknown Leonardo,* edited by Ladislao Reti (New York: Abradale Press, Harry N. Abrams, Inc., 1990), is a treasure-trove of ideas.

A good resource for older children and adults, is the video *Leonardo: To Know How to See,* produced by the National Gallery in Washington, D.C., and narrated by Sir John Gielgud. The museum lends it out to educational institutions, free of charge.

There are many ways of constructing the Platonic solids, ranging from gumdrop-and-toothpick models, to more durable productions. "Polydrons" are an excellent product for building sturdy plastic polyhedra, and can be handled, with a little practice, by a dexterous seven-year-old. They are not cheap, but you get what you pay for. (Call 1-800-452-9978.)

Several products from Key Curriculum Press can be highly recommended: *The Platonic Solids Activity Book,* and the accompanying video and kit for construction of polyhedra, are excellent, and can be adapted for use with different age groups. The Lénárt Sphere and accompanying textbook, *Non-Euclidean Adventures on the Lénárt Sphere,* are certainly "Leonardian" in spirit; they are intended for middle school and high school students (call 1-800-995-MATH).

tion between "art" and "science" is completely non-existent, and this very fact frees the student's mind from the Aristotelian confines that modern education, the offspring of the Enlightenment, deliberately fosters.

In our classes, we concentrated on (1) geometry; (2) perspective drawing and optics; (3) conic sections and conical forms in living organisms (snails); and (4) the science of water and its use to benefit man. In this series of articles, we will describe some of what we did in these areas. We left many areas of Leonardo's scientific work completely untouched, which future classes might certainly explore, such as the flight of birds; the anatomy and physiology of man and other creatures; astronomy; mechanics and the construction of machines; and music.

The Geometry of the Physical World

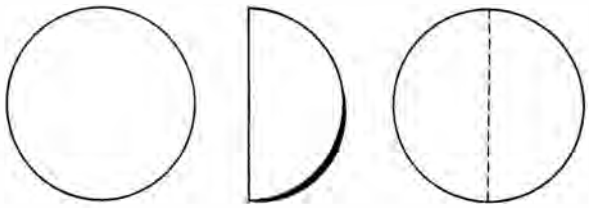
"Let no man who is not a mathematician read the elements of my work," Leonardo wrote. With that stern admonition in mind, we had better start with geometry.

Our approach is based on *construction,* beginning with circular action, showing how the circle can be folded to produce various polygons; exploring two-dimensional shapes and how they fit together with one another to "tile" a plane; moving on to the construction of *Platonic solids.* (See photos and figures.)

Among the most useful sources we found, was an article by Dr. Jonathan Tennenbaum, "Abstract Algebra Banned: A Mathematics Curriculum for Creating Citizens," published in the March-April 1983 issue of *Fusion* magazine (the predecessor of *21st Century*). Readers desiring a photocopy may write to the author; here, we quote from Tennenbaum's introduction, which sharply motivates the urgency of work such as this:

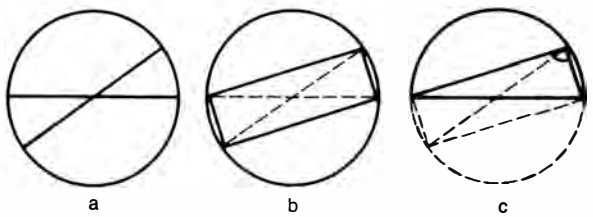
"Civilization cannot survive another generation of youth brought up on so-called modern mathematics (set theory) and related horrors of the last decades' educational reforms—not to speak of the worse horrors, including the replacement of teachers by computer terminals, now under advanced preparation in the United States and elsewhere.

"At stake is not only the urgent requirement for training the next generation of scientists and engineers, without whom critical technological breakthroughs will not be made, but also the fundamental



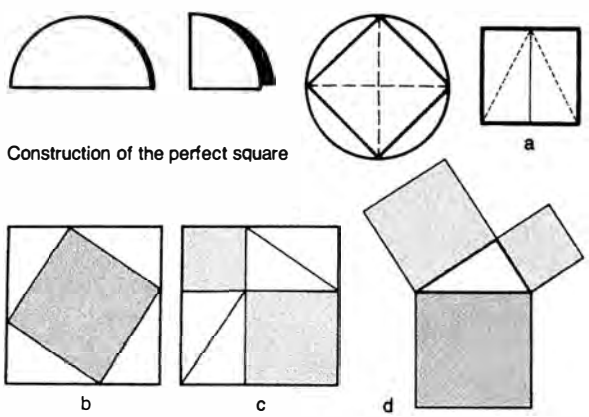
CONSTRUCTING A STRAIGHT EDGE

A straight edge is created simply by folding a circle onto itself.



CONSTRUCTIONS WITH A CIRCLE AND STRAIGHT EDGE

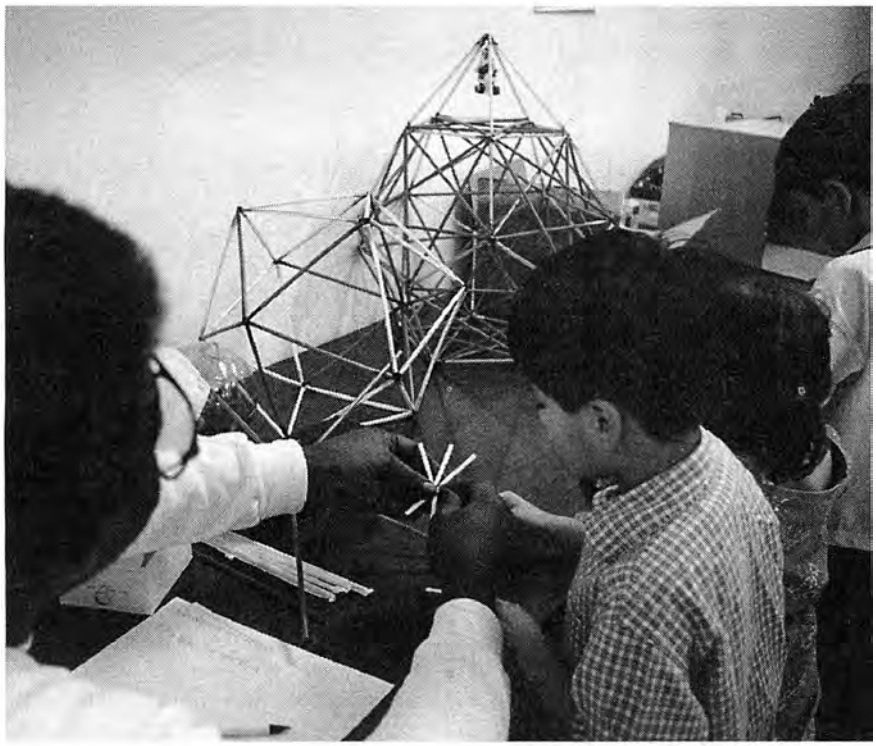
Once the children have created a circle and, by folding the circle onto itself, a straight edge, they are in a position to construct other derived figures: a point (a), a rectangle (b), and a right angle, the angle defined by two sides of the rectangle (c).



THE PYTHAGOREAN THEOREM

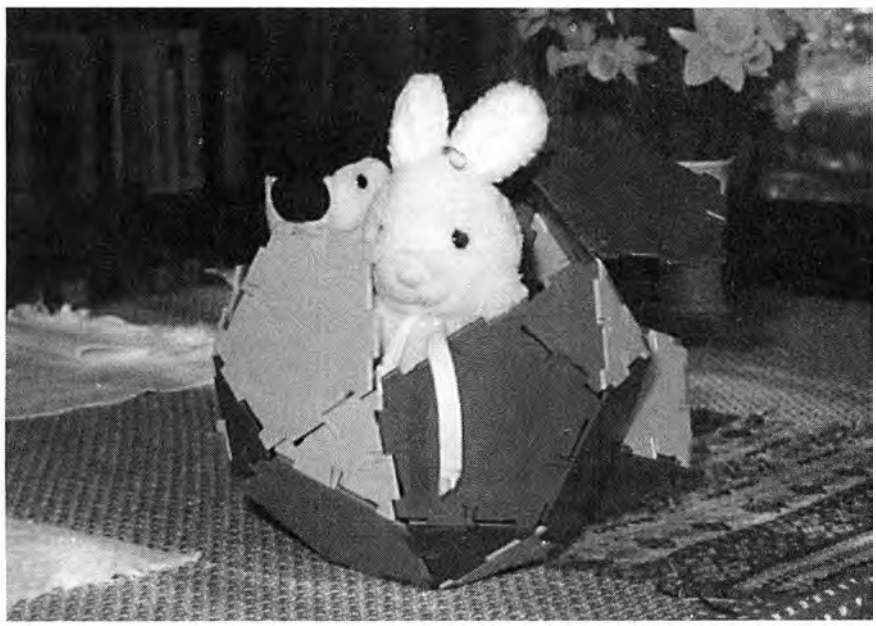
To generate Pythagoras' theorem, the children begin by constructing four 1-2 triangles: They fold a square (itself made from a circle) twice, once to get two rectangles, and again to form the diagonal triangles of those rectangles (a). They then arrange the triangles to form the large square in (b). The large square is outlined and the triangles are rearranged within it, in the configuration shown in (c). It is immediately evident that the area of the large square that remains after the triangles are subtracted from (b) is the same as the two squares remaining (shaded) in (c)—and that the square of the long side of a right triangle is equal to the sum of the squares of the other two sides.

Source of figures: Dr. Jonathan Tennenbaum, "Abstract Algebra Banned: A Mathematics Curriculum for Creating Citizens," *Fusion*, March-April 1983, p. 28.



Stuart Lewis/EIRNS

Construction of Platonic solids using drinking straws and grocery store "twisties," such as are used to close bags of bread. The twisties are inserted into the ends of the straws, then glued with a glue gun (by the adult). This can also be done using pipecleaners.



Susan Welsh/EIRNS

A seven-year-old's icosadodecahedron (with modifications, such as a back door) makes a home for stuffed animals.

identity of succeeding generations. Today's youth counterculture, with its hatred of school and indeed of all learning, its embrace of cultism and consumption of drugs, its immorality and arrogant indifference to the future, is directly the product of those so-called reforms, of which the virtual elimination of geometry in favor of meaningless set-theoretical jargon has been one of the most destructive features. Without a dramatic intervention to reverse the destruction, tomorrow's teenagers may no longer even resemble human beings. Whether future generations have the mentality of slaves or of thinking citizens, creators 'in the image of God,' depends to a great extent on the success of the speedy, forced implementation of programs along the lines proposed here.

"The key to the proposed mathematics program is *geometrical construction*. All abstract algebra, as well as the formal definition-axiom-proof routine customary in both traditional and set-theory-oriented teaching, will be banned from the start. Proofs will be proofs by construction. Properties of geometrical figures will be derived not from formulas, but from the manner in which the figures are generated in the process of construction.

"As a by-product of the emphasis on rigorous geometrical thinking, 13- to 15-year-old children will routinely be able to master areas of mathematical physics generally thought accessible only to doctoral-level university students. Indeed, by clearing away the mass of extraneous algebraic formalism that today mystifies much of mathematics and physics, the ideas and methods that have brought about progress in science will be revealed as 'childishly simple.' This demystification of science will have profound benefits not only for school education, but also for the frontiers of science, for example, in opening the way for a new geometrical attack on the problems of plasma and relativistic beam physics."

Based on our work with young children in the Leonardo Club, we can see that such optimism is not extravagant. By directing the children's playful exploration in "Leonardian" directions, we find that they quickly master concepts of geometry that many adults find quite daunting. Indeed, for a seven-year-old, what could be more sensible, than to build an icosadodecahedron, as a home for his stuffed animals?

In the next part of this series: Leonardo's optics and the science of perspective.

Notes

1. See, for example, Lyndon H. LaRouche, Jr., "Riemann Refutes Euler," *21st Century Science & Technology*, Winter 1995-1996, pp. 46-47.

Passionate Ignorance: The World According to Helen Caldicott

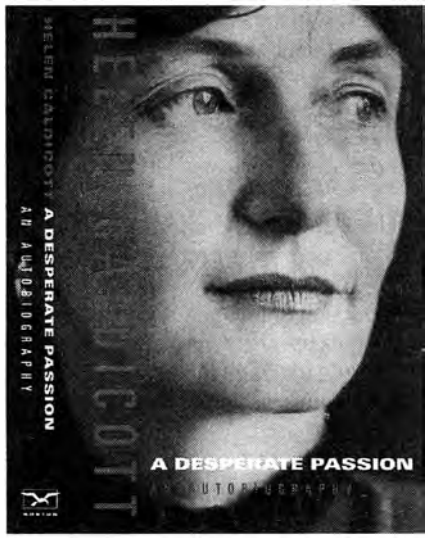
by Marjorie Mazel Hecht

A Desperate Passion: An Autobiography
Helen Broinowski Caldicott
New York: W.W. Norton & Company, 1996
Hardcover, 366 pages, $27.50

Australian physician Helen Caldicott, one of the best-known and most emotional of the international anti-nuclear activists, has been scaring people to death for 25 years, backing up her ghastly images of nuclear-incinerated babies with her medical authority as a pediatrician. Her skill at moving audiences to tears has made a major contribution to the increasing incapacity of Americans to think through scientific ideas with reason, surrounding them instead with a passionate ignorance. In the world of Helen Caldicott, men and industry are both oppressors, and feeling good about being one's self is a primary goal in life.

I read this autobiography in part because Caldicott has moved to the fashionable town of East Hampton, New York, where she is involved in attacking Brookhaven National Laboratory on Long Island, a longtime center for groundbreaking physics and medical research, along with three nuclear reactors in nearby Connecticut. Her tactics today are the same as those in the past: lies, half-truths, exaggerations—anything to scare the audience into attacking the "enemy" of nuclear technology.

I thought it might be useful to find out what drives such a "desperate passion," and such a disregard for science. Her autobiography did not tell me anything unexpected. The intersection of Hollywood, political figures, big money, big media, and anti-nuclear ideology is not a surprise. And neither is Caldicott's personal philosophy nor its dependence on the views of Bertrand Russell (who says that he welcomes wars, famine, and pestilence as natural ways of culling the population).



Caldicott tells you about herself in a warts-and-all, touchy-feely way. I am mistrustful of this tell-all frankness—is it really necessary to know about her mother's sex life?—but here's what I learned about Helen: She was a bright student, quite conventional, who sewed her own clothes and from an early time "used her sexuality to advantage." She describes, for example, how she made a "somewhat revealing" dress that she wore to an oral exam. ". . . I'm sure the dress was not a hindrance," she writes, telling how she came out top in that subject. She was scared into becoming anti-nuclear after she read Nevil Shute's novel *On the Beach,* about nuclear war survivors in a doomed world.

She goes to medical school, falls in love with a fellow student, gets engaged, gets pregnant, gets married, and stays home to care for their three children. While in Boston, where her husband is working at the Children's Hospital Medical Center at Harvard, she goes back to medical work part-time, working on cystic fibrosis.

Back in Australia, in 1970-1971, another book then changes her life: Germaine Greer's *The Female Eunuch.* Sexual liberation, she says, lifted her out of depression. "I was awakened sexually by reading the feminist literature, which did wonders to improve our failing marriage," she writes. From Greer, she moved on to her "next mentor," Lord Bertrand Russell and his three volume autobiography, with all the concomitant Russellite activism (as well as his Malthusianism). Caldicott says that with these books, she "found" herself, the real person that had been buried under layers of convention.

Her "coming out," so to speak, occurred at a posh church in Adelaide, where she was invited to speak on women's liberation and told to say what she really thought. So, she writes, "I said that women in Australian society were less confident than men because they rarely had orgasms, which I had discovered from surveying my patients in general practice. . . ."

Continuing her liberation, Caldicott began to expand her political activities, especially against the French government's nuclear tests in the Pacific. However, her arguments, and their scientific content, never rise above the anecdotal orgasm level.

Caldicott lobbies, gives interviews, addresses meetings, and works hard to establish a cystic fibrosis clinic at the Adelaide Children's Hospital. When the Australian government decides to mine and export uranium, she reads the quackiest book on nuclear energy (*Poisoned Power* by Arthur Tampin and John Gofman) and then hits the road, lecturing trade unions on why they should oppose this government policy.

Hit 'em in the Testicles

Caldicott's address to the Adelaide Trades and Labour Council sums up her concept of organizing: As she writes: "I'd worn a pair of black velvet slacks and an ivory-colored satin blouse—so that they

might at least look at me." When this didn't work, and the audience continued their own conversations without paying her any attention, she says: "I had a brilliant idea. I began talking about the medical effects of radiation upon testicles. Suddenly you could have heard a pin drop. Australian workers are not adamant about many things, but if there is one subject dear to their hearts, I had found it."

She then summarizes: "I learned something very important that night. Don't overwhelm your audience with data they can't assimilate, because you will lose them. Grab them where they are emotionally vulnerable; once they are with you, the whole occasion is extremely rewarding."

Her political organizing escalates, and Caldicott frankly discusses her method of using "a little flirtation" to obtain signatures, and so on. (How this fits in with the liberated feminist ideology is not discussed.) She carries this method to America, where she and her husband return in 1975-1976, although she acknowledges some difficulties with this form of organizing—such as the time George Meany (allegedly) invited her to his hotel bedroom.

It is in the United States that her activist career moves into high gear. Caldicott meets all the big players in the anti-nuclear movement and forms the Physicians for Social Responsibility, which is launched with flattering coverage in *The New York Times* and other press. Its membership got a big boost in March 1979, after "Three Mile Island melted down," as she puts it. Caldicott was now in her element, hitting people in the testicles, so to speak, with hysterical accounts of what the potential dangers of Three Mile Island were.

Riding a wave of television and press coverage, Caldicott then goes international, speaking and attending conferences in Hiroshima, the Soviet Union, and around the world—becoming a "nuclear bag lady," as she put it. She leaves her medical work at Harvard to devote herself to jet-set organizing and raising money, lots of it, for the anti-nuclear cause. There are no limits to the publicity her Hollywood and journalism connections can arrange.

One also learns the eye-color and build of all the well-known activists who are her friends, from the German Green Party's Petra Kelly, to Meryl Streep, Sally Field, and Lily Tomlin. Then there are the ins and outs of high-level anti-nuclear diplomacy, including Caldicott's meeting with President Reagan, arranged by his daughter, Patti Davis.

In 1984, Caldicott is forced to resign from the Physicians for Social Responsibility, by a leadership faction that dislikes her hysterical scare-mongering (theirs is more low key). She works feverishly in the Mondale campaign, and is crushed by his loss in the Presidential race. As she put it, "I'd reached the end of my tether." She and her husband vacation around the world and return to Australia. Then, another personal disaster occurs: her husband divorces her.

Caldicott Reborn

Here, the book ends, but Caldicott's crusade continues. After a long period of re-finding herself, Caldicott has settled in Long Island, N.Y., where she continues on her desperate and passionate way, dressing well and arousing her audience with emotional ploys and distortions of the truth.

Meanwhile, as a result of Caldicott's activities and with the complicity of masses of comfortable people who are all too willing to be hit in the testicles in order to become passionately ignorant, research at the frontiers of science, such as that conducted at Brookhaven, is stymied and people around the world are dying of starvation and disease, because we lack the benefits of nuclear energy and other nuclear technologies.

Have a Ball, with the Lénárt Sphere

by Susan Welsh

The Lénárt Sphere Basic Set, $59.95; Classroom Set of 8 units, $399.95;
Non-Euclidean Adventures on the Lénárt Sphere, paperback, 204 pages, $15.95
István Lénárt
Berkeley: Key Curriculum Press, 1996
1-800-995-MATH

Key Curriculum Press, Inc.

Student using the Lénárt Sphere for the study of spherical geometry.

It turns out that I have been living on a sphere, lo these many years! Imagine my surprise to learn that, on this very sphere upon which I live:

- Triangles can have three right angles.
- Polygons can exist that have only two angles.
- It is impossible to create two similar polygons of different sizes.
- There is no such thing as a square; although you can construct a quadrilateral with four congruent sides and four congruent angles, the angles will not be right angles.
- The Pythagorean Theorem is not valid.

You don't believe me? Get a Lénárt Sphere and find out for yourself! This wonderful set, with accompanying textbook, is too much fun to be limited to the middle school and high school students for whom it is intended. Everybody should have one.

As soon as my set arrived in the mail, my seven-year-old son confiscated it and proceeded to spend two hours in unbroken concentration, drawing multi-colored concentric circles on the plastic sphere with the spherical compass. This would be no surprise to Mr. Lénárt, who writes in his introduction to the textbook: "Let us digress for a moment from the middle and high school level to the elementary grades. Teaching spherical geometry in tandem with plane geometry to students who have not begun to study geometry gives rise to quite different problems and results. Younger children who initially learn both planar and spherical geometry can avoid developing biases that are so hard to get rid of later. It becomes natural for these children to compare and contrast different aspects of geometry. However, this curriculum also involves the risk of making children prefer the sphere to the plane!"

Lénárt sums up students' responses to the project by quoting a high school student who took part in a four-day Lénárt Sphere minicourse: "Each day I looked forward to disproving another theory I took for granted."

What could be more fun than that?

Origins of the Project

István Lénárt is a Hungarian teacher and mathematician, who describes, in the introduction to the textbook, his efforts to find a more effective way to teach spherical geometry:

"It soon became clear that the project would not be successful without real spheres! Even for university students, it was necessary to draw on a sphere to understand the geometry. But what sphere?

"We tried Ping-Pong balls, lampshades, glass balloons from the chemistry lab, black globes from the geography lab, wooden bowls, electric bulbs, and the like. None of these proved really satisfactory, so I tried to design a special device for the purpose."

When the Hungarian company with which he was collaborating went under, as a result of the political and economic crisis in eastern Europe, Lénárt sought out international assistance, and ended up in a partnership with Key Curriculum Press.

The result is a product that is not only excellent in conception, but also in execution. The kits are well-made and durable; the spherical compass doesn't slip; the textbook is clear, challenging, and imaginative. Every geometry classroom should have a set.

Cutting-Edge Material, Poorly Presented

by John Grauerholz, M.D.

What Your Doctor Doesn't Know Can Kill You
William A. Kent
New York: C.A. Inc., 1996
Hardcover, 228 pages, $24.95

There is a genre of medical article known as "report of a case and review of the literature." This book-length text could be described as a "report of *my* case and review of the literature." A more appropriate title might have been "How I learned to stop wheezing, love green tea, and loathe doctors."

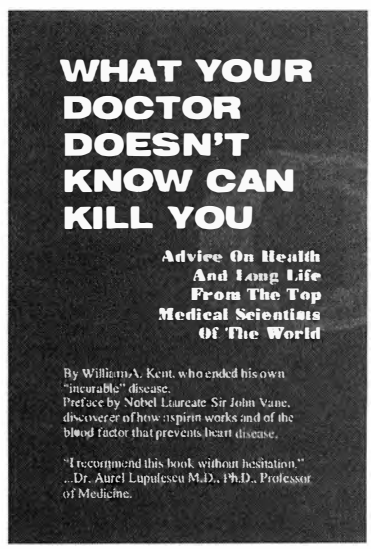
The author, a medical journalist, developed asthma unresponsive to conventional medical treatment and began a search of the scientific literature to find relief from his symptoms. He obtained relief and produced this manuscript which is a collage of his symptoms, his search, his readings, his interviews, and his low opinions of physicians.

His major finding can be summarized:

1. Arachidonic acid is bad for you.
2. Green tea, soy, and aspirin are good for you.
3. Physicians are, by and large, ignorant, arrogant, and greedy.
4. What you read about health in the popular media is incorrect.

If I sound dismissive of this book it is not because there is not good information in it, but because it is so poorly presented. The author provides no footnotes, but summarizes articles within the text. This is a useful pedagogic technique in an article, but in a long manuscript it becomes tedious. He attempts to chronicle his quest for this information, and intersperses this with anecdotes of his suffering, his unsatisfactory experiences with physicians, and summaries of various articles and interviews.

Compounding the problem with the structure of the text, there are copyediting errors that make it hard to read. This is a shame, because the material Kent covers is at the cutting edge of biomedical science and deserves the widest possible audience.



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In This Issue:

Agricultural Research Service/USDA

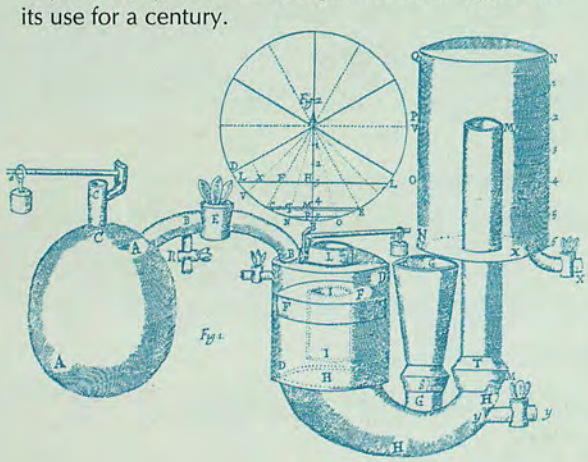
Plant pathologist Ken Deahl is breeding a potato germplasm line that is resistant to late blight, the fungus that causes the destructive potato disease. Left: Deahl and a colleague visit a Mexican field of potatoes that are resistant to the blight.

YES, WE CAN FEED A GROWING WORLD!

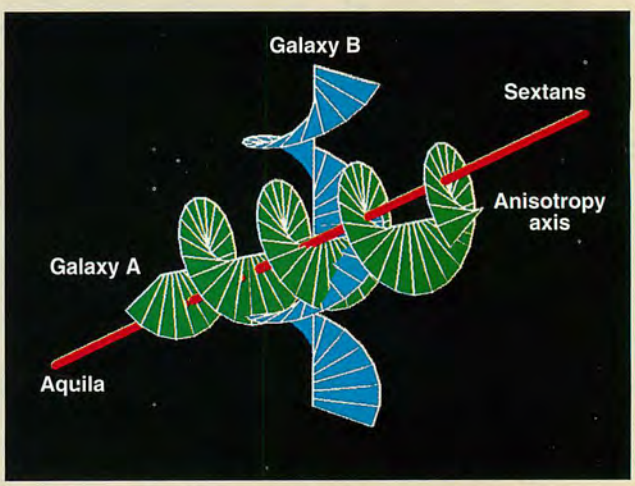
The Chinese government has told the Lester Browns of the world to eat their words when it comes to Malthusian warnings that the world, and especially China, will run out of food in the next decade. China has embarked on an ambitious program to use advanced agriculture and biotechnologies to increase the quantity and quality of food production. The Special Report reviews some of these technologies and their potential.

HOW STEAM POWER WAS DELAYED 100 YEARS

The steam engine was developed by Gottfried Wilhelm Leibniz and Denis Papin in 1690, only to be sabotaged by Isaac Newton and his associates in the British Royal Society. Philip Valenti tells the dramatic story of how the steam engine was directly developed out of the Leibnizian scientific hypothesis concerning the nature of the universe, and how the Royal Society stole the design and then suppressed its use for a century.



Papin invented and successfully operated the world's first direct action steam engine. By 1708, he combined his steam engine and his design for a paddlewheel boat, and built the world's first steamboat. Here, Papin's 1707 steam engine.



Borge Nodland

The plane of polarization of light or radiowaves may rotate more rapidly in the direction defined by Earth (at the intersection of the blue and green radiowaves) and the constellations Sextans and Aquila, and increasingly slowly when the light travels at larger and larger angles from this axis, such as that depicted from galaxy B.

NEW EVIDENCE THAT THE UNIVERSE IS NOT ISOTROPIC

Physicists Borge Nodland and John Ralston have assembled evidence showing that electromagnetic radiation behaves differently when travelling in different directions. The plane of polarization rotates as light travels across cosmological distances, even in the absence of magnetic fields, they say, and rotates at different rates when the light travels in different directions. If true, writes David Cherry, the finding sends a sacred cow of cosmology to the butcher shop, the dogma that the universe must be isotropic—must look the same in all directions.