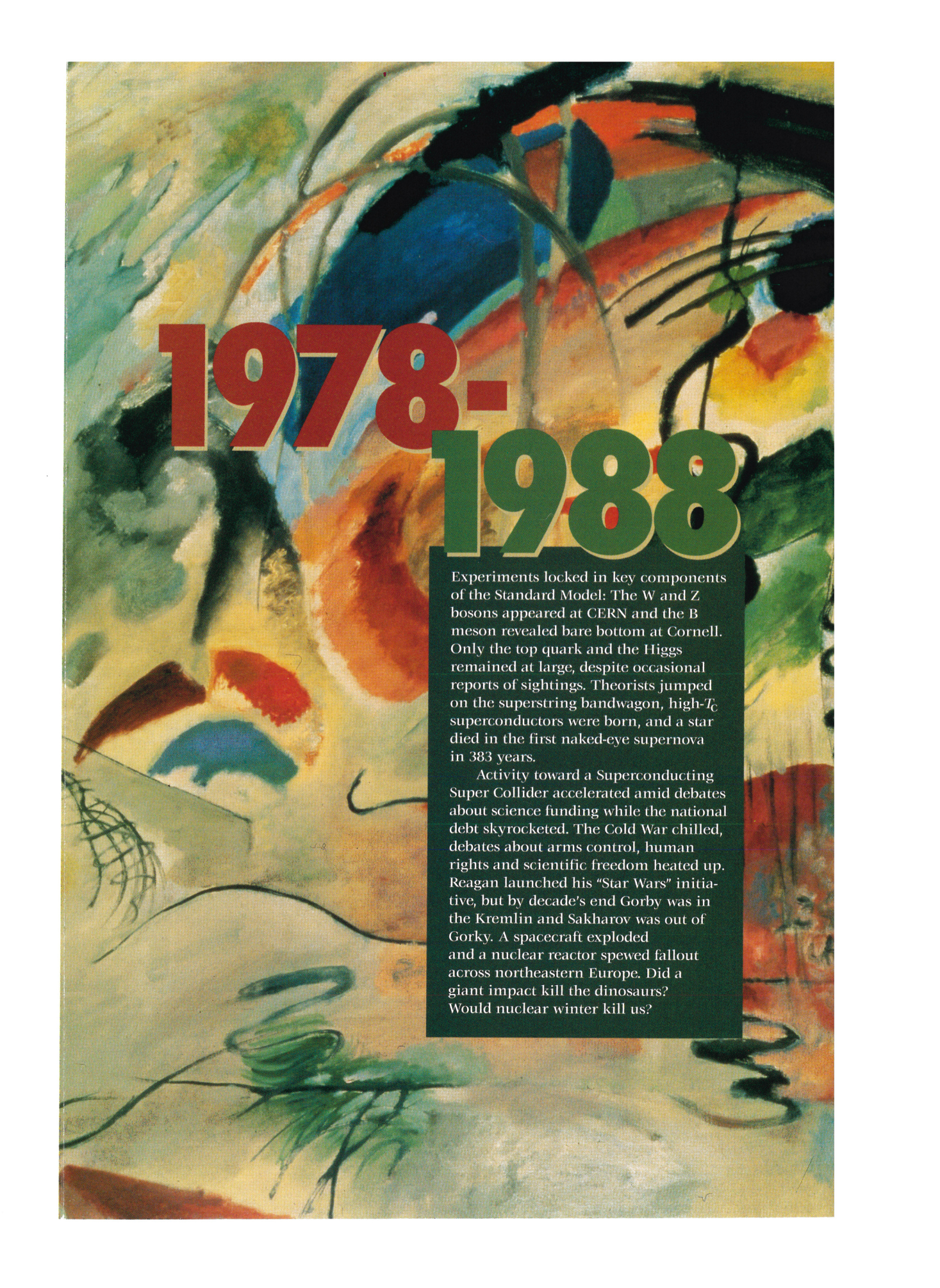
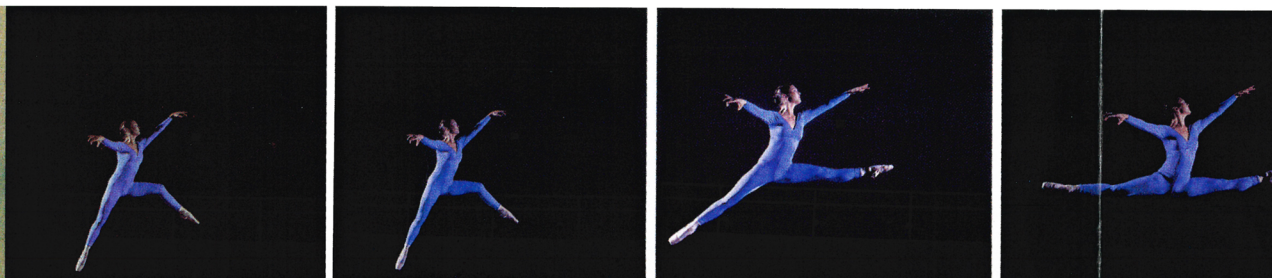


An abstract painting with a complex composition of swirling colors and bold black lines. The palette includes deep blues, vibrant reds, earthy oranges, and muted greens, all set against a light, textured background. The brushstrokes are visible, giving the artwork a sense of movement and depth. The overall effect is one of dynamic energy and emotional intensity.

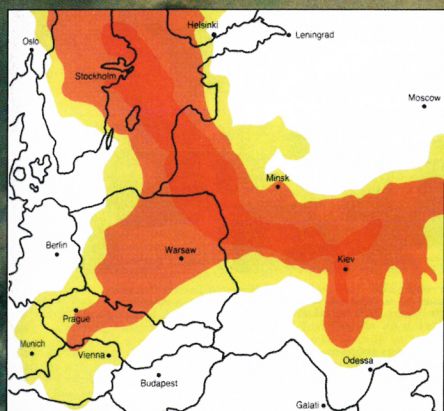
1978-1988

Experiments locked in key components of the Standard Model: The W and Z bosons appeared at CERN and the B meson revealed bare bottom at Cornell. Only the top quark and the Higgs remained at large, despite occasional reports of sightings. Theorists jumped on the superstring bandwagon, high- T_c superconductors were born, and a star died in the first naked-eye supernova in 383 years.

Activity toward a Superconducting Super Collider accelerated amid debates about science funding while the national debt skyrocketed. The Cold War chilled, debates about arms control, human rights and scientific freedom heated up. Reagan launched his "Star Wars" initiative, but by decade's end Gorby was in the Kremlin and Sakharov was out of Gorky. A spacecraft exploded and a nuclear reactor spewed fallout across northeastern Europe. Did a giant impact kill the dinosaurs? Would nuclear winter kill us?



Grand jeté performed by Jennifer Davis of the Pittsburgh Ballet Theatre. The floating illusion was analyzed in the February 1981 issue of *Physics Today*.



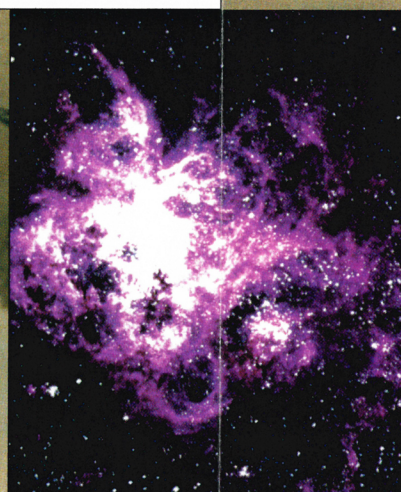
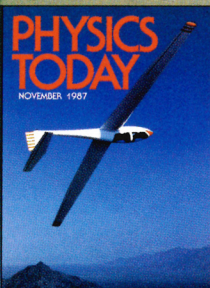
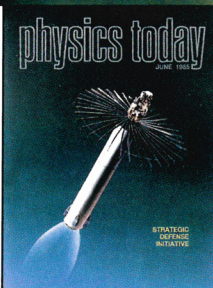
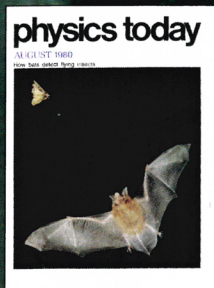
Chernobyl's fallout: Dose of Iodine-131 accumulated from 26 April to 1 May 1986 by adult thyroid glands, estimated by calculations done at Lawrence Livermore National Laboratory.

Students at a computer terminal at the Educational Technology Center, University of California, Irvine, using an instructional program to see how orbits vary depending on the initial conditions. From Alfred Bork's September 1981 article, 'Computer-Based Instruction in Physics.'

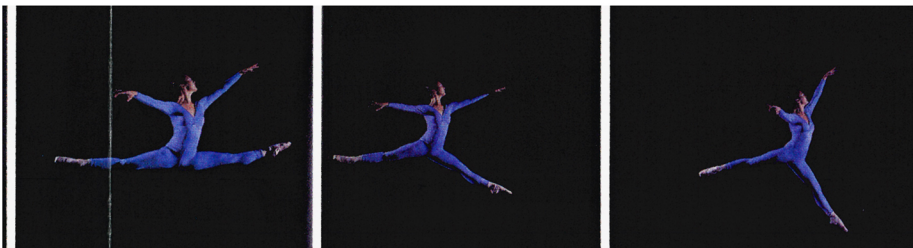


Challenger explosion 73 seconds after liftoff on 28 January led to an inquiry by a Presidential commission whose 13 members included four physicists—clockwise from top right, Richard Feynman, Arthur Walker, Sally Ride and Albert Wheelon.

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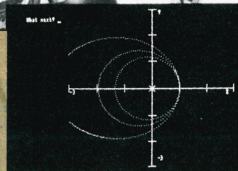
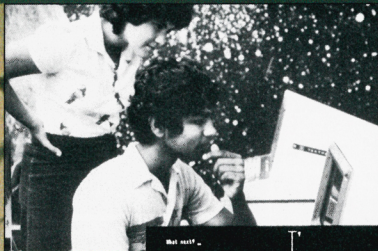


Supernova 1987a (bright star in lower left) ended a four-century-long vigil and started neutrino astronomy on 23 February. See David Helfand's August 1987 article.

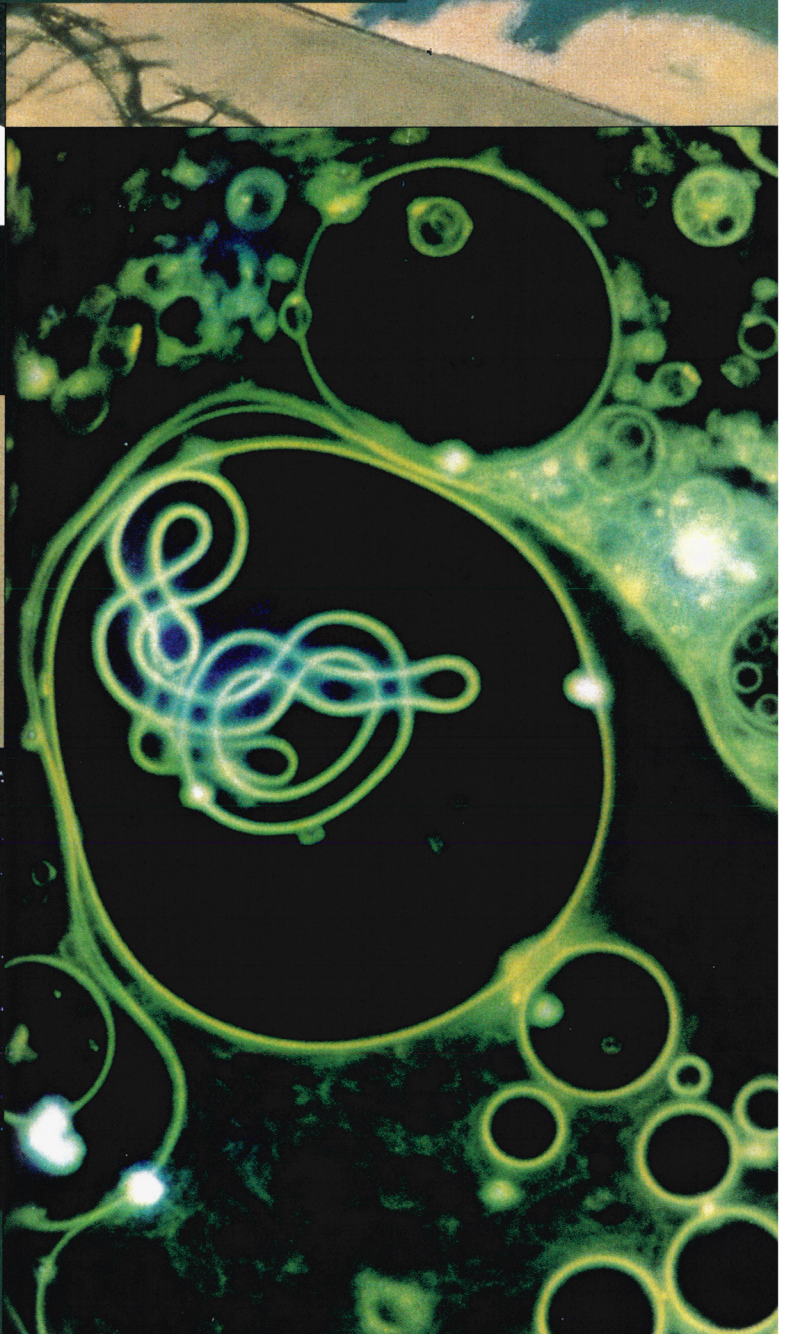


h was analyzed in the February 1985 article, 'The Physics of Dance' by Kenneth Laws.

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Vesicles formed in water from lipid-bilayer membranes. Such membranes, carrying complex enzyme systems, are the "ultimate in microelectronics," as discussed by Britton Chance *et al.* in an October 1980 article.



ova 1987a (bright star in lower right corner) ended century-long vigil and started the new field of astronomy on 23 February 1987, as discussed in elfand's August 1987 article.



East German physicist Alfred Zehe was arrested by the FBI at an American Vacuum Society meeting in Boston in 1983 and charged with espionage.

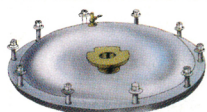


An accident on the Brooklyn-Queens Expressway in New York City in 1985. Arthur Damask's March 1987 article discussed the analysis of such accidents.

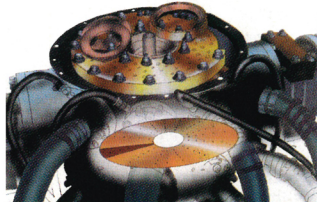
physics today

AUGUST 1984

First Annual BUYERS GUIDE



SPECIAL ISSUE
ON EQUIPMENT



A "Woodstock for physics" is how some hailed the session on high-temperature superconductivity that took place on 18-19 March 1987 in New York at the American Physical Society's March meeting.



Tactical nuclear weapons on parade through Moscow's Red Square. Wolfgang Panofsky discussed the role of science and technology in the arms race in his June 1981 article.

1978-1988

► **May 1978, page 9:**
From 'Hostages of Scientific Freedom in the USSR'
 by M. Ya. Azbel

▼ **May 1978, page 17: NMR imaging technique provides high resolution (as reported by Gloria B. Lubkin)**

A new tool is being developed for producing two- and three-dimensional images of the distribution of material within an arbitrary object. Christened "zeugmatography" by Paul Lauterbur, one of the leaders in the field, the nuclear-magnetic-resonance technique generally involves applying an inhomogeneous magnetic field to spread out the nmr signal in space. Ultimately, one can then deduce the spatial distribution of material, either by mathematical or analog manipulations.

Spatially controlled nmr techniques may prove useful in a variety of medical applications. For example, such techniques may be an alternative to computerized tomography for three-dimensional images. Or, they may be applied to studying flow in the cardiovascular system.



To pursue physics research, even theoretical research, in a developing country, is a heartbreaking task. When I returned to Pakistan in 1951 after working at Cambridge and Princeton in particle physics, I could, in a country of 90 million, call on just one physicist who had ever worked with Dirac's equations, for discussion, advice and stimulation. The most recent issues of the *Physical Review* available were dated just before the Second World War of 1939. The dues for The American Physical Society cost nearly one month's salary every year. There were no grants whatsoever for attending symposiums or conferences; the only time I did attend a conference in the United Kingdom I paid a year's savings.

► **November 1978, page 112:**
From 'Aiding Physicists in Developing Countries'
 by Abdus Salam

▼ **January 1979, page 101:**
APS council passes pro-ERA resolution

By a vote of 13 to 10 with two abstentions, the APS Council adopted the following resolution during its meeting in New York on 18 November:

"Whereas the Council of The American Physical Society supports the passage of the Equal Rights Amendment as one step in increasing equal opportunity for women in our society, including helping to increase the presently low proportion of women physicists;

"Whereas The American Physical Society will intensify its activities to assist and encourage women to study physics and to enter physics as a career:

"Be it therefore resolved that until the present Equal Rights Amendment is ratified, or the present period for the ratification lapses, whichever occurs first, the APS schedule general and divisional meetings, beyond those already scheduled, only in states which have ratified (and not rescinded—should Congress permit rescission) the Equal Rights Amendment."

▼ **June 1978, page 61: Headline**
Source of East Coast booming noises still a mystery

▼ **July 1979, page 12: A sampling from 'Letters' of the stir created by APS's pro-ERA resolution**

I wish to express my pleasure at the pro-ERA resolution passed by the APS council this past 18 November. The shallowness of the stand taken by W. Mollering, James Potzick and Benny J. Hill in their recent letters opposing the APS participation in the boycott of unratified states astounds me. If sexist conditions in human society prevent females from studying physics and later pursuing careers in science, does this not work counter to The American Physical Society's purpose of advancing and diffusing the knowledge of physics? I find the suggestion that "the pursuit of physics should cut across all such questions" to be as dangerous to humanity as it is personally offensive to me. To become a physicist should not entail the resignation of social responsibility.

JAMES A. SLAVIN
 University of California
 Los Angeles, California

5/17/79

I am writing this letter with a deep sense of outrage at the recent vote of the APS Council to boycott states that have not ratified the Equal Rights Amendment. I am very much in favor of having more women in physics, but I feel even more strongly that it is not appropriate for an organization whose goal is the advancement and diffusion of the knowledge of physics to become embroiled in this intensely political matter.

I believe that my views are shared by the vast majority of APS members, and I believe, as distasteful as it may be, that we should make our views felt in a more concrete way, by a council recall movement if it proves to be necessary.

FRED JEFFERS
 Spin Physics, Inc.
 San Diego, California

5/18/79

▼ **June 1978, page 17:**
Gloria B. Lubkin reports on Josephson-junction logic and memory circuits

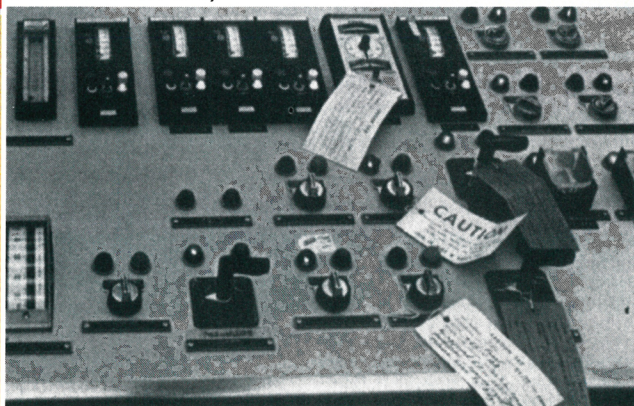
The superconducting tunnel effect predicted by Brian Josephson in 1962 is looking increasingly promising for another very practical application—as logic and memory circuits for computers. Josephson-junction circuits are capable of high switching speeds (50–100 picosec have already been obtained). And because such circuits operate at voltages comparable to the superconducting energy gap, the heat generated is typically microwatts, thousands of times lower than high-speed transistor circuits. The diminished heat-removal problem allows one to pack the Josephson circuits much closer than semiconductor circuits. Once high switching speeds are achieved, this packability becomes extremely important because then the major limitation on computer speed is how fast the electrical signal takes to move from one circuit to another.

Recently, groups at the IBM Research Center in Yorktown Heights, N.Y. and Zurich, Switzerland and at Bell Laboratories in Murray Hill, N.J., announced new results on making high-speed Josephson circuits that might be suitable for computer applications.

▼ June 1979, page 77:
**What went wrong with the
Three Mile Island reactor? (as
reported by Barbara Goss Levi)**

The Three Mile Island nuclear reactor near Harrisburg, Pa. has been cooling slowly after the crisis that began there on 28 March. The feverish activity to decipher this accident and prevent others has not abated, however. Details of the sequence of events that led to the damage of a large fraction of the nuclear core are only gradually emerging. Some answers must wait until the core can be safely approached, and still others may never be forthcoming. The events as understood on 4 April were related that day to the Nuclear Regulatory Commission by its staff. As part of a routine check of this PHYSICS TODAY account, we consulted several groups analyzing the accident. Although given ten days to reply, NRC failed to comment, despite repeated inquiries.

▼ February 1980, page 89: Study blames 'people-related problems' for TMI accident (as reported by Michael E. Jacobs)



Maintenance tags on TMI-2 control panel covered one of two lights indicating that the two emergency feedwater valves were closed. No one knows why the second light was missed. The closed valves were discovered eight minutes into the accident. Photo courtesy Metropolitan Edison.



Meeting in the Great Hall of the People. From left: Vice-Premier Fang Yi (president of Academia Sinica), Wu Ling-an (Institute of Physics), Li Ming-de (Foreign Affairs Bureau, Academia Sinica), Chien San-chiang (vice-president, Academia Sinica), Gloria B. Lubkin (PHYSICS TODAY).

◀ March 1980, page 32:
**PHYSICS TODAY's Gloria B.
Lubkin (shown at right in
photo) visits China and
reports on the status
of physics there**

When I landed in Peking one cold night last November I was warmly greeted by Kuan Wei-yen, a low-temperature physicist who runs Academia Sinica's Institute of Physics. It was the start of a three-week tour of the People's Republic of China as the guest of Academia Sinica, in which I met with Vice-Premier Fang Yi and other leading science officials, visited six physics institutes and five university physics departments.

▼ May 1979, page 65:
**Michael Aizenman reviews
Benoit Mandelbrot's *Fractals:
Form, Chance and Dimension***

Geometry provides the vocabulary for one of our fundamental modes of thought, and the geometrical constructs that we have at our disposition form an asset on which we often draw when constructing models or when laying the grounds for analytical investigations. *Fractals: Form, Chance, and Dimension* is a unique work that enriches our geometric resources by bringing to us some of the mathematical structure, physical significance and aesthetic appearance of shapes that may seem exotic to a mind accustomed to smooth forms.

Once one has a name by which to refer to them, "fractals" (a term coined by Benoit Mandelbrot) can be perceived in abundance. Examples from nature are the highly irregular shapes of coastlines, the very symmetric but rich-in-detail snowflakes, and our vascular system, which seems to combine regularity with randomness.

▼ May 1979, page 20:
**Bertram M. Schwarzschild
reports on scanning acoustic
microscopy**

The resolving power of the scanning acoustic microscope now rivals that of the optical microscope. Since Calvin Quate and Ross Lemons reported building the first scanning acoustic microscope in 1974, Quate's group at Stanford has been able to improve the resolution of this instrument every year by about a factor of two; they now report they have achieved resolutions of about half a micron.¹ Quate recently described his progress in an invited paper at the March meeting of The American Physical Society in Chicago. Quate's group has also recently reported the results of the first experiment with a photoacoustic microscope,² a new instrument that generates sound waves by heating a sample with a pulsed laser.

physics today

AUGUST 1980

How bats detect flying insects



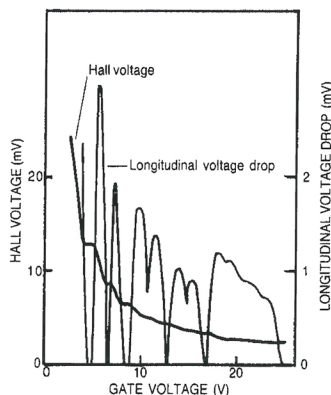
▼ August 1980, page 5:

COVER: Gerhard Neuweiler's article (page 34) explains how bats are able to echolocate insects flying among trees and foliage by using an "acoustical fovea"—an expansion of one portion of their ears' frequency spectrum—with frequency changes to allow for Doppler shifts. This photograph of the bat *Myotis lucifugus* about to catch a flying moth was taken by Frederic A. Webster.

1978–1988

▼ June 1981, page 17: Bertram M. Schwarzschild reports on the first observations of the quantum Hall effect

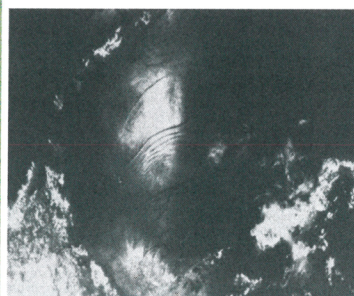
A year ago, Klaus von Klitzing and his coworkers demonstrated¹ at the University of Würzburg (Germany) that the Hall resistance of a two-dimensional electron gas in the inversion layer of a silicon MOSFET transistor, subjected to high magnetic field and low temperature, exhibited quantized steps as the transistor's gate voltage varied its Fermi level. At each step, the Hall resistance is given (to about one part in 10^6 in their latest experiments) simply, in terms of fundamental constants, by $R_H = h/e^2 n$, where the integer n is the number of "Landau levels" lying below the Fermi energy of



Hall resistance, as measured by Hall voltage across von Klitzing's MOSFET, falls in quantized steps as gate voltage increases, raising the Fermi energy through successive Landau levels. Resistance plateaus occur at deep minima in the longitudinal voltage drop, when current is lossless because Fermi energy is between Landau levels. Shallower minima are due to spin and valley degeneracies.

the gas, without further reference to experimental parameters. In MKS units, h/e^2 is about 25 813 ohms. In the same unit system, the fine-structure constant is given by $\alpha = (e^2/h)(\mu_0/2)$, where μ_0 is the permeability of the vacuum.

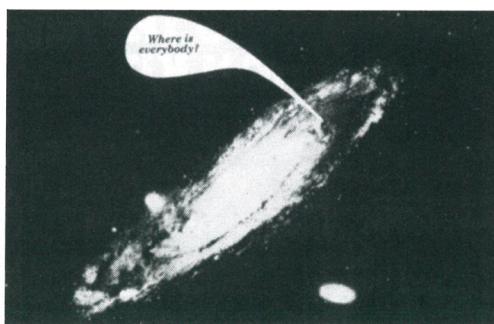
Last fall Daniel Tsui and Arthur Gossard at Bell Labs observed the same effect² under less stringent magnetic-field and temperature conditions at a GaAs-Al_xGa_{1-x}As heterojunction. Barry Taylor's group at the National Bureau of Standards is currently investigating both techniques in hopes of ultimately producing a measurement of α and an absolute resistance standard good to a part in 10^6 .



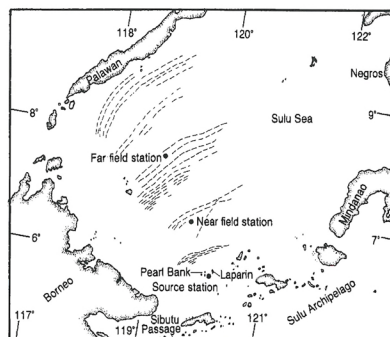
Peculiar striations more than a hundred kilometers long, visible on satellite pictures of the surface of the Andaman and Sulu Seas in the Far East, appear to be of interest in fields as far removed from oceanography as quantum field theory. A recent report¹ of underwater current and temperature variations associated with such surface phenomena in the Andaman Sea, by Alfred Osborne, a physicist at Exxon Production Research (Houston), and Terrence Burch, an oceanographer with EG&G Environmental Consultants (Waltham, Mass.), suggests that these striations mark the propagation of "solitons," exotic solutions of nonlinear wave equations that have captured the interest of mathematical physicists studying a broad range of phenomena spanning 22 orders of magnitude in size.

▼ June 1981, page 25: Andrei Sakharov, exiled to Gorky, writes on the responsibility of physicists

Western scientists face no threat of prison or labor camp for public stands; they cannot be bribed by an offer of foreign travel to forsake such activity. But this in no way diminishes their responsibility. Some Western intellectuals warn against social involvement as a form of politics. But I am not speaking about a struggle for power. This is not politics. It is a struggle to preserve peace and those ethical values which have been developed as our civilization evolved. By their example and by their fate, prisoners of conscience affirm that the defense of justice, the international defense of individual victims of violence, the defense of mankind's lasting interests are the responsibility of every scientist.



◀ April 1981, page 9: From 'Extraterrestrial Intelligent Beings Do Not Exist' by Frank J. Tipler



◀ November 1980, page 20: Great undersea waves may be solitons (as reported by Bertram M. Schwarzschild)

▼ August 1981, page 53: Iraqi reactor damaged in Israeli bombing raid (as reported by Barbara Goss Levi)

The Israeli destruction of an Iraqi nuclear research reactor on 7 June has challenged the world once again to reconcile the peaceful and destructive potentials of the atom. The recent drama in the Middle East has stimulated many physicists to think beyond the particular actors involved to some more general, technical questions: What opportunities does a reactor such as Iraq's provide for a nation to acquire significant amounts of nuclear weapons material? How can such attempts be detected or deterred? What types of research are appropriate to a reactor of that size? What radiation hazards might result if the reactor were bombed after it was fueled and operating?

The physicists who have tried to answer such questions, either privately or publicly, have reached differing assessments that result both from incomplete information and from the necessity for applying some individual judgment.

The target of the Israeli bombs was a research reactor being built by the French at the Iraqi Nuclear Research Center in Tuwaitha, 14 km from Baghdad. The large reactor, named Tamuz 1, was patterned after the 70 MW (thermal) Osiris reactor in France.

1978–1988

▼ September 1981, page 24: From 'Computer-Based Instruction in Physics' by Alfred Bork

Until now, the computer has played only a minor role in the teaching of physics and other subjects. In the next few years we can expect this to change dramatically because of the development and profusion of relatively inexpensive personal computers and because of the growing pressure to streamline the educational system. In the future, computer-based instruction may make practical the organization of colleges in which almost all funds are used for the development of curriculum material and relatively little is spent per student for delivery.

► January 1982, page 9: From 'The National Crisis in Scientific Equipment' by John H. Marburger



Isabella accelerator under construction at Brookhaven National Laboratory. Funds for its completion are uncertain; if the project is cancelled the US will lose a unique research tool.

▼ March 1982, page 59: Headline

Congress considers plan to dismember DOE

▼ April 1982, page 21: Bertram M. Schwarzschild reports on scanning tunneling microscopy

The earliest work on quantum tunneling in solid-state physics, more than fifty years ago, dealt with electron tunneling through a vacuum barrier. But for the next half century we had no clear experimental demonstration of this conceptually simplest of tunneling phenomena. Spectroscopic and technological exploitation of quantum tunneling was developed only with solid tunnel barriers. Metal-vacuum-metal tunneling requires a gap held constant at a few angstroms. At such small distances—just a few atomic widths—it is extraordinarily difficult to control the gap size and insure that surface contamination layers or irregularities do not result in an unwanted contact across the gap.

Theory predicts that the tunnel resistance across the vacuum barrier will

increase exponentially with gap size, with a logarithmic slope proportional to the square root of the mean work function of the two tunneling surfaces. Thus the most direct evidence of successful metal-vacuum-metal tunneling would be the observation of such an exponential resistance curve with an exponent appropriate to the work functions.

A recent *Applied Physics Letter*¹ by Gerd Binnig, Heinrich Rohrer, Christof Gerber and Edmund Weibel of the IBM Research Laboratory in Zurich reports just such an observation. This has been accomplished with a novel tunneling instrument that makes it possible to control the distance between tunnel electrodes with a precision of one or two tenths of an angstrom. Furthermore, the ability of their three-legged piezoelectric support system to control precisely the lateral position of the electrodes has enabled the group to exploit vacuum tunneling for scanning surface microscopy with a resolution of 5 to 20 Å in the surface plane.

▼ October 1982, page 33: Kameshwar C. Wali describes the famous dispute between Chandrasekhar and Eddington

Stellar evolution has for many years been one of the most exciting fields of research in astronomy and astrophysics. In the early 1930s, a young astrophysicist named Subrahmanyan Chandrasekhar certainly felt this excitement when in his theoretical work he found a fundamental parameter that determines the destiny of stars. By applying both relativity and the new quantum mechanics, Chandrasekhar found a critical mass, below which stars end up as white dwarfs, and above which, as later work would show, they end up as neutron stars or black holes.

Although we now recognize the "Chandrasekhar limit" as a major discovery, its validity and importance remained in doubt among astronomers in large part because a single individual felt that all stars should become white dwarfs in their terminal stages. A dramatic and unanticipated confrontation took place at the January 1935 meeting of the Royal Astronomical Society of England. As we will see, the brilliant but young Chandrasekhar, armed with a fairly simple derivation based on special relativity and the Fermi-Dirac quantum-statistical distribution laws, was no match for the ridicule by Arthur Stanley Eddington, a renowned scientist with tremendous international stature, authority and influence. And because physicists failed to counter Eddington publicly in their own area of expertise, astronomers remained confused about stellar evolution until the 1950s.

Global atmospheric effects of nuclear-war fires

When Yves Laulan says, "We would be returning to the Dark Ages," the chief economist of the largest bank in France is talking about the economy after a nuclear war. With half the Northern Hemisphere's urban population wiped out by the war's direct blasts alone, those remaining would find themselves in a barter economy trading in nothing more than the basic elements of survival: food, shelter and medical care.¹

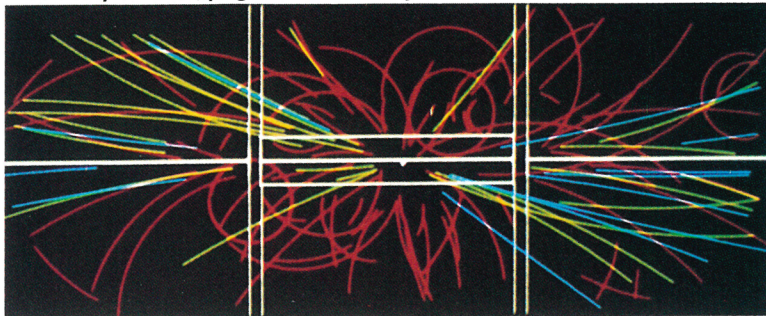
Now, some physical scientists, too, are saying that the months following a nuclear exchange may be a dark age—although in a more literal and more lethal sense. They estimate that massive secondary fires could inject enough smoke into the atmosphere to block 50 to 99 percent of the sunlight that would otherwise reach the surface of the Earth in the agricultural latitudes of the Northern Hemisphere. Research

on this little-studied atmospheric effect of nuclear war indicates that the blockage could persist for several months, stopping much of the world's food production, and subjecting all but a small fraction of the survivors of the initial nuclear effects to famine and disease. These survivors would see a darkened world much like the one some believe the dinosaurs saw as they perished 65 million years ago (PHYSICS TODAY, May 1982, page 19). This time, however, even after the particulate matter clears, a dangerous photochemical smog might take its place for several months.

◀ October 1982, page 17: Jeffrey D. Schmidt reports on nuclear winter

1978–1988

▼ April 1983, page 18: Discovery of the W boson



Event #1279 recorded in the UA1 central detector shows $W^- \rightarrow e^- + \nu$. Proton beam enters from right, antiproton beam from the left. A magnetic field into the page bends charged particles. Low-momentum tracks are in red (0–1 GeV/c) and yellow-green (1–3 GeV/c); they are bent more than high-momentum tracks, shown in blue (> 3 GeV/c). The electron from W decay (with 34 GeV/c) is a straight blue track at about 45 deg from beam in lower right quadrant.

▼ April 1983, page 112: Editorial. Harold L. Davis comments on the 1984 Federal budget proposal

The White House has removed all doubt that it recognizes the key contribution of basic research to the national welfare by making a very strong statement—a \$195 million (18%) increase overall in 1984 for NSF's budget (see our news story, March, page 61). The figures are even better for physics overall at NSF (increase of \$64.6 million or 21.6%), and within physics the budget provides for an increase of \$29.9 million (53%) for research instrumentation.

To enable the budget for defense R&D to be increased from \$25 billion to \$32 billion, the White House proposed no increase in the \$14 billion for nondefense R&D. Hence the increases for basic research will be obtained through cuts in applied research, with the expectation that industry will pick up the slack as needed. For example, DOE's fossil-fuels, solar and conservation programs face cuts of more than \$400 million.

▼ September 1983, pages 17, 19: HEPAP recommends building SSC (as reported by Gloria B. Lubkin)

A high-luminosity proton-proton collider (often called the Desertron) with 10 to 20 TeV in each beam should be the highest priority for the next US particle accelerator, according to all 17 members of the HEPAP subpanel, headed by Stanley Wojcicki of Stanford. By a slim majority, 10 to 7, the subpanel also recommended killing the Colliding Beam Accelerator (formerly known as Isabelle) at Brookhaven.

During the discussion among HEPAP members, Robert Palmer pointed out that the subpanel's cost estimate of \$2 billion for SSC did not include the cost of detectors or contingencies. "That is a very optimistic number. And it's not promising that Congress will appropriate it. I'm appalled at the kind of risk you're recommending."

▼ April 1983, page 20: Discovery of the B meson (as reported by Bertram M. Schwarzschild)

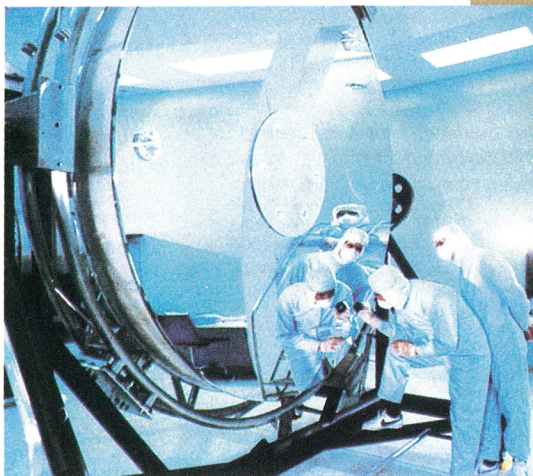
At the New York meeting of The American Physical Society in January, the CLEO collaboration working at the Cornell electron-positron storage ring (CESR) reported¹ the first direct observation of a new stable meson, labeled B because it is thought to be the bearer of the bottom quark b, carrying a fifth quark flavor.

► June 1983, page 41: Irwin Goodwin, in the first 'Washington Reports' column, writes about efforts to protect US technology

At San Diego, the Society of Photo-Optical Instrumentation Engineers had organized a conference on laser communications and infrared optics. The night before the meeting was to begin last August, officers of the society received a telegram from the Commerce Department warning that some of the presentations might violate existing technology export regulations. Next morning, several Department of Defense representatives summoned individual participants to a hotel room, in a scene worthy of a Kafka novel, to ask two questions: "Was your work sponsored by a DOD agency?" and "Have you secured clearance for your paper?" The tactic achieved the desired effect. "They never actually asked me to withdraw my presentations," said an engineer from an industrial laboratory, "but when I thought about the penalties for violating the export control laws, I was scared enough to pull them." In all, the participants withdrew more than 150 of the 626 papers submitted to the SPIE meeting.

▼ November 1984, page 17:

The 2.4-meter primary mirror of Space Telescope (In this photo, taken in December 1981) is being inspected after being coated with a reflective layer of aluminum and a protective layer of magnesium fluoride (to preserve reflectivity in the uv). Subsequently, despite clean-room precautions, the mirror surface became contaminated with fine particles. This June the surface was cleaned, just before the telescope was sealed.



▼ November 1983, page 17: Discovery of the Z^0 (as reported by Gloria B. Lubkin)

Once the W particle was reported in January, it was almost inevitable that the Z^0 particle would eventually be found, provided that both the CERN collider and the two detector groups worked long and hard enough. The discovery of Z^0 , the neutral intermediate vector boson, was announced on 1 June; the UA1 group said¹ it found five Z^0 events. The 270-GeV protons colliding with 270-GeV antiprotons had produced four events in which the Z^0 decayed into an electron-positron pair and one in which the Z^0 decayed into a $\mu^+\mu^-$ pair. On 15 July, the UA2 group also reported² finding the Z^0 .

1978–1988

▼ January 1984, page 76: 'Physicists Sign Appeal for Nuclear Freeze' (as reported by Daniel Gladstone)

By late November 15 000 physicists in 44 countries had signed the following appeal for a nuclear freeze:

We call for an agreement to halt the testing, production and deployment of nuclear weapons and nuclear weapons delivery systems. Meanwhile, no further nuclear weapons or delivery systems should be deployed anywhere.

Over half of the living winners of the Nobel prize in physics were among the signers.

▼ June 1985, pages 17, 21: Bertram M. Schwarzschild reports on stopping of atoms by light

In the 11 March issue of *Physical Review Letters*, two National Bureau of Standards groups reported^{1,2} that they were able to bring beams of 1000-m/sec sodium atoms essentially to rest by the radiation pressure of laser light directed upstream into the atomic beam. An even more recent achievement came as a surprise announcement at the Washington meeting of the APS in April. William Phillips, leader of one of the NBS groups (Gaithersburg, Maryland) was scheduled to talk about his group's beam stopping results, and how they "might" be exploited for actual trapping. But, it turns out, the published abstract of his talk was already obsolete. Phillips told the symposium that he and his colleagues had just succeeded in actually trapping these stopped atoms between the coils of a simple magnetic trap—the first such achievement for any neutral particles other than neutrons. . . .

▼ March 1984, page 115: Robert Hofstadter writes about Felix Bloch (1905–83)

Peter Debye, with whom Bloch studied at the Institute, suggested that he do his thesis work at Leipzig, where Heisenberg would soon join the faculty. In this way Bloch became Heisenberg's first graduate student. Under Heisenberg's tutelage he attacked the problem of the conductivity of metals and succeeded in his PhD thesis in finding the solution of the quantum theory of metals. This led in turn to the modern quantum theory of solids and eventually to modern radio, television, computers, and the electronic logic behind modern experimentation in virtually all fields of science.

▼ April 1984, pages 75–76: 'What Now for Sakharov and Orlov?' (as reported by Irwin Goodwin)

In one of the ironies of history, the seven-year jail sentence for Yuri Orlov, the accelerator physicist who was imprisoned in 1977 for slandering the Soviet regime, was to come to an end on 10 February, the same day Moscow announced the death of Yuri Andropov, who ran the KGB at the time of Orlov's arrest and trial.

Orlov is now starting the second part of his sentence, a five-year term of internal exile in Yakutsk in bleak eastern Siberia.

The death of Andropov and the succession of Konstantin Chernenko as Soviet leader contain elements that are both promising and threatening for scientists there who are victims of repression. Orlov's case, like those of Andrei Sakharov, a physicist, and Anatoli Shcharansky, a computer mathematician, is considered a test of Soviet attitudes toward scientists and other professionals who disagree with government policies. It also is a test of future scientific relations between the Soviet Union and Western countries.

Various groups have been striving to achieve Bose condensation with spin-polarized atomic hydrogen (PHYSICS TODAY, June 1980, page 18). Because atomic hydrogen is the only substance that remains a gas at absolute zero, these experiments do not require laser cooling. But the achievement of sufficiently high density appears now to be thwarted by recombination into molecular H₂ at the walls of the cryogenic vessel. Phillips suggests that one might solve this problem by replacing the physical walls with one or another of the atomic-trap designs that are now coming to fruition.

► June 1984, page 24: Detail of Maya Venus ephemeris, from 'Native American Astronomy' by Anthony F. Aveni

▼ July 1985, page 55: Irwin Goodwin reports on the projected cost of SDI

Measured in terms of SDI's estimated cost of \$26 billion over the next five years and the 7500 or so scientists and engineers now taking part at national laboratories and aerospace contractors, the program already dwarfs in size, if not political or psychological significance, the Manhattan atom-bomb project and the Apollo moon landings. A full-fledged space shield against nuclear missiles, developed along the lines Reagan outlined, might cost as much as \$2 trillion—more than double the entire annual Federal budget.

▼ April 1985, page 47: N. David Mermin quotes Richard Feynman, poet

The EPR experiment is as close to magic as any physical phenomenon I know of, and magic should be enjoyed. Whether there is physics to be learned by pondering it is less clear. The most elegant answer I have found¹⁷ to this last question comes from one of the great philosophers of our time, whose view of the matter I have taken the liberty of quoting in the form of the poetry it surely is:

We have always had a great deal of difficulty understanding the world view that quantum mechanics represents.

At least I do, because I'm an old enough man that I haven't got to the point that this stuff is obvious to me.

Okay, I still get nervous with it. . . .

You know how it always is, every new idea, it takes a generation or two until it becomes obvious that there's no real problem.

I cannot define the real problem, therefore I suspect there's no real problem, but I'm not sure there's no real problem.

Nobody in the 50 years since Einstein, Podolsky and Rosen has ever put it better than that.

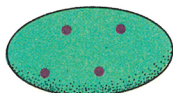


▼ November 1985, page 95: William Sweet reports on petitions against SDI

Petition drives opposing space weapons research are gathering a remarkably large number of signatures among physicists at some universities in the United States and Canada.

Both petitions were written shortly after SDI officials solicited proposals early last spring. The petitions were a reaction to public claims by SDI officials that submission of proposals by scientists implied academic support for the space-defense concept (PHYSICS TODAY, July, page 55).

1978–1988



▼ February 1986, page 11: From the extensive debate on SSC in 'Letters'

We have a correct, complete and consistent theory of elementary-particle phenomena, but this is precisely what bothers us. Our theory has too many adjustable parameters to be the last word. Unlike other scientists, we yearn for experimental data that will knock our theory down, so that our next one can be better yet. Who knows what surprises SSC will reveal? If we did we wouldn't need the machine. We don't quite know what we are doing nor where it will lead. That's what I mean by fundamental, and it's really the only honest argument we've got going for us.

SHELDON L. GLASHOW
Harvard University
Cambridge, Massachusetts

1/86

I have read the June 1986 PHYSICS TODAY—the special issue on the education of a physicist—with more than ordinary care. With this plethora of words on money and big black boxes with knobs to turn and lights to flash and grants and undergraduate research and computers, there is not a word or a phrase on the essential ingredient in the education of a physicist. Not a word!

This essential ingredient is learning how to think physics. There is little of this in any class at any level, from the kids in the elementary science classes to the upper and graduate courses in the university—and in these it is frightfully wanting. It is now all high-powered mathematical gymnastics and huge costly apparatus—and computers. Those learning their first physics with computers and in upper courses are not learning what physics is nor are they learning how to think physics! The young are enamored of this modern stuff and they consider old-fashioned questions like "Why does a brook gurgle?" beneath their dignity. The story of Ernest Rutherford and the stick in the pool of water has no meaning to these moderns, but look where it took Rutherford.

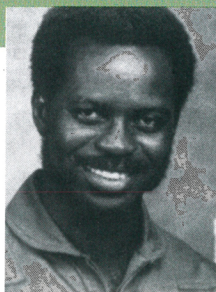
This decay in a feeling for what physics is does not bode well for the future of physics. And with this essential ingredient so wanting—so lacking—we cannot hope to produce a James Clerk Maxwell or a Michael Faraday—much less a Rudolf Clausius or a Ludwig Boltzmann.

JULIUS SUMNER MILLER
Torrance, California

6/86

► April 1986, page 72: Stephen C. McGuire writes about Ronald E. McNair (1950–86)

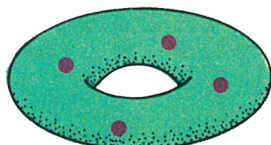
Ronald E. McNair



Astronaut Ronald E. McNair was among those who perished in the explosion that destroyed the space shuttle Challenger and its seven-member crew on 28 January 1986.

McNair was born in Lake City, South Carolina, on 21 October 1950. He received his BS in physics from North Carolina A&T University (1971) and his PhD in physics working with Michael Feld at the Massachusetts Institute of Technology (1976), where he specialized in quantum electronics and molecular spectroscopy.

◀ May 1987, pages 132–34: Letter



▲ November 1987, page 39: Feynman diagrams for strings, from 'Superstrings' by John H. Schwarz

▼ December 1985, page 38: Victor F. Weisskopf's personal memories of Wolfgang Pauli

Ehrenfest expressed it well after J. Robert Oppenheimer came to him as a young postdoc in the late 1920s. Ehrenfest was unhappy because Oppenheimer always gave quickly an answer to any question, and Ehrenfest felt that the answer was not always correct but was unable to reply fast enough. So he wrote to Pauli: "I have here a remarkable and intelligent American but I cannot handle him. He is too clever for me. Couldn't you take him over and spank him morally and intellectually into shape?" (*Zurecht prügeln*). We all were spanked into shape by dear Pauli and we loved it.

▼ December 1986, page 18: Barbara Goss Levi reports on the Soviet investigation into the Chernobyl accident

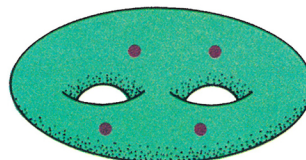
The Soviets have calculated that the power may have soared to 100 times its nominal value of 3200 MW_{th} within four seconds.

The huge release of energy (the Soviets estimate over 300 cal/g) from this power excursion essentially fragmented the fuel into minute (millimeter diameter or less), hot particles. The fuel cladding failed and allowed these particles to contact the coolant in the channels. Rapid steam generation together with expansion of the volatile fission products from the fuel raised the pressure enough to destroy the cooling channels. Steam erupting from these channels caused the vault containing the reactor core to fail catastrophically, lifting and tilting the cover plate above the core and opening the enclosure to air. These events led to a worsening of reactor-power transients, and a second explosion was reportedly heard two to three seconds later. No one yet knows whether there was in fact a second explosion and, if so, what caused it. The Soviet report said that "witnesses observed these reactions in the form of a fireworks display of glowing particles and fragments escaping from the units."

Handling the aftermath. Flaming pieces of core and hot graphite landed on several of the roofs of the reactor housing, starting fires in 30 places (see the photo on page 20). The fires were out by 5 am on 26 April. For about ten more days, however, reactions within the graphite continued to produce dark smoke. Starting on 28 April, military helicopters dropped about 5000 tons of boron, dolomite, sand, clay and lead on the smoldering core to absorb and filter the aerosol particles. On 4–5 May the Soviets pumped nitrogen under pressure into the space beneath the reactor vault to cool the fuel. Radioactive releases were continuing all the while.

▼ April 1986, page 56: A. F. Spilhaus Jr on AGU's joining AIP (as reported by William Sweet)

Asked whether one should visualize the average AGU member as someone like Robert Redford in the film *Out of Africa*, flying about in a biplane collecting rocks, Spilhaus observed with a slight hint of regret that one sees more ties and fewer field boots when one attends AGU-sponsored conferences these days. An increasing proportion of AGU's members work primarily in laboratories, he said.



February was a great month for physics. The subject of high- T_c superconductors exploded as labs around the world pushed the transition temperature for a variety of compounds above 77 K. The Reagan Administration announced its support for the Superconducting Super Collider as a major investment to push back the frontiers of particle physics. And on 23 February, astronomers ended a 383-year vigil as a naked-eye supernova blazed forth in the southern sky. (See figure 1.)

Telegram number 4316 of the International Astronomical Union flashed the news to astronomers around the

world:

W. Kunkel and B. Madore, Las Campanas Observatory, report the discovery by Ian Shelton, University of Toronto, of a mag 5 object, ostensibly a supernova, in the Large Magellanic Cloud. . . .

By the next evening, nearly all major radio and optical telescopes south of the Equator were observing the supernova, which, as the first such event discovered in the year, was designated SN1987a. Within 14 hours of the initial optical sighting, the International Ultraviolet Explorer satellite was obtaining short-wavelength spec-

tra of the exploded star. Within two weeks, physicists operating proton-decay detectors in Japan and Ohio announced the birth of a new field, neutrino astronomy, having recorded simultaneous bursts of high-energy particles hours before the optical sighting. One month after the event, the supernova story graced the cover of *Time* magazine with one word: "BANG!"

As of this writing, four months after the bang, the impact of the supernova on astrophysics and particle physics is already enormous.

► April 1987, page 7:
25 January 1987, just a
month after Sakharov's
return to Moscow
from Gorky

▼ July 1987, page 26:
Luis W. Alvarez on the
bolide impact theory of
dinosaur extinction

I have discussed the need for a plausible killing mechanism, so I want to show that it is reasonable to assume that Earth was hit 65 million years ago by a bolide 10 km in diameter. (Mount Everest is 8.8 km high.) It is easy to estimate the effective diameter of the bolide, but before doing so we need to know that the worldwide K-T clay layer is everywhere enriched in iridium. That was the first prediction of the theory, and iridium enhancements have now been seen at about 75 locations throughout the world in K-T clay layers. If we add up the amount of iridium on each square centimeter of Earth's surface, we find a total of about half a million tons of iridium. If we use the iridium abundance of 0.5 parts per million found in certain primitive meteorites as representative of Solar System debris, then a simple exercise in geometry tells us that a spherical bolide that brings in that much iridium would be close to 10 km in diameter.



Dinner in Moscow. From left are Herman Feshbach, Elena Bonner, Andrei Sakharov and Alexi Semenov. (Photo © Robert Arsenault.)

▼ November 1986,
pages 11-13: Reply to letter

KURT VONNEGUT COMMENTS: I got the idea for ice-nine, frozen water stable at room temperature, which is central to my novel *Cat's Cradle*, from my brother Bernard when we were both working for General Electric in Schenectady, he as a research scientist and I as a publicity man. Bernard was then involved, as he still is today, with the formation of ice crystals in the atmosphere. Ronald Reagan was also working as a flack for GE back then. What a time to be alive!

KURT VONNEGUT
New York, New York

6/86

◀ April 1987, pages 17, 23:
Anil Khurana reports on
the 'Woodstock for physics'

. . . Certainly, inquiries about superconductivity at room temperature no longer seem unreasonable. Several groups have observed sharp decreases in resistivity by two to three orders of magnitude in mixed-phase samples at temperatures near 240 K. The decrease in resistivity is reproducible and, many groups say, similar to the behavior that finally led to the discovery of superconductivity above 90 K. "If the same luck holds," Chu said, "superconductivity at 240 K may be obtained in the near future."

On 18 March, more than a thousand physicists jammed the outer lobbies of the ballrooms at the New York Hilton as they waited for more than an hour for the doors to open 45 minutes before the 7:30 pm panel discussion on high- T_c oxides. A brief, two-line announcement about the panel discussion had been made in the program for the annual March meeting of The American Physical Society, held in New York on 16-20 March. . . .

According to Ashcroft, more than a hundred physicists were still present when he closed the session at a quarter after three. Many remained until 6 am, when the hotel staff reclaimed the rooms.

▼ March 1987, page 13: Letter
The SSCene Creed

The physics community may stand or kneel.

I believe in the Copenhagen interpretation of quantum mechanics, the second law of thermodynamics and the unitarity of the S matrix.

I acknowledge one vacuum for the basis of Hilbert space, the inattainability of absolute zero and the nonobservability of phase.

I am willing to concede second quantization of fields, the wave-particle duality and the path integral formulation of quantum mechanics.

I am reasonably comfortable with canonical quantization, the manipulation of divergent quantities as though they were infinitesimals, and the confinement of quarks.

I am willing to speculate on the possibility of supersymmetry above present-day collider energies, the collapse of the wave packet upon measurement, and the "true" number of dimensions of the universe.

In my less lucid moments I will even buy supergravity and the introduction of local SUSY transformations on a manifold.

After a few martinis I will slur, "Hell yes!" to the suggestion that the underlying structure of the universe is a two-dimensional conformally invariant field theory.

After a prefrontal lobotomy I will declare fervently that a unified field theory encompassing all known particles and interactions is inevitable before the end of this century.

In the name of quantum mechanics, the Dirac equation and the compactification into itty-bitty circles of everything we don't observe,

Amen.

SANFORD WILSON
ERNEST LEWIS

University of Texas at Austin

6/86