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On the Cover: Astronaut David A. Wolf, STS-112 mission specialist, installs an exterior station television camera outside of the Space Station's Destiny Laboratory, in October 2002. Photo courtesy of NASA; cover design by Alan Yue.

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The 'Big Lie' About Radiation and LNT

Well-known toxicologist Dr. Edward Calabrese* made the startling discovery recently that the Linear No-Threshold (LNT) hypothesis, which governs radiation and chemical protection today, was based on a deliberate lie, proclaimed in 1946 by Nobel Laureate Hermann Muller for political reasons.

The LNT assumes that the known deleterious effects of very high dose levels can be extrapolated linearly down to a zero dose. Another way this has been put is that there is no safe dose of radiation. As most of our readers know only too well, the reigning LNT hypothesis is responsible for generations of fear of radiation in the population, the major factor in killing nuclear power and the enormous economic benefits it brings. On a world scale, the cost of not going nuclear can be measured in millions of lives lost, and millions more left to lead a life of misery. Meanwhile, billions of dollars are spent protecting society against the non-existing dangers of low-dose radiation.

Although the overwhelming experimental evidence that dose-response in radiation is *non-linear* has been known for decades, as have the health benefits of low-dose radiation, Dr. Calabrese's uncovering of Muller's "Big Lie" is totally new.

* Dr. Calabrese is Professor in the Environmental Health Sciences Division at the University of Massachusetts at Amherst. As a toxicology specialist, he has written scores of articles about the non-linearity of dose-response, including the benefits of low-dose radiation (called hormesis). He is founder and chairman of the advisory committee of BELLE, the Biological Effects of Low Level Exposure, a group founded in 1990, which includes scientists from several disciplines and aims to encourage assessment of the biological effects of low level exposures to chemical agents and radioactivity.

In brief, the story is that well-respected geneticist Hermann Muller (1890-1967) lied outright in accepting his Nobel Prize in 1946, when he stated flatly about radiation effects that there is "no escape from the conclusion that there is no threshold." Dr. Calabrese was able to document that Muller knew this statement was not true, and that he was intimately familiar with the competent research that contradicted his statement. He unearthed from the archives correspondence between Muller and co-workers that show without a doubt that Muller not only knew of the research results that showed a threshold, but that Muller et al. contrived to make those threshold results "disappear" from the scientific literature.

The full story will appear in our next issue, in an in-depth interview with Dr. Calabrese, to be posted on the *21st Century* website in advance.

Top-down Scientific Fraud

The perpetuation of a fraud this momentous deserves to be fully scrutinized as to motive. Some will point to the economic motive: The nuclear and medical establishments have a lot invested in the LNT, from the labyrinth of regulations regarding nuclear safety, to the legions of clean-up operations that are making the grounds of former nuclear sites edible in purity, to the exclusion of low-level radiation in treating diseases like gangrene and cancer in favor of less-effective chemotherapies.

But, as in most large-scale scientific fraud, the motivation is not merely economic, but ideological. The aim of those promoting the antinuclear movement, such as Britain's Prince Philip and his fellow Malthusian Maurice Strong, is to drastically reduce the world's population, from its present 6.97 billion to below 1 billion persons. Like the mythical story of the Olympian Zeus, who punished Prometheus for bringing the common man knowledge of fire (technology), the "Big Lie" about radiation is intended to prevent mankind's full use of nuclear fission.

Muller was not simply a leading geneticist. He was a protégé of the eugenicist Malthusian Julian Huxley, and he worked with the genocide advocate Bertrand Russell in the Pugwash "ban the bomb" movement. Muller's argument was that population quantity and quality needed to be planned, which could be accomplished by undoing the yoke between "personal love" and reproduction. As he explains in his 1935 book, *Out of the Night,* "The physical means for this emancipation are now known for the first time in history."

In his 1935 book, Muller argues the case for saving the sperm of "our greatest living men" in order to inseminate women of childbearing age. In this way, he wrote, "we should be able to raise virtually all mankind to or beyond levels heretofore attained only by the most remarkable gifted." Muller says that this would of course take "a century or two," for it would be "voluntary"—families could have "natural" children as well as sperm bank children, so the transition to an all-genius society would be slow.

"Now all this is no idle dream," Muller wrote. "It not only certainly can be done—I believe it certainly will be done. . . . Not only is our genetic improvement patently possible, but it is far surer and more feasible than any ultimate conquest of the atom, of interplanetary space, or of external nature in general. . . ."

There is clearly more to be uncovered in Muller's philosophy and political activities. But the fact remains that he deliberately lied to steer radiation policy into the realm of fear, instead of science. The question is, why is a fraud this enormous not making headlines? Why is there no clamor for a review of the LNT-based standards?

Until scientists and the public act to bring science back to radiation policy, society will continue to pay for Muller's "big lie" in lost lives and a lost future for the human species.

—*Marjorie Mazel Hecht*

Cosmic Causes of Weather

To the Editor:

I found your article titled "Saturn's Storm, Earth's Unrest, Science's Silence" [Editorial, Spring 2011] intriguing, as I recently have been curiously researching the potential cosmic causes of the increased global weather phenomena, earthquake, and volcanic activity. Your editorial suggests the role of the Sun's solar activity as one key element. However, I found that the current solar cycle has been considerably less active than previous cycles especially over the last three years when its activity was to have peaked. Based on this unusual decline I looked at other potential causes such as the jet steam and ocean currents.

I learned that the ocean currents influence the jet stream patterns, and while the last decade has actually been cooler than the previous decade, the oceans temperature has actually risen by 2 degrees Celsius over the past 20 years. It was noted that the increase in the ocean's water temperature is not due to atmospheric warming but to the hyper volcanic activity on the ocean's floor, estimated at over 5,000 spewing lava and greenhouse gases.

Due to rising ocean temperatures, the jet stream's patterns have been influenced to cause the abnormal global weather activity (drought and flooding) and the storm strength of hurricanes and tornados. Could this increased tectonic activity be the early indications of the potential for an ELE (extinction level event), as you discretely mentioned in your editorial?

Recently Lyndon LaRouche commented in an interview that the world would be experiencing a significant increase in nature's catastrophes, but he did not elaborate. Is he in agreement with your conclusion of this article or does the *EIR* staff have other relative cosmic information regarding nature's phenomena that you have determined too explosive for the general public to grasp? In other words, do your publications have an emergency preparedness plan in place, and if so please explain?

Steve Torrez
Houston, Tex.

The Editor Replies

There is no hidden agenda or preparedness plan. We have called for full funding for the "eyes and ears" in space, so that we may have the best possible knowledge of present and future threats. We have called for the kind of preparedness plans that should be standard for earthquakes—reinforced buildings, an adequately funded program for warning systems, and good evacuation plans. NAWAPA would provide protection from floods, drought, etc. by its vast improvement on water management, and the changes in weather patterns that these new distributions of water will produce.

There is no simple relationship of earthquakes and volcanoes to the solar cycle; however, solar and galactic influences are present and their causative mechanism must be sought out and better understood. There is some new evidence of a correlations of earthquake activity with the solar minima. Although we are experiencing a weak solar cycle, some very large solar flares have occurred. We have also recently discovered that flare intensity has to be measured over a longer period of time to find the true integrated effect.

The larger point to think about is: What changes in the galaxy influence the behavior of the Sun and such phenomenon as the Saturn storm? Rather than take a statistical approach to solar cycles, ask what larger process are they a part of.

You might find the book by Pulinets and Boyarchuk, *Ionic Precursors of Earthquakes,* helpful in thinking about various ways that atmospheric changes might influence or signal tectonic activity. Weather is also influenced by solar and cosmic radiation. In another highly recommended book, *Sun, Weather, and Climate* by Hermann and Goldberg, it is noted that a single cosmic ray of very high intensity, perhaps 10^{18}eV could trigger an Atlantic storm.

Best of luck in your researches.

ONE PLANET IS NOT ENOUGH, ISS CREW TELLS *21ST CENTURY*

LPAC TV

The upcoming ISS crew, at a NASA press conference in Houston, Sept. 20 (from left): NASA astronaut Donald Pettit, Russian cosmonaut Oleg Kononenko, and European Space Agency astronaut André Kuipers, engaged in an animated dialogue with 21st Century *correspondents.*

In a Sept. 20 press conference at the Johnson Space Center in Houston, U.S. astronaut Donald Pettit, Russian cosmonaut Oleg Kononenko, and European Space Agency astronaut Andre Kuipers responded enthusiastically to questions from *21st Century* representatives. The spacefarers, all scientists, called for putting human DNA on other planets as a matter of survival (Pettit), mining the Moon and colonizing the solar system (Kuipers), and exploring other galaxies (Kononenko). The three are set to launch to the International Space Station aboard a Soyuz TMA-03M spacecraft around December 26 of this year from the Baikonur Cosmodrome in Kazakhstan.

With a view toward the three-power alliance recently proposed by statesman Lyndon LaRouche, *21st Century*'s Ian Overton asked cosmonaut Kononenko about U.S.-Russia-China collaboration in space. Kononenko, a mechanical engineer and avid sportsman, replied that he would express his personal opinion: "I think that space has long been a sports arena, where every participant demonstrates how fast or how huge they are. I think that the future of space exploration is only in joint exploration, and we will be able to do deep space missions only if we cooperate. So I think our future is joint co-operation."

Juliette Lamoreux, also representing *21st Century,* ignited an animated discussion, asking, "And what do you think about the potential threat of cyclical mass extinctions every 62 million years, that we've seen on the Earth, and how mankind may begin to address that bigger galactic question?"

All three astronauts answered. "I'll tackle the galactic question here," astronaut Pettit, a chemical engineer, said, smiling broadly. "I'm a firm believer that one planet is not enough. And I like to say that perhaps the ultimate reason for exploring space can be learned from the dinosaurs. If the dinosaurs had explored space, if they had colonized other planets, they would still be alive today. So I think this is ultimately why human beings, if we want to live on the time scale of tens to twenties of millions of years, we're going to have to have our DNA on more than one planet!" Cosmonaut Kononenko added: "I think that problems with resources will always face humanity. So humanity will actually have to look for additional means of existence. And I think that it will be an urgent need to explore other galaxies and other planets. . . ."

Dutch physician and ESA astronaut Kuipers then added a crucial historical perspective: "We have been around for only a short time. And if we think in cosmic terms—I don't know who said this first—but we're standing at the edge of the ocean with only our toes in the water. There's an ocean to discover!. . .If you look back to our age from the far future, people will see that Sputnik, Gagarin, Armstrong, the first base on Mars (the space station will be skipped, because it will be normal—you'll have several), industrialization, mining on the Moon, all of these things will happen. I'm convinced that humanity will spread out through the Solar System, and who knows beyond. . . ."

The press briefing was broadcast live on NASA TV, and was also recorded. For more detail.

presidencia.gov.ar

Argentine President Cristina Fernández de Kirchner, with workers and national and provincial officials at the launch of the Atucha II nuclear plant on Sept. 28, 2011.

'THE BEST FUEL WE HAVE IS THE ARGENTINE PEOPLE'

Speaking at the Sept. 28 inauguration of the Atucha II nuclear reactor, the nation's third, President Cristina Fernández de Kirchner enthusiastically proclaimed Argentina's national identity as a country dedicated to scientific and technological advancement. "The best fuel we have is the Argentine people," she said, "and with this incredible nuclear reactor, I feel we are starting up the machine which our country Argentina was, which knew how to be a leader in all fields in Latin America—nuclear, aeronautics, building railroads, automobiles, scientific matters."

In a feisty response to attacks coming from the International Monetary Fund, the Obama Administration, and others, President Fernández noted that Argentina has the second highest economic growth rate in the world—8 percent this year—after China. She praised the dedicated workers present, and noted that 88 percent of the plant was "made in Argentina." And she outlined the future nuclear goals: to extend the life of the existing Embalse plant for another 25 years, to build Atucha III, and to build the 25-megawatt CAREM reactor for use in the country's interior to generate electricity.

NEW RUSSIAN RADIO TELESCOPE 1,000 TIMES RESOLUTION OF HUBBLE

Spektre R, the new Russian space telescope launched July 18, observes in the radio range of the spectrum and will open up an entire new era in astronomy. This is not only the largest radio telescope in space, but it will be integrated with a global network of radio telescopes on Earth, so that the network will function as if it were a single dish as large as the farthest orbital distance of the Spektre R from the Earth: 60 times the Earth radius. This gives the combined network, known as RadioAstron, a viewing resolution of 7 microarcseconds, which is 1,000 times that of the Hubble Telescope.

Videograb of Spektre R being readied for deployment into space on the Zenit 3F rocket.

Spektre R, combined with the infrared focus of the U.S. James Webb Space Telescope, ready for completion but threatened by the Administration's budget axe, will give us incredible viewing resolution. The Webb telescope has a primary mirror six times larger than that of the Hubble, which would open up a new range of studies, from distant galaxies, to the formation and composition of other stars and planetary systems, and to weather on other planets.

For more information.

SPACE APPLICATIONS WILL SHORTEN THE PATH OF AFRICAN DEVELOPMENT

Faced with all of the challenges of extreme poverty, African leaders expressed optimism about space science and technology, speaking at the International Astronautical Congress, held in Cape Town, South Africa, the first week in October.

"Space applications will shorten the path of development," stated Mustapha Masmoudi from Tunisia. "In 20 years, Africa should be on par with the rest of the world," Harry Kaane from Kenya, told the Congress. Dr. Sandile Malinga, the head of the South Africa National Space Agency (SANSA), who welcomed the more than 2,000 delegates at the Congress, captured the essence of the African plans for space technology development, saying, "We should start now, so future generations can look back at what we did." He stressed that "Science is imagination and wonder," not just technology. "Those things justify our spending on space."

At the opening ceremony on Oct. 3, Naledi Pandor, the South African Minister of Science and Technology, commented that space development in Africa will do more than help improve agriculture, communications, medicine, and education, and promote high-technology skills.

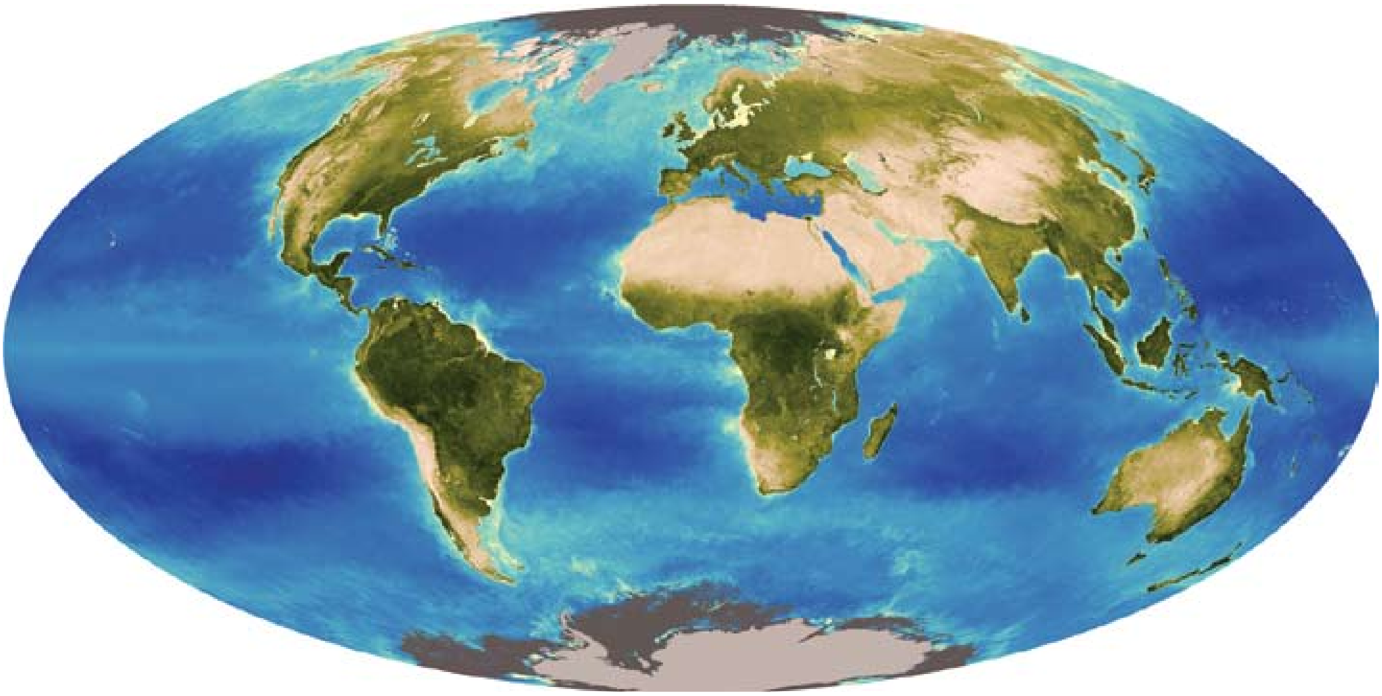
In an interview with *21st Century* Associate Editor Marsha Freeman, Pandor stressed that frontier science and technology projects, such as space technology, nuclear R&D, and medical research will be the key to uplifting the population. Responding to the observation that it is very inspiring that there are so many women in the leadership of the South African government, Minister Pandor said: "We all think about Eleanor Roosevelt and the contribution she made. She was a powerful woman, and we never forget that we wouldn't have the Universal Charter of Human Rights if not for her. So we draw inspiration. And that's what we would like America to go back to: to be the country that inspires us."

Courtesy of University of Kwazulu-Natal

Space physicist Dr. Sandile Malinga (right), at the University of Kwazulu-Natal explaining the LIDAR facility to a group of high school teachers.

The Universe Is Creative

by Sky Shields



James Rea/EIRNS

Sky Shields: "Everything you know as the physical universe is derived from that exact same process that you know in yourself as Mind. . . ."

Sky Shields, a member of the LaRouche "Basement Team," made this presentation, titled "The Preeminence of Science over Ideology," at the Schiller Institute European Conference, "Rescuing Civilization from the Brink," which took place July 2-3, in Rüsselsheim, Germany.[1]

I would like to take up the theme—it's a theme that is taken up in the recent series of videos which have gone under the title "Is the Past Fixed?"[2] but which are tackling a question that might be best described as the ontology of mind. People have a lot of different concepts, I think, attached to the word "Mind." But the problematic thread that I think runs through all the different concepts people have of "Mind," is that somehow, Mind is something which we possess: There's something that we recognize exists in us—but is completely distinct, and it's maybe observing something out there, called the objective universe.

That is to say, you've got something in *you*, you want to call "Mind," you want to name yourself. It has certain laws, certain rules to it. Certain words seem to come to mind when you think about it: ideas, concepts, like morality, beauty. There are certain principles that you consider to be definite principles of Mind. But then, these are not necessarily principles that you would assume exist in the so-called "objective universe." You assume that there must be some other thing out there that perhaps is more logical, perhaps has other characteristics to it, and we are using our minds to observe it.

The theme of this video series is what I'd like to cover today,

1. A video Shields's speech can be found here http://www.larouchepac.com/node/18723. The complete conference is available in video format. http://www.schillerinstitute.org/ The July 15 and July 22 issues of *EIR* also carried transcripts of speeches from the conference.

2. www.larouchepac.com/node/18639

using some of the work of Vladimir Vernadsky. I'd like to disabuse you of that idea, and develop a notion instead, that this thing we call "Mind" has a fundamental ontological significance. That is to say, that everything you know as the physical universe is derived from that exact same process that you know in yourself as Mind, to the extent that you recognize it in yourself and others. That this is a principle that has a very serious ontological significance that is the basis for everything that we see in Creation.

And, in the course of this, we will see that the actual scientific facts of the matter, agree very closely with the notion that you find in the Abrahamic religions, of man being made in the image of the Creator. We'll demonstrate that this is actually a very rigorous scientific concept, and it's the basis for all human knowledge, and it's the basis of all human economic activity in the universe: The ability for the human species to act on the universe is based on this principle, this ontology of Mind.

To do it, I'd like to give people an introduction to a thinker whom you have probably seen in various works of the movement. Mr. LaRouche has referenced his works in a number of different papers, a number of different locations: This is the Russian biogeochemist Vladimir Ivanovich Vernadsky. He is most well known as being the founder of the notion—he's not the person who coined the word, but he's the person who most rigorously develops the concept—of the Biosphere. And that, in its short description, is the envelope of the planet on which we recognize the existence of living processes.

But in its more in-depth investigation, it actually becomes something much larger. To make the point that people have seen, I think, in some of the recent discussion we've had, that has come under the rubric of "cosmic radiation": The entire first half of his book *The Biosphere* is describing processes that you would name, that would also fall under that rubric of "cosmic radiation."

Vernadsky: The Ontology of Mind

That is to say, his definition of that thin layer of the planet that we call the Biosphere, is that this is the only part of the planet which interacts with the rest of the cosmos. Or this is the part of the planet which most actively interacts with the rest of the cosmos, largely through the process we know as photosynthesis, where the steady flow of radiation from the Sun, electromagnetic radiation from the Sun, is being used to catalyze an amazing negentropic process of the development of the beginning of all of the food and all of the energy cycles that you see on the planet: The construction of the carbohydrate structures that form the bodies of these plants, and that are eventually incorporated, later on, into the bodies of animals, to be recycled, to pass through the Biosphere, in what Vernadsky called a biogenic migration of atoms, ultimately to become the structure of that Biosphere itself, via the death and the decay of various living organisms; to become other generated waste products, to become the mountains, to become the soils, to become the oceans.

www.tstu.ru/tambov/

Academician V.I. Vernadsky with his daughter, Nina, around 1910.

You've got a steady flow that, if you were to view it as this biogenic migration of atoms, would be something that continues from the far reaches of our cosmos into that thin layer we know as the Biosphere, and becomes the very structure of the Earth, the rest of it as we know it.

That's the scope of what he's actually describing. But in the course of describing that, he ends up drawing some conclusions which have major implications for ontology in general, but which we'll see—once we follow this path—lead us directly to this question of the ontology of Mind.

I'll give you some background. Vernadsky's life is a funny one. We've discussed this in the past. It spans a time period which is a very unusual, but very interesting and rich time period. It roughly spans a period between the American Civil War and World War II, so it positions him in an interesting place. He lives half of his life in Tsarist Russia, and half of his life in post-Tsarist Russia. And he's a major political player in organizing for the overthrow of feudalism in Russia, in particular. But because of his scientific views, he realized the necessity of this being the complete elimination of feudalism in order to facilitate the evolution of the human species.

Just to give you some idea of where he stands. A lot of his work leading into the Russian Revolution, and out of it, was on the topic of human economic studies, for that reason. You'll find studies of his on examining, comparing different kinds of farming practices, between the United States and Russia at the time. He does a study of U.S. agriculture, European agriculture, as he's trying to find out what's going to replace the feudal structure that exists in Russia at that time. He's looking, and says, "Well, after revolution—if you're going to end the idea of serfdom, you're going to end the idea of a feudal structure under the Tsar—what should replace that?" And in his mind, this was a real question of the scientific evolution—this is a question of the evolution of the human species. And you'll find writings of his on that subject already in the late 1890s, early 1900s; that this is a theme that's on his mind.

But he's investigating that at the same time as he's doing some early geological studies with his teacher Dokuchaev, examining, looking at the nature of soils, looking at the nature of the mineral composition of the Earth's crust. And in the course of this study, he quickly realizes that when he's looking at these minerals, that you're not observing a fixed system; that what you're looking at is a process that exists. He said, you're looking at a process that changes and evolves.

Dokuchaev Museum, St. Petersburg

Vasily Vasilievich Dokuchaev (1846-1903), Vernadsky's teacher is considered to be the father of soil science.

And very early on, he makes the statement that you see a process that exists *in time*. And this strikes him as early as, again, the 1890s, early 1900s; this strikes him as something that's unique to, first, geological processes. But then he realizes that every place you see change in these geological processes, it's connected to the action of living processes. And he realizes—his background is initially only in geology—that he needs to hurry up and give himself a crash course in the biological sciences, in order to be able to make any functional, useful statements about geology.

And so he does this. He does a whole investigation himself of figuring out, of just getting at what we later recognize as his impressive map of all life on the planet, really, everything you can possibly imagine. Because he realizes that all of this, this entire Biosphere, is involved in acting on, and developing, and changing the underlying abiotic structure of the Earth's crust.

'The Eternity of Life'

But then it begins to spark in his mind, from that observation of the way these biological processes operate on geological processes, it makes him begin to realize that, if this is true, then that earlier recognition that he had about the fact that geology is a science that exists in time, means that the thing he's calling time is closely connected to the action of living processes. And in fact, he coins a term that becomes very controversial, which he calls "the eternity of life."

Now, this has two interpretations at present. One is a very practical interpretation, which is not un-useful, but it's a very important thing to know this and kind of wrap your mind around: that, to the extent that he can observe these changes in geological structures over geological time, every metric of change that you have to look at is something that's connected to life. Everything, from carbon-dating, all dating methods in geological strata, depend on living processes. But then, he says, that these changes in the geological strata were exactly the thing that separates geology from the other sciences, because it gives us this feeling, this sensation that you want to refer to as "time." And what he concludes from that is that there's never been a period on the planet when life did not exist.

Now, this is very interesting for a couple of reasons. The first thing that should come to mind, as we had a discussion earlier: "Well, isn't it true, wasn't there some period of time when conditions on the Earth were so hot, so impossible, around the formation of the Earth, that you couldn't possibly have life? How could you have this guy Vernadsky claiming that life, as a principle, is something that's eternal, if there was some point where you couldn't have living things? Doesn't there have to be some moment of what's called abiogenesis, where life has to spring out of nothing and come into being?"

And Vernadsky is very insistent that, no, this is not true. And as early as 1908, we have him making the statement—which he'll refine—I'll give it in the form he gives it in 1908, but we'll see, as time progresses, that his development of this notion becomes much more complex. But he says, in 1908, he's beginning to recognize, *that life is a principle as fundamental as matter or energy*. This is as early as 1908, so you can get an idea of where his mind is going.

National Undersea Research Program/NOAA

"There's never been a period on the planet when life did not exist"—what Vernadsky called "the eternity of life." Here, tube worms feeding at the base of a hydrothermal vent, an environment where it was once thought that no life could exist.

That's obviously very different from the standard reductionist view. The view that is prominent today is that, somehow, life is just some epiphenomenon, composed out of non-living processes. And then cognition, we're just some epiphenomenon that grew out of living things. But he stresses, no; he's saying that this principle of life is something that exists, that, he says, is eternal, that predates all other phenomena that might be observable.

By 1920, he comes under very heavy attack specifically for that notion, the idea of the eternity of life. This is a period, after he plays a major role in the overthrow of Tsarism in Russia, but there's a coup that's launched by—he recognizes it as some sort of meddling. He's not totally clear that this is the meddling of the British Empire to ensure that the revolution that occurs is the Bolshevik Revolution, and not the kind of revolution that Vernadsky is looking for, but this happens.

In that context, you have the takeover in Russia of the ideology of dialectical materialism: The materialist aspect of that requires the reductionist notion of the progression upwards, from the abiotic, into the biotic, into the cognitive. Whereas Vernadsky is making this insistence, that processes are organized in the opposite direction. At this point, he's only being very explicit that it's life, as primary, that governs the processes that are below it. But then we'll see that he develops that further.

Party-line enforcer Alexander Oparin (1894-1980) was deployed to attack Vernadsky and his idea of "the eternity of life," in the early 1920s. Here, Oparin in 1938 with Andrei Kursanov (left) in their enzymology laboratory.

This becomes a huge deal. The paper he writes on the subject in 1920, which is called "The Origin and Eternity of Life," is completely censored. It's not allowed to be published, and the book in which he was planning to publish it, is heavily redacted. The piece that's most heavily redacted is his piece on human autotrophy, which is on the willful evolutionary development of the human species. So this gives you an idea of the context.

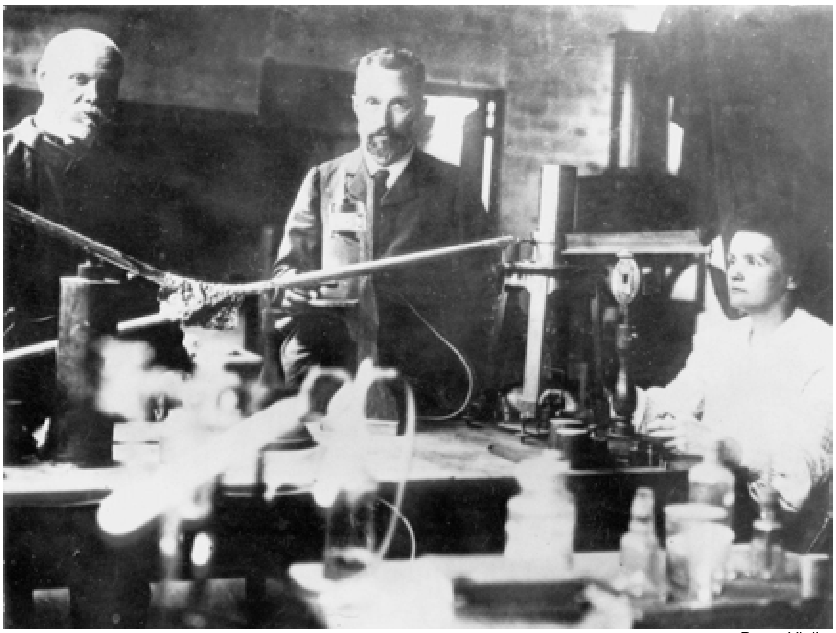
This notion of the eternity of life is exactly what Alexander Oparin is deployed to attack in Vernadsky's work, to attack and try to attempt to rework and rewrite and to explain away. But we'll see that Vernadsky is not only insistent upon that principle, but his later work develops that to an even higher level.

Work with the Curies

A major change in his development of this concept occurs in the period around 1924, when he moves to France to work in the laboratory of Marie Curie. Now, he's working there on various topics, many of which are dealing with the notion of radioactivity, obviously, and radioactive dating methods, which he saw as a major way to see this expression of time and development in the Biosphere.

But while he's there, he has a series of personal discussions with Marie Curie, and she relates to him the work of her husband, Pierre Curie. In that series of vignettes, it's interesting to see, he describes her description of dinner-table discussions with the family, which would be Pierre Curie, Marie Curie, and their daughters, on scientific topics. He mentions that they had a very peculiar working style, which is that they would spend a long time in discussions, that they would spend months in just discussion amongst them, developing these ideas in their head, and then Pierre Curie would write a very short paper as a result. And Vernadsky does a little summary; he points out that the Curies' life's work, which he says is about—he gives a figure of something like 25 years—some number of decades of life's work, fits in one volume. He says this is not because he's not a prolific writer, but because he writes these incredibly dense summaries of his thought process.

But, as a result, when Pierre Curie is killed, he doesn't get a chance to write out the final project that he was working on, which was the generalization of work that had been done earlier by Louis Pasteur. Now this was some work that Vernadsky was obviously very familiar with, on the question of handedness, or chirality. This was Pasteur's observation that there was a distinction between the same chemical compounds when they are produced: The exact same chemical compound, which is chemically identical, meaning it undergoes the exact same reactions, is produced in the exact same way in each case, but there's something fundamentally different for certain compounds, when they're produced by living processes, or in a laboratory, outside a living



Roger Viollet

Pierre Curie (1859-1906) and Maria Curie (1867-1934) in their laboratory in an unheated shed in the courtyard of the School of Physics and Chemistry in Paris. On the table is the Curies' quartz piezoelectrometer. At left is chemist Gustave Bémont.

process. And that difference is expressed in the ability of these compounds to rotate a plane of incident light.

If you have light that is polarized to oscillate in a specific plane, certain compounds produced by living processes would exhibit an ability to rotate that plane of light, whereas that exact same chemical compound, produced outside living processes, could not. And again, I'd like to stress that, in other respects, these compounds are completely identical. They are completely chemically identical, but somehow, their relationship to light changes, on the basis of their being generated, or not being generated, by living processes.

Now, Curie saw this as an expression of a much more broad principle of symmetry. And he had discussed this in work with his family, with Marie Curie. Vernadsky found this very exciting, and in particular, he said that he was excited about the universality of this principle of Curie, and in particular, that it had two expressions. One is a quote that became very fruitful in all areas of investigation later on, where Curie notes that a dissymmetry is an event.

Now what did he mean by that—that dissymmetry is an event? I can give you a mental image, which would help. If you were to picture in your head, right now, a rotating sphere; now imagine that we're talking about a perfectly geometric sphere, with no external markings. If it were perfectly geometric, no external markings on it, would you be able to register that that sphere was rotating? And in fact, could you even give a meaning to rotation? If it were perfectly geometric, no external markings to it, you'd find, as you look at the thing, it looks exactly the same.

If you do something to that sphere, and you change its spherical symmetry—say you put a dot on it, all of a sudden—so imagine you've got this spinning sphere, and somebody comes with a paint brush and they dab a dot on the side of that sphere: Suddenly you have motion, you have something that you recognize as rotation. That, as soon as you add a dissymmetry, you have something that becomes recognizable as an event. And Curie generalizes that, to say that in general, whenever you see something you recognize as a phenomenon, as an actual event, it's because you're seeing a dissymmetry that's generated out of a symmetry.

Now, this is important, because that principle alone, allows you to eliminate the idea of empty space. Because you realize that what seems in this case to be an object in empty space—in that case, you would say the dot moving on the surface of the sphere—is not. It is a process that initially seemed to be, with respect to some parameter, perfectly symmetrical. Suddenly, some portion becomes asymmetrical—you introduce a singularity in that process, and the asymmetry relative to the symmetry registers to you as an event, as a thing. And the simple sense-perception response to that, is to say, "Well, this is an object, whereas what you had before was empty."

But in general, Curie says no, that's not true. Everything you see as an event or an object, is, in fact, a dissymmetry being measured against a pre-existing symmetry, and that looks to you like an object against empty space.

And so Vernadsky recognizes in that approach Curie is taking, a very powerful heuristic tool. And if we get a chance, we'll be able to see that you will find that, in musical composition, that becomes a principle that you can play with, and you will see how it moves the mind: What you recognize as background versus foreground; what you recognize even as silence versus sound in a musical composition, is really playing on this question of the symmetries and asymmetries, in your mind: There's no such thing as empty space.

Francesco Redi (1626-1697) formulated the principle that all life comes from life.

So Vernadsky is excited about this, because he has started to realize that this gives you the ability now, to eliminate all the notions of the physicists, these sort of pre-existing unquestionable notions of absolute space, absolute time, and matter. He says, well, these are fictions, these are mathematical fictions, and in the real world, they don't exist. And you have to figure out a healthier way to get around them, to be able to approach actual phenomena, to describe actual phenomena as they are.

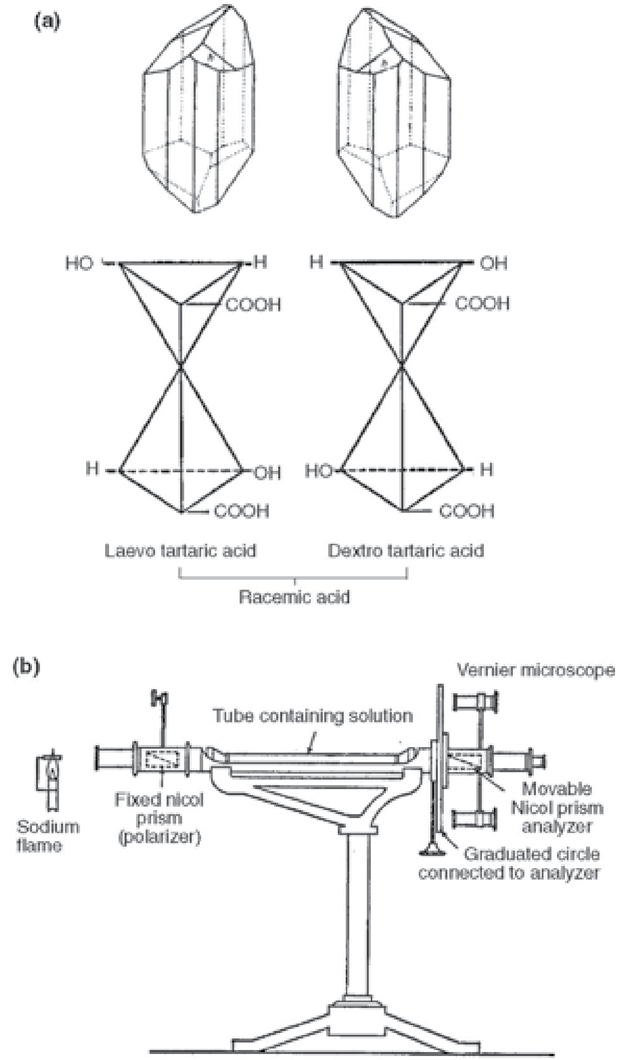
So that becomes an exciting notion.

The 'Principle of Redi'

But then he's also taken by the second element, that's often called Curie's Principle, which is that the symmetry of an effect must be contained in the symmetry of the cause. And so, he asks, what does that exactly mean? Curie has famous examples of it. The most famous example is, Pierre Curie and his brother—their discovery of the phenomenon of piezoelectricity.

Now, people may or may not be aware, that their discovery of piezoelectricity, that is, the ability for certain crystals, when compressed, to generate an electric current, is based entirely on considerations of symmetry. Of recognizing what pre-existing symmetry exists in a crystalline structure, and upon its compression, what sort of changes in symmetry are you observing? What occurs as a result? And do the induced symmetries—do they or do they not agree with the symmetry of an electric field,

Louis Pasteur (1822-1895) is shown here in his laboratory in an 1885 painting by A. Edelfeldt. Pasteur successfully separated the left- and right-handed forms of tartaric acid crystals (a) at right. Dissolving them in water and examining the two solutions in a polariscope (b), he found that one solution turned the plane of polarized light to the left, and the other one to the right. He then showed that only the left-handed form is produced in biological processes, while equal quantities of left- and right-handed forms arise in laboratory synthesis of the compound.



of a generated electric current? And on that basis, he's able to determine, first predict, that the phenomenon of piezoelectricity will occur; but then also be able to determine in what material could that phenomenon be generated. And it's premised on the idea that you can get the symmetries to agree between the electrical current and its associated magnetic field, and the crystal itself.

Vernadsky hears this in his discussion with Marie Curie, and then, in his own reading of Pierre Curie's work. And then he connects that with an idea that was already dear to his heart, which is this question of there not being any observed abiogenesis. The idea of what he calls the "principle of Redi":[3] that life always comes from life. That is to say, you never see the spontaneous generation of a living process. And what he observes in the history of the Biosphere, you see the steady emergence of life, from life, typically expressed as organism to organism.

But we will see that the symmetry principle is going to allow him to expand this notion of life much more broadly than even that simple description allows.

What he does see also, is that this peculiar symmetry that you see with the handedness—he goes back, now, and looks at the work that Pasteur had done on the ability for certain compounds, when produced by living processes, to be able to rotate the plane of light as it passes through them—and he starts to realize that there seems to be here an intrinsic handedness in the process itself.

Pasteur himself had already concluded that this was a form of handedness that had to exist in the very, very small; that this was not some property of the compound in the large. I'll give you an example: It was already known that certain crystals could rotate a plane of light when light was shone on them. For

3. What Vernadsky calls Redi's principle, "*omne vivum ex vivo*," is the principle, proven by Pasteur, that "all life comes from life." This principle was formulated by the 17th Century Italian scientist Francesco Redi (in the form "omne vivum ex ovo"—all life comes from the egg) and has not been disproven to this day: There has never been discovered any evidence of the ability to generate the living from the non-living.

N.N. Lusin (1883-1950)

Pavel Florensky (1882-1937)

Lusin and Florensky were part of a 20th Century Russian school of mathematics that opposed the concept that continuity is primary in philosophy (and mathematics). Vernadsky introduced the Curies' work to Lusin in 1929.

example, quartz crystal. Crystallized quartz, if you shine light through it, is capable of taking a plane of polarized light and then rotating that, as the light passes through it. But, if you liquefy the quartz, or you convert it into glass, the form that we often see it, in its liquid form or in solution, it loses that ability to rotate the plane of light. So you're able to conclude from that, that the rotation of light in the case of quartz has something to do with the crystal structure itself.

But then, in the case of these living products—like the famous example we discussed in a [[video]] on this subject on the website,[4] the case of tartaric acid: In the case of living processes, the plane of light is rotated in the solution by the liquid itself; which means in Pasteur's mind, that no matter how you change the liquid, it will continue rotating the plane of light as the plane of light passes through it. So in Pasteur's mind, this is a product of the solution in the very, very small.

A Fruitful Discussion

This is something about the handedness of the geometry that goes to the very, very small. He calls it molecular dissymmetry. Vernadsky takes a look at that, and says that that thing that Pasteur is calling molecular dissymmetry, is actually an expression of something much more fundamental. And remember, he's coming from the standpoint that he recognizes life as being an actual independent, active principle in the universe, a fundamental one.

So, he begins a discussion. He begins tossing these ideas around. They develop really to their peak in the period around 1929, 1930, 1931. In 1929, he begins a correspondence with a mathematician, but a very interesting mathematician, named N.N. Lusin, Nikolai Lusin. It's interesting, because Lusin is part of a very specific mathematical school in Russia at the time. This school includes Lusin, another figure named Pavel Florensky; there's a number of these folks. I won't give this as an endorsement necessarily, but to give you an interesting idea of what their mindset is: people who were opposed to dialectical materialism, because they were opposed to the concept of continuity as being primary in philosophy. And they stress that there had become an over-obsession in mathematics, in particular, with continuity in continuous processes.

And, so the discussion amongst themselves in this group, is that real processes are, at their heart, at root, discontinuous. And in their discussions, you find that they discuss, in particular, that political processes and social processes, do not occur by some kind of gradual social evolution, That they occur of necessity by discontinuous leaps, that they occur in revolutions.

And so they stress that any kind of mathematical study that is not taking discontinuity into account, is something that's problematic. Florensky, for his part, goes so far as to say that he thinks that it has the net effect of separating man from God, because of man's preoccupation with the necessity that things must continuously follow from what came prior.

So that's simply to give you some context. And among them, they form a group which was heavily opposed to the reigning ideology, the materialist ideology in dialectical materialism. Florensky himself is later executed. Lusin, in a major event in the early 1930s, becomes a target for execution, which is eventually stopped by Vernadsky, groupings around Stalin, and other people. I'll get into some of that and what's to come, but this is just to give you a flavor of what the discussion is.

So this is whom Vernadsky writes to, asking him about this question of handedness. He sends Lusin a copy of Marie Curie's book; it's a biography of Pierre Curie written by Marie Curie. Vernadsky sends this to his friend Lusin, and says: "Look, I'd like you to take a look at this"—this is in 1929—and simply: "look at this and tell me your thoughts on this. I'd like to know from your standpoint, is there any mathematical or geometrical significance to this question of handedness in living processes?" That discussion may end up being taken up in person between Vernadsky and Lusin, between 1929 and 1937, but the next letters we have between them are in 1937.

The Handedness of Space-Time

Before I get to that, I'd like to discuss some of the developments in-between, but that letter in 1929 just shows that this was something that was on Vernadsky's mind as a fundamental question, and already connected to his idea of, at this point, the primacy of life as a process. But in 1931, something interesting happens. In 1931, Vernadsky—already in his 70s—is again coming under heavy political attack from different circles. Some groupings within the Soviet Union are defending him; others are attacking him. Some of those that are defending him are attempting to defend his scientific work, but prevent it from being propagated into the general population, because people recognize that his concepts are obviously correct, because they're effective, but that they would be dangerous, were they taken up by the general population.

4. See "Louis Pasteur: The Space of Life."

University of Texas at Austin

The Russian Academy of Sciences enforced the Soviet doctrine of dialectical materialism among scientists and censored parts of Vernadsky's work.

So, one of the major moves of the censors at this time was, instead of stopping the publishing of his work, they would prevent it from circulating any wider than the Academy of Sciences. They would only allow the work to circulate among a very small circle of scientists and then limit the amount of publication.

But in 1931, he applies to do research abroad and is denied, and instead is told that what he can do is go and study in a special vacation house that's been set aside for members of the Academy of Sciences. So he's understandably upset. But this year, 1931, where he's in this vacation house, becomes a very fruitful year for him, because a number of ideas that have been floating around in his mind begin to converge. One, his concept of the eternity of life, this idea of life being an actual fundamental principle. But then, that combined with the notion of symmetry, as he had discussed it with Marie Curie from the works of Pierre Curie, and this combined, then, with certain other clear properties that he recognized.

One is, he recognizes the creative nature of living processes, that they express a very clear anti-entropy, where the only place that what you would call an "arrow of time" seems to be seen in the abiotic, at least in the small, as in what Sadi Carnot was able to describe for heat engines, which is their tendency over time for concentrations of heat to dissipate, etc., which was described as entropy, and named entropy. And he makes the point that it was erroneously attempted to be applied to the whole universe by Clausius. Vernadsky makes the point that that was an invalid attempt to generalize it, that nothing experimental demonstrates that. In fact, Vernadsky will show, when you're talking about the whole universe, it's going to have a characteristic which looks much more like a living process than anything else.

But he recognizes this anti-entropy, and he makes a very unique and interesting correlation, which is between that directedness of living processes, that anti-entropy of living processes, and the handedness as Pasteur had observed it. And he says, what we're seeing here in the case of the living processes is a handedness of time. And then in his writings, he says, well, of course, this makes sense, because it was actually an arbitrary division that was done by Descartes and Newton, to separate space and time into distinct things.

In fact, you only have one phenomenon here, which you would call space-time but really physical space-time. It's a process. The thing that you're calling space and time are reflections of some actual physical process there that is occurring. Since that's true, things that you see reflected in the characteristic space of a process should also be in the characteristic time. So, whatever this handedness of space that we're seeing in Pasteur's work, should also be connected to a handedness of time.

And he starts a deep investigation of this, really getting into the thick of it around 1931, when he does a full historical study of this discussion of everybody who tried to tackle time, and he concludes that—it's really at this moment, that he's doing his work now—the first moment that the greatest fallacy up until this point, has been the idea really imposed by Newton, that time and space are some sort of absolutes that are not subject to be studied by the human mind. That these are something that you're supposed to take as *a priori*, and not be able to question.

And he says, well, that's clearly wrong. He says that's something that the mathematician might think, that's something that even the physicists may think, but it's not something the real scientist, the naturalist, has the liberty to think.

So he begins elaborating this notion. He begins a series of discussions. He writes a series of papers in 1931 on this theme, on the theme of the, as he calls it, "living time," and sometimes, "biological time." But it's interesting that already in this period, over the Summer of 1931, he's beginning to realize that certain principles that you've already seen reflected earlier in his work about the nature of human activity and economic processes—he starts realizing that these are absolutely fundamental, in dis-

Sadi Carnot
(1736-1892)

Rudolf Clausius
(1822-1888)

Vernadsky understood that the dissipation of heat in heat engines, known as entropy, did not apply to the entire universe, as Clausius falsely claimed. The universe according to Vernadsky was anti-entropic.

cussing this question of even living time.

And you see there, in his work, as far as I can tell, the first reference to the works of Wolfgang Köhler and the Gestalt psychologists. And his explicit statement on that matter, He references the work of Köhler and the Gestalt psychologists, and he says that what's most interesting about them is that they recognize in perception the things that you would normally start to describe as perception, which is:

> They point out the necessity of recognizing certain geometrical forms or structures for visual space, for tonal melody, and for other such phenomena, which are connected with the structure of the spatially and temporally identifiable cognitive apparatus.

Wolfgang Köhler (1887-1967). Vernadsky began investigating the work of Köhler and the Gestalt psychologists in 1931, in particular their work on vision and hearing, specifically music, and tonal melody, as he was developing his notion of biological space-time.

And he points out that the "Berlin Professor Wolfgang Köhler extends these notions about the psychical forms, about these cognitive processes, to phenomena of zoopsychology and to physics." And this becomes a new philosophical current of Gestalt philosophy.

Now, it's important—I just want to draw your attention right there to that reference. He says specifically that what he's talking about when he's describing this character of biological creative space-time, is the best example of being able to start to examine these sorts of geometries—is what you see specifically in the work of the Gestalt psychologists, but specifically in their work on vision and hearing, and specifically music. Note the reference to tonal melody, because that will come up. His discussion of the significance of music for these geometries, and for the notion of time, will become interesting, especially when we come back to a discussion of what Köhler was working on at that time, elements of which would have undoubtedly been known to Vernadsky.

But I'll come back to that.

The 'States of Space'

I want to do a little more on the arc of what Vernadsky was doing. But keep in mind that reference, in his work on biological time, to specifically cognitive processes, specifically the work of the Gestalt psychologists, and then specifically the character of the role of music, and tonal melody in this process.

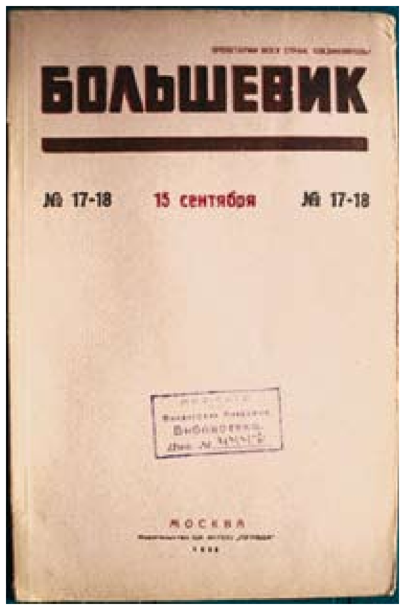
But that's 1931; you see that reference. And I know of one other reference at that time to Köhler's work, which is in his notes being prepared around the same period. So that develops.

And a number of other things begin to happen. He publishes those papers. He comes under heavy, heavy attack in 1931 as a result of that. I should add that in January of that year, he'd already come under fire. In the magazine *Bolshevik*, there was an article published which was called "Subversives in Science." And it was one of these things—clearly, to get how the process worked—you'd have these moments of just riling up the population. You'd build a rage in the population into a fever pitch, with the intent of targetting certain specific individuals, and usually they would meet with very bad ends.

And at this point, Vernadsky had been attacked. He had never made a secret of his own attacks on dialectical materialism, and he'd been attacked publicly for this before. But this one had a particularly sharp edge to it. And he was put on a list with a number of other scientists, a very short list, among whom was Alexander Gurwitsch, for the record, scientists who, this article in *Bolshevik* magazine claimed, were using their scientific work and using their positions to draw political and philosophical conclusions.

And I will make the point: He most certainly was using his scientific work to draw political and philosophical conclusions, and I think this was a moment of clarity on the part of the enemy at this point.

But he was singled out for attack. In that context, he still wrote what he was writing on this further development of his anti-reductionist work on life, and extending it more explicitly into cognition, in 1931, and published it. He presented it at that Fall's session of the Academy of Sciences, and he gave a speech on what he called "the problem of time in contemporary science," where he included his work on life, he included the reference to the Gestalt psychologists, and he included the reference to music, in particular. This came under fire from A.M. Deborin, who at the time, was sort of *the* watchdog



A.M. Deborin (1881-1963) was a leading party enforcer of what he called "subversives in science." His attack on Vernadsky was published in the magazine Bolshevik *(right) in 1931.*

for dialectical materialism. He was *the* Soviet philosophical defender of dialectical materialism; he was *the* person who would be assigned to try and attack you for being a subversive.

And attack Vernadsky he did: He launched a massive, scathing attack. It was very vicious, but everybody also recognized, it was sort of universally recognized, that it lacked content.

Vernadsky, again, in his 70s, responded—again, I'm going into this, to give you a sense of what the context was. This was a very sensitive situation. I mean, to draw in other people who would come under this kind of attack who had been exiled and/or killed—that was clearly what some people, whoever Deborin was connected with, were lining up Vernadsky for.

Biologist Alexander Gurwitsch (1874-1954) was another anti-reductionist scientist singled out for attack by Deborin.

So it was important that he handle this well; and he writes a large public response, and launches a very sharp counterattack on Deborin. And in it, he emphasizes his, Vernadsky's, own importance for Soviet science and the maintenance of the Soviet Union, and really lacerates Deborin for attempting to stop scientific progress with this attack, for his uneducated ideological reasons. And when you see Deborin's response after that, he actually puts Deborin on the defensive, which is very nice, and Deborin begins nagging somewhat after that, but then backs down in that series of attacks.

But now this frees Vernadsky up to do some other work, and he starts building networks to broaden this notion that he's been working on, this concept of—a term he borrows, that Pierre Curie used, that Marie Curie told him about—this "states of space." So he continues his work on what he calls the states of space. But he then stresses everywhere he writes it, what he means when he says that is, he's referring to this physical space-time.

In what follows, almost every time I use the word "space," unless otherwise specified, I'm referring to a physical space-time, and he's clear on that himself. This is, again, most explicitly after this 1931 period, where you've got his explicit work on time being carried out.

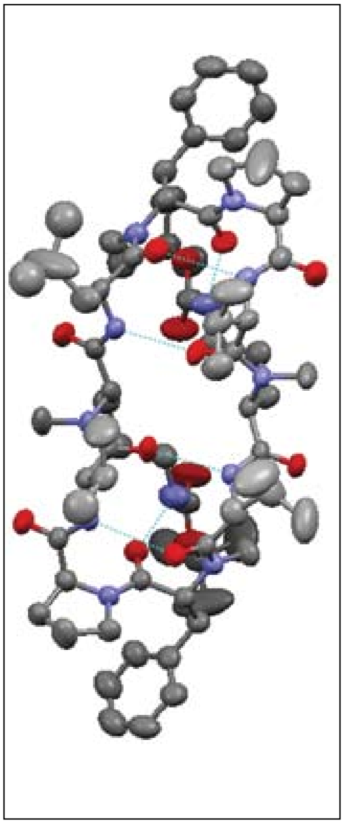
Georgii Frantsevich Gause

So then, in 1933, Vernadsky, then in his 70s, in his diary, he describes meeting with a 23-year-old researcher named Georgii Frantsevich Gause, and they discuss. Vernadsky had been familiar with Gause's mentor, who was a friend of his, and Vernadsky had three years prior approved for publication Gause's first published work. But in this meeting, Vernadsky's ill, and he's staying in a sanatorium to get better, a special sanatorium for members of the Academy of Sciences, and he has a number of people come to visit him.

In 1933, Gause comes to visit him, and what he tells Vernadsky is that he's doing experimental work on this question of optical activity in the protoplasm, that he's taking up the questions that Pasteur had posed on the optical activity of protoplasm, experimentally. And Vernadsky becomes very excited. He's thrilled this is taking place. He even goes so far as to offer Gause a position in his laboratory, because Vernadsky sees in this the potential to extend, experimentally, his idea, as he begins to work it around this time, that the principle that governs living processes is something that lies on a much more fundamental level than space, time, or matter; that this is something that space, time, and matter are a process, that they're a reflection of. These are simply projections of something much more fundamental.

So he offers Gause a position. Gause does not take it, but he agrees to research and publish things in the laboratory. The only reason Gause doesn't take it is because—if you take a look at the areas he's working on at the time, they're so broad, he feels he'll be limited if he leaves the university and goes to work for a specific laboratory.

But to give you an idea of the number of things that come out of this: Gause is able to confirm that the Pasteur principle of the handedness of time runs far deeper than had even been suspected prior, with just optical activity. In fact, if you are to take a look at the actual structural composition of an organism, there



Biologist Georgii Fransevich Gause (1910-1986) worked with Vernadsky, experimenting with Pasteur's idea of the optical activity of protoplasm. To protect himself from the Soviet science police, he becomes involved in essential work with the military during World War II, developing antibiotics. The crystal structure of Gause's naturally produced gramicidin-S is shown above.

Vernadsky put his attacker on the defensive, accusing Deborin of trying to stop scientific progress.

are certain principles of handedness that aren't violated.

For instance, the handedness of proteins, the optical activity of proteins in living processes, the amino acids that compose proteins, is always the same. You always have proteins that have what's called left-rotary power. They always rotate the plane of light to the left. The sugars that are involved in the construction of living processes will always have right-rotary power. They also rotate the plane of light to the right.

He does a lot of interesting work. He, unfortunately, comes under heavy fire from the Lysenko apparatus, and then the same groupings among the Soviet apparatus that are enforcing materialism as an ideology launch an attack on him; his main collaborator actually ends up being killed, is executed, and Gause becomes understandably afraid.

His work takes a very practical turn. He continues working with Vernadsky, and Vernadsky never leaves the direction that he's on. Gause makes a point, though, to avoid the actual work, the conclusions that Vernadsky is drawing about the states of space, but discovers a number of very interesting things. One thing is, he tries to, in the course of trying to take a practical job, he assigns himself to work with the Soviet military in World War II, making himself indispensable and un-executable, in the way he positions himself. He's the only person able to develop antibiotics for Soviet Russia, and he develops the first—possibly the only antibiotics during the war. I'm not certain, but definitely the first native antibiotics that Soviet Russia had during World War II were developed by Gause.

But an interesting spin on the story, is that it's a naturally produced antibiotic, that has the capability of rendering bacterial cell walls permeable and causing them to eventually just simply disintegrate. And Gause looks at their structure and he breaks down the amino acid structure of the antibiotic, and he finds out that it contains exactly one amino acid, which is mirrored in the opposite direction, as that which should be required for living processes. Every other occurrence of that amino acid, when it's in the organism, is left-handed, and this one case in the antibiotic is right-handed. He experimentally switches the hand, and turns it back left-handed, and it ceases to be an antibiotic.

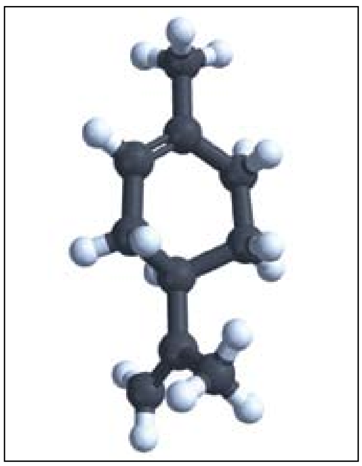
So he's able to demonstrate that the antibiotic character of this thing is closely connected to the nature of handedness in the antibiotic. A whole class of these antibiotics is developed, called "Gramicidin S" for Gramicidin Soviet.

But then there's a whole class of Gramicidins: Each and every one of them contains at least one flipped amino acid, where if you flip the amino acid back, it loses its ability to be an antibiotic. So then, despite the fact that he ceases to draw some of these more profound conclusions, he is able to conclude that this is a deep-running principle.

Now, we know that that shows up in a number of different places. I'll just give a list, so people know that it's true that living processes are uniquely sensitive to the handedness of the chemical compound. I'll just give you an example. People know maybe aspartame, which is the artificial sweetener. If you take the exact same chemical and you reverse the handedness of it, it ceases to be sweet and becomes bitter—chemically identical. Every experiment you could do, outside of experiments with light, would demonstrate those two compounds to be identical. But the organism recognizes them as a universe apart in terms of actual activity.

The smell of caraway and spearmint is the exact same chemical: The difference is the handedness. So, chemically identical, but you, your organism, recognizes them as being distinct. The limonene, which makes citrus fruit smell like citrus—orange, lemon, etc.—if you reverse its handedness, it begins to smell like pine or turpentine.

Some of these artificial drugs are nice: One called Darvon, in one form, is a painkiller. If you flip it to its mirror-image, it will have no effect on your pain, but it will cure your cough. And there are all sorts of insect pheromones and things, that have completely different actions: Exact same chemical, just flipping the hand, that changes fundamentally its biological effect.



Another example of handedness in chemical compounds is that of limonene (the citrus smell) and turpentine, which are chemically identical—except for their handedness.

Riemannian Geometry

So you realize there's a symmetry principle there in living processes that's very specific, and does not exist outside of it. In 1937, Vernadsky continues his discussions with Lusin on this topic, and he asks Lusin: "I want to ask you something that's more profound. Is there anything in Euclidean geometry that can account for this distinction here?"

Bernhard Riemann (1826-1866). Vernadsky and his circle of biologists, physicists, and others intensively studied Riemann's geometry and its application to physical space-time.

Supposedly, the standard description of what the handed molecule is, is a handed molecule floating in Euclidean space. And I've had discussions, we've gone to a number of these astrobiology events, talking to the people who are supposed to be the main workers in this area, and you'll find they all subscribe to this idea, that you cannot touch the nature of the space that things operate in. It is a Euclidean space with a handed molecule.

But Vernadsky goes deeper. He says, "Look, is there anything in a Euclidean space that can distinguish, fundamentally, between these hands?" And he assigns Lusin this investigation to figure it out. And they have a really wonderful dialogue back and forth. I won't go into all the details, but it involves them really hacking and slashing at everything that's known about Euclidean geometry and beyond, and concluding that there's not a way to make this distinction in Euclidean space—and again, I'm summarizing a lot of a very interesting discussion. We can have some more on it.

But then Lusin asks a friend of his, Finikov; he asks a number of mathematicians. They're all passing around Curie's book. And a friend of his relays back to Vernadsky, that well, no, in order to get to the phenomena that you're talking about, you're going to have to start looking at the works of Bernhard Riemann. And so you then begin to have a discussion, here, with Vernadsky, with a number of other thinkers, on the nature of Riemann's work.

They have a first-pass series of discussions, and you see this develop over time. It culminates in 1938, where Vernadsky holds a number of seminars at his house with these thinkers. At first, he initially asks Gause to come and just talk with him, and he gets the reply back that Gause will not meet in private with any professor, because there had been some bad blowback from the Soviets, due to people setting themselves up like that; he refused to set himself up in that way. But later on, Vernadsky was able to call together a larger meeting, including Gause, another histologist—essentially, it becomes two mathematicians (it sounds like we're setting up a joke!); two mathematicians, two physicists, and two biologists, and Vernadsky.

The biologists are experts in the handedness in living organisms: Gause and another thinker; two physicists, one an expert in relativity, and the other one an expert in spectrometry. And then the two mathematicians, Finikov, who is the expert in Riemannian geometry, and Lusin, who was the expert, who had this streak of requiring discontinuity, who said that continuity was the biggest problem you had in mathematics.

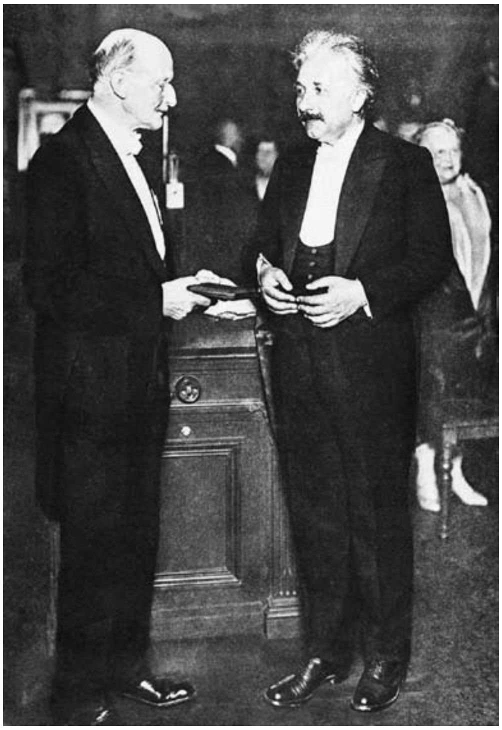
They have a number of discussions. Again, I'll just summarize: They conclude with Vernadsky's conclusion in 1938—what becomes the second in a series called "The Problems of Biogeochemistry," that living processes express a distinct physical space-time, and that that distinct physical space-time has to be of a Riemannian character. And again, there's a lot in this. There's a lot more to that, but then, in the course of discussing working on it, he's got a number of references where he's very, very explicit (and again, I'll make these available in an upcoming paper); but he's very explicit that the mind is capable of understanding this.

But in order to understand the actual character of the geometry that's characteristic of these living processes, it's necessary to embark on a more fundamental discussion of creativity per se. And you see a lot in his diary entries, of him discussing the fact that, likely, the model that we're going to need to look at, in order to examine, to look at the sort of space-time phenomena I want to look at here, is going to be the one you find in the compositions of Bach, Mozart, and Beethoven. There's quote after quote of him discussing that. This is in his private writings, not in the published ones, but you can see the direction his mind is going.

It's significant that he's doing this at the exact same time—this is almost exactly coincident with the time period, where you see Einstein coming to some of the same conclusions. He makes an explicit statement in a dialogue Einstein has with [Max] Planck, that some of the phenomena that are being run into in physics, the quantum phenomena, can only be addressed from the standpoint, he says, specifically, of a Bach fugue. So you start realizing this theme is coming up.

Trofim Lysenko (1898-1976), another Soviet science enforcer, who targetted the work of Gause. Here, Lysenko speaking at the Kremlin in 1935. At the back (from left) are Stanislav Kosior, Anastas Mikoyan, Andrei Andreev, and the Soviet leader, Joseph Stalin.

Remember that Vernadsky had started looking at Köhler's work on sight and sound, and realized that Köhler had been in a dialogue at that time and prior with Max Planck, whom Einstein was in his dialogue with, on exactly that theme, on the nature of the character of creativity, as it expressed itself in music and psychology, for physics.



Max Planck (1858-1947) and Albert Einstein (1879-1955), in Berlin, 1929, where Planck presented Albert Einstein with the Max Planck medal of the German Physical Society. Both scientists understood the intimate connection between music and science. Quantum phenomena, Einstein wrote Planck, can only be addressed from the standpoint of a Bach fugue.

Picking Up the Threads

I'm actually going to leave it at that point, because frankly, that's sort of the most honest thing that we could do here: Because things actually are left at that point right now. To give you an idea of where things stand, Vernadsky never finished founding the science that he wanted to found on that topic. There is an amazing body of work, and we want to assemble it so people can see what it is, but it was left unfinished. The threads that are required to be pursued there are very clear, though, on the investigation of creativity per se, and its expression in the anti-entropic nature of living processes. That that's going to have a very specific geometric characteristic that will be reflected in the space-time of the process.

All that is clear, but what's left to be done is going to require the work of people with the expertise in the right areas, with the right sense of the physical-scientific questions that are involved, but also, the sense that the resolution lies in the higher domain of Mind. It would have to be a group of people that somehow had an expertise in Classical artistic composition, maybe performed it often, maybe opened events with impressive performances. It would have to be that same group of people that would do these musical performances, that would also engage in their free time in profound scientific discussion. It would have to be a group of people which was interested in the exact same sorts of economic questions that Vernadsky was interested in, because you would have to be able to pursue a study of human activity in the large.

So it would require a very specific kind of grouping that you don't often find in history. That exact same grouping would be well situated to finally finish off, pick up the thread where it was left by Einstein and Planck, where they didn't get much further than the recognition that the whole approach quantum mechanics has taken to these questions is wrong, and the proper approach would have to be something that looked like something in the character of a Bach fugue.

Now, again, that was left undone. It's going to require a very specific grouping of people to be able to pursue that. I think people might get the idea. I'd like to propose that this is a task that we take up, and that we are well situated to take up amongst ourselves. And that, frankly, there's nobody else on the planet except for our association that's in the position to answer these questions.

Everything that came after has proven itself to be a dead end. The reductionist approach in biology has proven itself to be a dead end. The statistical approach in physics has proven itself to be a dead end. Not by coincidence, they're closely connected to the statistical approach, the fraud that's launched in economics, because it's the exact same problem expressed across the board, the same underlying ideological problem. And the resolution to all of these I think will be found at once. But that's a discussion that, hopefully, we'll be having over the course of the weekend, and in perpetuity, after this moment.

So, that's what I've got so far. We can pursue some more in discussion afterwards.

James Rea/EIRNS

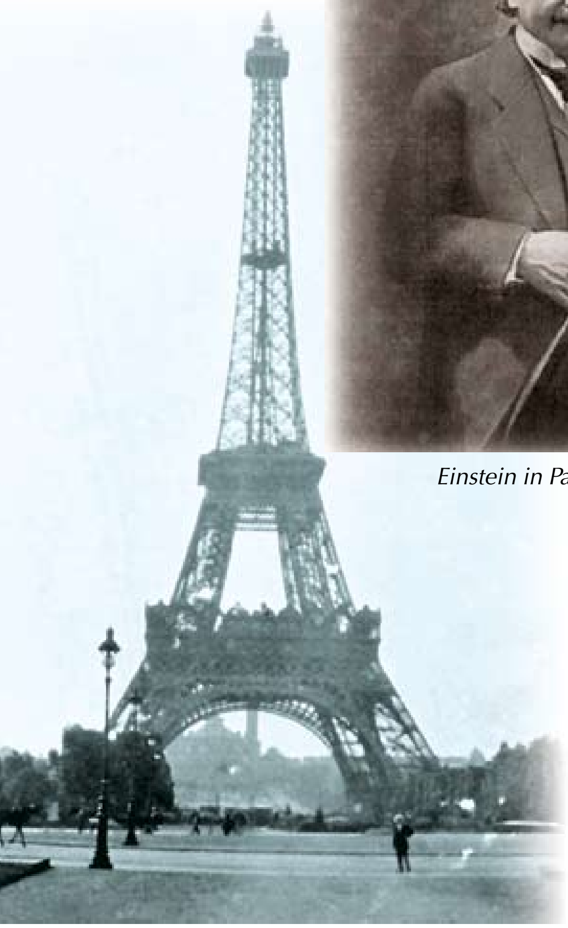
The Schiller Institute chorus performing at the Rüsselsheim conference in July, where Shields presented this speech. Shields challenged the audience to "pick up the thread where it was left by Einstein and Planck," away from the dead end of reductionism in biology, physics, and economics.

EINSTEIN IN PARIS

Einstein Presents And Discusses His Theory

by Charles Nordmann

Einstein in Paris, 1922.



The recent exposition by Einstein on his work, along with the discussions which followed at the Collège de France, was without doubt an unprecedented event. The famous physicist took part in it with inexhaustible patience. One felt in him the desire not to leave any misunderstandings in the shadows, not to ignore any of the objections, but, on the contrary, to provoke them in order to better tackle and wrestle with them squarely.

In the United States, in London, and in Italy where Einstein was successively received some months ago, he limited himself to explaining the Theory of Relativity in a conference format. In the United States and in London, he preferred to speak in German because of his imperfect knowledge of English; in Italy, he expressed himself in Italian, which permitted a more intimate contact with the audience. But in all of those countries he limited himself to a "non-contradictory" monologue—if I may borrow this incorrect but colorful expression from our political language.

In Paris, on the other hand, Einstein was not satisfied with speaking didactically *ex cathedra*. He resolutely launched into the controversy, replying publicly in what was to become a most celebrated series of discussions, taking on all objections and questions asked by some of the most eminent representatives of the scientific community.

I thought that it would be useful to give, for these historic joustings of thought, an image as exact as possible and from which, nevertheless, the too-esoteric language of the technicians would be exclud-

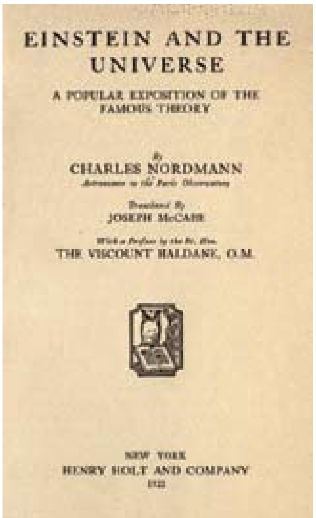
EDITOR'S NOTE

This is a translation by members of a LaRouche movement team of a 1922 article by Charles Nordmann describing several lectures by Albert Einstein during his visit to Paris that year. Nordmann's article, "Einstein Expose et Discute sa Théorie," appeared in Revue des Deux Mondes, *Vol. IX, pp. 129-166.*

Charles Nordmann (1881-1941) was an astronomer and physicist, whose research and publications were well known in the science community and in the public at large. He was a laureate of the French Academy of Sciences and a Knight of the Legion of Honor. One of his books, Einstein and the Universe: A Popular Exposition of a Famous Theory, *was translated and published in English in 1922 (New York: Henry Holt and Company).*

Nordmann published frequently on scientific topics in Revue des Deux Mondes *(Review of the Two Worlds), a French-language monthly cultural affairs magazine that has been published in Paris since 1829.*

A translator's note appears on p. 21. Numbered footnotes are from the original article, unless specified as a Translator's Note. Illustrations have been added, as have very occasional translations of foreign terms (in square brackets). Emphasis is from the original.



EINSTEIN AND THE UNIVERSE

A POPULAR EXPOSITION OF THE FAMOUS THEORY

By CHARLES NORDMANN
Astronomer to the Paris Observatory

Translated By JOSEPH McCABE

With a Preface by the Rt. Hon. THE VISCOUNT HALDANE, O.M.

NEW YORK
HENRY HOLT AND COMPANY
1922

Astronomer Charles Nordmann, with the title page from the book he wrote in 1922, the same year this article appeared.

ed. That is what guided me in the pages you will read. In times to come, some years from now, it is probable that the intellectual controversies, which Einstein's presence in Paris provoked, during this fresh spring of 1922, will have greatly surpassed in importance the affairs that present times have thrust upon us. I would wager that in a few centuries—and what is that in the astronomical or even simply biological time of the planet?—the recent discussion on relativity in the Collège de France will have marked off a new step forward on the road of human intelligence . . . while the Conference of Genoa [1922] will be long-forgotten, like so many useless past arguments, and some still to come in the future.

At the Collège de France, the fact that the sessions had the good fortune of reflecting a tight discussion, rather than didactic lectures, originated from a desire on the part of Einstein himself, a desire inspired in him by his modesty, or better said in his lack of confidence in himself.

In fact, here is what he wrote in a letter, a few days before he arrived in Paris:

> I will certainly have some difficulty expressing myself in French, but I think I'll be able to pull myself through, for example by reading a prepared text. Furthermore, formulas also help a lot,[1] and I hope a willing colleague will be good enough to utter and extract the words that would get stuck in my throat.
>
> It would perhaps be even more agreeable, and more useful if we were to have a sort of small congress on Relativity, in which I would only respond to questions. The difficulties of expression would annoy me less in this way than a more or less complete exposition of the theory.

As experience would have it, Einstein's fears were unfounded. At least for us they had been worth it, for these were the most passionate controversies one could possibly imagine, and they gave us hours of intellectual pleasure, as one too rarely has occasion to savor in the pedestrian monotony of this brief existence.

The merit of having brought success to these now famous sessions is not slight. It is due above all to Mr. Langevin, professor of experimental physics at the Collège de France, on whose request Einstein had been invited to Paris, as I have already mentioned. It is Mr. Langevin who oversaw the daily schedule of the small number of meetings, where so many subjects had to be covered. It was he who, with a firm and discrete hand managed to provoke the discussions, prevent the debate from leading astray, and restricted, whenever necessary but always with a well-chosen word, the exact positions of the adversaries. In rare but decisive moments, he also participated in the battle by helping the slightly wounded participants, or by giving the coup de grâce to those who were in such a desperate state that it was necessary to cut short their unnecessary suffering. Finally, it is he who played for Einstein the indispensable and difficult role that Einstein had asked for in his letter, the role of the intellectual Pylades, the informed cue-giver whose vocabulary and acute knowledge of the subject are never wanting.

The first session took place at the Collège de France, Friday

1. We must understand that Einstein speaks here of the language of mathematics which assuredly, with the aid of a blackboard, is the most international language . . . at least for the initiates, and the only one that dispenses with being multi-lingual.

The courtyard of the Collège de France, with a statue of Guillaume Budé, who was a contemporary of Erasmus and Thomas More.

A modern view of the auditorium where Einstein spoke at the Collège de France.

Translator's Note

Here, presented for the first time in English, is a firsthand account of Einstein's historic trip to Paris, after World War I. Not only is it of interest to the historian of science or researcher of international relations, but this snapshot from a turning point in time provides any thinker with an example of how a genuine idea can be presented and honestly discussed.

Being a social creature might not be exclusive to the human species, but coming to know personalities that are long dead, is definitely unique to us and is a very special tool in helping us live up to our uniqueness. Becoming friends with one of humanity's geniuses of the past provides a fun study in discovering an expression of the potential of mankind, and provides a clear example of what the nature of an individual man is, as opposed to a monkey.

I have specifically picked Einstein as my "buddy." As Einstein's future, we are able to reap the ideas and method that he sowed (if we bother to know him and our history), in order to provide a new platform of culture and ideas for our future. I hope that this peek into the past will help foster that for you.

In distilling the significance of the human individual's creative capability, you quickly realize the effect the interaction of the highest level of mind can have on the development of society at large; you see the grander impact a life can have on the world, rather than an existence of being consumed by the daily soap opera of personal situations that are inconsequential in the scheme of things (unless, of course, they help you develop your individual creativity to be an effective world citizen.)

Original sources are the only way to get a living sense of a debate. Not only the papers a person wrote, but his letters, lectures given by contemporaries on the topic, newspaper articles, and so on. These shadows of a process give you a chance to immerse yourself in an environment to appreciate and rediscover for yourself the cultural effect an idea has.

In search for such a context of Einstein's development of hypotheses, I reached a road-block in my research. The Princeton University Press had been putting out the collected works of Einstein, articles and letters, but at this point had only reached the year 1920-1921. Just when things start to get good! Einstein's theory of gravity had just been publicly validated and therefore popularized, he was plunging into General Relativity's implications on the shape of the universe and its interaction with other principles, such as electromagnetism.

In reading biographies of Einstein, the event they speak of as most important in these years—the early 1920s—is not some scientific paper being published, but Einstein's trip to Paris. One of the intended destructive effects of World War I was to cut off international intellectual relations. Einstein's trip would be the first step in mending French and German relations. This created quite a stir and many people were not happy on both sides.

With such an important instance in scientific and political history, I was surprised that I couldn't find Einstein's speeches from this conference, but only thirdhand short references to what was talked about. In contacting the Einstein archives, I was told that Einstein spoke informally, so there were no written notes from him personally, but the archivist gave me a date and the title of a journal for which a Charles Nordmann was commissioned to report on the event. I tracked it down and assembled a team to translate it from the French.

For more on the context of the political environment, please see Michel Biezunski's article "Einstein's Reception in Paris in 1922" in the book *The Comparative Reception of Relativity,** and an article by Nordmann in English on visiting battlefields with Einstein.** Both are priceless accounts that help you appreciate the actual struggle intellectuals went through to make humanity stronger through advancement in thought; and the fact that science cannot be separated from politics, and should take a leading role in culture.

Nordmann's article gives a good picture of the circle which existed, both as supporters and critics, around Einstein in the debate on The Relativity Theory. How refreshing it is to see how an idea can be honestly fought over, instead of simply deciding to agree to disagree, or deciding that anybody who dissents from the prevailing opinion is crazy. What's unusual in witnessing the back and forth, is that the opposition side is competent, for the most part, and is genuinely seeking the truth. This provides a foil to the lack of true scientific debate today in a Boomer era.

If you can become accustomed to the flowery descriptive nature of Nordmann's writing, you'll find this article useful, not only for the on-the-ground reporting in the middle of the development of Einstein's thoughts, but also because it provides a good overview of the fundamental principles on which Einstein's theory is based, and the many paradoxes that seem to come up according to common sense when faced with relativity. Also it presents a fair approximation for a layman of Einstein's basic method of approach.

For example, one thread that comes up repeatedly in the article is the subject of math. Nordmann, on behalf of Einstein, is sure to make the point that math is not useful in and of itself, and is out of reality, unless it is the servant of physics. Another continuous thread is the discussion of the metaphysical vs. positivism. It seems that Nordmann is sure to qualify both sides and imply that there's a balance needed; but from the work of Einstein and my coming to know his discovery process, it is clear that Einstein is simply above the mystic or the data collector, which comes up when Einstein discusses Ernst Mach.

As with all secondhand (or even firsthand) sources, the value comes from what you are able on your own to put together of the process of mind of the individual characters on stage, and what's pushing the overall drama as a whole, as opposed to having a perfect map of what was discussed when.

Therefore, I humbly submit to you this translation.

—Shawna Halevy

Footnotes

* Michel Biezunski on Einstein's reception in Paris, 1922.

** Charles Nordmann on visiting battlefields with Einstein.

March 31st at 5 p.m., in this Amphitheatre VIII which, even though it is the largest room of our fine institution, is nonetheless ridiculously small. Long before this session began, the fortunately privileged crowd that was admitted to this unique event had filled all of the seats and was spilling over into the narrow passageways of this all-too-modest room where Einstein was going to speak. And all those who were in attendance had to agree on the certainty of at least one thing, that, at least for this place, the non-existence of space was quite certain. There were students, professors, scientists, all the elite of French science and of French culture, all the great names which honor this country. From the density of attendees, one might believe oneself to be at a famous session, where recently the idolizing public would be flocking to a lesson of a Caro or a Bergson. But in regarding the crowd a little more closely, the comparison is not quite justified. There were truly very few famous actresses or high-society ladies, in this gathering of dignitaries whose compressibility was put to such harsh trial. Here again, Mr. Langevin's extreme honesty was manifested. To the extent that we had been generous in the distribution of tickets to people in science and research, even to young students whose attendance was considered legitimate, in the same degree, we were merciless in rejecting all who could represent snobbery, ham actors, or simple idle curiosity. Also, all things considered, I'm not quite sure one could have been able to enumerate among this center of tasteful intellectuals a half dozen of truly elegant women. Within the decaying walls of this jewel box, where the purest diamonds of the mind were about to reveal their luster, not even an ingenious thief would have been able to steal sufficient jewels to merit the least newsworthy comment for the newspapers.

This was also very much in harmony with the tastes of Einstein.

But, all of a sudden, on the lower platform of the amphitheatre where a little desk surrounded by some chairs is arranged, here comes Einstein accompanied by Mr. Maurice Croiset, administrator of the Collège of France, and Mr. Langevin, followed by the professors of the Collège. The whole room rose to its feet in one movement and greeted the wise one with a terrific acclamation. Einstein seemed moved and anxious. In some perfectly succinct and chosen words, Mr. Maurice Croiset welcomed him and told him how proud the Collège was to have him here. What Mr. Croiset does not say, but which all the idealists of the country are thankful for, is the role that he personally played, and not without courage, in bringing Einstein to this venerable house, and which showed itself, one more time, to be deserving of its high, and free tradition.

In a few phrases, Einstein, standing the whole time, thanks us with his soft and singing voice, initially not very confident-sounding. In a cautious manner, he remarks that his presence in this place is the happy sign that science is no longer threatened by politics. Then, he sits down: The respectful room, which was also standing, does the same. Immediately, and without transition,—Einstein has no taste for oratory—he begins to speak to us about the Theory of Relativity.

His diction is slow. You feel that the words are not going fast enough to follow the rapidly advancing and well-ordered troops of his ideas. The voice is caressing, and of a rather low and vibrant tone. Henri Poincaré had also an extremely low voice,

Albert Einstein and Prof. Paul Langevin in 1922.

but its tone was still lower than that of Einstein. Einstein doesn't ignore any of the nuances of our language which he pronounces with a slight accent. He says "les ékations," "la rélativité," "la kinématique."[2] While he speaks, his eyes, with very inclined eyebrows above the eye-sockets, converging upon an "accent circonflex" [^] towards the middle of the forehead, seem directed very far away, much farther than the ardent looks of the public for whom he had become the geometric center. Those eyes, which they contemplate, are the serene regions where the mind of the scientist synthesizes the marvels of matter and energy. This ideal contemplation is not at all that of a dream: that which he scrutinizes are lively realities, which are impressionable things; because, for Einstein—and he will not stop insisting on these ideas which separate him from certain contemporaries of his—the mathematical abstraction is not at all some winged thing used to lead the mind wildly astray, it is and does not need to be other than, the humble servant of things, such as they exist in reality. From time to time, he leans towards Mr. Langevin who is seated to his left and a little bit set back, to get the necessary word, the French word which he is having difficulty, following his own expression, in "extracting from his throat."

Sometimes, it's an English word that comes to his lips, and I hear him murmuring "assumption" while Mr. Langevin softly whispers "hypothesis." But these short pauses, which sometimes slow down his delivery, are not disagreeable, because they give the audience member time to better piece together the reasoning; whose extraordinarily dense succession of arguments makes this presentation the richest melting pot of ideas that can be imagined. And then, as if to lighten the heavy ideas of his presentation, each time that the desired word doesn't

2. [Translator's note] This may not be clear to non-French speakers. The actual French spellings of these words, with accents, are *les équations, la relativité, la cinématique*. It would be as if a German speaker said in English "He sait dat fery vell."


L'ILLUSTRATION

One of the many articles in the popular press reporting on Einstein's visit to France. L'Illustration *also covered Einstein's 1922 visit to a French village near Dormans (above), which had been destroyed in World War I.*

come easily, Einstein smiles, while waiting for Mr. Langevin to deliver to him the desired term. And this smile that was so well captured by the artist Choumoff, has something extremely seductive to it. It seems to me that it has something of a courteous reluctance, like a prayer to not become angry at these small, purely philological hesitations.

Moreover, Einstein speaks without any notes, with his sight aimed high. His usual gesture is to slowly raise his two hands with the thumb and index finger touching softly as if he were extending and slackening successively an invisible thread, the supple and silky thread for the demonstration.

In this first meeting, Einstein declared at the beginning his desire to limit himself to a sort of general exposition of the principle of relativity, or rather of the method employed in the elaboration of the theory. The following meetings, he added right away, will be entirely set aside for discussion.

To tell you the truth, ever since this initial meeting, Einstein had, by his own presentation, launched the controversy and debated with the sharpest precision some of the criticisms which were leveled at him, and some of the misunderstandings that the controversy had created around the new doctrine.

I would not be able, here, to follow Einstein step by step in his presentation, which lasted two hours. It would take me several hundred pages to translate it entirely into a language where the technical expressions would be made accessible to the non-specialized reader, since the words and the phrases with which we can express these things unfortunately don't have any of the dense and concise brevity of mathematical formulas. That which can be said in five minutes, when we can talk freely of coordinate axes, quadratic forms, geodesics, and transformation formulas, would require much more time to express when we have to first translate these esoteric terms into ordinary language. In his purely didactic part, the presentation of Einstein had moreover simply consisted in recalling the essential bases of his theory, and the notions already known by those who do me the honor of reading my own writings.[3] This leaves out the specifically critical and methodological part of the presentation which gives it its originality, and of which I now propose to express, in the simplest way possible, the profound interest and convincing conclusions.

The theory of Einstein is generated from problems that come from "experimentation." It is based on facts, and its author insists with much vigor on this point which has often been misunderstood. It is completely the opposite of a metaphysical system—and my readers remember that I have already developed this idea at length.

What are, therefore, the facts on which the new theory was built, and which seemed, in some way, to compel its acceptance? The point is this: There is, in classical science, or in the study of mechanics, which was laid out by Galileo and Newton, a principle which is called the "principle of relativity," which comes more or less to the following: In the interior of a material system, we cannot in any way show its motion, via experiments done within a vehicle in uniform translation. For example, in a train moving uniformly, (and not taking into account the vibrations, which are precisely alterations in the uniformity of the motion) we cannot by any known process show the reality and the magnitude of the motion. When two trains pass one another (not taking into consideration these alterations), the passengers cannot know which is actually in motion, that is to say, each one believes that it is the other one which is in motion. All classical mechanics, all traditional science, is founded upon this very simple principle. It has been verified throughout centuries. Not only is it the result of facts, but it has in it a *je ne sais quoi* of evidence which satisfies the course of our reason. The latter in fact, repudiates the idea that there could exist in nature, among all uniform motions, that is to say among similar motions, some which could be real motions, that would exclude other ones.

The good intuitive sense and the facts combined, have therefore come to agreement in cementing on solid foundations the classical principle of relativity, as far as uniform motions are concerned. But, note that since the 19th Century, another edifice was erected in science, which is not concerned with the displacements of material bodies, but rather with the subtle motions of light and electricity. On the other side of mechanics was erected electromagnetism which not only combines in a superb *theoretical* synthesis, optics and electricity, but which has led to magnificent *experimentally* verifiable predictions; among the most beautiful are the discovery of the wireless telegraph and the proof that Hertzian waves travel at

3. I may be permitted here to refer my readers to the articles where I have explained the experimental and theoretical foundations of the Special Theory of Relativity, and, for General Relativity, I refer the reader to my recent little book *Einstein and the Universe*, where the conclusions are found to be (as one would judge) entirely in agreement with those found in the controversies which provide the occasion for the present article.

the speed of light.

Electromagnetism reestablishes as a foundation this principle that the speed of light is constant in every direction.

But, observe that certain recent *facts,* certain experiments were shown to be incompatible, either with electromagnetism, or classical mechanics, or better still, with the two principles which serve as foundations respectively for these two disciplines, which are the principle of relativity and the principle of the constancy of the speed of light. The experiment of Michelson, among others, appeared to be leading to the necessity of abandoning either one or the other of these principles. This is when Einstein, through a profound analysis of the notions serving as foundations for classical mechanics, showed that this is deduced rigorously from the principle of relativity only if we allow for certain hypothetical entities which we call absolute space and absolute time.

French physicist Paul Langevin (1872-1946) worked closely with Einstein in science and politics.

If we eliminate these two hypotheses and if we define time and space, that is to say, extensions and durations as we observe them, by taking into account the non-instantaneous propagation of light, we then elaborate a new science of mechanics, the mechanics of Einstein, which is founded, like the classical one, on the principle of relativity, but which constitutes an application of this principle that is extricated from metaphysical hypotheses and from the *a priori* notions of absolute space and absolute time.

In a word, Einstein maintains the two principles that have been tested experimentally and which are at the basis of classical mechanics and electromagnetism. Solely by application of these classical principles, but which he purifies of their metaphysical refuse, he constructs a new science of mechanics without any special assumption. Then, it turns out: 1. that Einstein's science of mechanics accounts for both the facts explained by the old science of mechanics as well as this new one; 2. that it immediately solves the incompatibilities that the Michelson experiment had shown between mechanics and optics; 3. that it explains and predicts a number of phenomena, of *facts* pertaining to electrons and which escape the grasp of classical mechanics; that it accounts for certain old results that represented enigmas for traditional science, such as the Fizeau experiment.

As my readers will remember, I have explained all of this extensively in this review. I will, therefore, only retain this: The ontogenetic examination that we have just made of this theoretical body called Special Relativity proves clearly that this first aspect of Einstein's work *has been elaborated on the basis of data given by experimentation.*

The Theory of Relativity accounts for all of the results of the traditional doctrine and only differs from it by the fact that it has eliminated from it all remaining metaphysical residues. No one will dispute that this makes it a superior science. There is nothing in science but that which can be measured, and it is surely better to base science on this, than on that which cannot be measured.

Therefore, when the newspapers announced, with a touching tone of unanimity, the arrival in Paris of the celebrated *metaphysician* Einstein, they were certainly delivering the most falsified of all possible inexact news that ever came out of the whining printing presses. Obviously we are all more or less metaphysicians, starting with the housewife who is concerned about what she will feed her husband for supper tonight because she makes the assumption that her husband exists, and therefore, she is making a daring metaphysical assumption from beyond the outside world. However, this being the case, we can ascertain that Einstein is truly the least metaphysician of all physicists. His merit and the cause for scandal to the misoneists comes precisely from the fact that he has, better than anyone before him, de-metaphysicized the domain of science.

One of his constant preoccupations is to make clearly understood his particular concern in this respect. In his presentation of March 31st, and with the finesse-filled implications that characterize him, he explained this point extensively by addressing a particular species of metaphysicians known as mathematicians, that is, the pure mathematicians who, lost in their abstract dreams and carried on the powerful wing of their imaginations toward some unreal beauties, never put their foot down on the rigid soil *of what exists*.

Einstein certainly does not hold mathematicians in contempt. Without their collaboration, he probably would not have been able to bring his work to fruition. It is the absolute differential calculus of Ricci, the equations of Levi-Civitta and of Christof-

For a further explanation of Einstein's mechanics, see the video "The Genius of Albert Einstein."

Nimitz Library, U.S. Naval Academy, Special Collections and Archives

Physicist Albert Michelson (1852-1931).

fel, and the geometries of Gauss and Riemann which, when used judiciously, allowed him to complete his work. But, he refuses to consider that calculating is anything else but an instrument, that is, merely a bridge between his experimental premises and the lawful conclusions of experimentation. He wants mathematics to be the servant of the facts. Always and above all, he is preoccupied with the physical significance of mathematical symbols. Those who have seen in the Relativity Theory merely the mathematical apparatus, are like the passers-by who would mistake Trinity Church for the gigantic scaffolding that hides its harmonic lines, and which might otherwise even somewhat contribute to its strength.

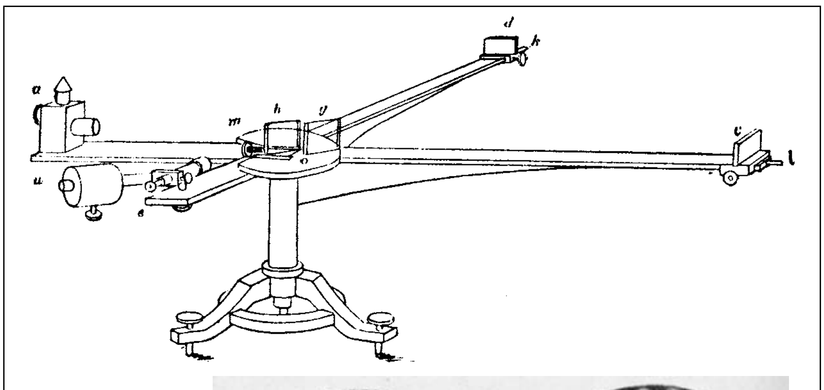
This is one of the most frequent misunderstandings that has arisen between those who consider the Einstein theory as a purely physical theory, and there are a few of us who for a long time have held that point of view, and a number of those who are his mathematical adversaries.

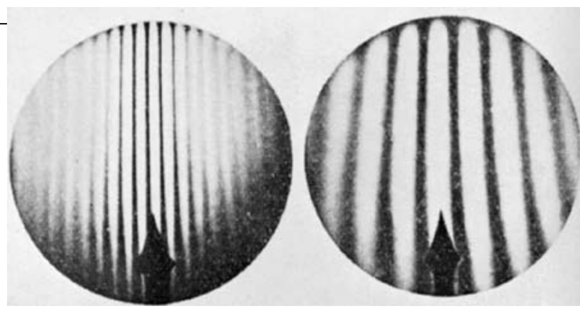
Einstein stood up with force against the often-expressed opinion that the Theory of Relativity is nothing but a purely formal construction. It is a physical theory, a theory of the outside world, a theory of the phenomena, of the events occurring in the universe. He said the following in his own words:

> Many mathematicians do not understand the Theory of Relativity although they may apprehend its analytical developments. They are wrong in seeing simply formal relations and of not meditating on the physical realities to which correspond the mathematical symbols in use.

Here is an example which, I think, will help us understand this conception. If a man who has learned nothing else but mathematics were to live his entire life inside of a closed room, he would be perfectly capable of reading and understanding the logical sequence of the formulas of a treaty of celestial mechanics. But, he would otherwise understand nothing of the celestial mechanics, because he would fail to understand that these formulas apply to the relative motions of real external objects that we call the stars. It is to this sort of man—due allow-

Figure 1
FIRST MICHELSON-MORLEY INTERFEROMETER (1881)

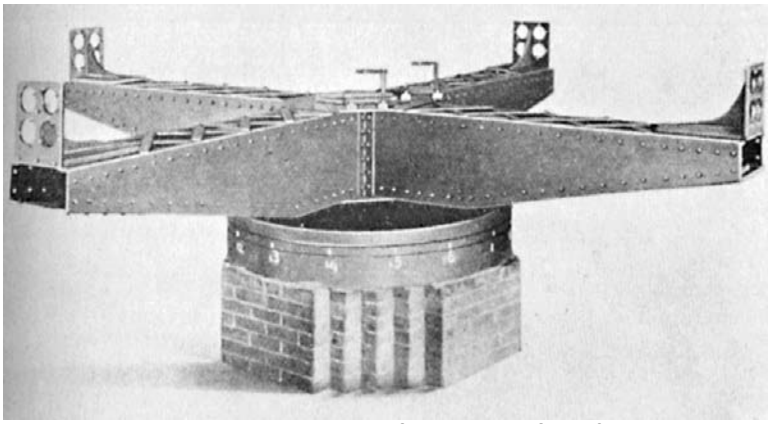




A. A. Michelson's instrument, constructed in Berlin in 1881, for detecting the relative motion of the Earth through the presumed stationary ether. The two perpendicular arms are rotated so that one points in the direction of the Earth's rotation. Half-silvered mirrors at the center create equal path lengths for the light ray in the two orthogonal directions. It is expected that the light ray moving against the ether stream will take slightly longer than the ray which traverses the other perpendicular arm. This will be evident as a shift in the fringe pattern in the interferometer positioned at e.

Inset shows the fringe patterns in narrow and broad magnification from a later interferometer.

Sources: A.A. Michelson, 1881 "The Relative Motion of the Earth and the Luminiferous Ether," *Am. J. Sci.*, Vol. 3, No. 22, pp. 122, 124. D.C. Miller, 1933, "The Ether-Drift and the Determination of the Absolute Motion of the Earth," *Rev. Modern Phys.*, Vol. 5, p. 211 (July).



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The Michelson-Morley experiment of 1887, set up in the basement of Adelbert Hall, Western Reserve University. Results were smaller than expected, though not completely null—an enigma to this day.

(For more on this topic, see "Optical Theory in the 19th Century and the Truth about Michelson-Morley-Miller," by Laurence Hecht, 21st Century, *Spring 1998.)*

ance being respectfully made to save their reverence—that Einstein will tend to compare those individuals who criticize his theories without having studied deeply enough their physical content.

Well then, the physical content, which is the basis for the entire Theory of Relativity, is the existence and the invariance of a quantity measurable with rulers and clocks, a quantity that we call the interval between things and which is neither their distance in time, nor their distance in space, but—my readers will remember—a sort of conglomeration between space and time.

The entire Einstein synthesis is founded on the belief of the real existence of this physical concept. If this concept does not exist—and this is conditional on experimentation and on the instruments of the physicist—the entire theory becomes nothing more than a play of mathematical formulas and vanishes. But, Einstein seems to be untroubled in this regard and we have to recognize that his tranquility is buttressed by solid demonstrations. Aside from all the verifications of classical mechanics that also verify Einstein's mechanics, it is the admirable *experimental* verifications of physical discoveries (distortion of light by gravitation explaining the anomaly of the planet Mercury) that have led to the new theory.

As he was speaking on these things, and because of his imperfect mastery of the French language, Einstein had a few verbal hesitations and he treated us to some inspiring flavorful neologisms. For instance, when speaking about classical mechanics, which differs from his own as does the static chrysalis from the fast moving butterfly, Einstein came up with the new expression of " 'antique' mechanics." I asked myself if the use of this improper qualification did not mask a little bit of deliberate irony.

It is not only Special Relativity which is based on the necessity of resolving problems posed by experimentation; it is also the case for General Relativity, which represents the admirable crown of his theory. In particular, almost the entire synthesis was triggered by the following fact that classical science had noticed, but was incapable of explaining, and in which Newton had only seen a coincidence: The numbers which express the weights of different bodies (that is to say, their reaction to gravity) are identical to those that express their inertia (that is to say, their reaction to some mechanical displacement). When we find similar types of identities in nature, such singular facts, it is natural that we seek to elucidate the matter differently than by simply saying that it is an unbelievable and fortuitous coincidence. That was nonetheless what Newton resigned himself to accept. This is something that Einstein was not resigned to accept at all, and his stunning penetration found the solution to the enigma in the theory of General Relativity, which brought together into a grandiose and unique synthesis these two domains of gravitation and mechanics between which classical science had erected an unjustifiable barrier. The *facts,* and nothing but the *facts,* are at the origin of Einstein's doctrine.

Again, it was by meditating more profoundly on perceived *realities* and on the experimental foundation of geometry which was carried out before him, that Einstein

French physicist Hippolyte Fizeau (1819-1896)

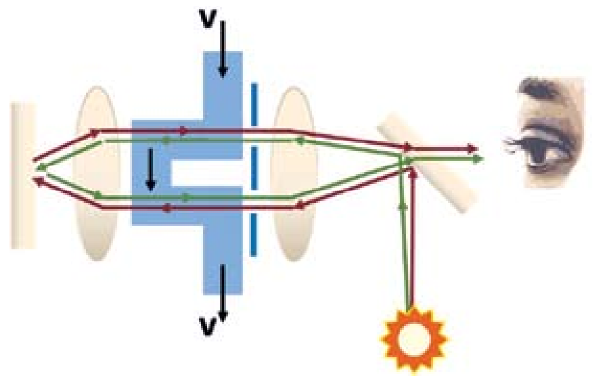


Figure 2
SCHEMATIC OF A FIZEAU INTERFEROMETER
Fizeau used his interferometer to measure the effect of movement of a medium upon the speed of light. He passed light in two directions through moving water, and measured the interference pattern. Both beams travel the same distance, but one goes in the direction of the water flow and the other goes in the direction opposing the flow. An interference pattern is formed (caused by the time differences of the beams) when the two beams are recombined at the detector.

Henri-Louis Bergson (1859-1941) in a portrait painted by J.E. Blanche in 1891.

Emile Roux (1853-1933) was a French physician, bacteriologist, and immunologist who collaborated closely with Louis Pasteur.

Polish-French physicist and chemist Marie Sklodowska Curie (1867-1934), in a photo taken around 1920.

arrived at the conclusion that the world in which we live is barely approximated by Euclidean geometry. This conclusion has also been confirmed by the *facts*: such as the bending of light rays by a massive body, etc. I have already explained these things, and I want to stress only this: The Theory of Relativity starts from sense-perception realities in order to lead to other sense-perception realities. Mathematics, however considerable its importance, its logical rigor, and its unique mode of expressions may be, only plays a role that is analogous to that of transmission belts in machine-tools. That is the reason why Einstein never stopped riveting himself to the real world, to the data. Better than Newton himself, he has applied the *hypotheses non fingo*.

The Theory of Relativity is the most profound and the most successful of all attempts by the human mind to ban from science what is not measurable, and to chase out of physics all that is metaphysical.

Such was the impression made upon us by Einstein on March 31st after he had ended with a few cosmological considerations, on which I shall return later. He made a penetrating exposé divested of any pretense, whose sole eloquence streamed from facts and from reason. Then, the great physicist stood up in the midst of applause.

* * *

The first discussion session took place on April 3rd in the physics amphitheater of the Collège de France, which is even more cramped than the "large" amphitheater in which Einstein spoke the previous Friday. The audience was composed almost exclusively of scientists, of philosophers, of researchers—and in the first among their ranks was Doctor Roux, his pale ascetic face capped with his small traditional skullcap, Mr. Bergson, Mme. Curie, and a great many members of the Academy of Sciences.

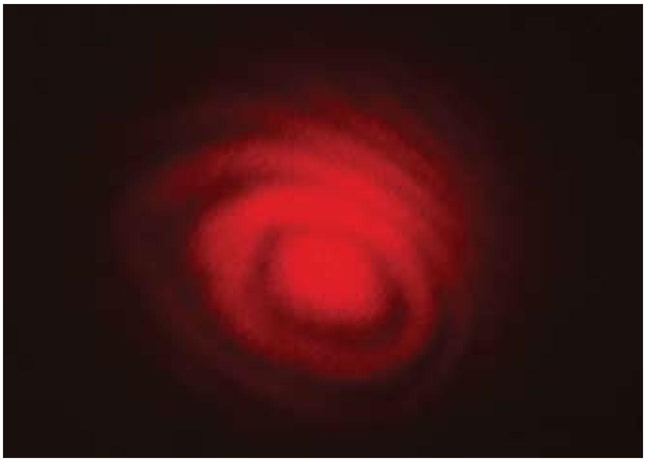
The session was to be dedicated exclusively to questions raised by the Special Theory of Relativity. Einstein was seated next to Mr. Langevin in front of a small table, to the side of a gigantic blackboard which would soon reveal the dialectical passion of the players.

The first question was on the Michelson experiment. My readers have not forgotten that, according to the Special Theory of Relativity, the length of a given object and the time separating two events are characterized by quantities which vary with speed, and which vary in such a way that the lengths and the durations (expressed in seconds) are shorter for a given observer when the objects under consideration move very quickly with regard to the observer. As far as lengths are concerned, I have even given an elementary explanation here. As for the times, an analogous explanation can be produced; but during this presentation, Einstein gave another demonstration of this fact, which was so simple that I simply cannot restrain myself from reporting it here.

It is known that light plays a fundamental role in the regulation of timepieces and the very definition of time; that there is no better definition for the duration of one second than the time necessary for light to traverse 300,000 kilometers, and that it is light or electricity (which has an equal speed) which are the practical agents for the synchronization of clocks. Let us therefore assume that the identity of time be defined by the time taken by a light ray to make a round trip along the distance between two parallel mirrors upon which the ray reflects normally. This going and coming of the ray situated between the two mirrors is an example of the type of periodic phenomenon by which time is measured out. It would, for example, define a three-hundred-millionth of a second, if the distance between the two mirrors is 50 centimeters. Such would be the value of the duration as considered by an observer situated between the two mirrors.

Now let us assume that the system containing the two mirrors passes before me at a very great speed, carried by a rapid translation, parallel to the two mirrors. I, who see it pass by, remark that the light ray, which leaves the center of the first mirror, must, in order to run to the center of the second, and from there back to the first, traverse a path slightly inclined in the direction of the translation and not normal to the mirrors. It follows that this trajectory, which defines the unit of time for the observer connected to the mirrors, defines for immobile me a time longer than my own unit of time. In other words, the durations of phenomena, the ticking of clocks, like all the gestures made in a vehicle in very rapid movement, will appear to be slowed down, and consequently appear prolonged to an observer in motion, and *vice versa*. Q.E.D.

In the course of his explanations, Einstein was led to specify that although the apparent contractions of objects by speed is deduced directly from the Michelson experiment by the theory, the apparent slowing of time follows from this experiment only indirectly. Experiments will perhaps someday permit time-contraction to be deduced from the observations of positive



The interference pattern produced with a Michelson interferometer using a red laser.

rays [ions] or from the observation of the eclipses of Jupiter's satellites. But the precision of astronomical observations seems insufficient at the present time to establish the latter.

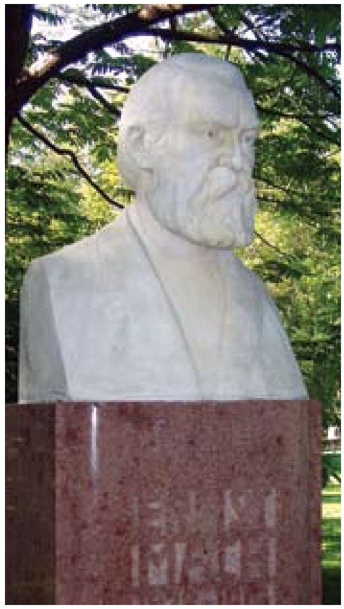
The principle and most certain demonstration of time-contraction caused by speed is found, as for distance-contraction, in the many indirect yet mutually agreeing verifications, which constitute the applications of this notion to the new mechanics and the verifiable consequences that it entails.

In regards to the Michelson experiment, Einstein has since recounted to me, that the famous American physicist told him one day: " 'If I had been able to foresee all the results that have since been derived from my experiment, I tend to believe I would never have performed it.' " It is incidentally something rather singular and very interesting from a historical point of view to consider this attitude of the principal precursors of Relativity when presented with the theory of Einstein. During the course of a recent conversation, Einstein gave me some curious clarifications on this subject, the essential elements of which I find useful to summarize for the reader here.

French mathematician, physicist, engineer, and philosopher Henri Poincaré (1854-1912).

Henri Poincaré has died, and it certainly would have been a profoundly moving thing to see Einstein discuss with this powerful mind, who had on so many points shown the way. Would he have been a partisan of the General Theory of Relativity? It is probable, but not absolutely certain. Studying the many famous pages on the origins and foundations of geometry, Henri Poincaré had arrived at the conclusion that, if it is not more ideally true than the others, Euclidean geometry is that which corresponds to the nature of the external world and to our sensations. On this point Einstein made a clean break with the ideas of Poincaré, starting from the day he forecast the curving of rays of light by gravity, which was recently verified, as we know, and as Poincaré had not imagined.

That is the keystone of all Relativity, the central point from which Einstein was able to deduce that the real geometry of the world is indeed a non-Euclidean geometry. It is quite difficult to know what Poincaré would have thought about this. Surely under this form or perhaps another, he would have been, in keeping with his own ideas, a full relativist; and he would certainly have accepted with total sympathy anything which would have permitted him to live without these mystical creatures which he found singularly repulsive: the notions of absolute space and of absolute time of Newton.

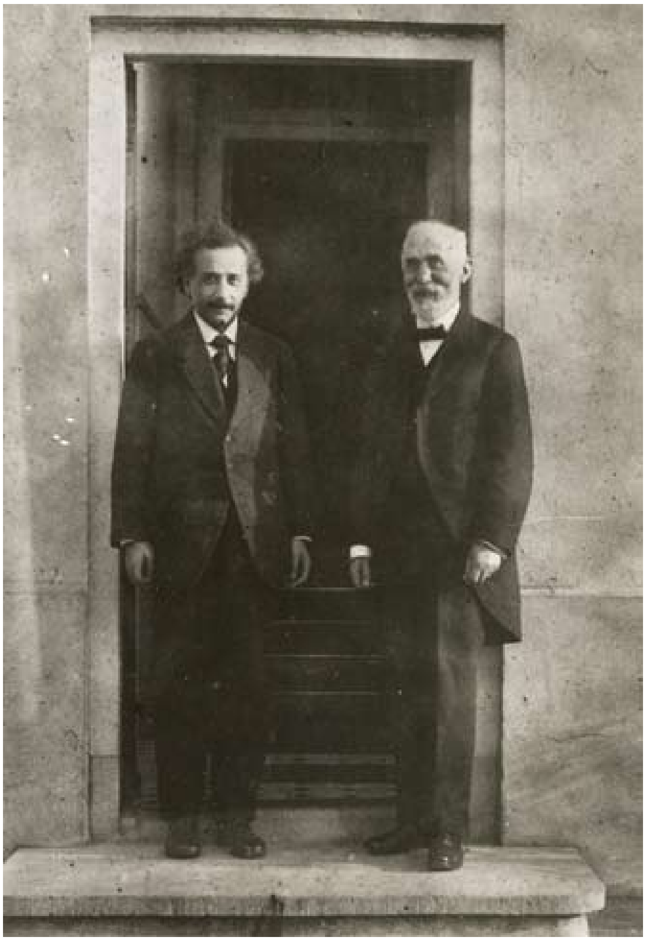


This bust of the Viennese physicist and positivist Ernst Mach (1838-1916), sculpted by Heinz Peter, stands in the City Hall Park of Vienna.

Perhaps even more than Poincaré, Einstein admits having been influenced by the famous Viennese physicist Mach (who had first discovered and studied the shock wave that rapid projectiles produce in the atmosphere.) Mach formerly strove to reduce all of mechanics to observable phenomena, all motions to material references and supports. Although he was not able to bring his ideas to maturity due to his lack of mathematical and philosophical tools, they are in complete harmony with the very principles of Einstein. However, just before his recent death, Mach declared his hostility toward the General Theory of Relativity. "But it is because he was old," Einstein told me, smiling.

As for Lorentz, who is incontestably the most certain precursor of Einstein, it appears that he admits the foundation of General Relativity, while at the same time refusing to accept the principles which established the basis of Special Relativity. However illogical this attitude may seem to be, it is not shocking if one recalls that Lorentz always defended the thesis of the absolute and immobile ether, and the actual speed-contraction of bodies. His overall attitude regarding Relativity is, as one could judge, similar enough to that of Mr. Painlevé. But, as of now, it is important to note that to admit General Relativity is the same as admitting the essentials and majority of Special Relativity, since the former was only created by Einstein to remedy the shortcomings of the latter; which today, moreover, it subsumes in a more general synthesis. If you take the greater, you get the smaller as well.

The conclusion of this first controversial session, and the beginning of the following session (which took place on April 5th), were almost entirely taken up by a passionate discussion provoked by Mr. Painlevé, who, to the delight of his friends, had



Museum Boerhaave, Leiden

Dutch physicist Hendrik Antoon Lorentz (1853-1928) photographed with Einstein in Leiden in 1921.

abandoned politics for a few hours. This discussion greatly contributed in definitely clarifying one of the most delicate points of the Theory of Special Relativity.

This animated and always courteous discussion was a most curious and interesting spectacle to watch in its perfect objectivity. In truth, Mr. Painlevé never ceased to publicly praise, on all occasions, his admiration for Einstein's genius. It was within a few weeks that a position of corresponding membership for the Mechanics Department had become vacant at the Academy of Science, and for which a few voices called for Einstein, who was neither a candidate, nor even presented himself. Mr. Painlevé was pleased to declare that his voice was among them. It was at this occasion that a highly esteemed member of the Academy proclaimed these delicious words: "How can you nominate Einstein as a member of the Department of Mechanics when it is Einstein, himself, who has destroyed the science of mechanics?" If it is true that all progress, all change, constitutes, in some way, a destruction of that which is modified, it is a natural tendency for many men to consider this destruction as necessarily bad. The same thing occurred when the Copernican system *destroyed* the Ptolemaic system, when Lavoisier's chemistry *destroyed* the old doctrine of Phlogiston. But it is, alas, the very nature of life's progress that it only grows and thrives upon destruction. The butterfly doesn't leave its cocoon; the bird doesn't hatch from the egg without destruction. Man doesn't become an adult without the death of that which made him a child. No flower would blossom that didn't first rupture the fragile envelope of its bulb. This is also the history of the Einstein doctrine. Unless you wish to see the universe seized within a monstrous lethargy, and ideas crystallized forever into rigid forms, whose immobility would be the equivalent of death, one must be resigned to accept, especially with science, that the only *raison d'être* is to strive always further.

French mathematician and Prime Minister Paul Painlevé (1863-1933).

Thus, Mr. Painlevé never ceased to praise Einstein as one of the greatest geniuses human history had ever seen. I know, that for his part, Einstein professed the most sincere admiration for the work of this famous French geometer. In these circumstances, the atmosphere in which the conversation between these two scientists opened, was infinitely propitious to the happy shocks that confronted and animated these sincere intellects and from which more light was shed.

Nothing was more amusing than seeing Einstein and Mr. Painlevé side by side in front of the blackboard: the first always calm, armed with the soft patience which comes with absolute security; the second, impetuous and lively, boiling with the effervescence of ideas and arguments; the first immobile, the second never remaining in one place and always going back and forth within the narrow arena in front of the board. Einstein was pale and his attitude and manner of speaking seemed to resemble the inflexible solidity of an immovable rock, resisting over centuries the forces of erosion; Painlevé was all flushed by the flux of his boiling blood, passionate in his gestures and arguments, attacking with the sudden outbursts of unpredictable and brilliant fits and starts that we usually witness in assaults against old and shaky things, with the idea of turning accepted order upside down.

Just by judging the appearance of these two men, who, armed each with a piece of chalk, covered the vast blackboard with battalions of their opposed equations, it truly seemed as though it were Einstein, who was the conservative, and Mr. Painlevé, the "revolutionary." And yet, oddly enough, the opposite was true. It was the first who had completely overturned the entire edifice of the traditional structure, where the human spirit had dozed with a false sense of security, whereby the second acted as a rampart in front of the fortress of Newtonian science that was under attack.

The discussion was focussed on an important point about the Theory of Special Relativity. It ended—as we shall see—with a complete agreement between the two challengers, and served to completely eliminate a misunderstanding which this first level of the Einstein monument could have born in some minds.

Here is how, I believe we can present, without the use of a single formula and without any esoteric calculation, the question that was raised and the response that was given to it:

We know, as I have explained in the past, that because of the particular propagation of light, there exists no universal or absolute time, and that the workings of two identical clocks would not appear identical to an observer attached to one of these clocks, and who sees the other passing by him at a very fast speed. As I showed earlier, the clock which is not moving with respect to me seems to go faster than that one which was moving speedily by me. In a general manner, the duration of events, such as the vibrations of a diapason, the beats of a heart or all other given phenomena, will appear shorter, more hurried, to a non-moving observer of these phenomena, than to an observer, in front of whom the vehicle on which those phenomenon are located, passes by quickly. For this last observer, these phenomena will appear to be slower. In a word, for a given observer, each vehicle in motion in space has its own particular time, its particular speed in which flow the phenomena. This time, this duration of a given phenomena (e.g., the burning of a cigarette), would seem always greater, when the phenomena are moving at a greater speed, in relation to me. Consequently, this time, this duration, has for me, its smallest value, when the speed is null, that is to say when I am attached to the vehicle in which the observed phenomenon is occurring. This minimum value of time, we shall call the *proper time* of the vehicle, and this expression is legitimate since it designates the time indicated by the proper clocks which are in the vehicle.

Further explanation of Einstein's clock on the moving train appears in the video "The Genius of Albert Einstein .

All of this is the necessary consequence of the stated laws of the propagation of light, and constitutes one of the foundations of the Theory of Special Relativity.

This said, we have here, reduced to its essential elements, the question raised by Mr. Painlevé and which at first sight, seemed to drive toward a contradiction, a paradox.

Consider a rapid train which passes through a station at full speed and continues its route with the same prodigious and uniform speed. This train has within it an identical clock to the one which is in the station. At the precise moment when it passes the station, the conductor of the train, who we may suppose (harmless hypotheses cost so little) is a skillful physicist equipped with all of the perfections of technique, who had managed to set the train's clock in sync with the station's clock at the instant that he saw this clock passing, that is, by the intermediation of light rays.

After having run the train for as many kilometers as we wish at the same prodigious and uniform speed, with his clock thus regulated, Mr. Painlevé supposed that the train suddenly stopped, and, suddenly, ran backwards, that is to say, returned towards the station, always with the same speed, but now driven in reverse. Now, we can calculate in these conditions (knowing the number of kilometers traversed by the train) the exact time marked on the clock [on the train] as it re-passes the station and the exact time marked off on the station's clock. In making this calculation, we find that at the precise instant when the train re-passes through the station, the clock in the train marked a shorter time than the station's clock, as this can be noted at the instant of passing by the station chief and the conductor, as the two clocks cross paths and are visible simultaneously.

In other words, if, at the moment the train crossed the station for the first time, the station's clock and the train's clock both indicated the time of noon sharp, or twelve hours, zero minutes, zero seconds, zero millionths of a second, this synchronization would no longer exist upon the train's return to the station. If the clock on the train indicated, say, 1 p.m. and zero millionths of a second, the clock in the station would indicate at the same moment (defined by the passage of the train through the station), 1 p.m. and some millionths of a second. We indeed assume, I repeat, two clocks of identical construction. In other words, the *proper time* elapsed between the train's two successive passes by the station would be shorter on the train's clock than the station's clock. The station chief would have also grown older than the train conductor during this interval. Thus, if we could sufficiently prolong the length and the speed of the train's voyage, it could happen that, as soon as it re-passed the station, the station chief would have grown older by ten years, whereas the train conductor would have only aged by one year. The chronometers and calendars of the two men, not to mention their state of age of their organs, or the number of their heartbeats, supposing that they were counted, would testify as witnesses.

These were the fantastic unsuspected consequences of the logic of the Theory of Special Relativity. But what appeared shocking and mysterious to Mr. Painlevé in its consequences, was not that it offends common sense; it wasn't that some men aged really much less than others, simply because they voyaged so; no. What shocked him was not that, if I could say, voyages not only formed but prolonged youth; his analytical imagination had already, doubtless, made dreams more astonishing than that, and he knew that a world in which men could travel at speeds of tens of thousands of kilometers per second, relative to one another, would be a world very different from ours.

No, once again, what shocks Mr. Painlevé about these consequences, is something else; it is something that, at first glance, seems to him to go against logic; it is the following: When in the Theory of Special Relativity one considers two observers in relative motion, one always makes sure to specify that the appearances observed by each subject are reciprocal. If, for example, observer A sees the number of meters travelled and the clock held by observer B respectively shrunk and slowed down by his speed, it will follow that observer B will see A's meters and held clock shrunk and slowed down by the same proportions. This results from the fact that the speeds of A in relation to B, and B in relation to A, are necessarily identical, and this reciprocity is in conformity with the classical principle of Relativity.

Is there not, asks Mr. Painlevé, an essential contradiction in all of this, in the fact that, in the chosen example, the station master sees that the express clock has slowed down compared to his own, while the train conductor sees, in agreement with the station master, that the station's clock runs early compared to his own? Shouldn't the reciprocity, which is commanded by the principle of Relativity, demand on the contrary that the train conductor sees the clock of the station run late relative to his? Besides, if that were the case, we would find ourselves with an absurdity, an impossibility, because it is contrary to common sense that if two men see clocks H1 and H2 at the same moment and at the same place, one can see H1 early relative to H2, and the other sees H2 early relative to H1.

How can we get out of all this, how can we escape from those difficulties, those contradictions that some might be tempted to consider as impossible?

Einstein's answer completely dissipated the misunderstanding because it is, as we shall see, only a misunderstanding, and, following his own expression, "brought to light the paradox." Here, reduced to its most important elements and freed from its technical terminology, is the way one could summarize the explanation of the great physicist, whose demonstrative evidence was—although a bit hidden—implicitly contained in the Theory of Relativity:

The Theory of Special Relativity exclusively concerns—my readers didn't forget it—systems in relative uniform motions to one another, that is, those systems which, in traditional mechanics, play a privileged role, and are the only ones to which can be applied the principle of Galileo's and Newton's classical relativity. But, it is convenient to recall, that the Theory of Special Relativity was first elaborated by Einstein for the purpose of enlarging and consolidating, if I dare say, this principle of Galilean relativity, with the intention of subjugating to it the optical and electromagnetic phenomena that seemed to rebel against it. Therefore, the equations of Einsteinian Special Relativity can only be applied to uniform motions, that is, to speeds constant in value and direction.

Thus, in the example which is the object of the debate, we could not consider the train, which goes to a certain place, stops, and then goes back, as in uniform motion. The sudden stop and return in an opposite direction constitute accelerations and perturbations of the train's movement, which momentarily ceases to be uniform, and then becomes uniform again, but in the *opposite direction*. Thus, even when considering the train only during moments when the speed is constant, it is clear that the same train on its outbound and return journeys does not constitute in reality the same reference system, but two different reference systems. As a result, the express train's clock, starting at the moment when the train reverses direction, must be adjusted anew to indicate the new proper time of the train, and the old adjustment must be modified to take into consideration the change of speed, because it is a change of speed when someone, relative to an observer, reverses the direction of the moving object.

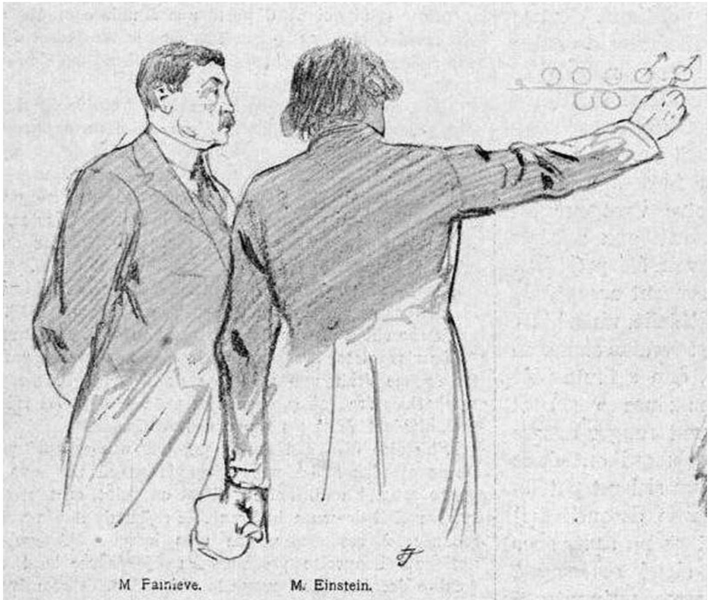
In a word, the train station, the departing train, and the returning train, really constitute, not just two, but three different systems, each having its proper time. It is not valid to suppose that the clock on the returning train could indicate the real time of the vehicle, if it did not receive other adjustments than those made when it departs the station. I propose to demonstrate this, with the following simple example: Let's suppose that another express train (let's call it Express 2) moves toward the train station, while Express 1, which we have considered until now, moves away from it with the same uniform speed. Let's suppose that the station's clock produces a light signal at precisely a quarter past noon, a signal from which Express 2 and Express 1 will synchronize their clocks. Each of the two train drivers sets his clock by considering the time taken by the signal to reach him from the station, which they consider as the distance from this station divided by 300,000 kilometers. But train driver 2 recognizes that his colleague from Express 1 made a mistake in this operation, because train driver 2 observes, while passing by Express 1, that the latter drives away from the light which, consequently, reaches him at a speed inferior and not equal to 300,000 kilometers. In consequence, train driver 2, if he had to fix his colleague's clock while passing by, would make a correction, which the latter did not take into consideration. This suffices to demonstrate that the clock on Express 1 would not be able to give indications comparable to the preceding ones, while he makes his return trip. Q.E.D.

But this only solves one part of the difficulty, and leaves untouched the one concerning the reciprocity of the vehicles' hourly indications. Respecting this point, the question in final analysis is posed thus: Since all motions are relative, shouldn't the result be the same, whether our express goes back and forth and the train station stays unmoved, or if we suppose our express stationary and the station going the distance back and forth? And, therefore why is it that the clock in the station, at the moment of the second intersection, runs early relative to that of the express, and not the other way around?

The answer is the following: In Special Relativity, only systems in uniform motion, in the Galilean sense of the term, show a reciprocity, from the standpoint of the measure of space and time, but it is not the same for systems in accelerated motion. This has been shown clearly since 1911 (at a time when Einstein had not yet developed General Relativity) by Mr. Langevin in a remarkable memoir on *The Evolution of Space and Time*.

In Special Relativity, all changes of speed, all accelerations relative to the environment in which light propagates, have an absolute direction. This is why, in this first theory, we cannot substitute the acceleration of our train when it changes speed, for an acceleration of the station in the opposite direction. Finally, this is why, between the indications from the station's clock and the one on the train, there is the dissymmetry that Mr. Painlevé has so appropriately brought to our attention.

At a time when we only knew of the Theory of Special Relativity, which gave an absolute value to accelerations in the Universe, as classical mechanics did, we had for a moment hoped to be able to demonstrate, through certain new electromagnetic experiments, the existence of a medium (let's call it ether if you wish) relative to which those accelerations were considered to exist.



A drawing by Lucien Jonas of Einstein and Painlevé discussing the moving clock problem, on May 28, 1922.

But there was something in this that was shocking to the mind of Einstein. His ideas made him reject *a priori* the possibility of ever attaining an absolute space. This is why he called the "Theory of Special Relativity" the first step of his work, which applied only to uniform motions, wanting to indicate that it was only a first step towards total relativism of all motions.

The interesting and so suggestive discussion brought up by Mr. Painlevé on this particular subject and which represented the high point of the discussions at the Collège de France, had the benefit of demonstrating brilliantly the fact that the Theory of Special Relativity maintained certain privileged motions in mechanics and certain somewhat absolute axes of reference in the Galilean-Newtonian sense of the term. Some people had assuredly the tendency to forget that, but such had never been the case for Einstein.

When Einstein developed Special Relativity, his only purpose was to introduce electromagnetic phenomena under the principle of classical relativity. But he knew better than anyone else that this was only a first step. It was for the purpose of eliminating that last remnant of absolute space which still survived within Special Relativity that he tackled the gigantic problem of General Relativity. Here, there was no longer any privileged motion. Both uniform and accelerated speeds were united together in a grand synthesis and were obediently subjugated to a unique conception of universal phenomena.[4]

We just saw that the paradox mentioned by Mr. Painlevé can be explained quite adequately by Special Relativity itself, but only on the condition that we maintain an absolute value for changes in velocity, which is precisely one of the residues of ancient mechanics. It would be easy to demonstrate that in General Relativity, the paradox can be explained even more easily, and this time without preserving anything remotely resembling absolute motion. But this demonstration would require more space than I have available, and besides, the question was not even brought up at the Collège de France.

* * *

When the evening session of Wednesday April 5th opened, Mr. Langevin first asked that those who intended to intervene not speak longer than twenty minutes each. Twenty minutes, timed on my watch! he added amongst the laughs. We shall never know if this only alluded to the proper time of each system of reference, or if it was rather a consequence of the practical necessity of defining things by a possibly arbitrary, but univocal unit. The second hypothesis is less flattering for clock makers, but the first is quite difficult to admit. Because, if ever some observers were rigidly attached to one and the same system of reference, it is obviously those, who, that evening, sitting closely piled together in a continuous mass on the small steps of the amphitheater of physics, were coordinating all their minds' tensors on unique axes all converging into Einstein's brain.

After Einstein and Mr. Painlevé had reached an agreement on the concluding statement by Mr. Langevin; a concluding statement that I replicated above and which was necessary to make in order to close the debate of the preceding session, the word was given for Mr. Edouard Guillaume, a Swiss physicist, to speak. In the previous days, most newspapers had published a wire announcing that this physicist had discovered blatant calculating mistakes in Einstein's theory, and that he intended to reveal them, *coram populo*, [before the public] at the Collège de France. These mistakes would naturally lead to a complete collapse of Einstein's synthesis, the total bankruptcy of this Law of Science. To be honest with you, all of those who had followed, with full knowledge of the facts, the series of analytical development of Einstein's theory, those who knew that after a thorough study, Mr. Hadamard, the profound mathematician and successor of Henry Poincaré, had proclaimed that mathematically speaking, Einstein's construction

Swiss physicist Charles-Édouard Guillaume (1861-1938), who received the Nobel Prize in Physics in 1920 for his discovery of anomalies in nickel steel alloys.

French mathematician Félix Édouard Justin Émile Borel (1871-1956).

4. See chapters V and VI of my little book: *Einstein and the Universe.*

had a most perfect and rigorous cohesion, without any logical flaw, or any formal defect; those, I say, were somewhat surprised by the news trumpeted in the press by the one who would, in no time flat, make mincemeat out of the poor Einstein.

Thus, Mr. Guillaume took the floor and started with a loud call to attention: “Ladies and Gentlemen.” Then, he went to the blackboard where he had pinned some clever pink and blue graphics ahead of time, and he began to line up his formulas. After a few moments, it became clear to everyone that this was not going to be the day, nor the individual, that would force Einstein to bite the dust. When the orator was done, it had taken less than two seconds for those who had understood, and all the assistants agreed, to shrink back this loudly trumpeted intervention down to its modest proportions. It was Mr. Borel who interpreted the unanimous opinion (since the thing was so simple, that there was not a single elementary mathematics student who would not have been able to pass judgment) and declared that “the whole argument doesn’t hold water, because it is not possible to first start by writing equations on Relativity and then introduce, solely by manipulating those equations, a series of foreign postulates which contradict the system.” The error was so obvious, as it followed from the principle of homogeneity, that it was necessary to dismiss it with a one liner. Refuting a scientific construction by first introducing elements which it rejects, is easy, but it proves nothing. Speaking in his turn, Mr. Langevin concluded by these textual words, which buttressed a demonstration that was as brief as it was clear, relative to a side issue: “The misunderstanding results from the fact that Mr. Guillaume does not understand what a light wave is.” As for Einstein, smiling, he took refuge in a charitable abstention by pretending not to have understood anything his opponent was trying to say. This is how this more comical than painful incident ended.

French mathematician Jacques Hadamard (1865-1963).

We then returned to serious matters. Mr. Langevin first exposed how he had come to establish the formulas of the new dynamics by simply starting from General Relativity and the principle of the conservation of energy. I have previously sketched for this publication the astonishing consequences of the new mechanics which show us that mass—which classical science considered constant—increases and decreases with speed, and that energy is endowed with real inertia. I have indicated—you will recall—some of the stunning verifications that the physics of the atom and the electron have brought to these revolutionary conceptions.

Einstein took the floor to praise the beauty of the work that led Mr. Langevin to those results. He himself came to them independently, but through a much more complicated way that calls upon notions that are still somewhat unreliable and in which the famous quanta theory, this Chinese puzzle of today’s physics, was required. In one of his usual humorous and agnostic formulations, Einstein concluded: “It is thus that mechanics is profoundly changed by the not-yet-existing quanta theory.”

Thus, ended the examination of the question raised concerning Special Relativity.

All that remained now, was to deal with the questions raised by General Relativity.

It was Mr. Hadamard, celestial mechanics professor at the Collège de France, who opened fire with a question relating to the formula by which Einstein expresses the new law of universal gravitation.

In this formula, under the simple form that Schwarzschild gave to it and that answers all the practical needs of astronomy, there exists a certain term that Mr. Hadamard is very much concerned with; if the denominator of that term becomes null, meaning if this term becomes infinite, the formula no longer makes sense, or at least one could demand what is its physical meaning.[5]

Mathematically this term cannot become infinite; but physically, practically, could it take place in nature? Not in the Sun’s case, but possibly in the case of a star that would be infinitely more massive than the Sun.

Einstein does not hide the fact that this very profound question is somewhat embarrassing to him. “If,” he says, “this term could effectively become null somewhere in the universe, then it would be an unimaginable disaster for the theory; and it is very difficult to say *a priori* what would occur physically, because the formula ceases to apply.” Is this catastrophe—which Einstein pleasantly calls the “Hadamard catastrophe”—possible, and in this case what would be its physical effects?

I thought it would be useful to intervene at this point in the discussion, and I noted that, although we know of some stars much larger than the Sun (such as Betelgeuse, whose diameter equals 300 Suns), for the few stars whose masses we have been able to determine, we find that they are never much greater than the solar mass.

Additionally, it seemed to me from the works of the English astronomer Eddington, that when a star’s mass has a tendency to increase more and more by gravitational attraction of outside matter, the internal temperature of this mass increases greatly and the radiation produced tends to throw outward (according to the Maxwell-Bartoli pressure) any new addition of matter, and to balance the attractive effect of gravitation. Therefore, it would be in the very nature of things that an insurmountable limit be reached in the increase of mass of a star. Such a star could never grow much greater than the mass of our own Sun. Therefore, the very physics of things would prevent the Hadamard catastrophe from ever happening, because the conditions of existence of stars that would have incomparably greater masses than the Sun could not be produced.

Einstein replied to me that he was not entirely reassured by

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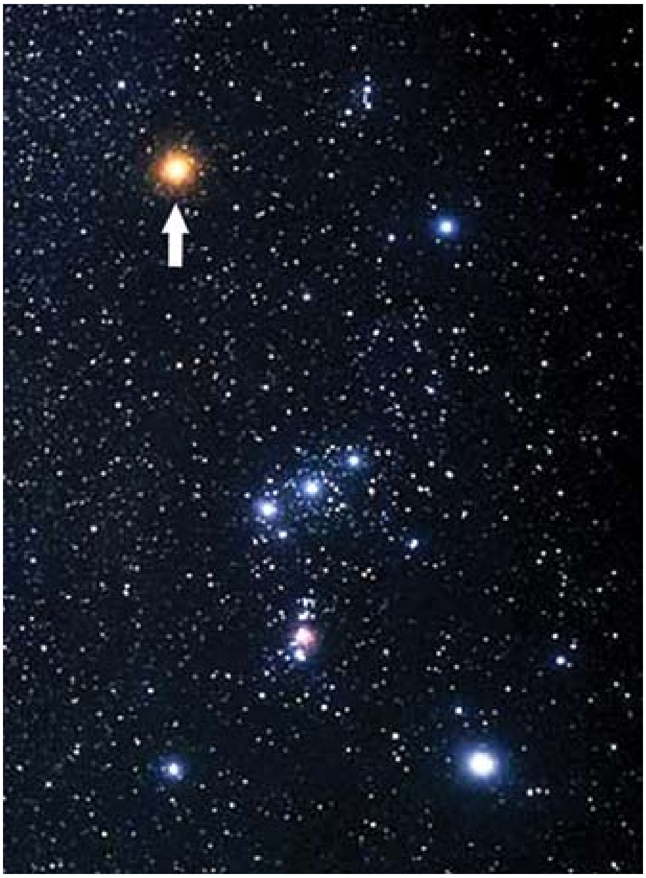
5. For the reader who wants more specifics, I allow myself to indicate that Einstein’s gravity formula is the following:

$$ds^2 = dt^2(1-a/r) - r^2(d\theta^2 + \sin\theta d\phi^2) - dr^2/(1-a/r)$$

where *ds* is the geodesic element traversed in the universe by a gravitating point. *r* designates the radius vector of this gravitating point with respect to the mass’s center and *a* is a length proportional to this mass and which, in the Sun’s case, is equal to about 3 km. We see that when *a* becomes equal to *r*, the last term takes on an infinite value, and Mr. Hadamard is then asking what would actually happen in reality.



Betelgeuse, in the constellation Orion, is the eighth brightest star in the night sky. Nordmann pointed out in the discussion that it has the diameter of 300 Suns, although he said that the few stars whose mass had been determined were never much larger than the Sun's mass.

these calculations that involve several hypotheses. He would much prefer another means to escape "the misfortune which the Hadamard catastrophe represented for the theory." Effectively, in the following session of April 7th, he brought up the result of a calculation he had made concerning this fine point. Here is what this calculation shows: If the volume increases indefinitely without increasing its density (this would be the case for a sphere of water) it happens, well before the Hadamard catastrophe conditions could be met, that the pressure at the center of the mass becomes infinite. In these conditions, given the General Theory of Relativity, the clocks move at zero speed, nothing goes on, it is death; and therefore any new change capable of bringing the Hadamard catastrophe has become impossible. Einstein asked if it might not be the case that, following his expression, "the energy of matter is transformed into energy of space," that is to say, when mass is transformed into radiation. "That is all I can say," he concluded, "because I don't want to make hypotheses," which sounded like the very words of Newton. Mr. Hadamard in these conditions declared himself satisfied, and believed impossible the catastrophe so greatly dreaded.

Such was the discussion surrounding one of the most curious points which were raised at the Collège de France. All would agree that it did not lack taste, nor insightful penetration. It well characterized the ideal atmosphere, saturated with an enthusiasm for pure truth and detached from the contingencies in which the now eternally famous controversies, took place.

During the last discussion session on April 7th, the question of the Hadamard catastrophe gave Mr. Painlevé the opportunity to ask Einstein some questions regarding his gravitational and similar formulas which now allow us to express new phenomena (the advance of the perihelion of Mercury, the deviation of light by gravity) observed in the fields of celestial mechanics and optics.

What followed was an extremely brilliant and sprightly discussion, at times so animated that everybody was speaking at once. At a certain point, while Mr. Hadamard and Mr. Painlevé were exchanging the most spirited and contradictory arguments about the meaning of the stated formulas, we suddenly saw Mr. Brillouin (who had given up any attempt at inserting a single word edgewise between the rapid fire of the two antagonists) leap to the blackboard with a piece of chalk in his hand, and shout: "Since you are speaking, I will resort to writing; because the simplest way to make a quadrature is still to write it!" In this manner, he was able to capture the attention of a breathless public without the slightest unsealing of his lips. It was really a very beautiful battle and a rewarding sport event. Moreover, the two adversaries were vying in courtesy with each other somewhat aggressively, and we could hear, at a certain point, Mr. Painlevé shouting at Mr. Hadamard: "I can't see how the discussion can benefit anyone by being conducted in this manner; but go on, I beg of you"; and the next moment, he apologized by saying: "Please forgive me for not making myself clear, but. . . ." While all the written and spoken arguments dashed and clashed against one another, quickly and sharply filling up the room with tumult, and the board with elegant integrals with their necks inclined like white swans, Einstein sat in the middle of the tempest, smiling and remaining silent.

French physicist and mathematician Marcel Brillouin (1854-1948).

Then, suddenly raising his hand as a schoolboy requesting the teachers attention: "May I also be permitted to say a little something?" he asked softly. Everybody laughed. Einstein spoke in the now restored silence, and within a few minutes everything was made clear. I believe this is how one can summarize the essential points provided by Einstein and which definitely settled the main objections raised.

Above all, people wanted to know what the quantities of Einstein's gravitational formula represented, and especially the radius vector, that is to say, the line joining the Sun to each planet.

Newton's law, the foundation of all traditional celestial mechanics, expresses a relation linking the masses of two stars (or celestial bodies) and their distance. Let's leave aside, to not overload this exposé, all that concerns the mass and let's consider only their distance. In order to make exact calculations, we must specify at which moment we consider the distance. Classical science, with its *a priori* notion of a universal and absolute time, ignored this difficulty and, if considerable mistakes did not follow, it was only because of the slow speed of the planets relative to the speed of light. Moreover, when classical astronomers determine by triangulation the radius vector of a planet, and translate their design on paper, they trace a rectilinear triangle, a Euclidean triangle, because they suppose that their line is rigorously straight. But since light is slightly curved by gravity, it is not. Thus, small but necessary corrections are to be made when we want to define the line linking two celestial bodies, of which classical science was unaware. Moreover, classically, it was supposed that the radial vectors were measured with identical rulers lined up from end to end, and whose lengths were supposed to be the same. There again, we did not do the necessary correction that follows from the apparent contraction of the rulers caused by speed, due to the particular propagation of light rays.

In a word, the magnitudes which are used in the new law of gravitation are concrete magnitudes. For example, the radius vector joining a planet and the Sun must be considered to be marked out by identical rulers (naturally assumed to be subject to elastic and thermal deformations) aligned in the direction of the line of sight, stationary with respect to fixed stars, and subjected to the gravitational action of the Sun. When a stone is thrown in the air, at the instant when it ceases to ascend and is about to begin to fall, it is entirely subjected to the effects of gravity. The rulers that constitute the radial vector under consideration must be considered as being in an analogous situation. To these rulers are supposedly attached identical clocks which are, also, ideally subjected to the action of the Sun. Under these conditions, the astronomical data are defined in a perfectly concrete and objective manner. "There is nothing left but rulers and clocks, there are no longer observers, and all that is subjective has been eliminated."

This is, to use Einstein's expression, a certain "absolute" manner of defining measured magnitudes in astronomy, since it is no longer necessary to relate it to a particular observer.

Such are the concrete, objective, measurable quantities which enter, without ambiguity, into Einstein's gravitational formula. By this mathematical metamorphosis, by these changes of variable that are called point transformations [mappings], we can certainly find other more or less different formulas for gravitation, but these transformations change nothing of the observable and objective things as we have just defined them.

There is, therefore, for Einstein, only one unique formula establishing an unambiguous relationship between measured quantities: it is that which Mr. Painlevé called ironically "the classical formula, the already classical Einsteinian formula of gravitation."

In a word, it is always better to give a measurable meaning to symbols that are introduced in formulas, and to never lose sight of the physical significance of these symbols: a physical significance which does not objectively change when the symbols have been transformed.

These same remarks are applicable to the interesting observations that were presented, at the end of the session, by a distinguished mathematician Mr. Leroux. Here, once again, Einstein strongly insisted on underscoring the fact that the only geometrical figures that he considers in space are those really traced out with rulers, and not the idealized figures of the purely formal geometries.

"We can always define," he concluded, "but we must define *physically*."

Thus, the cycle of these memorable discussions was concluded. And if, as stated by Mr. Langevin in closing them, we had not tackled all of the questions that could have been raised, at least, all of the questions posed received a satisfactory answer.

The theory of Einstein emerged from this tournament entirely unscathed, and Einstein himself came out of it greater than before. As Mr. Painlevé related to me with a most appropriate illustration, the work of the famous physicist stood firm like a perfectly coherent and inflexible granite block that did not have a single flaw. Relativity is a brick whose cohesion cannot be impaired, a system without logical contradiction, free of all ambiguity, and without any internal defects.

However, even though he conceded on the details, Mr. Painlevé still refused to accept the doctrine as a whole. He was incapable, as he confessed, of taking down such a majestic and practical edifice as that of classical science. For him, if I dare say, the cube rests on its vertex; for others, myself included, it rested unshakable on its base. Everyone can, depending on his inclinations, either distance himself with prudence, as one does when passing under an overhanging ledge, or on the contrary, make use of it as a pedestal capable of supporting an exact image of the world.

* * *

The discussion session that was held at the Sorbonne, on Thursday, April 6th, under the auspices of the French Philosophical Society, was not in any way to be dismissed as being of lesser importance than the physical-mathematical controversies at the Collège de France.

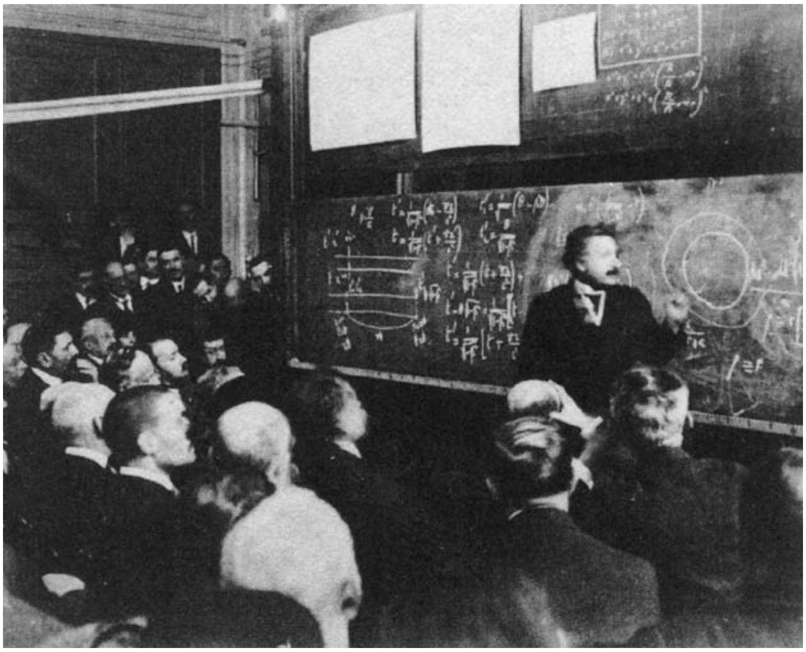
Although the philosophers already had the opportunity to discuss the Theory of Relativity, notably with Mr. Langevin, "the apostle of this new gospel," they nevertheless were quite numerous at this meeting, where the discussion was to take place in the presence of the monster himself.

After a good opening address from the President of the Society, Mr. Xavier Léon, the debate got started with a profound and remarkable exposé by Mr. Langevin which could have been entitled: "Why philosophers should be interested in the Theory of Relativity." The knowledgeable physicist described with masterful clarity the key elements of methodology and epistemology that established the strength and appeal of Einstein's work.

Some day, I plan to return to this penetrating commentary on relativity given by the French scientist who best mastered it. It deserves better than a summary of a few lines.

The discussion that followed, and in which a number of mathematicians participated, made it clear that, strictly from the standpoint of logic, the entire doctrine of relativity was coherent, and was free of any internal contradictions. This had already been the implicit conclusive assessment from the discussion at the Collège de France.

After the mathematicians, the physicists entered in turn into the discussion, introducing diverse questions posed distinctly, which led Einstein to give his opinion on several very interest-



The Albert Einstein Archives, Hebrew University, Jerusalem

Einstein at the blackboard during his 1922 lecture at the Sorbonne in Paris.

ing points on cosmology, on geometry, and notably on the quadrature of the circle. I will come back to this in a few days.

Following the scientific community, the philosophers took their turn at asking Einstein a number of questions. The ghost of Kant having been evoked, Einstein did not hide the fact that he was definitely opposed on several points to the ideas held by the Königsberg philosopher, for whom absolute space and absolute time were *a priori* notions already existing inside of us. The Theory of Relativity asserts the opposite, and, better yet, demonstrates it.

French philosopher and historian of philosophy Xavier Léon (1868-1935).

Even though Einstein might otherwise have some admiration for Kant, he apologized for having a somewhat personal view of Kantian ideas by saying: "Every man has his own Kant," (a statement which, another argued had been a pun dating back to … Plato), but by stating in jest: "Every man has his proper Kant."[6] This gains its fullest meaning when we remind ourselves that: "proper time" is one of the mother concepts of relativity. Einstein remarked elsewhere that two ways of conceiving things in the most opposite way imaginable is either from the standpoint of Kantian a priorism, or from the standpoint of Poincaré's convenience principle. "All I can say," added Einstein, "is that between these two lines of thinking, one has to choose according to experience." We presume that he doesn't consider the kind of experience that would be favorable to the a priorism of Kant to be of great interest.

German philosopher Immanuel Kant (1724-1804). "Every man has his own Kant," Einstein quipped.

Finally, after a remarkable exposé by Mr. LeRoy, Mr. Bergson was asked to speak. He recounted in his usual engaging and pictorial way, his own ideas of the notion of time, that he had, as we know, so profoundly pondered. The Bergsonian time, which, if I may be so bold to say is a sort of "proper time of our soul." This feeling of our inner passage is also, in some way, the feeling of the flow of our environing matter. Our surroundings coincide with the fluidity of our inner life. But where does the extension of our surroundings end? Very far from us, we can imagine other consciousnesses, as links across the universe, and beyond these links, a sort of universal consciousness, that would be as their integral, and toward which the totality of the phenomena would be flowing. Thus, the Bergsonian notion of duration would be dissolved in the end into a sort of universal time. Mr. Bergson wishes to believe that there is no antagonism between this manner of seeing and the relativistic conception of time. If we cannot demonstrate the concordance of the two conceptions, we could not, without a doubt, determine their discordance. Mr. Bergson thinks besides this that there could be an incommensurability between purely qualitative intuitive time, and quantitative relativistic time. In conclusion, he doubted that Relativity would be able to completely ignore the intuitive point of view, especially when it involves the notion of simultaneity of the phenomena in which he estimated that our sensations have a role to play, one way or another.

In his response to the points raised above, Einstein does not share in any of the viewpoints of Mr. Bergson. He maintains that the time of the philosophers cannot differ from the time of the physicist: It is the same. One needs validation, assuredly, in the definition of time, starting with intuitive time, which is the sentiment of the order that is given to us and in which our states of consciousness proceed in succession. Two individuals who are in agreement with each other already constitute a first step towards a sense of objective time; because—at least, Einstein affirms that he is convinced—, there are objective events which are distinct from subjective events. As far as the "simultaneity" of

6. [Translator's note] "Chacun à son Kant à soi," or "Chacun a son Quant-à-soi) could be heard as "Everyone has his own Kant" or "Everyone has his own reservations." "Quant-à-soi is an expression meaning to be reserved, not expressing your feelings or your ideas.

two events is concerned, Einstein recalled that, for a long time, they were considered practically the same for two neighboring individuals, because of the great magnitude of the speed of light. But, when we analyze that notion more closely, and take into account that the propagation of light, as rapid as it is, is not instantaneous, we come to the conclusion of Relativity: that simultaneity is a notion that varies from one observer to another. According to Einstein, there is nothing in our consciousness which indicates to us the simultaneity of the contemporaneity of events: these are logical concepts, not psychological concepts, and they are immediately given. If the philosophers are able to conceive of an abstract time, a sort of extrapolation of their state of consciousness, there is, as well, an abstract time for the physicists: It is the absolute time of classical science. In a word, Einstein thinks that the philosophers don't have their very own time.

This does not mean that the Theory of Relativity is incompatible with the Bergsonian conception of time. Einstein believes that any reasonable philosophical system, that is to say, that which is a coherent system, is always necessarily in accord with natural and physical science. Here we have the independent variables, as the mathematicians say.

In short, a scientific theory is not a philosophy, but it is something which philosophy must take into account. If the Theory of Relativity is exact, any consistent philosophy will have to put itself in agreement with it; but by itself, it doesn't constitute a philosophy.

Emile Meyerson (1859-1933) was a Polish-born French chemist and philosopher of science.

In response to a question which was posed by Mr. Meyerson about the ideas of Mach, Einstein was led to give more precision to his conception of science. Although he agrees with Mach that scientific concepts must always agree completely with observable data, he refuses to admit that science only consists of simple relationships between the facts. For him, a science is a system, that is to say, a logically deduced synthesis, not simply a "catalogue" of facts, as Mach would claim.

* * *

And now let us endeavor to conclude. Of all these discussions in which passion was not at all absent—and that pleased Einstein, because he knew that you only push on something that offers resistance—of all these intellectual shocks where the calm mastery and lucid logic of the new Newton evinced itself, the Theory of Relativity came out intact.

In order to summarize the results of the controversy, it seemed to me that the best way was to make use of Socrates' method of midwifery. Here you have those questions which, I think, can be asked in order to specify the most important points.

1. Is it true that the Theory of Relativity, maintains all the ancient and confirmed results from classical science and, in particular, of mechanics and astronomy? Is it true, consequently, that renouncing the classical model in order to adopt the Einsteinian model, is in no way a renunciation of any of the least solid conquests of the former?

2. Is it true that to these acquired results, that it incorporates and preserves, Relativity is adding new results which it has foreseen, which classical science had not foreseen and could not have foreseen, and which have been experimentally verified?

3. Is it true that Relativity, in a unique synthesis, unites domains, like mechanics and gravitation, and like optics and mechanics, which used to obey disparate and sometimes irreconcilable laws of classical science?

4. Is it true that the principal criterion for the value of a scientific theory is the principle of simplicity, and that among all the possible theories of the same phenomena, the one which applies the least number of hypotheses and which eliminates the greatest number of occult and non-measurable assumptions, is preferable? Is it true that in this regard, classical science is not on par with the Theory of Relativity?

5. Is it true that Relativity explains certain facts which seem contradictory in classical science and which the latter has not yet succeeded in explaining?

If all this is true,—and who could think otherwise—we must logically conclude that the Theory of Relativity is the only theory which gives a complete representation and an explanation of known facts, and which has allowed us to go further still in foreseeing new phenomena.

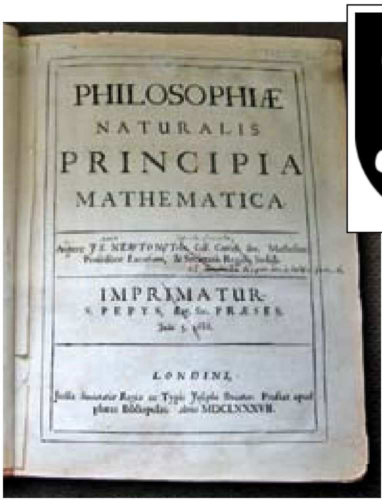
Never before has the human spirit crafted a framework more magnificent in its simplicity, and more exactly attuned to the nature of reality, from which to understand the mysterious image of the world. Never has the eternal sphinx been enchained by links more solid, more supple, and which follow with such harmonious precision, the lines of its superb and deceptive body.

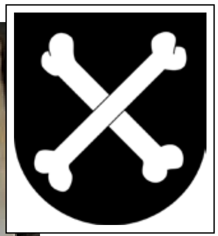
* * *

And yet .... And yet, beyond the penetrating, subtle, and scholarly questions that were asked in these recent discussions, no one thought of raising a few others which seem particularly troubling to me. One day, when Einstein scolded me in a friendly way for "the flowers" that my admiration had sometimes lavished on his work, I promised him to always have henceforth some criticisms mixed-in. In order to be faithful to that promise, but above all because it is important to never forget that every human work is perfectible, I ask permission to present here some remarks that I did not think should have been brought up at the Collège de France, because they could not have resulted in any positive or negative assertion, but only in a feeling of doubt.

The essential experimental foundation of Relativity resides in the contradictory facts that the Michelson experiment and analogous experiments have displayed. These facts correspond with other explanations besides the Einsteinian one. Whether we acknowledge the reality of the Lorentz contraction (and the fact that all bodies are composed of electrons makes this hypothesis acceptable), or whether we return to a possible new emission theory of light, or whether we accept the existence of an accompanying flow of Lorentz's ether in the neighborhood of massive bodies; the fundamental facts of Relativity imply other explanations of that theory. Granted, the researchers, if there are any, have yet to bring us results. But the simple fact that these other explanations are *a priori* conceivable, makes an experimental departure from the Theory of Relativity a debatable proposition.

In a word, the disconcerting facts which are at the foundation of the theory of Einstein can have other results than that theory.





Newton's view of absolute time and space, expressed in his 1686 Principia*, was overturned by Einstein. Inset is the personal coat of arms of Sir Isaac Newton.*

There are certainly very strong arguments that lead us to reject the "absolute space" of Newton *a priori*. But if the privileged space of classical science is nothing but the immovable ether of Lorentz, one can reconcile the relativist's agnosticism with this ether, and save the principles by assuming that our whole Universe is a beautiful bubble of movable ether in an etherless assemblage.

In a word, the experimental starting point of Relativity can appear less solid than its experimental end point, itself, marvelously powerful, which rests on the astronomical and optical observations that everyone knows. Classical celestial mechanics will have to undergo a readjustment in order to adapt itself to these novelties, but it is nowhere demonstrated, *a priori,* that this readjustment could not be accomplished within the framework of the old system based on the ether of Lorentz.

I know that none of these arguments are very convincing; that so far they have merely been defeats. But, the mere fact that they suggest the possibility that conclusions other than Einstein's may be drawn from the experimental facts, gives us the right to reserve judgment, until all the other attempted theories, which are bound to be made, have been proven false.

However, be that as it may, there is still something infinitely troubling in the Einsteinian system. This system is admirably coherent, but it rests on a particular conception of the propagation of light. How are we to imagine that the propagation of a ray of light could be identical for an observer who flies away from it, and for an observer who rushes forward to meet it? If this is possible, it is in any case inconceivable to our customary mentality, and no matter how hard we try, we cannot make the mechanism and nature of that propagation intelligible.

It must be confessed that here lies a "mystery" which eludes us. The whole Einsteinian synthesis, as coherent as it is, rests on a mystery, exactly like the revealed religions. Classical science at least appeared to be based on clear and simple notions. We are now told that they never existed, or, at least, that they were merely metaphysical. The future will tell whether or not we will be able to re-establish them in their reality, by means of the Lorentzian ether, and of the non-absolute, but privileged space, that it may define.

If that occurs, the founding notions of classical science will cease to be metaphysical; but today, as metaphysical as they may be, they seem clear and conceivable, if not measurable. On the contrary, the Einsteinian notion of the propagation of light still remains inconceivable.

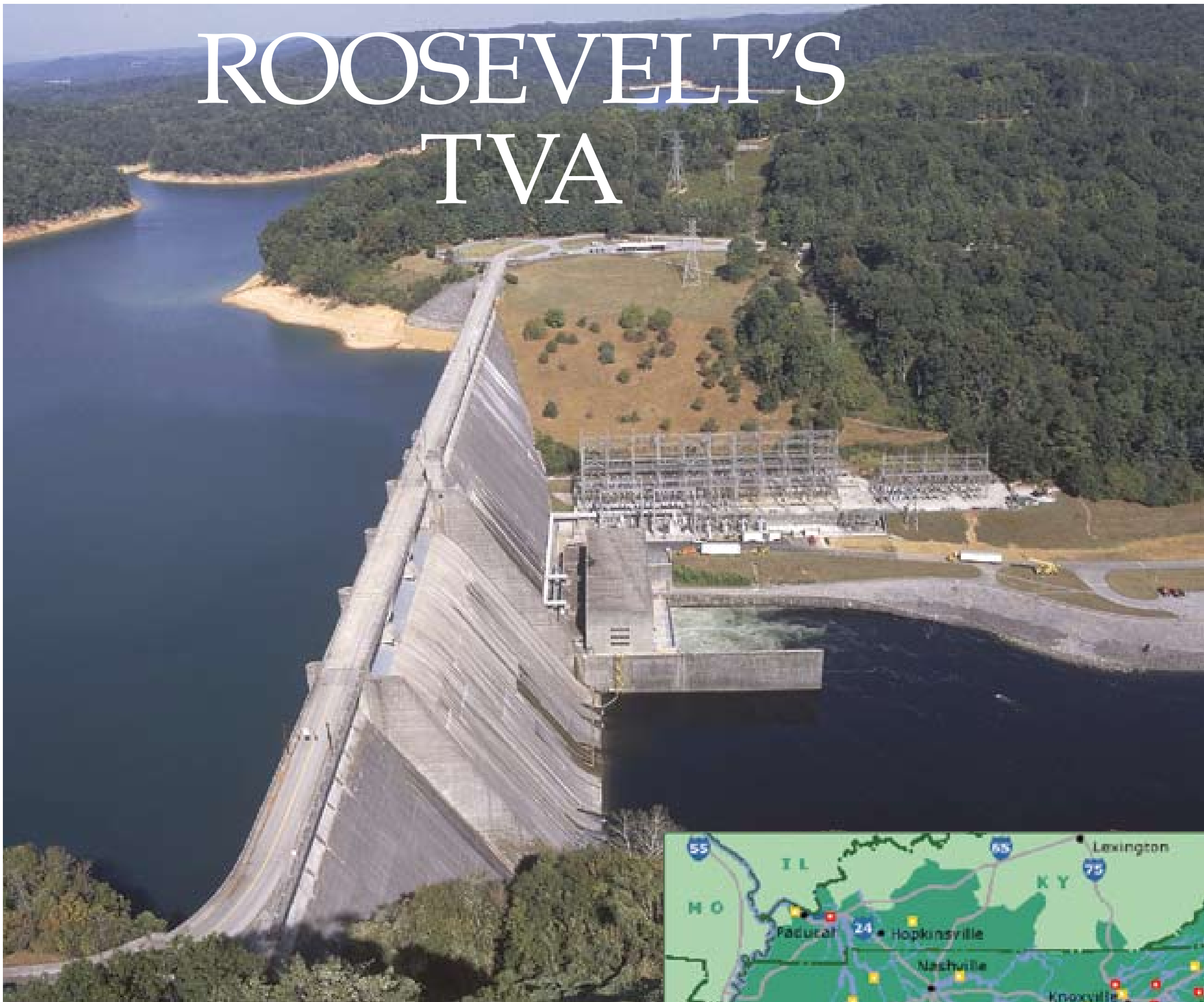
Certainly, there has to be some profound, substantial reality, which is subtly concealed in the still elusive role played by the number expressing the invariable speed of light. This must be the case, simply judging from the stunning and verifiable consequences that Einstein has been able to derive from this mysterious foundation.

Simply said, the foundations of classical science lie beyond the grasp of our senses, but not beyond the powers of our imagination; while the basis of the Einsteinian doctrine is, on the contrary, perceptible, though unimaginable. Therefore, we would be justified in hesitating to choose one over the other. But, a comparison of the construction of the two systems, their respective volumes, and the unequal vastness of horizons that they open upon the universal landscape, necessarily forces us to lean toward the latter.

The theory of Einstein is a marvelous tree that has grown farther and higher than any other ideal flowers of human thought. Similar to the palm trees of the Wadi in the Sahara, this singular tree emerged from a shadowy well, in which invisible life-giving water sings. . . .

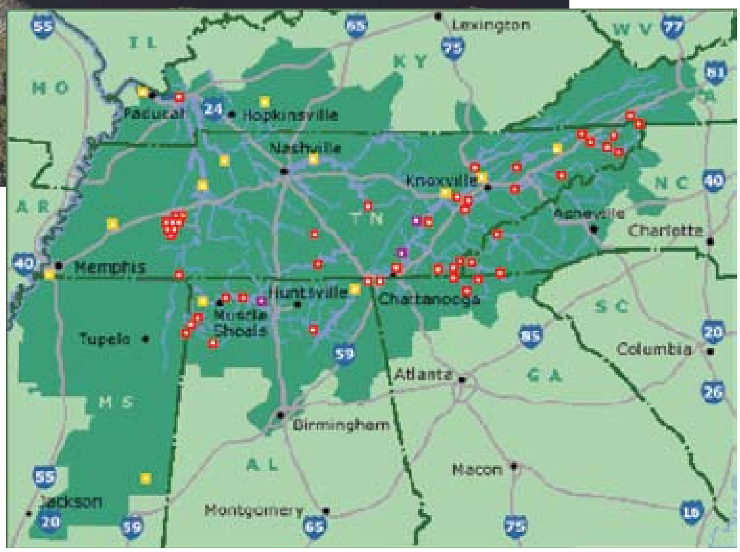
"The theory of Einstein is a marvelous tree that has grown farther and higher than any other ideal flowers of human thought," Nordmann concludes. Here, Einstein in Berlin in 1922.

ROOSEVELT'S TVA



TVA

Norris Dam on the Clinch River in Tennessee was the first major TVA project.



The Development Program That Transformed A Region and Inspired the World

by Marsha Freeman

President Franklin Roosevelt's TVA brought the most backward region of the country into the modern age, setting an example for the rest of the country, and providing a record of rapid development that the rest of the world rushed to emulate. The TVA tamed rampaging rivers; replenished the depleted farmland; mechanized agriculture; built dams, power plants, libraries, and educational facilities; trained and employed legions of unskilled and skilled workers; and helped win World War II. America, and the world, had seen nothing like it before.

Today, we still enjoy the benefits of the TVA, especially its plentiful and cheap electricity, but our nation's economy overall is a wreck, far worse than the Depression inherited by Roosevelt, and without even the productive industrial base that existed in the 1930s.

The remedy is at hand. The pathway out of the current threat to the very physical existence of the United States and its people is to put in to place the financial reorganization of the economy, through a new Glass-Steagall policy, to enable a great infrastructure project that will demand the rebuilding of the physical economy, transform the population both materially and culturally, and enable long-term science-driver projects for future generations.

The 1964 North American Water and Power Alliance project (NAWAPA), reformulated by economist Lyndon LaRouche and his colleagues in expanded form, can transform America, the global economy, and the Biosphere.[1] Apart from delivering water from Alaska and Canada to water-starved regions of the American West and Mexico, NAWAPA will create new waterways from the Great Lakes to the Pacific and Arctic Oceans, unleash a renaissance of nuclear power and high-speed and maglev rail development, and quickly create 4 million new skilled jobs and job-training opportunities in the United States. It would include major infrastructure development projects such as the Congo River/Lake Chad development project, the huge Eurasian Land-Bridge program, and a Bering Strait bridge/tunnel and Darien Gap development project that would eventually connect Eurasia to the tip of South America. By extending the reach of science and development to the Arctic regions, NAWAPA will link the Earth to its cosmic environment.

This article will look at the history of the Tennessee Valley Authority (TVA), created in 1933 by President Roosevelt not only to provide immediate economic relief, but, more important, to return the U.S. economy to an American System approach of permanent "internal improvements." The TVA aimed to lay the basis for economic development for "generations yet to come."

Although its activity was centered in the seven-state watershed of the Tennessee River, the TVA was never a "local" or even regional project. The lead personalities who created the TVA, protected it, and made it a success, came from Nebraska, New York, and the Midwest. The materials needed for the construction projects came from across the country.

The organizers of the TVA gave the agency and the region the responsibility of becoming a leader in science and technology, in agriculture, mapping and geographic analysis, forestry, manufacturing, and nuclear and fusion energy. From the time it began pouring concrete to build dams, the TVA was a model for world development; an inspiration to other nations whose people also lived in the "third world." The goal of the leaders of the TVA was to create such projects "in a thousand valleys."

The history of the TVA is also instructive as a microcosm of the tragic history of the second half of the 20th Century. While the TVA operated under the vision and protection of President Franklin Roosevelt, it met its goals. But in most of the succeeding decades, the TVA came under attack, by the British Empire and its satraps directly, and by the parade of "left" and "right" free marketeers, budget balancers, financial interests, and environmentalists.

Building a Nation

In 1824, Secretary of War John C. Calhoun sent President James Monroe a report recommending the improvement of the Tennessee River at Muscle Shoals, as part of an ambitious plan for a system of integrated roads, canals, and rivers to connect the eastern part of the country to the opening west. Surveys of the Ohio and Mississippi Rivers were authorized, which found that the major obstacle to connecting the 600-mile Tennessee River to the Ohio and Mississippi Rivers was the 37-mile stretch of rapids and irregular rock formations at Muscle Shoals, Alabama.

A key obstacle to moving forward was removed by a 1824 Supreme Court opinion, written by Chief Justice John Marshall, establishing exclusive control over interstate navigation to the Federal government. In the decades that followed, three attempts were made to build canals at Muscle Shoals, to enable navigation from the east coast to the Mississippi, all of which failed.

In 1916, the National Defense Act authorized the Wilson Dam, two nitrate munitions plants, and two steam-powered electric plants to be constructed at Muscle Shoals, for World War I. Wilson Dam was begun two years later, but was not completed before the end of the war. Construction of the dam was halted in 1921, and was finally completed in 1925, burying the treacherous shoals under a new lake. The Wilson Dam completion then made it possible to plan to use the other infrastructure that had been laid at Muscle Shoals but never put to use.

But in 1928, President Calvin Coolidge used a pocket veto to stop a bill that would have done just that.

The development of the wasted Muscle Shoals region became a passion of George Norris, a Republican Senator from Nebraska, who had been born in Ohio in the early days of the Civil War. In 1921, Norris became chair of the Senate Committee on Agriculture and Forestry. When President Warren Harding, eager to privatize Federal projects, had stopped the construction of Wilson Dam, Henry Ford offered to buy the property for $5 million.

The Passion of George Norris

In 1926, Norris countered the privatization drive, by introducing a bill for a comprehensive plan for Federal flood control and development of the Tennessee River and the Valley, greatly expanding the Muscle Shoals project. Then in 1931, President Herbert Hoover vetoed the bill, which had passed the Senate in a 2:1 vote the year before. Hoover described the operation of public utilities, in general, as "degeneration." This, while the Federal Trade Commission was investigating the "roaring twenties" private utilities, for their inflation of capital values through "watered stocks," the concentration of control through pyramiding holding companies, and other crimes.

By 1933, 138 legislative proposals had been initiated to develop the Tennessee Valley, none having succeeded.

Meanwhile, in 1929, then-New York Governor Franklin

1. Articles, maps, and interviews on NAWAPA can be found here.

TVA

President-elect Roosevelt and Senator Norris visit Muscle Shoals in December 1932. In April 1933, the President sent a message to Congress creating the Tennessee Valley Authority.

Roosevelt proposed that the State build dams and power plants on the St. Lawrence Seaway to produce electricity. He was angered by the gross price-gouging by private power companies, which were charging New York State customers several times more than their Canadian neighbors. Senator Norris took notice of this proposal.

A great experiment for the benefit of generations to come and millions of yet unborn.

—Franklin Roosevelt, December 1932

In December 1932, just weeks after winning the Presidential election, President-elect Roosevelt invited Senator Norris to accompany him to Muscle Shoals. Roosevelt could immediately see the potential of developing the Tennessee Valley, telling the press that this "great experiment" could provide 200,000 jobs. Muscle Shoals, Roosevelt said, would become "part of an even greater development that will take in all that magnificent Tennessee River from the mountains of Virginia to the Ohio," for the benefit of "generations to come," and "millions yet unborn."

On April 10, 1933, Roosevelt transmitted a Message to the Seventy-Third Congress: "A request for Legislation to Create a Tennessee Valley Authority—A Corporation Clothed with the Power of Government but Possessed of the Flexibility and Initiative of a Private Enterprise." The Tennessee Valley project, if envisioned in its entirety, the President explained,

> transcends mere power development; it enters the wide fields of flood control, soil erosion, afforestation, elimination from agricultural use of marginal lands, and distribution and diversification of industry. In short, this power development of war days leads logically to national planning for a complete river watershed involving many States and the future lives and welfare of millions.

FDR proposed that the TVA "should be charged with the broadest duty of planning . . . for the general social and economic welfare of the Nation."

The Act creating the TVA gave the new agency sweeping powers and charged it with responsibilities for national defense, agricultural and industrial development, flood control, and navigation, also for the Mississippi River Basin. The TVA Board was authorized to contract with commercial producers for the production of fertilizers, to arrange with farmers for large-scale practical use of new fertilizer; to produce, distribute, and sell electric power. The board was authorized to issue bonds for $50 million, "fully and unconditionally guaranteed both as to interest and principal by the United States, [for] the economic and social well-being of the people" living in the Tennessee Valley.

The Father of Public Power

One of the most important actions taken by FDR, was the appointment of David E. Lilienthal to the three-man Board of Directors of the TVA. Born in Morton, Illinois, in 1899, Lilienthal went into law. In his twenties, he began his career litigating against the private utility monopolies, and he was 34 when he became one of the three Members of the Board of the TVA. Lilienthal served as chairman of the Board from 1941 to 1946, overseeing the mobilization of the TVA during World War II, which included the construction of 12 dams in five years. It was, at that time, the largest engineering and construction project in U.S. history, exceeding the Panama Canal.

David Lilienthal's vision for the TVA was as an agency for social change. More than just providing flood control, electric power, shipping, and recreation, the TVA would bring the residents of the Valley in to the modern, scientific era. With a mandate from the President to promote the general welfare, Lilienthal met each challenge in the Valley with a solution.

In January 1933, just months before he would join TVA, Lilienthal gave an informal speech about it in the South.

> More today than a mere opportunity for the Federal Government to do a kind turn for the people in one small section of a couple of States . . . it is an opportunity to accomplish a great purpose for the people of many States, and, indeed, for the whole Union.

The planning for regional development, he said, is an opportunity "not just for ourselves but for the generations to come."

In 1944, in his book, *TVA: Democracy on the March,* Lilienthal sums up his belief, developed after a decade at the TVA, that:

> There is almost nothing, however fantastic, that *given competent organization* a team of engineers, scientists, and administrators cannot do today. Impossible things can be done, are being done, in this mid-twentieth century. . . .
>
> No longer do men look upon poverty as inevitable, or think that drudgery, disease, filth, famine, floods, and physical exhaustion are visitations of the devil or punishment by a deity. . . . [T]he quantity of electrical energy in the hands of the people is a modern measure of the people's command over their resources, and the best single measure of their productiveness, their opportunities for industrialization, their potentialities for the future. A kilowatt hour of electricity is a modern slave, working tirelessly for men. . . .

TVA

David E. Lilienthal, TVA chairman: "There is almost nothing that given competent organization, a team of engineers, scientists, and administrators cannot do today."

"A kilowatt hour of electricity is a modern slave, working tirelessly for men."

When David Lilienthal came to the Tennessee Valley in 1933, only three out of every one-hundred households had electricity. The average farmer's income was $639, while the national average was $1,835, nearly three times as much. Per capita income was $168. More than 300,000 acres of farmland had been destroyed, and 4.5 million acres were on the decline, because farmers were growing soil-depleting cash crops—particularly cotton and tobacco. Erosion was spreading, driven by deforestation, planting on hillsides, and the stripping of nutrients from the soil. More than a million acres of topsoil had disappeared. Fires had destroyed three quarters of a million acres of forests.

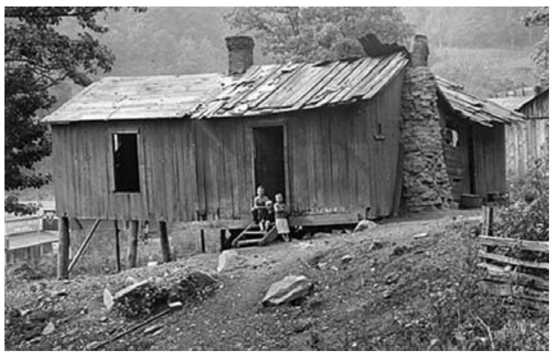
Malaria was endemic in more than half of the Valley area, with infection rates of up to 60 percent in some regions, affecting up to 30 percent of the total population. There were 7.6 deaths per 100,000 population from typhoid and 79.4 deaths per 100,000 population from tuberculosis. Smallpox was still a threat. The average expenditure per child for education was about $23.

This would quickly change. On the day the TVA Act was signed into law by President Roosevelt, less than one hundred days after he assumed office, people danced in the streets of Muscle Shoals, and celebrated with fireworks. In the depths of the Depression, in one of the most depressed regions of the country, people now looked toward their future with the belief that better economic times lay ahead.

Electrification for All

The first challenge facing the TVA was to gain control over the Tennessee River and its major tributaries. A series of dams would be constructed, but these would not just be flood control dams, or irrigation dams, or hydroelectric power dams, or navigation locks and dams—they would be *all* of the above. Many engineers insisted that such multi-purpose dams could not be built. TVA hired those who believed they could.

On October 1, 1933, the first day of the new fiscal year, and less than five months after the President signed the legislation creating the TVA, shovels were in the ground, with the start of construction of Norris Dam on the Clinch River. In its first 20 years, the TVA built 20



TVA

In 1933, the average farmer's income in the Tennessee Valley was $639 per year, about a third of the national average.

TVA

Erosion was widespread throughout the TVA area. More than a million acres of topsoil had disappeared.

TVA

One of the goals of the TVA was flood control.

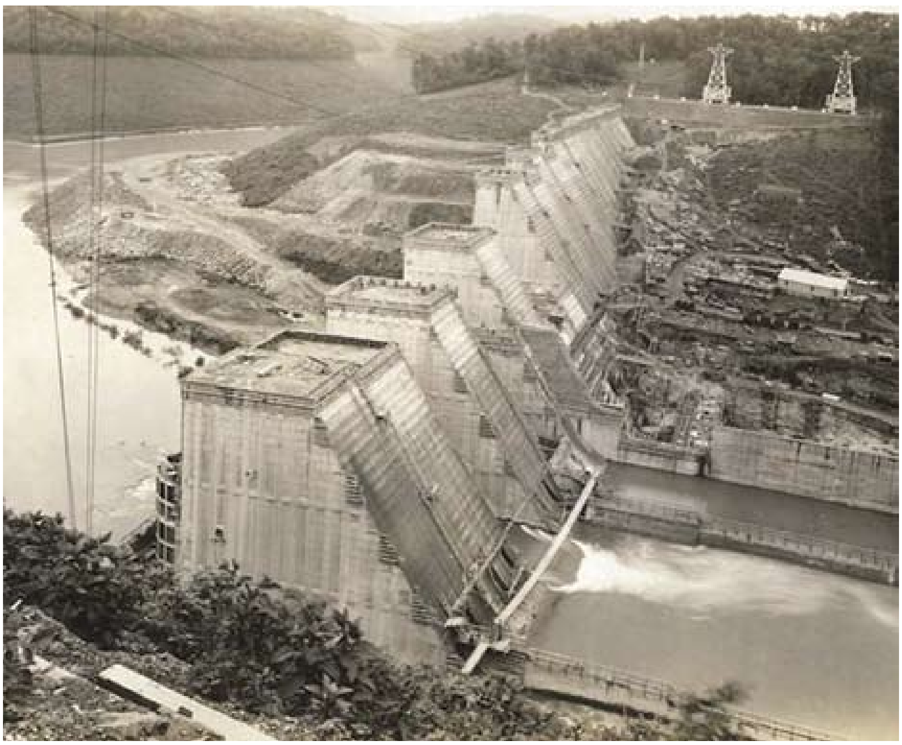
dams. This required 113 million cubic yards of concrete, rock, and earth, or 12 times the bulk of the seven great pyramids of Egypt. The TVA employed nearly 200,000 people over the course of its first 20 years, and apprentice programs created skilled craftsman out of sharecroppers, and mechanics out of tenant farmers.

TVA's dams can store 22 million acre-feet of water, enough to cover the state of Illinois to an eight-inch depth. The completion of the dams created a navigable water transportation artery stretching from Western Virginia to the Ohio River, and connecting the Eastern United States to the Mississippi and the Gulf of Mexico. The placement of dams on the larger tributaries of the Tennessee River greatly reduced flooding, and also helped regulate water flow in both the Ohio and Mississippi Rivers.

But unquestionably, the contribution that the dams made to the Tennessee Valley that was felt most by the largest number of people was the provision, for the first time, of electricity. In 1933, only 3 percent of the farms in the Valley had electric power. A year later, the TVA had 18 megawatts of electric generating capacity. By 1942, there was a near order-of-magnitude increase in generating capacity on line—1.37 gigawatts. In 1934, the TVA had 6,507 retail customers. In 1942, there were nearly half a million. There were zero miles of transmission lines being built in 1934. From 1938 to 1942, approximately 5,000 miles were built each year.

An overriding mandate of the TVA was to provide reliable electric power to the entire population, at the lowest possible rate. In order to do both, the approach of the TVA was to encourage the maximal use of electricity. Over most of its history, TVA electric rates have been about half the national average, while annual use per capita is about twice the national average.

About half the farms in the Valley had electricity by the start of World War II, but most farmers did not know what to do with it. The TVA sent out convoys of trucks, with the help of students from area colleges, and set up tents in rural areas to demon-



TVA

Shovels were in the ground to start construction of Norris Dam less than five months after FDR signed the legislation creating the TVA.

TVA

The Civilian Conservation Corps camp #19 near New Tazewell, Tennessee, in 1933, with the foundation for the winter barracks in the foreground. The CCC worked on reforestation in the Clinch River watershed, above Norris Dam.

TVA

A 1934 parade in Tupelo, Mississippi, to celebrate the city's contract with the TVA for electric power—TVA's first such contract.

strate the use of electrical appliances. Lilienthal persuaded President Roosevelt to form the Electric Home and Farm Authority, which provided low-interest loans to stimulate the sales of electric appliances. The TVA induced dealers to arrange store displays of appliances, and TVA economists visited homes to discuss their use. In 1938, sales of home appliances were $1.61 million. By 1941, sales were $18.5 million.

But the dams, electricity transmission systems, the new roads, rail tracks, and new towns could not be built with a population suffering from disease. Malaria was attacked by reducing the mosquito population, because there was (and still is) no effective vaccine. By 1934, working with county health departments, the TVA provided typhoid shots at dam work sites, and made the shots mandatory for all TVA employees. After an epidemic of smallpox, one of the biggest killers in the South, broke

TVA

Stringing power lines in the Tennessee Valley. Starting in 1933, the TVA began to bring electricity to all, building 5,000 miles of transmission lines each year from 1938 to 1942.

TVA

The Electric Home and Farm Authority gave low-interest loans to people in the valley, to help them purchase electric appliances like stoves.

TVA

By the late 1930s, the TVA was circulating about 13,000 books a month.

TVA

The TVA sprayed against mosquitoes to stop the spread of malaria and inoculated half a million people against smallpox.

TVA

TVA agricultural programs brought Tennessee Valley farmers into the 20th Century. Particularly important was the introduction of fertilizer, which was showcased on demonstration farms and in teaching films. This photo is of a test field, showing its use in producing ground cover.

TVA

The first CCC group assigned to TVA to concentrate on erosion control and tree planting. By 1944, the TVA had planted more than 150 million trees in the Valley.

out in Alabama in 1938, the TVA offered free smallpox shots. By 1951, TVA had inoculated half a million people in the region, helping to produce a regional revolution in public health.

In 1933, the Valley had many totally isolated counties with populations in the thousands, with no railroad service, no newspapers, no radio, and no public library. As the TVA sent armies of workers in to remote areas to build the dams and power systems, it decided to provide access to books, for the "welfare and well being" of the workers, and their families. TVA set up rural libraries, located in stores, post offices, and gas stations. Bookmobiles travelled the countryside. By the late 1930s, TVA was circulating about 13,000 books a month. When the construction of TVA's dams was almost complete, David Lilienthal lobbied—and secured—state support for the continuation of the libraries.

Reclaiming the Land

In 1933, the primary economic activity of the Valley region was farming. Immediate measures had to be taken to restore the productivity of the ravaged land.

Teams of chemists and chemical engineers were assembled to begin operation of a phosphate-based fertilizer production program, to take farming out of the 19th Century. Two hundred TVA experts fanned out across the Valley, to meet with farmers, introducing them to scientifically based modern farming methods. Thousands of demonstration farms were set up, with TVA donating its new phosphate-based fertilizer, and the demonstration farmer opening his farm to share his results with his neighbors. In 1935, TVA produced 24,000 tons of concentrated superphosphate, which grew to 136,000 tons by 1953. TVA fertilizer, which was shipped all over the country, accounted for 24 percent of national fertilizer production between 1934 and 1955. By 1941, 47 states had tested the TVA fertilizer, and 27 were conducting test demonstration programs.

The TVA program had a dramatic impact worldwide. It is estimated that 2-3 billion people, or nearly half the world's population, are alive today because of the development of synthetic fertilizer, more than 70 percent of which was developed at TVA's National Fertilizer Development Center, in Muscle Shoals, Alabama. An investment of $41 million through 1981 returned $57 billion to U.S. agriculture. Fertilizers are responsible for more than a third of U.S. crop production, according

TVA

The Copper Basin in southern Tennessee was a desolate desert after 90 years of copper mining killed off vegetation and eroded the land. Today, more than 90 percent of the area has been reforested.

to the International Center for Soil Fertility and Agricultural Development at Muscle Shoals. Dr. Norman Borlaug, father of the "Green Revolution," which saved millions in the Third World from starvation, was on the board of directors of TVA's International Fertilizer Development Center from 1994 to 2003.

An estimated 2-3 billion people are alive today because of the development of synthetic fertilizer, more than 70 percent of which was developed at the TVA.

The only bona fide desert east of the Mississippi in the 1930s was the Copper Basin in southern Tennessee, which is more than 50 square miles of desolation. It has been compared to the Dakota Badlands, the Gobi Desert, and the Moon.

Ninety years of processing the mined copper that had been discovered there in the 1840s, had killed flora and fauna, and parts of the Ocoee River. Nearly 35,000 acres were completely bare, losing nearly 200 tons of soil a year, and silting the river where TVA had three dams and reservoirs. By 1944, the TVA had planted more than 150 million trees in the Valley. Today more than 90 percent of the Copper Basin has been reforested.

By 1941, the TVA was well on the way to transforming the economy, and lives of the people of the Tennessee Valley. But its greatest challenge was to come.

Winning the War

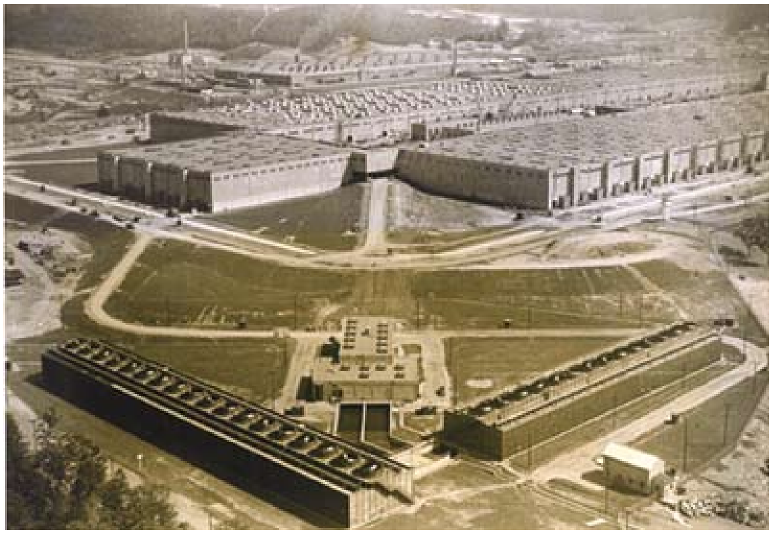
It is reported that not even TVA Chairman Lilienthal knew what was going on in the buildings at the "Clinton Engineering Works," not too far from TVA's Knoxville headquarters, in 1943. Seemingly overnight, new facilities, housing, and a whole new town had sprung up in Oak Ridge, Tennessee.

When the decision was made by President Roosevelt to embark upon the Manhattan Project to develop an American nuclear weapon, there were two prerequisites for success: the best scientific minds the nation could mobilize, and a virtually unlimited source of reliable electrical power. The President turned to the TVA, giving what became the Oak Ridge National Laboratory the task of producing the nuclear materials for the bomb, enriching uranium, and then separating the plutonium. Enrico Fermi who had built the nation's first "graphite pile" reactor in Chicago, then built the Graphite Reactor at Oak Ridge, which produced the world's first sustained nuclear reaction. After the war, this reactor produced the world's first medical isotopes.

Even before the United States was fighting in the war, in preparation, President Roosevelt asked Congress to approve funding for Douglas Dam in east Tennessee in 1941. Opposition on the part of the Congress ended with the bombing of Pearl Harbor. Douglas Dam was completed in a record-breaking 12 months and 17 days. During the war mobilization, the TVA built 10 dams, working 24-hours-a-day, utilizing three shifts, and floodlights at night.

Since 1935, the Aluminum Company of America (Alcoa) had been buying TVA power for its factory near Knoxville, which was then the largest aluminum plant in the world. In 1941, as World War II loomed, Alcoa gave the government its Fontana property, a prime site for a dam, and the bill authorizing construction of the dam was signed just 10 days before Pearl Harbor. The Fontana site was located in the remote Smoky Mountains of North Carolina, and in order to build the dam, a railroad was built to transport supplies. Almost overnight, the TVA erected dormitories, houses, trailers, and tents for the workers and their families. A hospital, bank, library, post office, and schools were built from scratch.

In addition to aluminum for planes during the war mobilization, the Valley processed metals, food, fibers (for uniforms), timber, and chemicals, and manufactured ship boilers, gas masks, and explosives. The fertilizer plants in Muscle Shoals



U.S. Army

TVA

Aerial view of the massive K-25 plant on the Oak Ridge reservation, which used the gaseous diffusion method to separate uranium-235 from uranium-238 for the war effort. Begun in June 1943 and completed in early 1945, the K-25 plant employed 12,000 workers.

The TVA was crucial in the war effort, supplying the enormous amount of electricity required by the K-25 plant, along with materials and manufactures, and preparing survey maps. Without the TVA, the United States in 1941 would not have been prepared to fight, the Federal Power Commission stated.

ORNL

General Leslie Groves (left) and David Lilienthal discuss the transfer of responsibility for atomic energy research and development and weapons production from the Army to the civilian Atomic Energy Commission, which Lilienthal was appointed to head.

supplied the raw materials for thousands of tons of munitions, in addition to the fertilizer to help grow food.

In 1943, the U.S. Army asked the TVA for help in preparing survey maps of enemy-held territory. The first assignment was to map 30,000 square miles of Nazi-occupied France, based on its experience in mapping the Valley. The Armed Forces acquired 470 TVA mapping experts and technicians. The TVA, together with the U.S. Geological Survey, developed advanced mapping techniques and made maps from aerial photographs of a half-million square miles of foreign territory during World War II. An estimated 70 million of TVA-produced maps were used to prepare for the Normandy invasion in June 1944.

After the war, the Federal Power Commission declared that without the TVA, the United States in 1941 would not have been prepared to fight.

But some did not appreciate the TVA's success. One year after FDR created the TVA, the Authority had five law suits pending against it. By 1938, TVA, like other of FDR's New Deal programs, had been attacked on constitutional grounds, in 41 legal cases. Direct legal expenses to the TVA were $518,159. Revenues lost from the delay of hydroelectric projects because of such legal battles amounted to nearly $5.5 million. The challenges would eventually go all the way to the Supreme Court.

For 20 years, the TVA had successfully beaten back attacks by the private utilities to stop its dam and power programs, and by "free market"-advocating Congressmen. Under the protection of President Roosevelt, the TVA had accomplished what only a handful of visionaries had believed was possible. After the war, and with President Roosevelt gone, TVA would face its most serious threat yet.

'Creeping Socialism'

In 1952, for the first time in the TVA's existence, there was a Republican President headed for the White House. President Eisenhower described the TVA as "creeping socialism," and instructed his new TVA Board chairman to "disband the agency," as the Congress tried to dismantle what was left of FDR's New Deal. The stupidity of accusing TVA "socialism" of squelching private enterprise in the region, was demonstrated by the fact that more than a half-million jobs in business and industry were created in the region between 1933 and 1950.

It fell to TVA chairman Gordon Clapp to defend the very existence of the TVA. Clapp was hired by the TVA in its first months, when he was just 27. A Wisconsin native, he became Director of Personnel, then in 1939, he became General Manager, becoming Chairman in 1946 after David Lilienthal was tapped to head the new Atomic Energy Commission. Clapp's philosophical approach, which cohered entirely with Roosevelt's and Lilienthal's, was to develop the resources of the Valley to raise the living standard of the population, not simply to "build dams." The Republicans tried to make the case that TVA's work was finished because the dams had been completed.

TVA Chairman Clapp pointed out the hypocrisy of the Administration's support for a "TVA on the Jordan," as an important peace initiative in the Middle East, and the simultaneous attack on the TVA, at home. To counter the erroneous assertion that Federal funds to TVA constituted unfair "Federal aid" to one particular region, Clapp pointed out that more than half of the $1.4 billion that the TVA spent to buy equipment and materials, was spent *outside the Tennessee Valley*. Ten years earlier, David Lilienthal had explained that the tens of thousands of electric ranges, water pumps, and refrigerators purchased by people in the Valley, were not manufactured there, but in places like the General Electric factories, in Schenectady, New York.

TVA

Gordon Clapp succeeded Lilienthal as TVA chairman in 1946, having worked at the TVA from its first months.

Throughout the Eisenhower years, the debate raged over cutting domestic spending, and the TVA's budget dropped drastically. Finally, in 1959, although Congress was unable to kill the Authority, a law was passed amending the TVA Act, which authorized the TVA to sell bonds on the private market to finance its operations, and removed funding for its power investments from Federal appropriations. It further required the TVA to pay back in annual installments to the Treasury, funds previously invested by Congress, along with an annual rate of return on the outstanding investment that had been made over the previous 20 years! Since 1959, TVA's massive

TVA

President Kennedy spoke at Muscle Shoals on May 18, 1963, the TVA's 30th anniversary. "Let us all resolve that we, too, in our time, 30 years later, will, ourselves, build a better Nation for 'generations yet unborn.' "

electric power development program has been self-financed.

After the war, demand for residential electricity alone rose by 60 percent from 1945 to 1947. Gordon Clapp proposed that a coal-powered steam plant be built to help meet the fast-growing electric needs of the Valley. Congress opposed it, insisting that coal-fired plants would compete with private utilities. After many trips to Washington, to argue his case, Clapp got approval for the coal plant. "If TVA ever ceases to be controversial, it will cease to exist," he stated. Later, this defense of TVA's broadest purpose, set the precedent for leading the TVA to the forefront of the age of nuclear power.

TVA's Work Will Never be Done

On May 18, 1963, President John F. Kennedy travelled to Muscle Shoals, Alabama, for the 30th anniversary celebration of the TVA. Among the dignitaries recognized from the podium was Governor George Wallace. (This must have been somewhat awkward, not only because of President Kennedy's stand on civil rights, but also because the TVA was racially integrated and union organized, from its earliest days.)

"There were many who still regarded the undertaking with doubt, some with scorn, some with outright hostility," President Kennedy said of the TVA:

> Some said it couldn't be done. Some said it shouldn't be done. Some said it wouldn't be done. But today, 30 years later, it has been done.
>
> Despite a record of success, TVA still has its skeptics and its critics. There are still those who call it "creeping socialism." There are still those, and some of them from Massachusetts, who say that this asset serves only the valley. . . .
>
> By working together, we have recognized that a rising tide lifts all the boats, and this valley will not be prosperous unless other sections of the country are rich, nor will other sections of the country be rich unless the valley is prosperous. That is the lesson of the last 30 years.
>
> Finally, there are those who say that TVA has finished its job and outlived its challenges. But all of the essential roles of TVA remain.

The President then cited the region's importance for atomic energy, commerce, and opening new frontiers:

> In short, the work of TVA will never be done until the work of our country is done.
>
> Franklin Roosevelt came from Hyde Park, New York, more than 1,100 miles from this community. George Norris was not a representative of this State. He came from McCook, Nebraska, also more than 1,100 miles from this community.

The President continued: "George Norris's favorite phrase was his reference, and his dedication to 'generations yet unborn.' So let us all . . . resolve that we, too, in our time, 30 years later, will, ourselves, build a better Nation for 'generations yet unborn.' "

Harnessing the Atom

The promise of the quantum jump in energy flux density possible through nuclear technology was nowhere more aggressively pursued than in the Tennessee Valley, and not just for the United States.

In 1963, as the TVA was developing its plan for going nuclear, Oak Ridge National Laboratory scientist Philip Hammond suggested that fresh water, so desperately needed globally, could be produced economically by using the excess heat from nuclear power plants for desalination. Laboratory director Alvin Weinberg, a member of President Kennedy's Science Advisory Board, promoted the idea, as a way to make the "deserts bloom."

The next year, the term "nuplex" was coined, for nuclear-centered agro-industrial complexes, to describe the multi-purpose potential of nuclear energy. In 1964, Oak Ridge Laboratory staff members travelled to India, Israel, Puerto Rico, Pakistan, Mexico, and the Soviet Union, to help plan desalination projects. In 1965, 100 researchers at the Lab were studying how to apply new technologies to nuclear desalination.

Because of its location within the TVA service area, the nuplex research carried out during the 1960s at the Lab by nuclear scientists, chemists, materials specialists, agricultural experts, and engineers could be put to the practical test. In 1971, for example, it was decided that the TVA's Browns Ferry nuclear reactor, then under construction, would include a demonstration greenhouse, which would use the waste heat from the nuclear plant to grow food.

In 1966, the TVA announced plans to build 17 nuclear plants at seven sites in Tennessee, Alabama, and Mississippi. This was slated to be the largest nuclear construction project in the world. Construction began the next year on the world's largest nuclear power plant, at Browns Ferry, just west of Huntsville, Alabama. Seven years later, the first generating unit went into operation.

At the same time, the 1973 war in the Middle East, organized and provoked by British and British-controlled financial and petroleum interests, created an "energy crisis" in the United States, which saw the price for oil, gasoline, and coal quadruple, virtually overnight. The skyrocketing cost of energy and the overall economic contraction led to a drop in energy consumption. This was followed by the second "oil" crisis in 1979 and further economic decline. As energy consumption fell, doubt was raised that more generating capacity, meaning nuclear, would be needed, even by the TVA.

In the midst of these concocted "energy crises," the election of Jimmy Carter as President in 1976 brought a new line of attack upon the TVA, this time, from the so-called "left."

Attack of the Eco-Fascists

In 1977, Jimmy Carter appointed S. David Freeman (no relation to this author), as chairman of the TVA. At the end of his tenure at the TVA, in 1984, Freeman would brag that he oversaw the cancellation of 8 of the TVA's planned 17 nuclear power plants.

In 1978, Freeman told the *Christian Science Monitor* that "conservation" would be one of TVA's major goals. Freeman had been the director of the $3 million Ford Foundation Energy Policy Project, between 1971-1974, which promoted the insane idea that energy efficiency and cutting back on consumption, could be a major "source" of power. (later described as "negawatts"). Former TVA chairman Aubrey Wagner described Freeman's approach as making electricity use "a sin."

Video image from Institute of International Studies, University of California at Berkeley

S. David Freeman, appointed by President Carter to head the TVA in 1977, made "conservation" a TVA goal. He also opposed the Clinch River Breeder Reactor and the completion of the Tellico Dam.

Freeman was the principal architect and promoter of Carter's anti-human energy and environment policies. He was sent to the TVA explicitly to oppose construction of the Clinch River Breeder Reactor and the completion of the Tellico Dam. Clinch River was not needed, and was a bad investment Freeman counseled. There were nonproliferation concerns, and the demand for electricity was lower than projected, he said, so more nuclear plants were not needed. Further, Freeman advised that the breeder must be able to "compete" with solar energy.

In June 1978, Freeman's second assignment was fulfilled, when the Supreme Court stopped the Tellico Dam project, on the Little Tennessee River. This, under a provision of the 1973 Endangered Species act, which protected the tiny snail darter fish, whose habitat was threatened by the dam. The Tellico Dam, which had been first planned in 1939, was then halted when 95 percent complete, after the TVA had spent $109.4 million to build it. It was finally completed in 1979, when the U. S. Senate voted to exempt Tellico Dam from the Endangered Species Act.

Playing on the media-induced irrational fears of nuclear energy after the March 28, 1979 accident at the Three Mile Island nuclear plant in Pennsylvania, Freeman gave a speech in October that year, stating that millions of Americans are concerned about safety. While professing to be "pro-nuclear," Freeman announced his policy to limit construction of future TVA nuclear plants to the seven sites where TVA was

TVA

Construction is now under way to bring the uncompleted Watts Bar 2 nuclear plant into operation.

already building reactors. "I really don't know for sure whether nuclear power is safe," he said.

Then, to "save" energy, Freeman's TVA started delivering wood burning stoves to poorer families in the Valley in 1978, along with a smoke alarm and a fire extinguisher! The TVA gave 20-year low interest loans to buy and install solar water heaters, and loans for attic insulation.

Rather than fight the Malthusians who were making policies in the Environmental Protection Agency, that, if enforced, would have shut down all of American industry, Freeman negotiated a "deal" with the EPA, which eventually cost the TVA more than $6 billion for pollution controls at its coal-burning plants, none of which would have been necessary, had the nuclear program continued, and the coal plants, retired.

When he was not reappointed to the TVA Board by President Reagan in 1984, Freeman continued his destructive career, which included overseeing the development of the Power Exchange (spot market) and Independent System Operator for the State of California, in the early 1990s. "I thought deregulation might work," Freeman said in 2001, as rolling blackouts hit the State.

In January 2009, as the TVA was restarting work to complete the nuclear plants that S. David Freeman had stalled, Freeman apparently finally "got it." He said:

> I tried real hard to make TVA more environmentally sensitive. But . . . I felt like I was a heart transplant that got rejected. . . . The organization itself never got over its low-cost power mission as the overriding mission.

Thank goodness for us all!

Nuclear: A Slow Climb Back

As part of the economic fallout from Three Mile Island, all five of TVA's operating nuclear reactors were shut down in 1985 for a few years, to upgrade safety. As Ronald Reagan's 1980s wore on, and the economy did not improve, work was stopped on TVA's Bellefonte 1 and 2 units (88 percent and 57 percent completed), and Watts Bar unit 2 (60 percent completed) in 1988. But staff were kept on site, while the units were deferred indefinitely. The billions of dollars that had been spent for nuclear construction was now debt being carried and serviced by the TVA, as a dead weight.

With the ascension of the Newt Gingrich neo-conservatives, as the Republican Party gained the Congressional majority in the 1994 election, deregulation of the electric utility industry became the latest attack, not only on public power, but on virtually *any* kind of power. The industry would be turned over to the likes of Enron. In 1995, House Speaker Newt Gingrich set up a House privatization task force, but lost a proposal to privatize the TVA by a vote of 284-144. "There are those who would privatize the Grand Canyon if they got a chance," remarked TVA chairman Craven Crowell.

Threats were made, and pressure was put on the TVA to be ready to "compete" with deregulated private companies. Thousands of TVA employees and contractors were laid off, many of whom the TVA had tried to retain in the nuclear/construction field, as the agency sought to reduce its debt, which was coming perilously close to its Congressionally mandated $30 billion limit.

In 1996, Crowell said the TVA was seeking competitive proposals on options to buy power, "as an alternative to building plans or completing unfinished nuclear units." (In 1994, a similar request for proposals resulted in purchase agreement con-


TVA

Browns Ferry nuclear plant unit 1 was brought into service from its dormant state in 2007.

tracts with Enron, which the TVA ended up suing in 1999 for non-delivery of power.)

But this madness came to a screeching halt in early 2000. TVA chairman Crowell observed: "It's interesting to note that TVA was tempted to follow California's example—rely on the marketplace for electricity rather than investing capital in new generating capacity." Good thing the Tennessee Valley isn't Silicon Valley, was one comment.

With demand rising, and the collapse of the "free market" in electrons after the implosion of Enron, the TVA had only one viable option for meeting the coming increased demand for baseload power: to restart the nuclear build program. That is exactly what the TVA did. In 2002, the Board voted to spend $1.7 billion to return the dormant Browns Ferry unit 1 to service within five years. And five years later, in May 2007, Browns Ferry unit 1 went in to service. It was the first "new" U.S. nuclear reactor in the 21st Century.

In July 2006, the TVA Board authorized an evaluation of the cost and schedule to finish the nearly completed Watts Bar 2 nuclear plant, and approved $20 million for the study. The next Summer, the Board approved the completion of Watts Bar 2, at a cost of $2.49 billion over 54 months. More than 2,300 construction workers were hired by the end of 2009.

Two years ago, the TVA allocated $10 million for a study to see if one or both of the mothballed twin reactors at the Bellefonte site should be completed. In August 2010, the Board unanimously approved spending $248 million in the next fiscal year, to develop the plan to finish Unit 1, which would cost up to $4.7 billion. It had been more than 80 percent complete when construction was stopped in the 1980s.

In 2005, the TVA, came under the provisions of the Sarbanes-Oxley law, which had been enacted in 2002 in response to the Enron debacle. TVA chairman Crowell characterized it as "the first steps toward privatization of TVA." It mandated regulation by the Securities and Exchange Commission, forcing a write-off of billions of dollars of nuclear plant assets, and "allowed" TVA to borrow money from banks and financial institutions.

Today, the TVA is building the only nuclear plant in the United States.

A Model for World Development

It had always been the intention of President Franklin Roosevelt and David Lilienthal for the TVA to be a model for other nations, where people were suffering from the conditions of poverty that had been endemic to the Tennessee Valley before the TVA. As would later be the case for the successful effort of the United States to land a man on the Moon, the economic and cultural transformation of a "Third World" region of America, was held in great admiration, and was America's most effective presentation of itself to the rest of the world. (In fact, stages of the huge Saturn V rockets that would take men to the Moon were assembled at NASA's Marshall Space Flight Center in Huntsville, Alabama, and shipped to Florida through the locks at TVA dams).

By 1944, David Lilienthal wrote, the "more than eleven million people who have visited the TVA in recent years," have included an agricultural commissioner from New Delhi, a group of Swedish journalists, a Brazilian scientist, a Czech electrical expert, Israeli Prime Minister David Ben-Gurion, Indian Prime Minister Nehru, and President Gabriel Gonzales Videla of Chile.

The TVA also functioned as a "training ground for foreign technicians," he reported, including

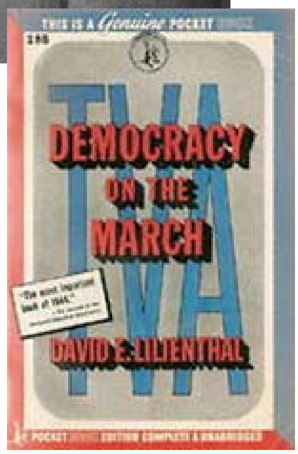
> two score engineers and agriculturalists from a dozen republics of South America; a similar contingent from China. . . . There has been a group of Russian engineers working with TVA technicians on Lend Lease hydroelectric plants that in 1944 will be producing power on streams "somewhere beyond the Urals."

David Lilienthal reported in his 1944 book, that Supreme Court Associate Justice William O. Douglas spent summers travelling on horseback in remote areas of Asia, and Douglas related that

> A Druze chieftain, south of Damascus inquired about it [the TVA]. I was asked about it many times as I traveled the length of the Tigris and Euphrates. . . . Below Baghdad I saw 50,000 people homeless by reason of a flood. They

TVA

TVA chairman David Lilienthal with a visiting Chinese engineer, discussing the TVA and potential projects for the Yangtze River. Inset is Lilienthal's 1944 book, Democracy on the March.



too had heard of the TVA, and wanted one for themselves.

In the 1953 revised edition of his 1944 book, *TVA—Democracy on the March,* which had been translated into 14 languages (with more than 50,000 copies in circulation in Chinese alone), David Lilienthal summarized some of the potential regional economic plans under discussion for TVAs around the world. No major region would have been left untouched by TVA-inspired development. Projects were outlined for the Valley of the Nile River, embracing more than a million square miles, with reaches in to Sudan, Egypt, Ethiopia, Kenya, and Uganda. Parts of the then-Belgian Congo and Tanganyika were also included. TVA-modelled projects were conceived for Niger and Uganda (the African TVA).

The historic Tigris and Euphrates Rivers enter Iraq from Turkey and Syria to the northwest, and flow southeasterly across the country, to empty in to the Persian Gulf. The Iraq plan, to develop this potentially fertile region, Lilienthal reported, "has been described as a project that is essentially an expansion and adaptation along the lines of TVA." Extensive work was done later by David Lilienthal, personally, and his D&R Corporation in Iran.

"To the northwest of India and Pakistan beyond the famous Khyber Pass lies the extremely mountainous country" of Afghanistan, Lilienthal wrote. There are plans, the former head of TVA stated, to develop the Helmand River and its tributary, the Arghandab, for power and irrigation. James B. Hayes, a former TVA project engineer, was the project chief for the American contractor who worked on the 1950s Afghan project, Lilienthal reported.

For India, in addition to two projects already under way along TVA lines, Lilienthal outlined development projects on tributaries of the Ganges River. The Sutlej Development project would include a 560-foot-high dam, electric generating capacity, and a 1.5 million-acre irrigation area.

Today's destroyed nation of Haiti, which is about one fourth the area of the Tennessee Valley, had plans to develop the Artibonite Valley, Lilienthal reported. In 1952, the Inter-American Institute of Agricultural Sciences, founded in Costa Rica in 1942 by President Roosevelt, put forward a plan for a "little TVA" in the Valley. It encompassed not only a series of power, flood control, and irrigation projects, but also industrial development and expanded public health and education.

In 1946, Lilienthal travelled to Mexico, where he encountered former TVA engineers, and young Mexicans who had trained with the TVA. Construction equipment still had the letters "TVA" on the trucks and gondolas, he observed. The Papaloapan Commission, or as it was referred to, the "Mexican TVA," developed a plan to build four dams for flood control, and the integrated expansion of navigation, industry, agriculture, irrigation, and power development.

The underdeveloped "vacation" haven island of Puerto Rico had plans in the early 1950s for a "junior-sized TVA." Four dams were proposed for power and irrigation. The chief engineer for the project was Carl Bock, formerly with the TVA.

In 1942, the government of Peru asked the U.S. to send experts to that nation to supervise a project to develop Duck Canyon, formed by the Santa River. This "Andean TVA" was overseen by three engineers—civil, construction, and electrical—who were all former employees of the TVA. Specialists from the Chilean Development Corporation, which was established in 1939, trained at the TVA for 6 to 12 months. Extensive plans for Colombia and Brazil were also developed.

In the 1930s and 1940s, the Tennessee Valley was a training ground for visiting experts from abroad who could bring integrated regional economic development planning back to their nations. In the 1950s, the experienced technical managers of the TVA were ready to fan out across the globe to help these projects come to fruition.

In 1945, David Lilienthal was distraught at the death of President Roosevelt. Although he continued in government, as head of the new Atomic Energy Commission, Lilienthal could see no way that the Truman Administration would carry the TVA to "thousands of valleys" around the world. In fact, Truman, was busy helping Winston Churchill reestablish the British Empire's control over the very nations in the Middle East and Africa that Lilienthal had hoped to help develop.

In 1955, Lilienthal and Gordon Clapp formed the Development and Resources Corporation, to "provide planning and administrative services in resource development along TVA lines." With experienced experts from the TVA, and a cadre of young, eager engineers, D&R worked around the globe over the course of the next 20 years, to replicate the success of the TVA.

National Archives

Bureau of Reclamation engineer John Lucien Savage (center), was invited to China by Chiang Kai-shek in 1944. Savage, who had worked on many TVA dams, made a detailed proposal in 1945 for the Yangtze River development (below). But it took until 1992 for the Three Gorges Dam program to get under way.

The TVA on the Jordan

The area of what was called Palestine in the 1940s, is slightly over 10,000 square miles, or one quarter the area of the Tennessee Valley. In the mid-1950s, the men who had played key leadership roles in the TVA presented a plan for integrated development to the region's nations and to the United Nations. The proposal was to build a series of dams on the upper Jordan River and its tributaries, which would store water and divert resources into a network of irrigation canals. To compensate the Dead Sea for the loss of these waters, seawater from the Mediterranean would be introduced at a point near Haifa, and conducted through tunnels and canals down the below-sea-level Jordan depression, to the Dead Sea.

It was estimated that 660 million kilowatt-hours of electricity per year could be provided by the dams, and more then 600,000 acres of land could be irrigated for cultivation. In the mid-1950s, Gordon Clapp, who had a 21-year career as general manager and chairman of the TVA, headed the U.N. Economic Survey Mission for the Middle East. The network of water projects required the participation of Syria, Lebanon, Israel, and Jordan. Only such a multinational project would break the death-grip on the region, stemming from the British-French Sykes-Picot Agreement of 1916. In anticipation of the breakup of the Ottoman Empire after World War I, Western Asia was secretly partitioned by these colonial powers into spheres of influence and control, through which the British still today keep the entire region on the cusp of war. The TVA on the Jordan was not started in 1954, and two years later, the British threw the region into the Suez crisis.

In 1990, during the build-up to the Gulf War, economist Lyndon LaRouche resurrected his earlier, 1974 plan for regional economic development planning, his "Oasis Plan" for the Middle East. By that time, with the possibility of using the most advanced nuclear energy technologies for regional economic projects, LaRouche proposed that water not only be captured and diverted, but also *created* through the use of high-temperature nuclear reactors for desalination. These projects, and peace in the region, still await realization.

The Challenge of the Yangtze

One of the greatest legacies of the Tennessee Valley is the role it played in the taming of China's Yangtze River. As David Lilienthal remarked in describing the challenge in the 1950s, "The terms gigantic or colossal are not inappropriate for this plan, which dwarfs the TVA by comparison." Within a 300-mile radius of the proposed dam site, more people would be affected than live in the entire United States, he said. The Yangtze River, more than 3,500 miles in length, is the third longest river in the world, with a drainage area that is nearly

For a history of the Three Gorges Dam, see "Three Gorges Dam: The TVA on the Yangtze River," by William C. Jones and Marsha Freeman, 21st Century, *Fall 2000. A text-only version is available here.*

20 percent of the land area of China.

Plans to dam the river to prevent its periodic catastrophic flooding and bring electric power to an isolated and backward population, were put forward by Sun Yat-sen, the founding father of modern China, as early as the second decade of the 20th Century. A massive flood on the Yangtze in 1931 took the lives of 145,000 people and an equally devastating flood four years later, killed nearly as many people.

Our delegation succeeded in killing a 700-foot high dam on the Yangtze River that a bunch of engineers there had been in love with for the past 20 years.

In 1939, China's ambassador to the U.S., Hu Shih, suggested to TVA Chairman Lilienthal that the TVA should help rebuild China after the war. During the war, engineers from China's National Resources Commission visited the TVA, and a TVA engineer was an advisor to China's War Production Board. In July 1944, the Resources Commission of China met at the headquarters of the TVA. That year, John Lucien Savage, a master builder from the U.S. Bureau of Reclamation who had worked on a number of TVA dams, was invited to China. Savage laid out a detailed and extensive plan for the Yangtze River program, and recommended the training of Chinese engineers at the TVA.

Near the war's end, President Roosevelt dispatched representatives to China, who brought with them the TVA's plans, a Chinese translation of Lilienthal's 1944 book, and offers of cooperation. But the death of Roosevelt, and the civil war in China, delayed for decades what, finally, in 1992, became the Three Gorges Dam development project.

In 1980, the year after the re-establishment of diplomatic relations with the People's Republic of China, the United States and China signed a "Protocol on Cooperation on Hydroelectric Power and Related Water Resource Management." Unfortunately, the team dispatched by President Carter to China, to discuss joint projects, included his TVA Chairman and Malthusian fanatic S. David Freeman, who boasted upon return:

> I think our delegation succeeded in killing a 700-foot high dam on the Yangtze River that a bunch of engineers there had been in love with for the past 20 years.

In the Spring of 1981, a 10-man delegation from the Reagan Administration's Bureau of Reclamation was in China to study the proposed Three Gorges Project. But with the advent of the Clinton/Gore Administration in 1993, the "environmental" lobby now had a catbird seat in the Vice President's office, and American firms were forbidden from participation in this vast project. Nevertheless, both the Chinese, and the TVA, persevered. As President Clinton worked to improve relations with China in 1998, doing an end-run around eco-saboteur Al Gore, Tennessee Governor Don Sundquist and TVA Chairman Crowell organized a conference in Beijing on "Economic Opportunities Through Water and Energy." It was facilitated by Clinton's Ambassador to China, Jim Sasser, a former Tennessee Senator.

In 1998, a Cooperative Agreement was signed with China for the TVA to review China's master plan for dams and develop-

The Mekong River: President Kennedy tried to recruit David Lilienthal into a diplomatic position to develop a "Southeast Asian TVA" here.

ment of the Han River, the largest tributary of the Yangtze, which is one and a half times the length of the Tennessee. In addition to decreasing the flow to the Yangtze for flood control, the plan is for a channel to be built to divert some of the excess water from the Han River to the dry north, and to Beijing.

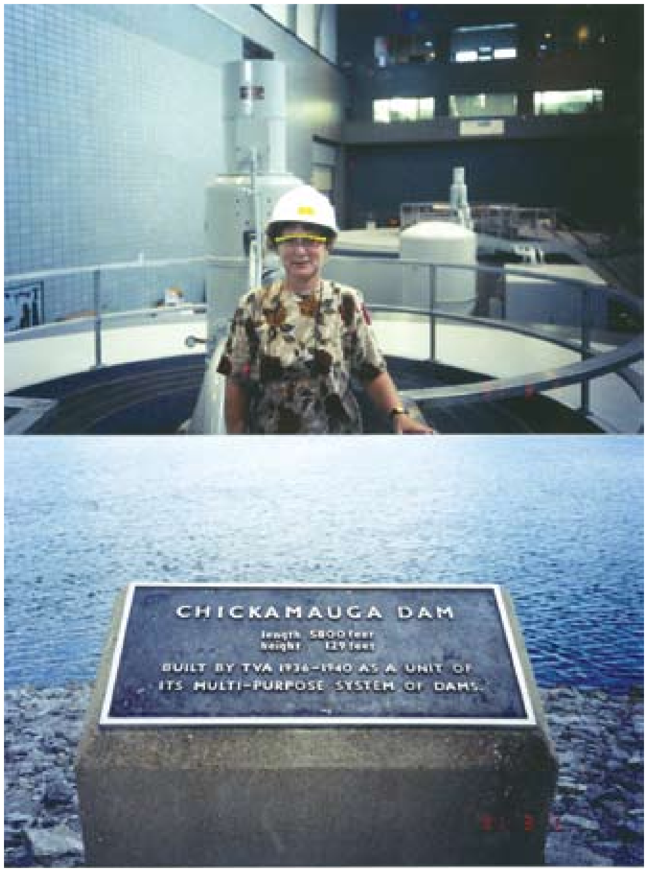
The Three Gorges Dam is now producing power, controlling floods, and allowing navigation along one of the world's great rivers, thanks, in significant part, to the model that was provided by the TVA.

The War We *Could* Have Won

In the early 1960s, the Kennedy Administration tried unsuccessfully to recruit David Lilienthal to a diplomatic position. Offering him the ambassadorship to Thailand, Under Secretary of State Chester Bowles tried to tempt him, by suggesting that the job would help to "create the atmosphere and steam behind the development of the Mekong River, a big Southeast Asian TVA." History would have been written differently, had that project become the centerpiece of the Johnson Administration's policy in Vietnam, rather than the deployment of hundreds of thousands of troops.

The Mekong project was unfortunately conceived of by the White House primarily as a "postwar" reconstruction initiative, although there were attempts to use it as an instrument of reconciliation. David Lilienthal made four trips to Vietnam during 1967-1969 to meet with officials there, survey the area, and develop a plan. Finally, in April 1970, Lilienthal's company, D&R Corporation, seeing little progress, ended its presence in South Vietnam. Lilienthal presented a 600-page report, "The Postwar Development of the Republic of Vietnam," to the Vietnamese government, and then to President Nixon in 1970.

The Vietnam War did more than sacrifice the lives of more than 58,000 Americans and millions of Vietnamese. It destroyed much of the moral fiber of this nation, pushed the economy down the road to the physical wreckage it has become, and killed the most effective science driver for the future, the post-Apollo space program.



The author in the turbine room at the TVA's Chickamauga Dam.

FDR's Legacy

In the Fall of 2005, after the devastation of Hurricane Katrina, which struck the poorest region of the United States, proposals were put forward on how to rebuild the Gulf states. *Executive Intelligence Review* examined the economic profile of the most affected states, mapping the region county-by-county. The study found that only the TVA region had almost no counties of "persistent poverty," defined as having poverty rates of 20 percent for a decade or more.[2] FDR's bold initiative of the 1930s had fulfilled its promise. Reflecting that achievement, Lyndon LaRouche called at the time for a "Super-TVA" to rebuild the Gulf.

After the election of Barack Obama in 2008, hysteria broke out among the third-generation Wall Street neo-imperialists, in the footsteps of those who opposed Franklin Roosevelt's fight against fascism, at the possibility that the incoming Democratic President might become "another FDR."[3] A barrage of books, articles, TV commentaries, and editorials burst upon the scene to try to convince policymakers, and the American people, that Roosevelt's New Deal was a failure. The TVA, which, along with Social Security, is the most enduring legacy of FDR, was a prime target.[4]

In fact, there was nothing for these fools to worry about. President Obama had no intention of becoming "another FDR." Instead he continued the British/Bush policies of hyperinflationary bank bailouts, endless wars, and the increasing impoverishment of the American people.

In the 1930s, the TVA reshaped the seven-state Tennessee Valley and transformed its population, using electricity as an engine. NAWAPA will directly reshape a continent, drive the most dramatic change in economic policy since the New Deal, and push the frontiers of science in the polar regions and our connection to space. Like FDR's Bretton Woods agreement, a new global financial architecture will enable other nations—most immediately, Russia, China, and India—to join this global reconstruction effort. NAWAPA will be the true legacy of President Roosevelt's TVA.

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2. "Super-TVA Needed, Not Halliburton Profiteering," Paul Gallagher, *EIR*, Sept. 16, 2005.

3. See, "Fascists, Then and Now, Stalk the FDR Legacy," by Jeffrey Steinberg and John Hoefle, *EIR*, Feb. 27, 2009; and, "Amity Shlaes' Not-So-New American Fascism," by Jeffrey Steinberg, *EIR*, March 20, 2009.

4. The year 2009 saw the revival of William Chandler's 1984 book, *The Myth of the TVA*, which tried to use statistical hocus pocus to "prove" the TVA had failed.

A misguided pair of diplomats: Ban Ki-Moon (left) and Tuiloma Neroni Slade in discussions at a recent Pacific Islands Forum in Auckland, New Zealand.

Pacific Islands Forum

The Mirage of Rising Sea Levels

A non-problem that is stealing the limelight from real problems in the real world.

by Nils-Axel Mörner

United Nations Secretary-General Ban Ki-moon and Tuiloma Neroni Slade, Secretary-General of the Pacific Islands Forum, have recently claimed that serious sea-level-rise problems occur both in Tuvalu and Kiribati. This is what two misguided politicians may say. But, we must ask, what is the reality?

The answer is clear and straightforward: There is no sea-level rise going on now, nor for at least the last 18 years, either in Tuvalu or in Kiribati. Over and over again, I have tried to demonstrate (Mörner 2007, 2010, 2011) that sea level is not in a rising mode in Tuvalu, judging from the only observational information there is: the tide gauge records.

The same documentation has been made by others, especially New Zealand climate scientist Dr. Vincent Gray (2010). This is illustrated in Figures 1 and 2, where there are no signs of any sea level rise.

So, if our observational facts say that there is no rise in sea level, why are people continuing to drive the sea-level-rise illusion. It doesn't become better (rather the opposite) if you are the secretary-general for the United Nations, or the Pacific Island Forum. It is simply wrong. But what is worse: It steals the limelight from real problems in the real world.

The same is true for the island nation of Kiribati. It lies in an area of the Southwest Pacific where satellite altimetry proposes a sea level rise in the order of 5 mm/year. Gray, in a 2010 article, showed that this indeed does not concur with the last SEAFRAME tide gauge record from Kiribati (Figure 3), a record that spans 17 years. The observed measurements do not record any long-term

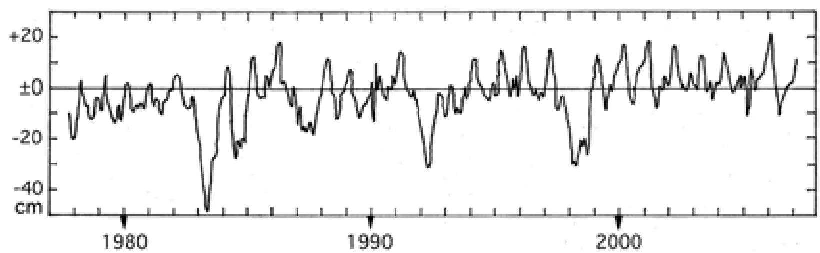

Figure 1
TIDE GAUGE RECORD FOR TUVALU (1978-2007)
The total tide gauge record for Tuvalu from 1978 shows that since 1985 there are no signs of any sea level rise. Three major ENSO events with significant drops in sea level are recorded in 1983, 1992, and 1998. ENSO refers to El Niño/La Niña-Southern Oscillation, a somewhat periodic climate pattern that occurs across the tropical Pacific Ocean.
Source: Mörner 2010

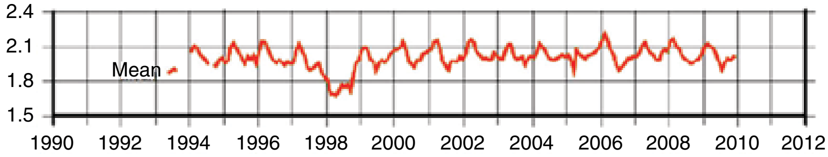

Figure 2
SEAFRAME TIDE GAUGE RECORD FOR TUVALU (1990-2010)
The SEAFRAME tide gauge record from Tuvalu, showing no sign of any ongoing sea-level rise. SEAFRAME, or Sea Level Fine Resolution Acoustic Measuring Equipment, is a network of monitoring stations throughout the South Pacific region that provides data on sea level.
Source: Adapted from Gray 2010

sea level rise, just a stability.

Vanuatu is another famous site in the sea-level debate. Here, too, there is a total absence of indications of any sea-level rise over the past 17-18 years (Mörner 2007, 2011; Gray 2010).

The list of sites with no observed sea-level rise can be enlarged over wider areas (the Indian Ocean with places like the Maldives and Bangladesh) and even wider areas all over the globe. Not the least of these is Northwestern Europe, where it all can be put to a test, even in Venice.

Obviously, there is a major clash between scenario-based computer simulations and reality, in the form of measured data and observations in nature itself. Therefore, logically, there are scientific reasons to turn away from the propaganda, and concentrate all attention and interest on observational facts. In this case, those facts give a very clear and irrefutable message: There is no alarming sea level rise either in Tuvalu or Kiribati.

Ban Ki-moon and his colleague from the Pacific Islands Forum should both feel ashamed of their claims and statements with respect to Tuvalu and Kiribati.

Nils-Axel Mörner is a renowned oceanographic expert who has studied sea level and its effects on coastal areas for some 45 years. He recently retired as director of the Paleogeophysics and Geodynamics Department at Stockholm University, and can be reached at Paleogeophysics & Geodynamics, in Stockholm, morner@pog.nu.

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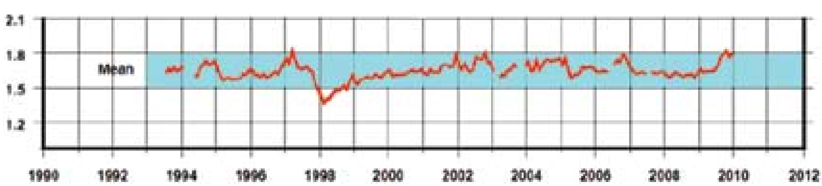
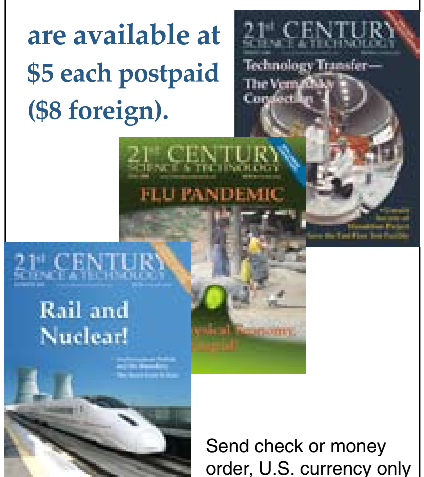


Figure 3
SEAFRAME TIDE GAUGE RECORD FOR KIRIBATI (1994-2010)
The SEAFRAME tide-gauge record from Kiribati documents that there is no long-term sea-level rise. It shows only the stability of the past 17 years.
Source: Adapted from Gray 2010



INTERNATIONAL MEETING ON RADIATION PROCESSING

To Double World Food Production Proliferate Radiation Technologies!

by Matthew Ehret-Kump

NUCLEAR REPORT

The 34th annual International Meeting on Radiation Processing, held in Montreal June 13-16, 2011, brought together leaders in science, industry, and government from around the world to discuss the recent breakthroughs in radiation-based technologies. The focus of the conference was the civilian application of X-ray, gamma ray, and electron-beam technologies as applied specifically to the domains of food preservation, health care, and life sciences more generally.

This year, as daily news reports remind us, there is an even greater urgency to increasing the food supply. Twenty-five to 50 percent or more of food crops are lost to insects, fungi, and other spoilage around the world. Food irradiation can begin to reverse this, especially in the developing sector.

Food production has been decimated by years of imperial monetarist policies, and shortages have been compounded by extreme weather patterns; growing anti-science, eco-fascist hysteria in the general population; and speculation.

Although the ability to control the electromagnetic spectrum is a relatively recent breakthrough for humankind, it has an important and ever increasing role in improving the productive powers of labor, and humanity's mastery over the universe. The creative application of our understanding of radiation for the interests of the common good has been the primary variable behind the amazing increases in population potential over this century, and the foundation upon which the continued increase of that potential into the unbounded universe now rests.

Ruth Brinston/IMRP

A technical presentation at the IMRP conference.

Today, increasing world food production is essential to prevent the looming mass starvation and death, and this absolutely requires radiation-based technologies. The LaRouche movement has called for *doubling* world food production, along with a new financial architecture (including a return to Glass-Steagall) that is necessary to make this happen. We can succeed in creating the necessary higher platforms of human potential only on the condition that the embrace and expanse of radiation-based technologies occur globally and swiftly.

In this spirit, we spoke with many conference participants, and here we present excerpts from some of these discussions, along with three longer interviews.


KAERI

Illustration of the industrial science complex for radiation-based technologies, being constructed near the Advanced Radiation Technology Institute.

INTERVIEW: DR. YOUNG-JIN KIM

Unique Nuclear Center Is a Backbone for Industrial Growth

Dr. Young-Jin Kim is Vice President of the Korea Atomic Energy Research Institute (KAERI) and Director General of Advanced Radiation Technology Institute, Republic of Korea. The interview took place on June 14, 2011 at the International Meeting on Radiation Processing in Montreal, Canada. Kim was interviewed by 21st Century *correspondent Matthew Ehret-Kump.*


KAERI

Dr. Young-Jin Kim

* * *

***21st Century:* You mentioned the very interesting industrial-science complex that will be constructed in South Korea near your facilities. What does the Korean Atomic Energy Research Institute hope to accomplish with this plan, both for South Korea and the world at large?**

Kim: The Korea Atomic Research Institute is the sole institute concerned with the research and development of nuclear technology. It is located in Daejeon, where the science park was already formed some 30 years ago, when our government decided to install the Advanced Radiation Technology Institute in Jeongeup city. This is around one-and-a-half hours driving distance south of the Daejeon headquarters. . . .

About two years ago, it was decided that Jeongeup city, which is 1,000 years old, would be the location of an industrial complex, and now they are preparing the land, so that companies will build their factories here.

About 10 years ago, our government made a plan to improve the regional economy and make it grow in tandem with the central capital in Seoul, the Seoul metropolitan area. Seoul is where most of the money, most of the jobs and the companies are located. So our growth pattern is quite biased.

In the countryside, agriculture is the most important industry. Do you know how difficult it is to gain any economic benefit by growing rice, corn, or vegetables? So this is the area where we were located five years ago. This institute was created five years ago, after the previous five years had been used to make special laws as well as the planning; finally this institute was founded and opened in 2006.

We do a lot of research and development in the area of industrial materials as well as environmental technologies. Our efforts are also on the biotechnologies using irradiation. We have one department where we can use radiation to make mutations, so that we can develop new plants and new flowers.

***21st Century:* You said that there are already similar industrial science complexes throughout South Korea, but that this one is unique. How?**

Kim: It is unique because this one is based on radiation. The other industrial complexes are mostly electronics, car manufacturers, steel manufacturers, information technologies. Those are just some examples, but this is unique because the radiation technologies are based on many different kinds of radiation instruments, such as the cyclotron emissions, gamma rays, electron beams. These beams are used to produce new types of material, or new radioisotopes, and new materials.

For example, for artificial hip-joints, we have new polymers that can be made harder and have a greater longevity. These are made using gamma rays. Also hydro-gels for burn-wound dressings. We also make space food. We sent our first astronaut using the Russian rocket, and she carried this irradiated food up, and they had a party in space. So our research areas are quite diverse.

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The Advanced Radiation Technology Institute in Jeongeup, where Dr. Kim is the director general. The Institute will be designated as an IAEA regional training center for South East Asia.

***21st Century:* You mentioned that this research facility is working to attract various creative minds from across Eurasia, to collaborate together to share ideas and discoveries.**

Kim: Yes, that is our goal. But right now, we will be designated as an IAEA (International Atomic Energy Agency) training center, and regional training center for the Regional Cooperation Area that covers South East Asia. This means we will be training and educating the scientists from Southeast Asian countries like India, Pakistan, Indonesia, Malaysia, Thailand, Vietnam, and some in China, Ukraine, and Mongolia.

Those scientists from about 20 countries come over to our institute to get one to two weeks in training courses, and then they return to their home countries. The program is determined by the IAEA. They decided which programs would be planned for this year, then they informed us so that we could prepare. They decided the lecturers. We are also part of the lecturers for this program. The rest of the work will be done by us.

We are a unique institute for radiation technology in Korea. We were able to successfully develop about 30 good products, and we were able to give them to small and medium companies so that they can grow with our technology. From now on, we will give our technological output to the companies located here in the industrial center.

***21st Century:* So there is an immediate technology sharing that will occur in such an environment.**

Kim: Yes, so we are the backbone for the growth of the industrial complex.

***21st Century:* It would seem that it would affect agriculture as well, since you are in a very rural environment.**

Kim: That is right, but the agriculture portion is very small.

***21st Century:* Will you be involved in genetic modification?**

Kim: No, our work is not genetic modification, it is actually mutation. This is not the same thing. Mutation is a natural phenomenon that occurs in nature. Take, for example, certain flowers. In nature, when mutation occurs the colors change. Once this happens, we take these new species, so that we can further develop them.

Now consistency is a very important factor, because we will need to produce the exact same color of flower, and this process can be accelerated by irradiating the species of flowers, or grains, or some other thing. So this is an artificially driven mutation.[1]

***21st Century:* It's like making nature's natural evolution occur faster.**

Kim: That's right! Exactly. This is one of the examples: [pointing to flowers in exhibit booth] This is our national flower,

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1. S.Y. Kang, D.S. Kim, and G.J. Lee, "Genetic Improvement of Crop Plants by Mutation Techniques in Korea," , Vol. 1, No. 3, pp. 7-15, December 2007. http://mvgs.iaea.org/pdf/PMR2007120103.pdf

KAERI

Matthew Ehret-Kump interviewing Dr. Young-Jin Kim at KAERI's exhibit booth at the International Meeting of Irradiation Processing.



KAERI

KAERI's gamma irradiator and (inset) the cobalt source.

the Rose of Sharon (*Hibiscus syriacus*). We have developed a very small one, so that we can keep it. This is a new breed.

***21st Century:* Is this utilizing the gamma ray technology?**

Kim: That's right. A low level of gamma rays. Because if you use a high level, the seeds will die. Right now we use only gamma rays, but we will eventually also use electron beams.

***21st Century:* Can you mention some examples of how this technology in agriculture benefits a nation?**

Kim: Well, Korea sometimes suffers from typhoons and hurricanes. When there are heavy rains and heavy winds, the problem is that the rice probably can not withstand them, and the stalks collapse. The crop production will decrease quite significantly. But with the gamma-ray induced mutations, we can create species of crops that can withstand heavy winds and rains. This is one area.

Another is that you want to produce food which has better taste and is more nutritious. In this way, this technology can be used very effectively.


KAERI

The gamma phytotron, where gamma ray technology is used to create artificial mutations in plants, such as new flower colors of more nutritious crops.

***21st Century:* The LaRouche political movement has promoted the policy of doubling world food production very soon. And with an increasing world population this is very necessary. It seems like your program will be very necessary as a model for other nations to follow if we are to meet this challenge.**

Kim: Yes. That's right. There are three ways of breeding new types of species. The first is the conventional way called cross-breeding. The second is the radiation-induced mutation, and the third is genetic modification.

These days, the Americans, especially Cargill, which is the most powerful industry, creates these GMPs (genetically modified products). Today about 50 percent of the world's beans are genetically modified organisms, GMO. But Europeans strongly object to it. They do not want to get GMO crops imported to their countries. Our government has the same stance, but most of the imported beans are GMO.

Now … the radiation-induced mutations are very safe, because this is just the acceleration of naturally occurring phenomena. So we are pushing our government to increase our capability of using this technology. Over the years, we did not have a plan to secure and protect our own crops. Significant amounts of our national crops are already gone—stolen by the industrialized countries. This is the case for most of the underdeveloped countries.

***21st Century:* I know that there has**


KAERI

Researchers checking on gamma treated plants.

been a call internationally in recent months to put a cap on food prices, which are artificially rising due to speculation and biofuels. And to do so as a collaborative effort of national governments which act now to protect their populations from the collapsing speculative financial system. This sounds like something that would be very necessary for South Korea to participate in, with China, Russia, India, and various other nations, like the United States.

Kim: Yes, that's right. But the real problem is that the big companies have already secured the different crops of so many types from the underdeveloped countries. We were a very poor country about 40-50 years ago, so that's why we didn't know how to protect ourselves, because there was no person who was concerned about this, or thought that this was very important. Nowadays, our government has realized that this is very important, and we need to protect our own crops.

21st Century: **Absolutely. Food sovereignty is the right of every nation.**

Kim: Yes, that is the case. So this is one area, and a biological resource too.

21st Century: **And nuclear energy as well.**

Kim: Yes. You know Korea ranks sixth in the world in terms of nuclear energy. Thirty-five percent of our electricity comes from nuclear, and now our government has planned to increase that to 45 percent.

21st Century: **Even with all of the fear and hysteria being created around Fukushima?**

Kim: Oh yes. That's right. Our energy dependency is around 97 percent. We import oil, coal, and everything, so we only have a 3 percent control of our own energy. We also produce around 30 percent of our own food, and 70 percent is imported.

KAERI

The seed storage room at the Advanced Radiation Technology Institute, where new seeds are banked for research. The Institute is pushing the Korean government to increase the use of radiation-induced mutation.

Nuclear energy is concentrated energy, meaning you don't need much land. So nuclear energy for Korea is not a choice. It is one of the most important strategies for survival. Otherwise we have no choices. That is why our government is pushing very hard these days. Because of the Fukushima accident, the anti-nuclear activists and environmental groups strongly oppose it.

21st Century: **Well, they're being fed with a lot of fearful propaganda that has no connection with science.**

Kim: You are right. But the problem is that public acceptance is most important, and the public doesn't believe scientists these days, all over the world.

KAERI

New rice cultivars bred by radiation to withstand heavy winds and rains.

21st Century: **Do you think your government has been doing a good job at educating the population of South Korea on the necessity of nuclear energy?**

Kim: We do. . . .

21st Century: **Because the governments have completely failed in Europe.**

Kim: Our government sponsors nuclear public relations institutes, and these organizations continue educating the public, starting with the primary schools. So this is the current situation, but still, some people are not familiar with the science and engineering, and they tend to listen to the anti-nuclear activists because they always use very sensational issues, even though they are not true. They say that because of the nuclear plants nearby, that the baby cattle are born with no brains. That's propaganda.

21st Century: **If anyone is born with no brains, it's those pushing this propaganda.**

Kim: That's right! But this is the case. And it is also the case that we have a very difficult time to prepare the spent fuel, to store it, and this is currently the big issue.

21st Century: Do you have any policy to reprocess the spent fuel? Is that a national intention?

Kim: We now have one big program, which is the sodium-cooled fast reactor.[2] The fast reactor is fueled by reprocessed fuel. For this we are developing pyroprocessing.[3]

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2. *A National Historic Engineering Landmark: Experimental Breeder Reactor 1, Idaho National Engineering Laboratory*, by the American Society of Mechanical Engineers, June 15, 1979, is an informative pamphlet tracing the historical process which led to the construction of the first nuclear reactor capable of producing more fuel than it consumes.

3. Kee-Chan Song, Hansoo Lee, Jin-Mok Hur, Jeong-Guk Kim, Do-Hee Ahn and Yung-Zun Cho, "Status of Pyroprocessing Technology Development in Korea," *Nuclear Engineering and Technology*, Vol. 42, No. 2 (April 2010).

Korea ranks sixth in the world for nuclear energy, with 35 percent of the nation's electricity coming from nuclear. Shown are Korea's nuclear plant sites.

INL

Korea's sodium-cooled fast reactor, now under development, is based on the experience in the United States with the EBR-II fast neutron reactor, which operated for 30 years and demonstrated that this type of reactor can be safely shut down in the event of a serious accident. Here, part of the new EBR-II display at Idaho's Experimental Breeder Reactor-I Atomic Museum.

This technology was also developed at the Argonne National Laboratory in the United States, 30-40 years ago.

At yesterday's keynote speech at the conference, one of the professors talked about pyroprocessing. The first power reactor of this type was EBR-1, the Experimental Breeder Reactor, first demonstrated at the Idaho National Laboratories in 1951.

This was the first fast neutron reactor that produced power, electricity. After that they built EBR-2, which had around 100 megawatts electric power. EBR-2 used a metal-type fuel and a sodium coolant. The EBR-2 researchers wanted to demonstrate to the public worldwide that they had successfully developed the sodium-cooled fast reactor. They also wanted to demonstrate that, even in the most serious accidents, the EBR-2 could be safely shut down without any significant radioactivity release to the environment.

As the speaker explained yesterday, one of the more serious accidents is the loss of coolant. So, in testing the EBR-2, they stopped the primary pump, and they showed that the temperature goes up slightly and then comes down very quickly, and then the reactor stays in a stable condition.

The other serious accident which the EBR-2 is able to handle is the failure of the secondary heat exchanger, so that the reactor heat inside cannot dissipate beyond a limit to the outside.

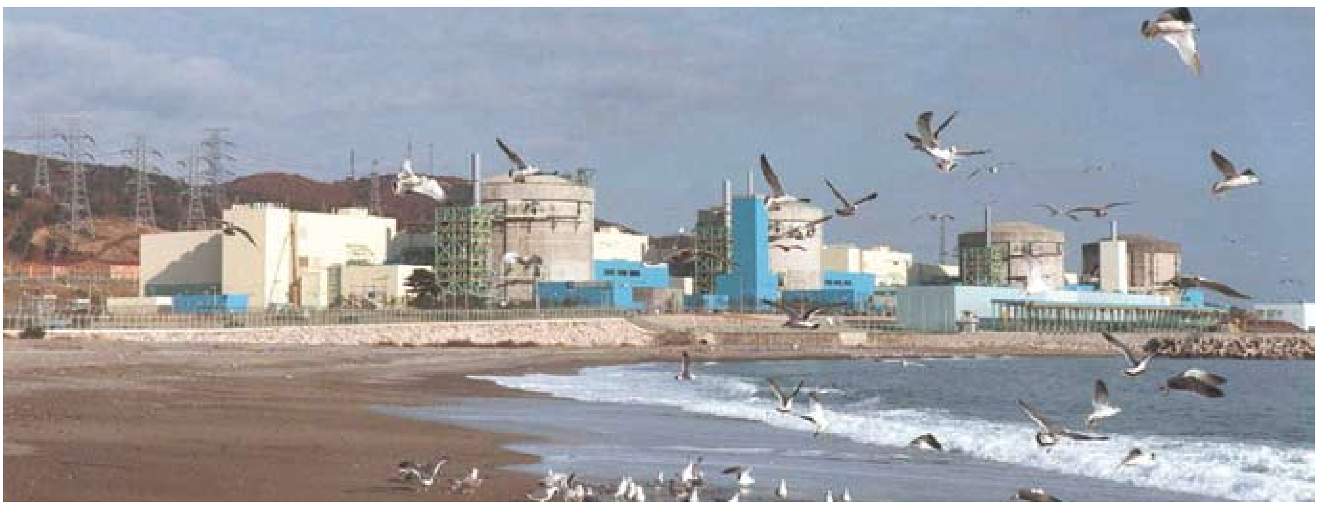
***21st Century:* So its like a melt-down-proof system.**

Kim: Just like that. The problem with the Fukushima accident in Japan, was that they lost the cooling capability. With the EBR-2, they deliberately created a loss of power in the coolant primary pump, and then demonstrated that even with the reactor in this condition, it can be shut down without any problems very safely.

But to get back to your 21st Century about reprocessing: the problem is that the Korean government is not allowed to reprocess.

***21st Century:* Why not?**

Kim: Because that's the policy of the United States. Even though we have developed this pyroprocessing further, we recently had an agreement. The United States does not think that this pyroprocessing-reprocessing technology is "proliferation resistant." The United States and other industrialized countries are worried about the proliferation of nuclear technologies because of the nuclear bomb, that a country could make an atomic bomb, like North Korea.



Canadian Nuclear Association The Wolsong Nuclear Plant, one of the four CANDU-type reactors operating in Korea. The CANDU reactor uses natural uranium as fuel.

That's why they keep us from actually handling the spent fuel. So we have changed it from reprocessing, to the re-use of spent fuel. Yesterday, the speaker mentioned that the CANDU reactor produces a lot of spent fuel (four times more than the PWR, Pressurized Water Reactors) because the CANDU doesn't use any enrichment; it uses only natural uranium as the fuel.

***21st Century:* It's ironic that here in Canada where we have this capability, we have not produced a reactor since the 1980s.**

Kim: I know! We actually have four CANDU reactors operating in Korea.

AECL/CANDU

Korean nuclear operators trained on this CANDU simulator in Canada.

***21st Century:* Well, it seems Canada has a lot to learn from South Korea's experience, and other nations do too.**

Kim: Yes, that's why we have 21 nuclear power plants in operation. Of that, 4 are CANDUS, and 17 are PWRs of different companies. The first 4 PWRs were constructed by Westinghouse. We even had French President Mitterrand visit our country to sell us their PWRs. The deal was that we were to buy their power reactors, and they would return our old cultural records, which were stolen by the French.

***21st Century:* Really!? The French stole these ancient books?**

Kim: Yes. In the late 19th Century, the French navy actually invaded Korea.

***21st Century:* I didn't know that. And they took these cultural heritage pieces to France? And so, in agreeing to a technology transfer, they also agreed to return the books?**

Kim: But, it did not happen. Mitterrand did not keep his promise. Now early this year, France allowed the return—on lease!

***21st Century:* You're so fortunate! You get to borrow your own cultural heritage books.... Well, Mitterrand had a history of being a skunk.**

The world has a lot to learn from the experience of South Korea right now, and we hope that greater collaboration occurs.

Kim: I hope so too. Because the Koreans are special in the sense that the parents are always eager to educate their children, and education is the first priority. Always. Parents will sell everything to keep their children in school. They even send their children to the industrialized countries like the United States, or Japan or Europe, and this is one of the strongest aspects of the Korean economy.

We emphasize education and that means we build a higher level of human resources. I think that this is the main reason that Korea was able to develop very quickly.

***21st Century:* Well, the children are the future.**

Kim: Another thing, is that we kept the Confucian tradition.

***21st Century:* You didn't go to Taoism?**

Kim: No. That's why we have a great deal of respect for our parents, good family unions, and relations, international cooperation.

We had a collaboration with AECL (the Atomic Energy of Canada Limited) to build a multiple purpose research reactor, the Hanaro, with 30 megawatts thermal power, a world-class research reactor. This was in the middle of the 1980s. I came here to Montreal two times.

At that time we didn't have any of the infrastructure for basic science. This was our first high flux research reactor, and we successfully developed and constructed the 30-MW Hanaro. Hanaro means unity in Korean, or uniqueness, because this Hanaro is the only one in operation anywhere in the world.

Even though the fuel bundles were originally developed by AECL, all other work was done by ourselves! Now, at that time, Nordion had a plan to build two 10-MW Maple reactors.... The Canadian firm Nordion is one of the big guys in radioisotope production and export.

The reason we decided to collaborate with AECL on that project is because in the early 1980s, Nordion asked AECL to build radioisotope-only reactors, reactors that are dedicated to producing radioisotopes. So we chose AECL because their plan was two years ahead of us. That means, if they made a mistake, we could learn it right away, and that would be a very safe way to develop our own reactors.

Now, the problem was that their plant was delayed and delayed. So, we have no reference.

***21st Century:* That made you the pioneers all of a sudden.**

Kim: Yes. We became the pioneers, and the contract has been changed. The initial contract read that all responsibility for the development was on AECL, but just three years later everything had changed. That means we are now on our own, and AECL is only supplying some major components and collaborating in some areas, but is not the main contractor.

We took around 10 years to complete this project successfully. Hanaro was completed in 2005, 10 years from its start. However, because this was our first research reactor, our regulatory body did not allow us to operate it at full power. So our plan initially was that we would operate the plant at 10 megawatts, and then by showing our experimental data to our regulatory bodies, that we would be able to increase it another 5 megawatts. It took almost nine years to come to the final stage.

***21st Century:* What's the full potential?**

Kim: Full potential is 30 megawatts. But now the reactor is not at full potential, but rather at what is called design power. Design power means that we can increase the power beyond the 30-MW limit. If we can prove experimentally that we can operate the reactor at 35 MW, then we can increase it.

Design power now is 30 megawatts. We can run this at 30 megawatts for 24 hours per day for up to three weeks, with 10 days for maintenance and refueling. So all together, we operate for about 230 days per year, continuously 24 hours, and this is quite an achievement. Now, initially, after we constructed the reactor, there was no experimental facility whatsoever! Nothing. So then in 2005, our government decided to give us the money to build the necessary instruments, meaning it took another 10 years to install all the equipment for basic science and industrial application. I was the one who made a plan to build what you call the cold neutron system. . . .

KAERI

The 30-megawatt Hanaro research reactor, used for producing radioisotopes, was developed with Canada's AECL, and completed in 2005. Because Canada discontinued its two similar Maple reactors, KAERI is pioneering this new design. Hanaro now has the instrumentation for use of cold neutrons. Construction for a second research reactor for isotope production will begin next year. similar reactors.

Cold neutron means that the wavelengths are almost nanoscale in size. A neutron behaves both like a particle as well as a wave. Cold neutrons can be applied to characterize nanomaterials as well as biomaterials. For example if you have to transfer a medicine through the membrane.

The advantage of the cold neutron is that its energy is very low. The energy is comparable to the excitation of the atom. This way we can investigate the characteristics of the dynamic properties of the materials. The cold neutron research facilities are available only in some countries, such as France, where Cadarache has the most powerful research reactor; and Germany as well, located in Munich. Japan has it. The National Institute for Standards and Technology has it in the USA, and also the Oak Ridge National Laboratory. And those are the only nations that have it.

***21st Century:* We have been advocating for many years, that a much better metric for economic value is not determined by markets, but rather by isotope production. We've produced various papers around the idea of an isotope economy. That the best way to measure the health and wealth of a nation is by its capacity to produce the greatest density of isotopes and bring them into use in human society.**

Kim: Maybe you can talk to the Nordion people, because the AECL gave up. They successfully constructed two 10-MW Maple research reactors, but they couldn't get a license from the government regulatory body, because of some safety problems. They tried to solve it for five or six years, and then they gave up. They announced that they wouldn't continue this process, and are now under lawsuit from Nordion.

***21st Century:* Well, look at the mess of the Chalk River isotope production reactor, and that was a 1950s technology.**

Kim: That is the NRU, the National Research Universal reactor. It gave them a problem because it was too old. The operation was not stable, and it was sometimes out of service.

There was another isotope production reactor located in Petten, the Netherlands, which was also 50 years old. It had a problem in the primary circuit, and so they had to shut down that reactor for almost two years.

That meant that the supply of technetium-99m was very unstable.[4] And that lack of medical isotopes is why we had troubles in the medical sector in the diagnosis of cancers. That is why the OECD called all of its member countries, and had a discussion on resolving these issues about three years ago. At the end, the OECD gave each country the duty to produce a certain amount by 2016, which is five years from now.

We had our quota. So our government decided to build a new research reactor mainly to produce radioisotopes. The government approved the plan this year, and we can start the construction of this new research reactor as of next year.

***21st Century:* I'm sure that the collaboration between the western nations, and eastern nations around these great endeavors will only improve as people come back to reality. So thank you very much for giving me your time.**

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4. For more on this, see the interview with Dr. Guy Turquet de Beauregard, "We Need to Expand Medical Isotope Production!" in *21st Century*, Winter 2009-2010, pp. 46-50.

Producers and Consumers Benefit From Food Irradiation Technology

Dr. Arun Sharma is the head of the food technology division of the Bhabha Atomic Research Center of India. He has more than 300 publications in national and international journals, and in 2006, he received the Indian Nuclear Society's award for outstanding achievements in the field of radiation and radioisotope applications. This interview with Matthew Ehret-Kump took place at the International Meeting on Radiation Processing in Montreal, June 14.

* * *

***21st Century:* Can you describe for our readers what food irradiation is, how it is different from chemical food treatments, and why it is so necessary for nations to attain food security?**

Sharma: Food irradiation is a physical process. The U.S. Food and Drug Administration treats it as an "additive" process, but it is actually a physical process by which the controlled doses of radiation are applied to commodities. Commodities are exposed to controlled doses of radiation to achieve certain objectives, such as food safety, food security, or to overcome quarantine barriers.

Ionizing radiations achieve these objectives by inactivating DNA, the genetic material, of microorganisms or insects that contaminate food, or, at very low doses, by preventing or delaying physiological processes such as sprouting, ripening, and senescence of fresh fruits and vegetables.

Ionizing radiations used for processing food include gamma radiation from radioisotopes such as cobalt-60, or electrons generated through machine sources called electron accelerators, or X-rays. When electrons fall on certain targets such as tantalum or tungsten, they get converted into X-rays. So, one can use gamma rays from radioisotopes, and/or electron beams or X-rays from machine sources.

When you say chemicals these are mainly fumigants. Fumigants like methyl bromide, and ethylene dibromide are used for killing insects in stored grains, cereals, and their products, or in fruits, both fresh and dry. Ethylene oxide (ETO) is used for destroying microorganisms in foodstuffs.

There are problems with chemical methods. The biggest problem is that they are not environmentally friendly. Since they are halogenated (chlorine- and bromine-containing) hydrocarbons, they react with ozone. Also, they leave residues on food materials which could be carcinogenic or harmful to human health. Therefore, governments around the world have plans to phase them out by 2015 under the Montreal Protocol, and irradiation is a good alternative.

Moreover, irradiation is a cold treatment. It is also called cold pasteurization.

***21st Century:* What does that mean?**

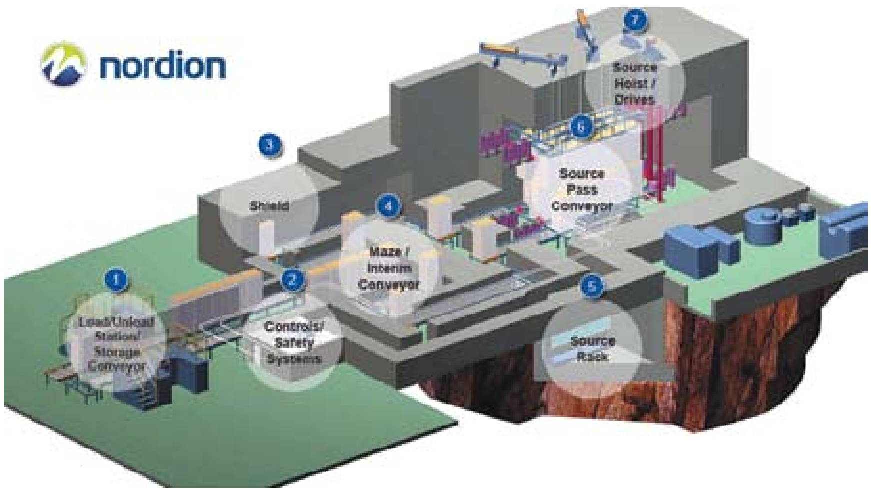
Sharma: That means that it doesn't raise the temperature of the commodity being processed by it. The commodity retains its fresh, or as it is, character. Unlike heating, it doesn't change the texture or flavor of food, whereas, thermal treatments, as you know, change it completely.

Chemical treatments also sometimes change some of the characteristics of food like color, besides being harmful. So, irradiation is a very friendly treatment for agricultural commodities.

***21st Century:* Can all food products be irradiated, or only some?**

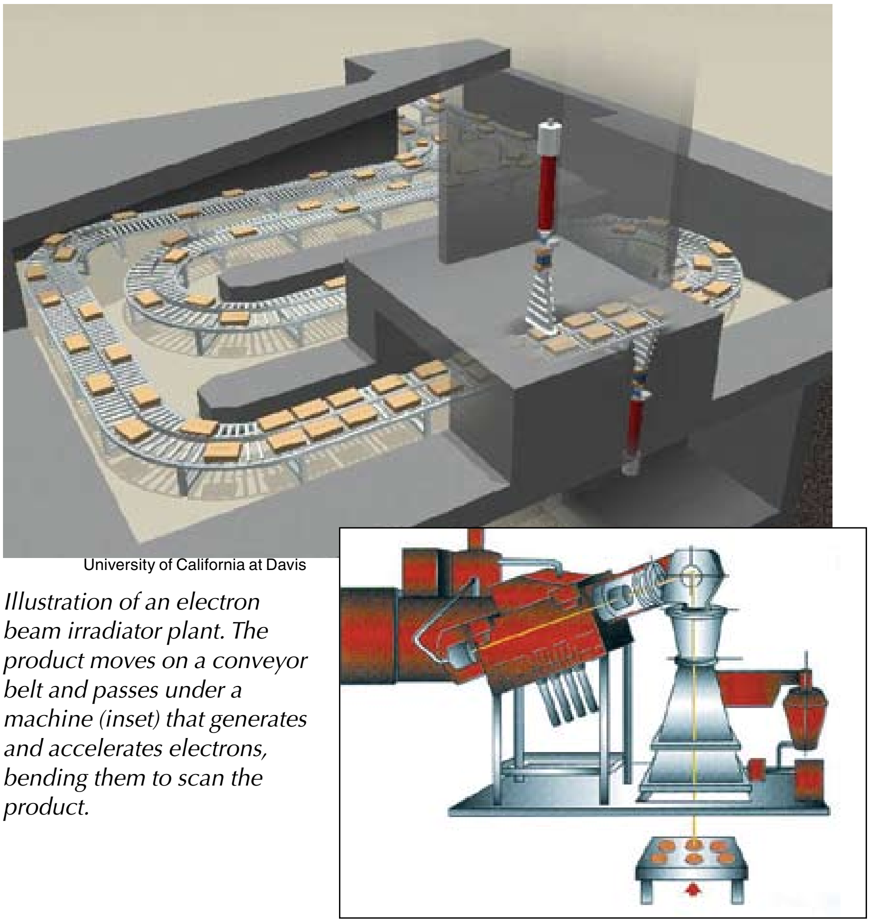
Sharma: In principle, you can process most foods by irradiation, by manipulating the conditions of irradiation. In general, to achieve objectives mentioned above, the food is exposed to doses less than 10 kGy (1 gray is 1 joule of energy absorbed in 1 kilogram of food), that can be applied under ambient conditions.

To sterilize certain categories of food like meat products, and make them am-



Nordion

An interactive illustration of a gamma ray irradiator (using cobalt as a source). The product moves on a conveyor belt past the irradiation source, where it receives a preprogrammed and timed exposure.



University of California at Davis

Illustration of an electron beam irradiator plant. The product moves on a conveyor belt and passes under a machine (inset) that generates and accelerates electrons, bending them to scan the product.

bient stable (for example, astronaut meals), doses of radiation much higher than 10 kGy are used, and the process is carried out at very low temperatures, to eliminate unwanted changes in food flavor while achieving the desired objective of total sterility.

This is one technology that allows you to process most of the food commodities; but certain food commodities are treated in a better way with other processes. One example that can be given is milk and milk products. Irradiation is normally not used here, because we already have thermal technologies working very well for milk and milk products. And also, some of these products may be very sensitive to radiation-induced oxidative changes affecting flavors.

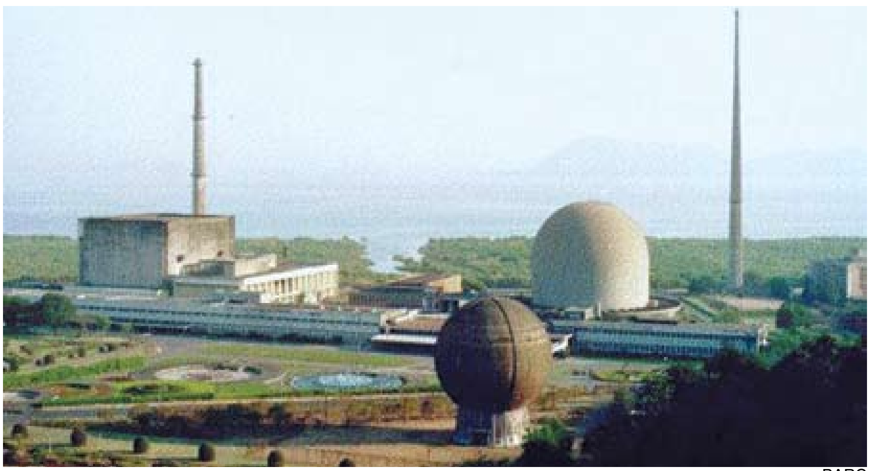
Irradiation can be a very effective way of ensuring food safety and security, in commodities like spices, grains, cereals, dry fruits and vegetables, and fresh produce.

***21st Century:* Food spoilage is a great problem in the world right now. We have two physical problems which are compounded. On the one hand, we have been lowering per capita production of agriculture in recent years, but at the same time, much of what we have produced has gone to spoilage. If a large-scale irradiation program were applied more seriously by national governments, how much food could be saved from food spoilage globally, more generally, and India more specifically?**

Sharma: Food spoilage is a major problem in developing countries, mainly because the means to store food in a proper way—like cold storage facilities, silos, appropriate or adequate packaging—are not available. Sometimes, even roofed or indoor storage is not available, and often the grains in jute bags are stacked in open fields with a tarpaulin cover. This results in a lot of spoilage.

It is well documented that spoilage can be as high as 50 percent in some of the fresh produce like fruits and vegetables, and as high as 25-30 percent in cereals and grains. And, looking at the cost of these commodities in today's market, and calculating for the volumes at today's prices, the figures could be mind-boggling—running into billions of dollars in losses.

It is worth preventing the spoilage, and using it to uplift the segment of population for which food is not quite affordable, and those living below the poverty line. So, there is a lot to be gained by the use of appropriate technologies like irradiation to prevent spoilage and making food available to the underprivileged section of our society.



BARC

The Bhabha Atomic Research Center is multidisciplinary and pursues the full range of nuclear science and engineering technologies. BARC was founded by the great Indian scientist Dr. Homi Bhabha in 1944, just after the announcement of the discovery of fission. Four years later, India set up its Atomic Energy Commission. A research reactor began operation in 1956.

IRRI

Food irradiation can make a big difference in developing countries, where proper storage is not available, and food spoilage can be as high as 50 percent. Here, grain stored in the open in jute bags.

Exported spices are irradiated abroad, but India would also benefit from spice irradiation domestically, Sharma says, to prevent loss in storage to insects, fungi, and other contaminants. Here, spices in Mapusa Market, Goa, India.

21st Century: **In your conference presentation you mentioned that even though India was the largest producer of spices in the world, only a mere 2,000 tons were irradiated. Could you say something more about that?**

Sharma: Well, you see this irony in spice irradiation. The fact is that ultimately, irradiation, like any other technology, is need based. In India, as institutional cooking is rather small, and there are only a few large food service companies, most of our spice consumption is at the household level. The traditional cooking methods where spices are used during cooking and tempering take care of most of the resident spice microflora, and no major safety issues are encountered.

But when these spices are to be exported to be used in institutional cooking, or used directly to spice or garnish cooked food, the food safety issues assume importance. Microorganisms and pathogens in spices can live happily or even outgrow in cooked food, posing health risks to consumers. Therefore, there is a need for spices to be free of microbes and to decontaminate them by a cold treatment like irradiation.

In India, irradiation could be used for another purpose, that is for preventing storage losses in spices or retaining their quality. There are spoilage losses in spices too. Many times the spices get infested with insects that bore into them and reduce their quality. Sometimes, during storage, spices also get infected with toxin-producing fungi, and may get contaminated with carcinogenic mycotoxins like aflatoxin, and these spices would not pass the test of quality for human consumption.

Therefore, I think there is a need for applying this technology in India too for improving storage of spices, and not as

Irradiation helps preserve commodities like these in storage, which means more food available for human consumption. At left, nonirradiated compared with irradiated (right).

Government of India

A demonstration irradiation facility for spices, began operation at Vashi, Navi Mumbai, in January 2000.

much as a food safety measure as is done in the rest of the world. Therefore, spices exported from India are mostly irradiated abroad rather than at home. So it is purely driven by the perceived need.

***21st Century:* Many people have argued against the idea of having a mass irradiation program because the process has a tendency to raise the price of the food, since it is still at a stage where it is very expensive. What would you say in response to this critique?**

Sharma: See again, the increase in the cost of food by this process is relative, in the sense that if you have large throughputs—that is, if you have economies of scale—then the processing costs are very insignificant. In fact, we have worked out these costs, and most of the time they can be less than 5 percent of the commodity cost. That is insignificant compared to the gains you have with the application of the technology.

Those gains can be in terms of saving the commodity, or in terms of improving the quality of the commodity, or in terms of gaining market access. And, those gains are tremendously large compared to the processing costs that you incur. And, if you use the facility at the designed throughput level, you will always benefit.

***21st Century:* And every technology at its earliest stages is always expensive, but as we saw with the expansion of nuclear energy in the 1950s and 1960s, through governments offering national insentives and proper mission orientation, the price would obviously go down.**

Sharma: That's right. As you use the technology more and more, in the example you have cited of nuclear energy, where over the years, the costs and the time of installation of nuclear power plants have drastically come down. As a result, the cost of generating electricity from nuclear plants has also reduced. This ultimately benefits the consumer.

Similarly, here, as for any other technology, when it improves or used on a large scale, the cost definitely comes down and additionally, its employment potential also increases. Those are the benefits of using the technology on a large commercial scale.

***21st Century:* For all of this to happen though, at this point, when you look at the speculative monstrosity that the world economy has tended to become over the past decades, it will be very important for nations to clean things up and return back to a sane economic program, where money is a servant of the people and not of speculative finance for middle men who have no interest in the general welfare.**

Sharma: Yes, you are very right. The actual benefits of the technology should go to the primary growers, the primary producers, and the consumers. The middlemen? Of course they are a part of the stakeholder chain, but they should not be the major beneficiaries of this supply chain. That is how everyone can have a win-win situation.

Basically, the primary grower, and the consumer should benefit largely from the technology. Of course, the middlemen and traders have their stakes. We don't deny them their role and due. I think it is good for the countries and the economies if the primary producers and consumers benefit from the technology.

***21st Century:* That's a good lesson!**

USDA

A 2007 press conference in Washington, D.C. celebrating the first imports of irradiated Indian mangoes. The United States bans imported tropical fruit that is not disinfested.

INTERVIEW: PHILIPPE DETHIER

Particle Accelerators Have Advantages for Irradiation

IBA

Philippe Dethier: "E-beam and X-ray sources are powered with electricity, so if you switch off the machine, you have no more radioactivity going around."

Philippe Dethier is the marketing manager of IBA, a Belgium-based international company that supplies ion beam accelerators and associated technologies. He was interviewed by Ilko Dimov.

* * *

***21st Century:* Can you tell us what your company does?**

Dethier: IBA supplies particle accelerators for multiple applications including medical device sterilization, polymer crosslinking, and food irradiation.

When it come to food treatment, irradiation technologies are clean alternatives to traditional fumigant technologies such as ethylene dibromide (EDB), methyl bromide, ethylene dichloride, and hydrogen phosphide, which are pesticides banned in many countries for health and environmental reasons.

There are three main irradiation technologies for food: electron beam, X-ray, and gamma ray (or cobalt-60). IBA is active in irradiation technologies based on e-beam or X-ray accelerators, using electricity as the source power. Whether you choose one or the other technology depends on the products you are processing.

E-beam is very efficient but has low penetration properties, and is suited for bulk processing of small-dimension products. The main difference between X-ray and e-beam is that X-ray has high-penetration. Such high penetration properties allow treating products on pallets, which is typically what the food industry requires.

Here at IMRP 2011, we are introducing a new technology, high powered X-rays, able to treat food on pallets, with a technology that is fully powered with electricity.

IBA

IBA's Rhodotron TT1000, which is now operating in a Swiss medical device sterilization plant, has multiple beamlines which allow the energy to be tailored to the product, using X-rays or e-beams.

***21st Century:* So the source of the X-rays is not radioactive?**

Dethier: Exactly. E-beam and X-ray generators are powered with electricity, so if you switch off the machine, you have no more irradiation generated. And that's why we believe it is the future, not only from a safety point of view, but also from an economic point of view. If, for example, a food producer wants to treat food only during peak season (let's say three or four months of the year), you can completely switch off the machine during the off-peak season and stop your costs related to electricity.

With irradiation technologies based on radioactive sources, such as gamma irradiation, if you close the facility for three months, your gamma source is still decaying (losing activity), which represents a cost without any product being treated.

***21st Century:* So this is good, because it resolves many ques-**

tions regarding proliferation, terrorism, and all this crazy stuff.

Dethier: Exactly. X-ray systems do not require radioactive sources. Electricity is available all over the world. . . .

21st Century: **Right now there is a food poisoning epidemic in Europe, in particular in Germany, where many people have died from *E coli.* How can your machine treat this problem?**

Dethier: Irradiation technologies can indeed help in sanitizing food.

Food irradiation is all about managing the dose you administer to your product. Product irradiation is never perfectly homogenous because of the non-homogenous density of the product and the varying distances from the product to the irradiation source. The key parameters to consider are minimum dose and maximum dose. Inactivating a specific pathogen will require a given minimum irradiation dose, which depends on the resistance of the target pathogen to irradiation.

On the other hand, authorities regulate the maximum dose which can be administered. Too high dose may also deteriorate products which have low resistance to irradiation.

So the whole game is to find a good balance between the minimum dose to kill the pathogen, and the maximum dose which is allowed by authorities and which will not damage the product.

For example, let's say to inactivate a specific pathogen I need 400 gray,[1] and authorities allow irradiation with a max dose of 800 gray. You now have your maximum and minimum dose and can decide which technology you want to use to treat your product.

The big advantage X-rays offer is to reduce the min/max dose to the minimum, compared with other irradiation technologies.

Other irradiation technologies, such as gamma irradiation, cannot go as low in the min/max ratio—meaning that for a given minimum dose (dictated by the pathogen resistance to irradiation), the maximum dose in the product will be much lower when using X-rays than when using other irradiation technologies.

Biological and Agricultural Engineering, Texas A&M

An electron microscope image of green-leaf lettuce, where rod-shaped E. coli *bacteria nestle inside a minute pore in the leaf called a stoma. Food irradiation technology can reach pathogens such as* E. coli *in stomas, but conventional technologies cannot.*

21st Century: **Is your machine already in operation?**

Dethier: Many X-ray systems are in production around the world, but we have installed the first high-power X-ray generator recently in Switzerland. That system is now in operation, and its configuration is optimized for medical device sterilization—but the technology is the same as for food treatment.

The technology is available and mature, since it is based on well-proven accelerators; but we expect the industry to require some time before being convinced by its efficiency.

21st Century: **Can you say something more about the economic effects?**

Dethier:I think it would more interesting to ask what is the expected cost per ton of treated product? Expense will become less of a barrier as irradiating food will become cheaper than the 70 euros ($101) to 120 euros ($172) per metric ton it costs now.

Costs depends of course on the volume the X-ray treatment facility handles. The bigger the facility, the more economies of scales and the better prices can be achieved.

21st Century: **One of the problems we have right now, for example in Africa, is that up to 50 percent of the food they produce gets destroyed by birds, bugs, and disease. What would an irradiation plant cost for a developing nation?**

Dethier: There are multiple applications with food irradiation which can help developing countries. Some of them are:

- Inhibition of sprouting in potato, onion, or garlic.
- Phytosanitary treatment for insect disinfection on exported products, such as grains, papayas, mangoes, avocados, etc.
- Delaying of maturation
- Control of foodborne pathogens for beef, eggs, flounder, crab-meat, oysters, etc.
- Shelf-life extension for chicken and pork, low fat fish, strawberries, carrots, mushrooms, papayas, etc.

21st Century: **Are there any government agencies in European nations that are studying the applications of your technology and that could potentially be able to put it in operation?**

Dethier: We are talking to several companies evaluating the possibility to open new X-ray facilities for food processing. For the moment, the main interest is for phytosanitary applications, where food exporters (mainly to the United States) are looking for alternatives to comply with the U.S. import regulations.

Additionally, traditional fumigation methods based on methyl bromide are banned by the Montreal Protocol.

Phytosanitary treatment requires typically a minimum dose lower than 400 gray (depending on the insect) and max doses less than 1,000 gray. The main economic advantage of X-ray phytosanitary treatment is that it opens the door to food producers for exporting local production to the U.S. market.

* One gray is the absorption of one joule of energy, in the form of ionizing radiation, divided by one kilogram of matter.

INTERVIEW: DAVID PYMER

Medical Device Sterilization

Mr. Pymer is general manager of Harwell Dosimeters, Ltd. in the U.K. He was interviewed by 21st Century *correspondent Ilko Dimov.*

Question: What is the advantage of irradiation for the sterilization of medical or other forms of equipment?

Pymer: Medical device sterilized by irradiation tends to be done because it can be done at the end use, so its a final, terminal sterilization system. The good thing about it is that it can be manufactured and sealed and then packed into its shipping quantities, and then irradiated. So the radiation passes through the material and keeps it intact and sterile within its material. So as long as the barrier—the seal—is maintained, the irradiation passes through the boxing and packaging, and does what it needs to do in sterilizing the product.

Question: Right now, you have a huge debate in Europe. Germany is moving away from nuclear, and Italy, had a referendum a few days ago against nuclear energy. What do you think about this? Is this fear justified?

Pymer: . . . The issue with nuclear, is the by-product, the fuel, the waste. Can that be managed? I've heard a keynote speaker today who says "yes it can." It should be managed, and they should build fast neutron reactors that will help, and actually remove the waste that's currently in the world, and generate electricity. So that's a wonderful thing to hear today, but will the world say "yes, that's what we want to do," or will they just forget about it and bury it under the ground?

. . . [I]f they can use it to provide more electricity, that would make perfect sense. . . .

Harwell Dosimeters, Ltd.

David Pymer

INTERVIEW DR. JU-WOON LEE

Educate the Consumer!

Ju-Woon Lee is general manager of the Advanced Radiation Technology Institute at the Korea Atomic Energy Research Institute. His presentation at the conference was on irradiating Korean seaweed soup for meals in space. He was interviewed by Ilko Dimov.

***21st Century:* What is your message for the North American consumer about radiation technologies?**

Lee: The German [anti-nuclear] strategy is a pity. But another chance is coming to change the acceptance of the consumers. I think that education and communication are very important things, rather than technology.

Radiation technology is well documented and well launched. But the important thing is the choice of the market, and a lot of the market is consumers.

IAEA

Irradiation allows tropical fruits to be picked ripe before being irradiation processed for export. The consumer benefits by having a tastier product.

***21st Century:* In developing sector countries, what is required for food irradiation, and how is it beneficial for consumers?**

Lee: I think the adoption of this technology is dependent on the situation of each country. The technology is used for both food safety and food security, which are both very important for the progress of the human being.

This technology is very useful to manage and maintain food preservation, and hygiene quality, and also developing other needs of industries.

But scientists in the industry have to think about how to introduce this technology, how to educate and communicate this technology with consumers.

Ruth Brinston/IMRP

Conference participants at the IMRP exhibition hall, where many irradiation companies had informational displays.

Radiation Roundup

A selection of responses from conference attendees to Ilko Dimov's "roving reporter" questions on radiation.

Question: What is the most common misconception people have about food irradiation?

One misconception the general public has, is not knowing the difference between radiation and radioactivity. There's a big difference! When we are using radiation in all of these applications, the radiation is imparted, and as soon as the process is complete, there is no more radiation.

If I irradiate a product, I get the desired effect, but I don't have any radioactivity in the product. So if you irradiate a polymer, or a fruit, or a medical device, you deliver the radiation dose and it does have some effect—killing insects, or killing microbial populations. But the radiation finishes as soon as the process is completed.

There are rules and regulations in our industry for the types of materials that can be irradiated. For example, the higher the atomic number of the material that you are irradiating, the greater the chance that you can turn something radioactive. And so things like copper and some other things cannot be irradiated with the types of modalities that are used here.

What we are measuring (with dosimeters) is the amount of radiation dose that is delivered by the process; once that measurement is confirmed, we know how much dose is delivered, and there is no more.

* * *

Question: We constructed a cloud chamber in our office with dry ice, and inside the chamber you can see the cosmic rays. So we are bombarded with radiation.

In some places in the world, the background radiation may be six times higher because of the rock formation, so this whole argument about "zero radiation" is not possible.

* * *

Question: What is your vision for the future? Will we see more irradiated products on the market?

That's our hope. But the perception the public has is not a good one. In the early days of atomic energy, I think the governments were afraid to let the information get very far out, so they made it sort of secretive. . . .

And then people remember Nagasaki and Hiroshima, so there is "the terror" as we call it, when we do risk factor analysis. Because in the public perception, fear of death from radiation is somehow much worse than from natural gas.

If a natural gas pipeline blows up and kills 20 people, its just an "unfortunate" incident, but if 1 person were to die from a radiation overdose, oh my god, it's so much higher in magnitude in the public mind.

So you have to deal with this. How do you transmit the knowledge to the public in a way that they can perceive and understand that this is safe?

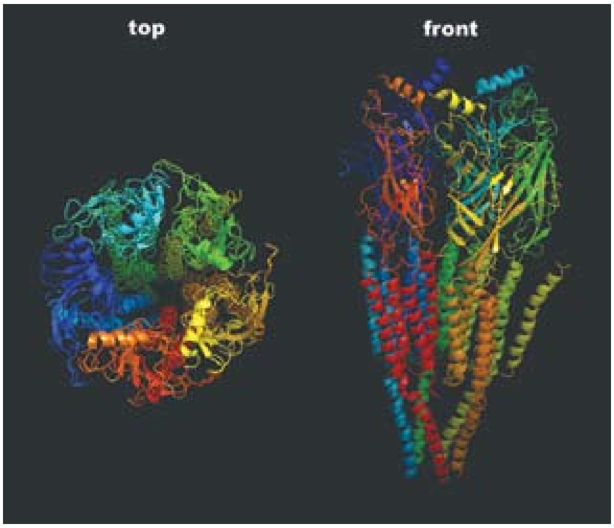
HOPE FOR MG SUFFERERS?

Monarsen: An Orphan Drug In Need of a Sponsor

by Marjorie Mazel Hecht

Officially, Monarsen is an "orphan drug," looking for an investor to fund phase II clinical trials. But for the thousands of sufferers of myasthenia gravis, Monarsen, which performed extremely well in its first clinical trials, is a lifeline to better functioning and a better future.

Myasthenia gravis (MG) is a debilitating auto-immune disease affecting neuromuscular transmission, and causing specific and progressive muscle weakness and exhaustion. MG afflicts 70,000 or more Americans (the conservative estimate of the Myasthenia Gravis Foundation of America), and 400,000 people worldwide, another conservative estimate. The disease is undercounted because MG is difficult to diagnose: The symptoms wax and wane, and vary in each case, often mimicking those of other ailments.



Top and front view of a 3-D model of the muscle-type nicotinic acetylcholine receptor. In myasthenia gravis, the body's immune system attacks the acetylcholine receptor that transmits the signal to the muscle.

The disease tends to strike women in their 20s and 30s, and men after 50, in all ethnic groups. The eye and facial muscles are commonly affected (drooping eyelids and difficulty swallowing), often arms and legs, and in the most serious cases, the pulmonary muscles.

MG is usually not fatal, just disabling. Many patients can achieve remission and lessened symptoms, but can also relapse. Although the initial cause of the disease is not known, the mechanism responsible for the weakness in the voluntary muscles (the muscles that we can control) has been identified as a disconnect between the nerve and the muscle: The receptor for the chemical acetylcholine, which is necessary for transmission of the neutral signal, is attacked at the neuromuscular junction by antibodies produced by the body's own immune system.

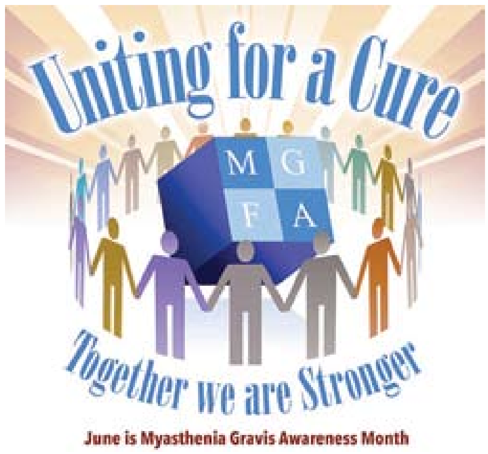
These antibodies disrupt the neurotransmission, and the muscle fails to contract. Current approved pharmaceutical treatments for symptoms include the drug Mestinon (pyridostigmine), which inhibits the cholinesterase enzyme that normally breaks down excess acetylcholine, thus increasing the amount and duration of acetylcholine available; and immune suppressant drugs like Prednisone, Cyclosporine, and Azathioprine. All of these drugs have long-term side-effects, however. And some MG patients become resistant to pyridostigmine.

Living with MG

Myasthenia gravis is found around the world, and in all ethnic groups, but tends to occur more among younger women and older men.

This article was occasioned by the plight of one young woman, the mother of three children under six, and her difficulties coping with the symptoms of her recently diagnosed MG. How does she explain to her youngsters that she can't do the things she used to—pick them up, play with them, take care of them? How does she keep from being depressed about the fact that her symptoms may worsen, and that there is as yet no cure for MG?

Because she has had difficulty with allergic reactions to certain drugs, for her—and for many others—Monarsen holds out much hope. As one British MG patient commented on the promise of Monarsen, "If I had 20 million dollars, I would give them to Prof. Soreq straight away [for the clinical trial]. A good medicine for myasthenia gravis is definitely overdue."



Poster of the Myasthenia Gravis Foundation of America.

MG often affects the eye and facial muscles. The drooping eyelid of this MG patient is typical.

In life-threatening cases, such as an MG patient who is unable to breathe, blood cleaning (plasmapheresis) is a short-term treatment, as is treatment with intravenous immunoglobulins. Most radical (and controversial) is the surgical removal of the thymus gland, which is believed to be involved with MG.

An 'Antisense' Approach

Monarsen (previously known as EN 101), operates entirely differently from these conventional treatments. It is an "antisense" drug, which works by inactivating acetylcholinesterase, the protein that breaks down acetylcholine, *before* the protein is synthesized. This allows more of the acetylcholine to react with the receptors on the surface of the muscle cells.

It is called "antisense," because it makes use of the opposite sequence, or "sense," of the RNA messenger gene associated with acetylcholinesterase. (See interview.)

Monarsen is based on the innovative research work of Prof. Hermona Soreq at Hebrew University, who pioneered antisense technology and acetylcholinesterase biology. After animal studies showed that Monarsen successfully alleviated MG symptoms in rats that were engineered to have MG symptoms, human trials were initiated in 2002, to assess its safety and efficacy.

The results of a small clinical trial carried out in Israel and the U.K., showed a range of 27.8 to 53.4 percent symptom improvement—far better results than those of the current first-line MG treatment with Mestinon. Mestinon (pyridostigmine) targets the finished protein, thus stimulating the body to produce more acetylcholinesterase, which "triggers a battle between the drug and the nervous system," as the Monarsen developer describes it. In contrast, Monarsen inhibits the synthesis of acetylcholinesterase and "doesn't cause this vicious cycle."

In addition, Monarsen can be taken orally only once a day, instead of several times daily for pyridostigmine; it has a far lower dose; and it has no significant side effects. These advantages could make a difference in returning MG sufferers to their former lifestyle and employment.

This was the "first demonstration of the safe and effective use of an orally administered antisense therapy for a neurological disease," according to the now defunct Ester Neuroscience, Ltd., the Israeli pharmaceutical firm that conducted the trial.

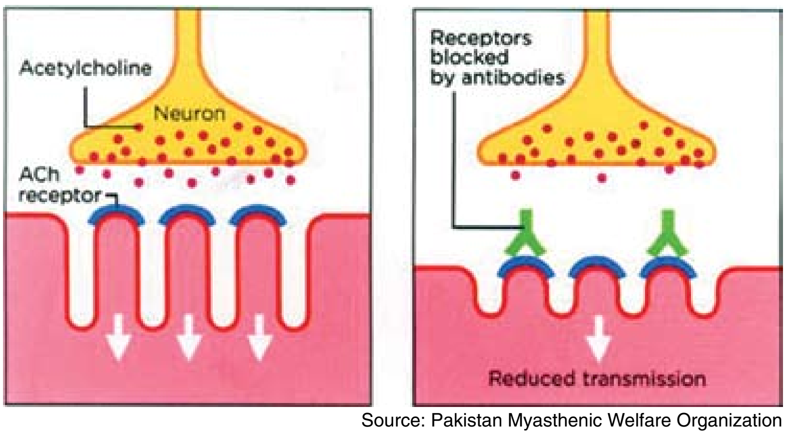
An 'Orphan' Orphaned Again

Ester Neurosciences secured "orphan drug" status for Monarsen from the Food and Drug Administration the next year, 2003. This designation is given to potentially beneficial treatments for severe illnesses that affect 200,000 or fewer people, and conveys to the developer tax incentives, a reduction from certain fees for marketing approval, and marketing exclusivity in the United States for seven years after approval. Ester also received "orphan" status for Monarsen in Europe.

But as the next clinical trial was being organized, in 2007, Ester Neurosciences was sold to the small U.K. pharmaceutical firm Amarin, which had initially agreed to develop Monarsen. Sadly, the company changed its strategy, and dropped Monarsen, leaving the orphan drug without a sponsor. However, as of 2011, the development rights are back in the hands of Hebrew University's technology transfer company, Yissum, which is again actively looking for an investor.

And so, Monarsen's fate depends on the whims of a "market" that invests its money where it can make the most profit, without regard to the human consequences of not developing this improved palliative treatment.

What about non-profit backing? The MG Foundation of America has ruled out support for clinical trials. When asked about Monarsen, foundation chief executive Tor Holtan, told me that the Monarsen alternative was not "100 percent proven yet" in terms of efficacy—a curious response, given the less than optimal state of the currently used treatments for MG. Mr. Holtan also said that the foundation



Source: Pakistan Myasthenic Welfare Organization

DIAGRAM OF NEUROMUSCULAR JUNCTION

In a normal neuromuscular junction, acetylcholine transmits a signal from the nerve to the muscle to contract. In a myasthenia gravis patient, the immune system produces antibodies that attach to the receptors for acetylcholine on the muscle cells and reduce signal transmission; muscles then fail to contract, causing weakness and fatigue.

The current treatment of choice, the drug pyridostigmine, inhibits the enzyme acetylcholinesterase which normally breaks down excess acetylcholine. In contrast, Monarsen works by interfering with the synthesis of acetylcholinesterase, thus allowing more acetylcholine to function.

did not support drug development, only basic research, and that the foundation had very little funding available in general, because MG is a "small disease."

The National Institute of Neurological Disorders and Stroke (NINDS) at the National Institutes of Health, which oversees research on MG, along with hundreds of other neurological disorders, last year invested $11 million into MG research, and now has two active clinical trials. NINDS program director, Dr. John Porter, told me:

"It is NIH policy to not offer public opinions on the potential for specific therapies that are under development, so I cannot comment on any strengths/weaknesses of the existing data or on the rationale for Monarsen as a putative therapeutic for myasthenia gravis."

"Many putative therapies do fail in development," Dr. Porter said, "so it is important that they be tested rigorously. NINDS has several mechanisms to support preclinical and clinical therapy development efforts in rare diseases, such as myasthenia gravis.... Like any candidate therapeutic, the later stage development costs of Monarsen may exceed NIH resources (NINDS alone is responsible for 400-600 neurological disorders) and the developers would also have to attract partners (venture capital, Pharma) to the effort."

At this time, NIH is funding two clinical trials for MG: one to determine whether thymectomy benefits MG patients who are receiving Prednisone, and another to test a drug that increases skeletal muscle activation.

A fanciful 1624 drawing depicting John Smith taking King Opechancanough (1554?-1646) prisoner. Opechancanough was a tribal chief of the Powhatan Confederacy in what is now Virginia. A description of his ailment included the drooping eyelid characteristic of MG.

From Captain John Smith's General History*, 1624.*

The Larger Picture

The short history of this orphan drug, points to the sad state of the U.S. health system. A promising drug languishes for want of a sponsor's capital, while thousands of MG victims (not to mention those yet to be diagnosed) continue to suffer with treatments that are less than optimal and at the same time far more costly in human and monetary terms than the few million dollars it will take to conduct the next phase of trials for Monarsen. In addition, indications are that Monarsen might also have benefits for other diseases, including Alzheimer's and ALS.

In the larger picture, MG is still a disease without a cure, and without a known cause. The mechanics of the symptomatic muscle weakness are now increasingly well characterized; science researchers continue to probe these mechanics in finer and finer detail, as medical research and imaging techniques advance.

In fact, MG is "the best understood autoimmune disorder, serving as a model for understanding not only autoimmunity, but also synaptic function," according to Henry J. Kaminski, M.D., a prominent MG expert. Such a "model" serves to highlight what's missing: For a disease whose symptoms were noted in the 1600s (including the famous case of the American Indian Chief Opechancanough, who died in 1644), shouldn't we have come further in learning what initiates MG, and being able to prevent it?

INTERVIEW: DR. HERMONA SOREQ

The Development of Monarsen for MG

Chryssa Panoussiadou

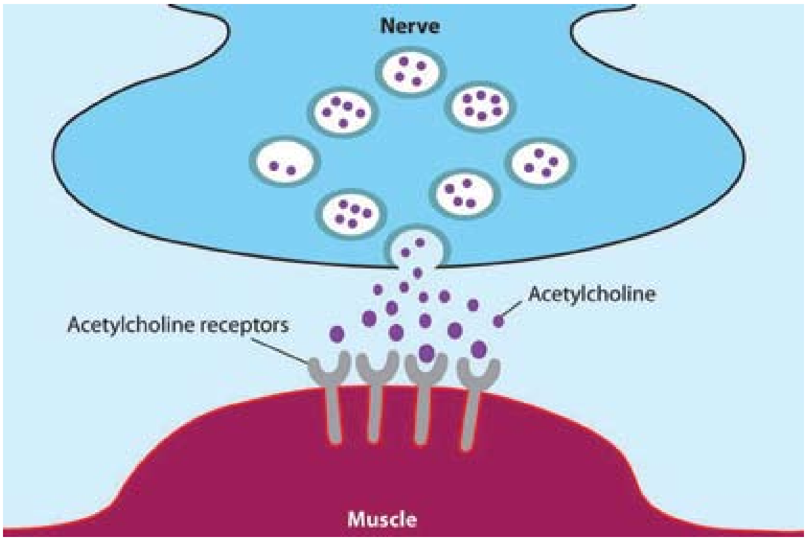
Hermona Soreq, Ph.D., is a Professor of Molecular Neurobiology at Hebrew University's Edmond and Lily Safra Center for Brain Sciences. She has published more than 250 peer-reviewed articles and seven books, especially in the field of brain-to-body communication. The past president of the Israeli Society of Biochemistry and Molecular Biology (2000-2002) and the first elected woman dean of the Hebrew University's Faculty of Science (2005-2008), Soreq collaborates with top scientists worldwide, is a member of the European Community's advisory committee on health-related issues, and a consultant to the Israeli Ministers of Health, Commerce, and Science.

She has also received many honorary Ph.D. degrees and prizes for her work. With 12 patents, two recombinant proteins, and one DNA-based drug at different stages of clinical trials, Soreq is also an Adjunct Research Professor at the Arizona State University BioDesign Institute.

She was interviewed in February 2011 by Marjorie Mazel Hecht.

Question: How did the idea for Monarsen come about?

Soreq: Most of my research efforts during my academic career were aimed at the cholinergic system, and I was pain-



NORMAL ACETYLCHOLINE RECEPTORS ON MUSCLE

In myasthenia gravis, the body's immune system disrupts the acetylcholine receptors (proteins) on the muscle, which normally receive the signals from nerves telling the muscles to contract. This causes muscle weakness and fatigue.

Source: Muscular Dystrophy Organization

fully aware of the shortcomings of the small molecule inhibitors of acetylcholinesterase (AChE) that are available for therapeutic indications in general, and for the treatment of myasthenia gravis in particular: First, there are many variant AChE proteins with different biological properties and functions, but the small molecule agents block all of them nonselectively.

Second, exposure to these agents induces rapid overproduction of AChE, which should be avoided. Third, the small molecule agents are needed in relatively large doses and display short duration of activity. Since I have cloned the human AChE gene, I thought that targetting the mRNA transcript could overcome these limitations—be variant-selective, act in low dose and for a longer duration, and limit the side effects. All of this came true.

Question: Monarsen makes use of a fairly new concept—antisense technology. Can you say something about how antisense works?

Soreq: Antisense sequences are inversely oriented compared to their mRNA targets; they can bind their target tightly by forming hybridization bonds, like the two DNA strands; and they can both block the translation of their targets into protein and induce the degradation of these targets. We protect our antisense agent by introducing methyl groups, which stabilize the molecule and prolong the duration of its effect.

Question: How is Monarsen different from the current therapies for MG?

Soreq: You may think of gene expression as a pyramid: one copy of the gene (DNA), several hundred mRNA molecules per cell, and many thousands of protein product molecules. The current therapies, like most of the medications we know, are targetted to block the active site of the protein product. This is economically unwise because you need many more drug molecules to reach an effective dose; but we did not know enough about mRNA until lately, so that this traditional approach was the best that was available.

Furthermore, many different proteins share some structural features of their active site, which causes side effects due to the interaction of protein blockers with other targets. But today, with the Human Genome project being completed, we know the mRNA sequences for all of the human genes so we can design antisense chains. Their interaction is far more specific, avoiding side effects; they need to block far fewer molecules, which can reduce the effective dose by several orders of magnitude, limit the side effects even further, and achieve better specificity.

Last, but not least, they can block only the targetted mRNA transcript, avoiding undesirable effects.

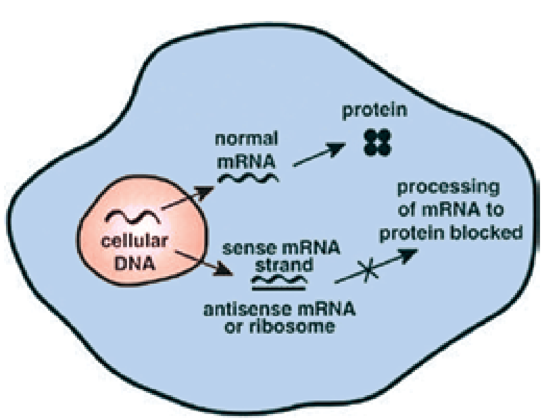
Question: How did Monarsen perform in the clinical trials?

Soreq: Very well indeed: It improved the myasthenia symptoms of progressive muscle fatigue at least as effectively as the currently employed small molecule drug, but at 1,000-fold lower dose and

ANTISENSE SEQUENCE BLOCKS THE PRODUCTION ACETYLCHOLINESTERASE

Monarsen inactivates acetylcholinesterase, the protein that breaks down acetylcholine, before the protein is synthesized. The diagram illustrates in general how antisense mRNA works.

Source: Global Library of Women's Medicine, DOI 10.3843/GLOWM.10274, 2008



Hebrew University

Prof. Soreq (left) speaking at a recent conference.

for far longer period (24 hours, unlike the multiple daily doses needed with the current drug). There were practically no significant side effects, and the patients seemed very happy. (One of them wrote me that he never felt that well ever since he was diagnosed, 29 years before. . . .)

Question: Since Monarsen appears to be more effective in helping MG patients, and does not have side-effects, what is holding up further trials and commercialization? What are the chances for speeding up this process?

Soreq: I am a university professor, not a pharmaceutical company. Patent applications on this invention were submitted to the authorities by the technology transfer company of the Hebrew University, Yissum, which holds the rights to this invention. The rights to develop this project were then licensed to a U.S.-Israel venture capital fund, Medica, which established a start-up company, Ester Neuroscience, to develop this invention.

Ester Neuroscience completed toxicity tests and phase I and phase IIa clinical trials, obtained an Orphan Drug approval for the use of Monarsen, and was then sold to Amarin, a U.K./Irish start-up pharmaceutical company which planned to proceed with phase III trials, but then went through managerial changes and refocussed its efforts on cardiovascular drugs.

Consequently, Yissum requested—and received—the rights to develop this project, which happened very recently. At present, Yissum seeks strategic partners to complete the development of this new drug.

Question: Is this the first drug you have worked on using this concept? Has Ester been involved in producing similar drugs for other diseases?

Soreq: This was not the first antisense agent I used for research, but the first one which reached clinical trials from my laboratory, and the only one to be developed by Ester. Because it is targetted against AChE, which is involved in several other diseases, there may be other diseases where patients can benefit from its use.

There are many more oligonucleotide agents undergoing clinical trials at present, for different diseases; and a joint international academia-industry society, Oligonucleotides Therapeutics Society (OTS) was established to develop this direction, of which I am one of the founding members. The current president is Prof Gunther Hartmann of Bonn University, Germany.

Question: Have you looked into what causes MG? Could there be bacteria involved?

Soreq: Myasthenia gravis is an autoimmune disease, where antibodies are erroneously formed against the muscle receptor for acetylcholine, which is the neurotransmitter activating our muscles. It is yet unclear whether the initiation of this disease is triggered by bacterial or viral infection, but this is a possibility.

The History of the Biosphere Cannot Exclude Mankind

by Aaron Halevy

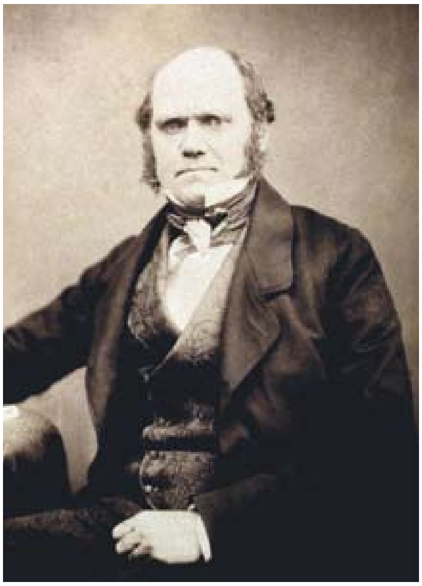
Evolutionary History: Uniting History and Biology to Understand Life on Earth
by Edmund Russell
New York: Cambridge University Press, 2011
Paperback, 216 pp., $21.97

Edmund Russell's book, *Evolutionary History*, is written as an analysis of man's specific effect on "evolution in populations of other species which in turn has shaped human experience," and to forge from this, a new academic field which unites history with biology. "One of the central goals of this book," he writes in the first chapter, "is to contradict the sense many of us have that evolution is something that happens, 'out there'—well away from us in time, well away from us in space, well away from us as a species, and certainly well away from us as individuals."

This view, to expand the study of human history to include a knowledge of the history of the biosphere and its changes over billions of years, is an aim with which the great historian and dramatist Friedrich Schiller would agree. As Schiller wrote, "... the whole history of the world at least would be needed to explain this very moment." Yet, in attempting this, Russell seems debilitatingly unaware of the genesis and the effects of the mental disease known as environmentalism, which plagues our species today.

We live in a society today which has been effectively lobotomized. *Very few human beings recognize that human beings are the only species on Earth that can willfully express the unique characteristic of creativity,* and the people who should be most cognizant of this fact, "scientists," are often the most ignorant of it. To propose a "synthesis of man and nature" today, without taking this qualitative difference properly into account, is flatly untrue.

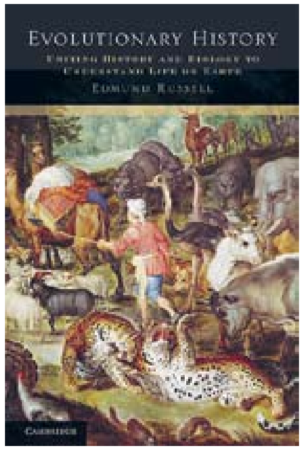
To remedy this, Lyndon LaRouche's "Basement Team" of researchers is developing the concept of biospheric management, which is intended to reorient current liberal scientific methods to the proper self-conception of mankind as creators.[1] If mankind is to survive this current breakdown of the global financial system, we must confront the great fallacies in thinking which have brought us to this point.



Author Edmund Russell has a "fondness for Darwin's ideas," seemingly unconcerned about Darwin's lack of humanity. Here, Charles Darwin in an 1855 photograph by Maull and Polyblank.

Evolution of the Biosphere

Russell begins his study from the works of Charles Darwin. "Evolution," he writes, "involves changes in inherited traits or genes of populations over generations." It can result from any cause, including natural (i.e., *animal*: unconscious) or intentional (i.e., *human*: conscious). For Russell, all forms of evolution, including man-induced evolution, fall somewhere in these categories.



"I like to think of this book as following in the Darwinian tradition, which partly explains my fondness for appealing to Darwin's ideas," he writes. Apparently, Russell is unconcerned that Darwin seems consciously to have sold his own humanity to serve the animal kingdom instead.[2,3]

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1. For more on the "Basement" work, see www.larouchepac.com/basement

2. I.e., The British Empire! See, "The 'No-Soul' Gang Behind Reverend Moon's Gnostic Sex Cult," by Laurence Hecht, *21st Century*, Fall 2002).

3. This statement on p. 26 of Darwin's *Autobiography*, was written in 1876, when he was 67 years old, six years before his death:

"I have said that in one respect my mind has changed during the last twenty or thirty years. Up to the age of thirty, or beyond it, poetry of many kinds, such as the works of Milton, Gray, Byron, Wordsworth, Coleridge, and Shelley, gave me great pleasure, and even as a schoolboy I took intense delight in Shakespeare, especially in the historical plays. I have also said that formerly pictures gave me considerable, and music very great delight. But now for many years I cannot endure to read a line of poetry: I have tried lately to read Shakespeare, and found it so intolerably dull that it nauseated me. I have also almost lost my taste for pictures or music. Music generally sets me thinking too energetically on what I have been at work on, instead of giving me pleasure. I retain some taste for fine scenery, but it does not cause me the exquisite delight which it formerly did. . . .

"My mind seems to have become a kind of machine for grinding general laws out of large collections of facts, but why this should have caused the atrophy of that part of the brain alone, on which the higher tastes depend, I cannot conceive. A man with a mind more highly organised or better constituted than mine, would not, I suppose, have thus suffered; and if I had to live my life again, I would have made a rule to read some poetry and listen to some music at least once every week; for perhaps the parts of my brain now atrophied would thus have been kept active through use. The loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect, and more probably to the moral character, by enfeebling the emotional part of our nature."

The fallacy of this approach from the outset, is that there is no such thing as an individual species. As the great biogeochemist Vladimir Vernadsky emphasized, all species are an interconnected representations of the developing biosphere as a whole.[4] Each individual form of life represents a sort of door, through which the chemical elements—specific isotopes, including the cosmic ray spectrum—pass through. This is what Vernadsky termed "the biogenic migration of atoms." All life must be observed as a single developing system.

Darwin's theory of evolution was caricatured in Punch *in 1882, under the title "Man Is But a Worm."*

Each of the biosphere's new species is an advancement of forms with higher and higher biogenic-throughput into the living system. Evolution is a phenomenon of the system, as in the development of life capable of living outside the oceans in the Ordovician, or the period of the dominance of the mammals 65 million years ago; it can not be seen as a local change in the system. This process as a whole, striving into more complex life forms, into more species diversity, for over 4.5 billion years, reflects that which Moses Mendelssohn defines as beauty: "The striving for unity, a harmony in multiplicity."[5]

The Triumph of Mankind's Evolution

Until the turn of the 20th Century, mankind's emergence on the planet was understood as the summit of all the previous changes in this evolutionary process of the biosphere. Russell cites a few examples of this view: He reports that Thomas Bell said in 1837, that domestication shows the "triumph of human art and reason over the natural instincts of the inferior animals." Yet in the chapter "Evolution Revolution," Russell mocks this view of man as "the master breeder narrative," and poses a few cases, such as the early domestication of dogs and the so-called agricultural revolution of 10,000 B.C., where these processes could have had less intention, and more chance and accident.

Dogs have been with mankind since before recorded history, so the genesis of this relationship is difficult to determine. An interesting Russian experiment, initiated by Dmitri Belyaev in 1958, took more than 100 wild Siberian foxes and selectively bred them on the basis of "tameness."[6] After only a dozen generations of this breeding, some unique, unsuspected, but well-known traits in these animals began to appear, as if miraculously. The new foxes began to have more curly tails, more floppy ears, coats with more variation in color. They began barking (which foxes do not do), and they looked for attention from their human caretakers. In short, they had been tamed, within the lifetime of one human being.

Later, it was assessed that the adrenaline content was much lower in the tame foxes than in their untamed cousins. The conclusion reached by the team was that the change in the adrenaline affected the chemical balance in the other genes, or combinations thereof, and "this chemical imbalance made some traits dominant and others recessive."

Then Russell says the "master breeder narrative" compels us to believe this domestication process as intentional and full of imagination and pre-knowledge: Early man must have (1) understood the inadequacy of his ancestor's methods of hunting; (2) must have imagined that he could domesticate a wild species (which had never been done before); (3) "imagined traits in wolves . . . that they had never seen"; (4) must have "believed they could tame wolves by raising cubs in captivity," etc.

This scenario shaped by Russell in a specifiably pessimistic bent, brings him to the conclusion that this is all absurd. "In addition to calling for almost divine foresight and skill, the master breeder narrative makes dicey assumptions about wolf biology."

But the issue is not the pre-knowledge which makes a discovery; it is the hypothesis about the universe which allows the unknown to be tested. Anyone who knows Johannes Kepler's work, knows that that is what creative discovery is, and that it is a uniquely human ability! That is the difference between man and animal.

Ignoring Man's Reason

Instead of accepting the paradox that all mankind has expressed a quality of reason, Russell writes: "Rather than assuming that people fifteen thousand years ago used breeding techniques common today, let us see how domestication might have resulted from actions hunter-gatherers took for immediate gain."

Russell next forms "another narrative" in which he sees the wolves hiding outside the camp of nomadic man, picking up his scraps on the side. Those wolves who have the courage to come up and get closer to the men seem to have an advantage, and they eventually get very close to men, and eventually, they were tamed by the benefits these specific wolves received. Taking this "more likely" scenario together with the evidence from Dr. Belyaev's team, Russell writes that "these findings, provide evidence that people could have created dogs from wolves, by piling chance on unwitting chance."

In another example about domestication, Russell poses the domestication of cotton and other plants in a similar way: How? Man could have eaten some seeds in his meal and then excreted them near the camp and the next year, when he returned, he would find growing plants. Again Russell is viewing evolution and

4. *The Biosphere*, by Vladimir I. Vernadsky (1926).

5. Moses Mendelssohn, *On Sentiments* (1761).

6. Conducted by the Russian Academy of Sciences, through the Institute of Cytology and Genetics-Novosibirsk, Russia,

domestication as a change in relationship between two fixed animal species, and he asserts that domestication which benefits the domesticated, occurs by placing a demand on the domesticators, making them serve their partner species. "We might say that domestication depends as much on domesticating a population of human beings as on domesticating a population of non-human species," he writes.

Returning to the Vernadskian view, the universe is embedded with purpose, with intention. Russell's failure to recognize that, and his inadvertent determination to attack its manifestation in mankind throughout his book (as is popular among environmentalists today), is the source of his failure to grasp the higher role of man in the universe and our distinction as subduing the animals, not becoming them.

A domesticated Siberian fox at the Institute of Cytology and Genetics (Novosibirsk, Russia) that has bred tame foxes for over 50 years. Russell questions whether man intended to domesticate the fox and wolf, saying that it could have happened by chance.

Mankind and the Biosphere

The main point of *Evolutionary History,* is Russell's attempt to solidify the benefits of the unification of biology and human history. Russell converges on this point, "as if by accident," in asserting that each stage of human development requires the entire history of all living species, all civilizations, and their interconnections up to that point. His crowning example is the chapter titled, "Evolution of the Industrial Revolution." There Russell argues that the invention of the cotton gin and the manufacturing capability of Britain (the "industrial revolution") was not all that should be credited. Rather, the whole 5,000 years of farming and breeding of the cotton strain which was capable of withstanding the machines also should be included and credited for the revolution.

"The agricultural revolution," Russell writes, "was an evolutionary revolution because it depended on domestication, which altered inherited traits and genes of populations and organisms over generations. So most of recorded history is a by-product of anthropogenic evolution." Therefore "anthropogenic evolution facilitated the Industrial Revolution by enhancing the suitability of cotton fiber for spinning and weaving."

Russell rightly argues that this idea is itself a challenge to modern historians. "One might challenge my proposition on the grounds of intentionality, sufficiency, or proximity," he writes, instead of taking the point to assert this connection over long periods of time as prescient intentions. Russell also rightly asserts that "when people modify organisms to provide human beings with goods and services, those organisms become tools."

Yet in all cases, Russell allows the environmentalist dogma of "man as beast competing with beasts" to ruin his otherwise useful ideas. Just before his concluding remarks, Russell states that human-induced evolution of plants and animals should be seen as merely a "mutually beneficial," agreement, "an adjustment … rather than one species imposing its will on another."[7]

Mankind Is an Immortal Species

The conclusion of Russell's book, "…uniting the insights of history and biology in evolutionary history enables us to understand the past more fully than either discipline does alone," might find its way into the future of human thought, but not in the way the Russell wishes it. Only by rejecting the environmentalist-fascist ideology can man understand his true role on the planet, and in the galaxy. When humans evolve, we do not grow extra limbs or webbed feet; we evolve in the culture, in the means by which we perpetuate our species at a higher quality and higher density of people.

This is the view of Vernadsky, and of LaRouche's "Basement" team, and only an understanding of this idea can bring about a moral and scientific view of mankind as both a living and a spiritual being in this universe as we know it.

We have arrived at a time in which there is no living entity on Earth which is too small, or too large, for humanity to be able to study and interact with it.

We aid the growth of plants by helping them develop certain characteristics; we keep alive those which would otherwise die off, or produce little. We protect animals, develop their best traits for survival, and bring them into a higher population density than they ever could achieve alone. We bring new species into existence which would take hundreds of thousands of years to develop otherwise. We can

NASA

There is no limit to the creative potential of mankind or the evolution of the biosphere! Here children launch a rocket at Astro Camp at the John C. Stennis Space Center in Hancock County, Miss.

7 Shakespeare's Edmund in "King Lear" should love to join this remark with his infamous, "Now, gods, stand up for bastards!"

have an effect on what we deem good, as well as bad, bacteria in agriculture. We exterminate diseases for ourselves and our animal friends. We plant new forests, drain swamps and marshes, create new water sources, and bring rivers to deserts to transform them into fertile meadows.

Man tames the wildness of nature to create a place for a better peace of mind. Mankind uplifts all living things on this planet to a more important significance by his use of them, and brings life one step closer to its goal: spreading life beyond this planet.

Look to the Future

The place to truly begin the study of human history, is from the future: What will the human species be doing in 100 years? 1,000 years? 10,000 years? As there has not been a limit to the habitation of man in any realm of the Earth so far, which has included short forays into nearby "space," is there any limit on the potential of man to ferry civilization to other planets? To mine the Moon and to harvest the asteroids for our resources? To use those refined materials to manage a solar economy? To use that as a basis from which mankind begins to colonize the galaxy? And then beyond?

No, there is no limit to the creative potentials of mankind! There is no limit to the evolution of the biosphere which man shall bring with him as he develops; and, therefore, there is no Second Law of Thermodynamics, and no need to continue to tolerate the religion of environmentalism.

Ignoring the Truth about the Bomb

by L. Wolfe

The Most Controversial Decision: Truman, the Atomic Bomb and the Defeat of Japan
by Wilson D. Miscamble, C.S.C.
New York: Cambridge University Press, 2011
Paperback, 174 pp., $24.99

It is easy to prove a point when you choose to ignore the truth. What is perhaps most annoying about Wilson Miscamble's apology for the use of atomic weapons on Japan is that it purports to present unbiased scholarship, claiming to have calmly reached the cold-blooded, but, as he says, unpopular "fact" that the atomic slaughter of Japanese civilians was necessary to end the war and prevent American and Allied high casualties, in what would have otherwise been a terribly bloody invasion of the Japanese homeland.

Miscamble's work ignores whatever truth might inconveniently get in the way of his clearly prejudged opinion of the validity of the "decision" to drop the atomic bombs on Japan. Here I will make a few relevant points that indicate the extent of his scholarly lying.

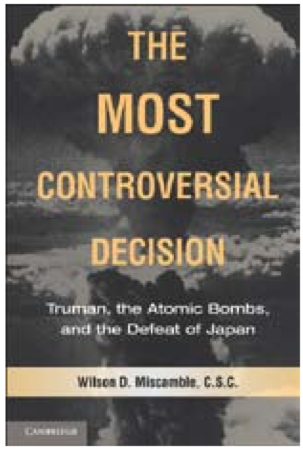
Miscamble asserts at one point in his account of the decision-making process that resulted in the bombing, that Truman and others involved were merely carrying out what the dead Franklin Roosevelt had "intended" in using the bomb as a weapon against Japan. There is not one shred of evidence to support this assertion, and none is presented.

Instead, there is much evidence that FDR had only agreed to develop atomic weapons as a possible counter to a Nazi effort to do the same, and that he had never seriously considered using them in Europe, especially when it was clear that the Nazis were already on the road to defeat and that their atomic program was unsuccessful.

Miscamble's lying assertion about FDR's intent is further weakened by the mountains of evidence of Roosevelt's pursuit of a backchannel peace agreement with the Japanese, mediated through the Vatican, to which effort he deployed trusted assets from American intelligence circles.

Those familiar with FDR's thinking on this matter—including some people whom I spoke to who were personally involved—say that if anything, FDR might have agreed to a demonstration of the power of the new weapon, without using it on Japan, to help strengthen factions in the imperial household and government who were seeking peace with honor. Miscamble somehow overlooked this backchannel.

The author makes much of the fact that secret code intercepts made it apparently clear that the Japanese would not surrender without assurances that the Emperor could stay on in some role. He correctly attributes to Truman advisor Jimmy Byrnes the demand for the continuation of the unconditional surrender policy. But Miscamble claims that because Byrnes had been an advisor to FDR, he somehow channeled the late President and knew that he would have not given in on a future role for the Emperor in a defeated Japan.



My sources told me that if it were required to end the war, FDR would have found a way to accommodate that Japanese request (the which request was ultimately given in a private assurance after the bombs had been dropped. And, these sources said, that if that assurance had been given earlier, it might have yielded a peace without Hiroshima, negotiated through the Vatican backchannel).

Preventing a U.S.-Soviet Alliance

Miscamble also chooses to claim that because the simple but evil Truman was not capable of conceiving a grand strategy versus the Soviet Union, involving the atomic bombing of Japan, that no considerations to that effect were involved in the decision. That is palpable nonsense, as several other authors have pointed out (Gar Alperowitz, *The Decision To Use the Atomic Bomb,* New York: Vintage Books, 1996, for example).

Churchill and the British, as well as many of their counterparts on the U.S. side, were more concerned ultimately about the effect of the bombing on the Soviet Union than they were about its effect on Japan.

Such factions were interested in break-

President Truman (third from left) and Secretary of State James F. Byrnes (second from right) saw the bombing of Japan as a geopolitical move directed at the Soviet Union. Here they pose at Potsdam in 1945, with Josef Stalin (second from left) and others at the conference.

ing apart the alliance that FDR had envisioned between the United States and the Soviet Union against the British Empire—an Empire, which FDR once told a trusted aide, would give the U.S. more trouble than the Nazis. This created an environment in which the decision to drop the bomb was made, and it is absurd to claim that Truman and Byrnes (who Miscamble claims wanted to drop the bomb to justify to American taxpayers the billions that had been spent on the project!) were impervious to this.

Perhaps the most ridiculous assertion by Miscamble is that he has finally put to rest the argument that the dropping of the bomb was militarily unnecessary. He reports on Japanese troop movements in preparation for a possible Allied invasion of the main islands, and then states: So much for the claim that Japan was on the verge of military collapse.

The esteemed professor misses the point entirely: Japan was a *defeated* nation prior to the dropping of the bomb. General MacArthur, and others who thought like him, did not believe that a military invasion was necessary, as Japan no longer represented a military threat to anyone. Its supply lines to Korea and Manchuria were cut off, and it did not have on its home islands sufficient fuel for those factories still left standing from the withering Allied bombing attacks.

(It had been a mistake, in the eyes of many people, to have misdirected bombing away from military targets into a form of terror attacks on populations. In the end, these had no effect on ending the war, while the attacks on military and production facilities cut into Japan's ability to fight on, a fact that weighed heavily on saner military leaders and members of the imperial family, including the Emperor, who did not want to see his people slaughtered.)

The fallacy-of-composition argument of Miscamble, that the dropping of the bomb was necessary to prevent high levels of Allied casualties, assumes that an invasion of Japan was necessary to defeat the country. It was not: A blockade of its ports and continued bombing of its war-making capacity, would have eventually driven Japan to surrender on the same terms as those that took place after the atomic bombing.

Such a strategy, as I have presented previously ("A Tragedy in Three Acts: The Beast Men Behind the Dropping of the Atomic Bomb," *21st Century,* Summer 2005) was consistent with MacArthur's successful plan for bypassing and isolating Japanese strong points. The U.S. invasion plan was an exercise in military and strategic foolishness.

In sum: Miscamble has presented a nice story, all neatly tied together with abundant research and citations. The only trouble is that it is an historical fiction.