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ERNEST P. GRAY and ALBERT M. STONE

THE HISTORY OF THE APL COLLOQUIUM

The APL Colloquium has had a continuous run for over four decades. It is prized both by the Laboratory staff and by members of the local scientific and engineering community. Many renowned people have spoken at the colloquia. We recount in this article a history of the institution from its earliest days.

INTRODUCTION

Almost every Friday at 2 PM, from October through May, an audience ranging from 100 to 500 gathers in Parsons Auditorium or the Kossiakoff Center to hear an eminent speaker. The weekly APL Colloquium, on a rich variety of eclectic topics, is one of the oldest and most popular continuing scientific lecture series in the Washington–Baltimore area.

Started in 1947 by Robert Herman to enable the members of the recently formed Research Center to hear first hand about the latest scientific research, the colloquium has since then abandoned its exclusivity and broadened its appeal. It has evolved to serve not only the entire staff of the Laboratory, but also the local scientific community. Its scope now encompasses the latest findings in science and technology and includes such related topics as science policy, the industrial research laboratory, the 100th anniversary of the eruption of Krakatau, election statistics, and other subjects deemed broadly educational for our staff. The schedule of forthcoming lectures is available not only within the Laboratory, but also is mailed regularly to about 250 organizations and individuals in the Washington–Baltimore area.

Each year, 25 to 30 lectures are scheduled. Typically, about 30% deal with physics, astronomy, astrophysics, and space science, 30% with engineering and computer technology, 20% with chemistry and materials science, and the remaining 20% with biomedical and occasionally esoteric topics. By and large, we have had excellent speakers (among them, 14 Nobel Laureates) who have attracted large, lively, and responsive audiences, including many visitors from outside APL. The exceptional quality of the audience has, in fact, led to an unusual rapport between the speaker and his listeners, and has often made the question period following each presentation the most interesting feature of the colloquium.

Many lecture series begin with high hopes but then falter. Others satisfy only the needs of a limited audience. Few continue to appeal to an audience as diverse and sophisticated as ours.

EARLIEST REMEMBRANCES

Unfortunately, there are no surviving records of the early days. The memories of Robert Herman (now at the University of Texas at Austin) and such other early attendees as Ralph A. Alpher (now at Union College in Schenectady, New York) and James W. Follin, Jr., and William H. Avery (both still at APL) are fragmentary. What is certain is that in those first days the colloquium convened on Fridays at 3:30 PM in a small lecture room at 8621 Georgia Avenue in Silver Spring, the original APL site. Some of the outstanding speakers who addressed the colloquium are still remembered.

One of the most memorable early speakers was George Gamow, professor of physics at George Washington University, where he was Alpher's mentor and universally recognized as possessing one of the most fertile imaginations and best scientific minds of his day. At that colloquium, Gamow speculated about the genetic code. The presentation was given shortly after publication of James Watson and Francis Crick's landmark paper (which later led to a Nobel Prize for medicine) announcing the discovery of the structure of DNA as a double helix made up of long sequences of four nucleotides. Gamow explained that since these sequences had to code for the 20 amino acids (the building blocks of proteins), the code for any amino acid requires a sequence of at least three nucleotides: there are only 16 different combinations of two—too few—but 64 combinations of three. The overabundance of such triplets makes possible some highly desirable redundancy as well as the inclusion of other messages such as where the protein should start and stop. Gamow's speculation was wrong in detail, but his concept was right; his APL Colloquium may have been the first forum at which this ingenious idea was ever presented.

Another notable lecturer was then-Captain Hyman Rickover (the unexpected replacement for Admiral "Red" Raborn, head of the Polaris project), who discussed the prospects for missile-carrying nuclear-powered submarines. In the question period, Colonel Harold S. Morton made a suggestion, long since forgotten. But Rickover's terse retort is still remembered: "Damn you guys with the five-minute solutions."

Other outstanding speakers included Nobel Laureate Harold C. Urey from the University of Chicago, who discussed his ideas concerning the origin of the Moon; Franco Rasetti, a former collaborator of Enrico Fermi's, then at JHU, who told us about his hobby of collecting trilobites (about which he is one of the world's foremost experts); Scott Forbush from the Carnegie Institution's Department of Terrestrial Magnetism (DTM), speaking on the decrease in cosmic radiation—called the Forbush

decrease—during magnetic storms; and Richard B. Roberts, then back at DTM but a pioneer at APL in the days of the variable-time fuze, on his new interest in molecular biology.

THE MOVE TO HOWARD COUNTY

In 1955, Robert Herman left APL and Albert M. Stone took charge of the colloquium. The date coincides roughly with the opening of Building 1 at APL's present Howard County site and the availability of the William S. Parsons Auditorium, which holds 147 fixed seats and enough additional space to accommodate nearly 200 attendees. With its excellent acoustics, built-in slide and movie projectors, and large fixed screen, it was a spectacular improvement over the facilities available in Silver Spring. During the 1955–56 season, Parsons Auditorium was phased in; as soon as enough of our staff had moved from Silver Spring, it became the exclusive colloquium site.

The records of those days are more complete, but still fragmentary. We do know that the first colloquium held in Parsons Auditorium, on 21 October 1955, was presented by Columbia University's Polykarp Kusch, who discussed his work on atomic beams. Less than two weeks later, he was awarded the 1955 Nobel Prize for physics for that work. What an auspicious beginning for our new colloquium venue!

Other eminent speakers during those years included Nobel Laureate in physics Chen N. Yang (a former student of APL's Chih K. Jen) from the State University of New York (SUNY) at Stony Brook, who discussed the nonconservation of parity (Fig. 1); Nobel Laureate in physics Eugene Wigner from Princeton University, who discussed whether the known principles of physics and chemistry suffice to explain life; Herman Kahn from the Hudson Institute, who presented a three-hour lecture entitled "Thinking the Unthinkable," concerning thermonuclear conflict, which incidentally attracted then-Secretary of State Dean Acheson (see Fig. 2); Buckminster Fuller of geodesic dome fame, who inspired us with reflections on his philosophy; Otto Neugebauer from Brown University, who presented a fascinating talk about Babylonian observations of the planets and their interpretation; and Donald R. Griffin from Cornell University, who told us how bats navigate by acoustic pulse transmission and echo reception.

We also heard Mark Kac from Cornell University and Arnold Siegert from Northwestern University, who both addressed us twice on topics in random noise and statistical mechanics; Robert H. Dicke from Princeton University, who reported on measurements with the radiometer he had invented, which eventually made possible the discovery of the cosmic microwave background radiation; Peter Goldmark from the CBS Research Laboratories, who discussed extrafine groove recording, the basis for the then-new 33⅓-rpm records; C. Stark Draper from MIT, whose gyroscopes made possible inertial navigation of submarines and Minuteman missiles; S. Fred Singer, an APL alumnus, then at the University of Maryland, in the first two of many APL Colloquia he presented over the next 25 years, one dealing with cosmic ray measurements, the other describing his proposal (well before Sputnik) to launch an Earth-orbit satellite he named MOUSE (Minimum Orbital Unmanned Satellite Earth); Jesse Beams, an outstanding experimentalist from the University of Virginia, in the first of three colloquia (the second about eight years later, and the third at age 74 in 1972) describing some uses of high-speed centrifuges, especially for an accurate measurement of the gravitational constant; John C. Slater, the pioneer solid-state physicist from MIT, who discussed his seminal paper on band theory in solids; and John A. Wheeler from Princeton University, coiner of the term "black hole," who reviewed some aspects of general relativity.

Figure 1—Nobel Laureate Chen N. Yang being shown through a Research Center laboratory. Left to right, Norman Lord (now at Mitre Corporation), Ernest P. Gray, Yang, Chih K. Jen (retired), and Albert M. Stone (retired).

Figure 2—Herman Kahn (right) talking to former Secretary of State Dean Acheson (to his right). Others are, left to right, Wilbur H. Goss (retired), Ralph E. Gibson (deceased), and Albert M. Stone (retired).

At some point during this period—the records are missing and no one remembers precisely when—a practice began that has become a tradition; with few exceptions, the new colloquium season began each October and concluded each May with an APL speaker. This practice has several advantages: It puts an APL stamp on the colloquia; it says to the scientific community that significant research is conducted here; and it honors the speaker by giving him a prestigious forum for presenting his accomplishments, both to his APL colleagues and to his outside peers.

Several administrative changes were instituted during this period. In 1956, Ernest P. Gray started to assist Albert Stone in arranging the colloquia. In 1958, Stone (now retired) and Gray were joined by James W. Follin, Jr., in an informally constituted Colloquium Committee, which met several times a year to propose potential speakers. In 1961, the committee, enlarged by the addition of George F. Pieper (recently retired from NASA's Goddard Space Flight Center as director of science) and William Liben (now deceased), was formally appointed by the Director, Ralph E. Gibson. This arrangement has proven to be very fruitful because so many more speakers and topics were considered. Other staff members who have served on the committee in the past include Stanley E. Rauch and Ronald E. Walker, who have since left APL, and Robert R. Newton and Chih K. Jen, who have retired. Today, its eight members are Walter G. Berl, Robert E. Fischell, James W. Follin, Jr., Harold E. Gilreath, Earnest P. Gray (chairman), Samuel Koslov, Mary D. Lasky, and Kishin Moorjani.

Efforts were also made to publicize the colloquia throughout the Washington–Baltimore scientific community. The external mailing list of our colloquium schedule, which numbered 14 in 1955, rapidly grew to above 100; today we send out 256 schedules. Because of the increased publicity, the gradual growth of the staff at the Howard County site, and efforts to offer excellent speakers on a variety of interesting topics, the colloquium attendance gradually rose from about 70 during the 1956–57 season to nearly 100 during the 1959–60 season.

THE SIXTIES: A DECADE OF CHANGE

During the sixties many major changes occurred that affected the colloquia. In 1961, Stone relinquished the chairmanship of the Colloquium Committee and turned it over to Gray, with Stone remaining as advisor. Although it was first intended that these positions would rotate biennially, they have remained unchanged to this day.

Also, some innovations were adopted that improved the availability of the colloquia. Starting in November 1961, all talks were audiotaped. Thus, staff members who had to miss a lecture of interest to them could listen to it later. In 1962, the technology was in place for videotaping the colloquia and transmitting them on closed circuit to a remote monitor in the cafeteria whenever the audience exceeded the capacity of Parsons Auditorium.

Beginning in the fall of 1966, the colloquia were moved from 3:30 PM to 2:00 PM, with the colloquium tea held afterward instead of before. The objective was to prevent the embarrassing scramble of people leaving to meet car pools on those occasions when a speaker ran over the prescribed hour. Also, holding the tea after the talk offered an opportunity to discuss the lecture and ask the speaker additional questions.

One improvement in publicizing the colloquia was instituted in the sixties. We had noticed that occasionally the lecture did not meet people's expectations. The only basis on which they could decide whether to attend was the title, and that gave insufficient, sometimes deceptive information. In the fall of 1969, we began sending out a weekly Colloquium Information Sheet, containing a brief, informative abstract, as well as some biographical information about the speaker. In 1970, we also added a brief list of relevant references, copies of which were displayed in the library during the week preceding and the week following the lecture.

Many memorable colloquia were presented during the sixties. The roster of speakers contained an unusually large number of famous and brilliant leaders from academia, government, and industry. They included three Nobel Laureates, two who were later awarded the Nobel Prize, anthropologist Margaret Mead, and William S. Albright, who deciphered the Dead Sea Scrolls.

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1960—**Thomas Gold** from Cornell University, co-originator of the steady-state theory of the universe, a lively speaker, and one of the most imaginative and controversial astrophysicists, lectured twice, once on some problems concerning the solar system, and later (in 1961) on his theory that the lunar surface consisted of a thick layer of dust in which astronauts could be trapped. **Gordon Gould** from TRG, Incorporated, who has only recently won a patent fight against Nobel Laureates Charles H. Townes (Gould's former thesis professor) and Arthur L. Schawlow, presented one of the first talks anywhere on the laser. **Hugh Odishaw** from the National Academy of Sciences Space Science Board summarized findings of the International Geophysical Year (and a half) of 1957 to 1959. **Vernon Hughes** from Yale University, later president of the American Physical Society, discussed the recently observed but ephemeral muonium atom. And political scientist and demographer **Richard Scammon**, then at the Government Affairs Institute, told us about programming election predictions.

1961—**Robert V. Pound** from Harvard University described his landmark experiment of weighing photons, confirming the equivalence of gravitational and inertial mass. **George W. Stroke** from MIT told us how he made large diffraction gratings more accurate than those made on Robert W. Wood's famous ruling engine at JHU. **W. F. G. Swann**, an eminent physicist from the Bartol Foundation, spry and sharp at age 77 (only a year before his death), gave us insight into the well-known "twin paradox" of relativity. Nobel Laureate **Norman F. Ramsey** from Harvard University discussed the significance of potentials in quantum mechanics. **Harrison S. Brown** from the California Institute of Technology talked about natural resources and the future of industrial civilization. **David J. Rose** from MIT discussed prospects for controlled thermonuclear fusion. He came again in 1984, almost incapacitated by emphysema and just two years before his death, to talk about options to combat the greenhouse effect. In a fascinating talk, **John C. Lilly** from the Communications Research Institute in Miami told us about communication by dolphins and illustrated his talk with audiotapes. Finally, Nobel Laureate in chemistry **Peter Debye** from Cornell University discussed the relation between critical opalescence and molecular structure in liquids.

1962—**Marshall W. Nirenberg**, then at NIH and six years later Nobel Laureate in medicine, reported on progress in breaking the genetic code. **Lewis M. Branscombe**, painstaking experimenter in atomic physics, then at the National Bureau of Standards and later chief scientist at IBM's Watson Research Laboratories, reported on his measurements of the spectra of negative ions. **Manfred R. Schroeder** from the Bell Telephone Laboratories presented some of the first digital simulations of concert hall acoustics. **Henry Margenau**, well-known physicist and philosopher from Yale University, discussed the quantum theory of measurement, a subject then neglected but recently very much in the forefront. **George F. Carrier** from Harvard University, a powerful mathematical analyst and outstanding fluid dynamicist, presented a theory of wind-driven ocean circulation. And **Leon M. Lederman**, then at Columbia University and now director of Fermilab, described some experiments with high-energy neutrinos for which he has just been awarded the 1988 Nobel Prize for physics.

1963—**Harold S. M. Coxeter** from the University of Toronto gave a brilliant talk on the map-coloring problem, more than 15 years before the famous four-color theorem was finally proved. **Frank Press**, then director of the California Institute of Technology's Seismological Laboratory and now president of the National Academy of Sciences, spoke on recent developments in seismology, especially as they affect the Nuclear Test Ban Treaty. **Herman Mark** from the Brooklyn Polytechnic Institute presented his work on the physics of polymers. **John P. Blewett** from the Brookhaven National Laboratory made some predictions about accelerators of the future. **Ali Javan** from MIT told us of some of the first applications of gaseous lasers to precision measurements. And **Milton S. Eisenhower**, President of JHU, discussed Latin America on the verge of revolution (Fig. 3).

1964—We got a fascinating colloquium from **Carleen M. Hutchins** on the physics of violins. She had studied the subject in depth and had fabricated a whole class of stringed instruments. The lecture was musically illustrated by **George Steiner**, violinist, and **Ervin O. Klinkon**, cellist, members of the University Faculty Trio from George Washington University. **S. Fred Singer**, then at the U.S. Weather Bureau, talked about weather satellites. **Philip Morrison**, just leaving Cornell University for MIT and one of the most original thinkers and marvelous speakers anywhere, discussed cosmic X rays and gamma rays. **Henry Guerlac** from Cornell University, one of the earliest and most respected historians of science, shed new light on Newton's theory of optics. And **Herbert Friedman** from the Naval Research Laboratory talked about X rays from supernovae.

1965—The colloquium year began with a lecture by **P. James Peebles** on gravity research being conducted by a group at Princeton. He pointed out, for the first time in public, that one ought to be able to detect at about 3 K the relict cosmic radiation from a primordial fireball. This was the time when Arno A. Penzias and Robert W. Wilson from the Bell Telephone Laboratories were observing such radiation without understanding its origin or significance. The two groups subsequently got together, and Penzias and Wilson's Nobel Prize for physics followed in 1978. **James W. Rouse**, the guiding spirit behind the new city of Columbia, Maryland, discussed the complex and thoughtful planning process for that project. **Benjamin Lax**, director of MIT's Francis Bitter National Magnet Laboratory and associate director of Lincoln Laboratory, reported on progress in quantum electronics, a field then in its infancy. **Solomon J. Buchsbaum**, an outstanding physicist at the Bell Telephone Laboratories, now a vice-president of AT&T, talked about waves and resonances in solid-state plasmas. And **Arthur R. Kantrowitz**, founder and director of the Avco–Everett Research Laboratories and vice-president and director of the Avco Corporation, discussed magnetohydrodynamic generators.

1966—**Jacob Rabinow** of Rabinow Electronics, one of the most ingenious, prolific, and successful inventors of his day, presented an informative and entertaining lecture on his experience with inventions and patents. **William H. Huggins** from JHU showed us for the first time how to generate computerized animation for films. **Oskar Klein** from Stockholm University, a giant in the development of quantum mechanics during the twenties, spoke about the origin of the local system of galaxies. **Robert A. Frosch**, director of DARPA, later administrator of NASA, and now vice-president for research at General Motors, discussed seismic arrays, especially as they relate to detecting underground nuclear explosions. **Richard W. Courant** from New York University, director of the Institute of Mathematical Sciences (which was later named for him) and a noted mathematical analyst, surveyed the work on the numerical analysis of the mathematical equations of physics being carried out at his institute. He was 78 years "young" at the time! **Robert G. Sachs** from the Argonne National Laboratory discussed time reversal invariance. And **Karl F. Herzfeld**, who for three decades had built up the Physics Department of the Catholic University of America almost single-handedly and who was still the active chairman at age 74 (a post he held for two more years), gave us new insight into Newton's laws and to what extent they are definitions.

Figure 3—President of The Johns Hopkins University, Milton S. Eisenhower, at the lectern in Parsons Auditorium, with Ernest P. Gray standing at left.

1967—**William B. Kouwenhoven**, professor of both electrical engineering and medicine at JHU and a pioneer in cardiopulmonary resuscitation, came here at age 81 to tell us about the effects of electric shock on the human body. His lecture stimulated APL to organize some after-hours courses in CPR. **Herman Kahn** from the Hudson Institute presented a three-hour colloquium on his predictions for the year 2000. Since Kahn's talk, more than two-thirds of the interval remaining before the bimillenial has already elapsed, and at least one of his most confident predictions is becoming evident: the emergence of Japan as a superpower that would economically rival and surpass the United States and the Soviet Union. APL's own **Richard B. Kershner** described how he had solved a long-standing mathematical problem, namely, the complete list of convex polygons that can be used to pave the plane. Also in that year, APL's **Robert R. Newton** told us why Earth is slowing down. And **Nicholaas van Kampen**, a distinguished theoretical physicist from the University of Utrecht in The Netherlands, explored the reasons why relativity makes it appear to a stationary observer that a moving body cools.

1968—**Nicolaas Bloembergen** of Harvard University, who in 1981 was to be awarded the Nobel Prize in physics, discussed the stimulated Raman effect as it applies to lasers. **Robert C. Wood**, Secretary of the Department of Housing and Urban Development, outlined the uses of technology for solving urban problems. **Stirling A. Colgate**, president of the New Mexico Institute of Mining and Technology, an outstanding physicist who has contributed to a variety of fields, spoke about interpreting quasars as supernovae. **Fred W. Friendly**, then at Columbia University and the Ford Foundation and now a well-known educational television producer, discussed the use of satellites for educational television. **Emmett N. Leith** from the University of Michigan, one of the fathers of holography, talked about that subject. **Daniel B. deBra** from Stanford University described the theory of and some experiments with drag-free satellites. These studies, done in conjunction with APL's Space Department, later led to the DISCOS satellite and its progeny. **Abraham Robinson** from Yale University discussed the rebirth of the infinitesimal, Newton's original concept for the differential calculus. **S. Fred Singer**, then deputy assistant secretary for science programs at the Department of the Interior, returned to discuss the origin of the Moon and some geophysical consequences of various theories. **Peter H. Rossi**, professor of social relations at JHU, gave us a sociologist's view of the civil disorders then so prevalent in America. Finally, **Philip H. Abelson**, director of the Carnegie Institution's Geophysical Laboratory, a distinguished physical chemist who later became editor of *Science*, presented his insider view of science and politics.

1969—**Anthony J. DeMaria** from the United Aircraft Corporation Research Laboratories described experiments with ultrashort laser pulses. **C. A. Doxiades**, a renowned Greek city planner, discussed the history of human settlements and its relevance to modern city planning. **William S. Albright**, the eminent Near Eastern specialist at JHU who had studied and deciphered the Dead Sea Scrolls, told us how a scholar uses whatever historical and archaeological information he can gather to reconstruct an ancient civilization. **J. Lamar Worzel**, associate director of Columbia University's Lamont-Doherty Geological Observatory, surveyed the evidence for the long-rejected and at that time only recently rehabilitated theory of continental drift. **Martin A. Uman** from the Westinghouse Research Laboratories presented an overview of lightning, about which he was becoming one of the world's foremost experts. **Louis Flexner**, the eminent anatomist from the University of Pennsylvania, described his fascinating experiments on the physiology of memory. **Raymond J. Seeger**, whose efforts helped to create the National Science Foundation (of which he had been director), gave a lecture on the relation between nature, art, and mathematics. A special treat was a lecture by **Margaret Mead**, world-renowned cultural anthropologist and curator of the American Museum of Natural History, who spoke of cultural factors in population control. **Edward C. T. Chao** from the U.S. Geological Survey presented preliminary results of analyses of the Apollo 11 lunar samples. And **Albert W. Crewe** from the University of Chicago discussed high-resolution scanning electron microscopy, a new technique that had revolutionized the application of electron microscopy to biological and other samples that would be damaged by high-intensity electron beams.

THE SEVENTIES: STATUS QUO

No major changes in the colloquia occurred during the seventies. The lecture series continued to attract an impressive audience because of the quality of the speakers. Again, Parsons Auditorium overflowed frequently, and the lecture could be viewed on TV monitors in the cafeteria. Among the speakers during the decade were a Nobel Laureate, two others who were later awarded the Nobel Prize, anthropologist Louis B. Leakey, and two U.S. senators.

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1970—**Simon Foner** (brother of APL's Samuel Foner) from MIT's Francis Bitter National Magnet Laboratory told us about high-field magnetism and some of its applications. **M. King Hubbert** from the U.S. Geological Survey, one of the first to call attention to the rapid exhaustion of some vital natural resources, spoke on physical constraints that endanger the future of our petroleum-based culture. **Robert R. Stromberg** from the National Bureau of Standards discussed polywater, which seemed so exciting at the time but later proved to be a spurious artifact caused by contamination. **Hannes Alfvén** (Fig. 4) from the University of Stockholm, who would win the Nobel Prize for physics later that year, made a visionary proposal of a manned space mission to an asteroid. Then-senator from Maryland **Joseph D. Tydings** talked on crime, judicial reform, and urban problems (Fig. 5). **Irwin J. Shapiro** from MIT described the then-new fourth test of general relativity by means of radar reflections from Mercury. **Stanislaw M. Ulam** from the University of Colorado, one of the world's foremost applied mathematicians, presented some unusual uses of computers. **J. Murray Mitchell**, then project scientist at NOAA and a world-renowned meteorologist, discussed air pollution and global climatic change. **Walter M. Elsasser** from the University of Maryland, a pioneer in the early development of quantum theory and one of the originators of the dynamo theory for the origin of the Earth's magnetic field, talked about sea-floor spreading and mountain building. **Morton B. Panish** of the Bell Telephone Laboratories described the evolution of room-temperature solid-state lasers. And **Chung-Ming Wong** from the U.S. Department of the Interior raised concerns with a powerful lecture on environmental survival and the challenge it presents to scientists and engineers.

1971—**Joseph Weber** from the University of Maryland, a careful and skilled experimenter, described his work on the detection of gravitational radiation. His positive results have never been replicated, but neither has his experiment been convincingly refuted. **Milton S. Eisenhower**, President of JHU, returned to discuss the final report under his chairmanship of the National Commission on the Prevention of Violence, entitled *To Insure Domestic Tranquility*. **Albert H. Owens**, world-famous oncologist from the Johns Hopkins School of Medicine (of which he later became president), reported on the remarkable progress occurring in the treatment of acute leukemia. **Alexander M. Letov** from the Soviet Institute for Control Problems, the first Russian to visit and speak at APL, had promised to give us a survey of Soviet spacecraft. Despite his strenuous efforts over many months to obtain permission to discuss this topic, it was refused. Instead, he talked about the Soviet lunar rover. **Leon M. Lederman** from Columbia University, recipient of the 1988 Nobel Prize for physics, returned to APL to talk about the then-current understanding of elementary particles.

Athelstan F. Spilhaus, then a Woodrow Wilson Fellow, formerly president of the Frankin Institution and the American Association for the Advancement of Science, spoke on his vision for a more stable world, less subject to violent technology-caused social upheavals. **Herbert Gursky** from American Science and Engineering, Incorporated, reported on the first X-ray astronomical observations from the APL-constructed Uhuru satellite. Former APLer **George F. Pieper**, then assistant direc-

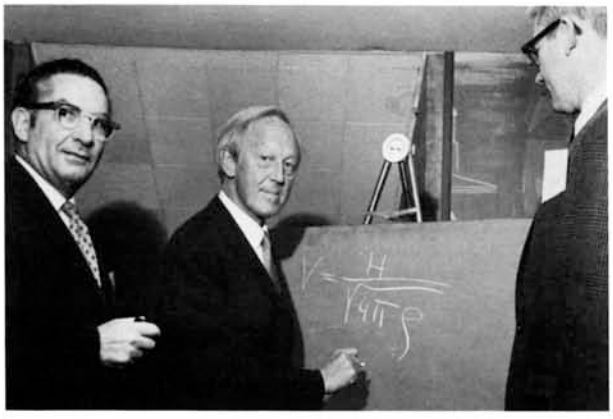

Figure 4—Nobel Laureate Hannes Alfvén at the blackboard, with Albert M. Stone (retired) on the left and Alvin W. Trivelpiece (then at the University of Maryland, now director of the Oak Ridge National Laboratory) at right.

Figure 5—Senator Joseph D. Tydings strides through the front door into the lobby of Building 1. Trying to keep up with him are, left to right, Frank B. Proctor, Frank T. McClure (deceased), and Ernest P. Gray.

tor for space science at Goddard Space Flight Center, gave us NASA's vision of priorities for space research in the 1970s. A truly memorable speaker was **Louis B. Leakey**, the eminent anthropologist, who (with his wife and later his son) had made important finds in Olduvai Gorge in Tanzania. His talk included recollections of his unusual life and career and a description of how his discoveries have revolutionized our ideas of the origin of *Homo sapiens*, modern man. And sociologist **James S. Coleman** from JHU, author of the famous Coleman Report (1966), *Equality of Educational Opportunity*, surveyed changes in the way the young are entering adult society.

1972—**Chandra K. N. Patel** from the Bell Telephone Laboratories spoke on tunable Raman lasers, which had just been developed. **Samuel Rosen** from Baltimore's Mount Sinai Hospital gave us an eye-opening report on his just-completed trip to China, where he was one of the first few Americans to witness the seeming miracle of acupuncture. **Jesse Beams** from the University of Virginia, still active at age 74, returned to APL to describe his measurements, far more accurate than any others, of the gravitational constant. **Remo Ruffini** from Princeton University gave an excellent talk on black holes in our galaxy. **Theodore W. Hansch** from Stanford University reported on his recently developed technique of saturation spectroscopy for obtaining emissions from pulsed lasers that were narrower than Doppler broadening would normally permit. **John H. Nuckolls** and **Lowell Wood** from the Lawrence Livermore Laboratory reviewed the recently partially declassified and very exciting subject of laser-driven controlled thermonuclear fusion. **Max V. Mathews** from the Bell Telephone Laboratories discussed and demonstrated computer music.

APL's **Chih K. Jen**, just returned from the first of many extended visits to his native China, presented his impressions of science and technology there and told us of his personal meetings with Mao Tse Tung and Chou En Lai. **Oskar Morgenstern**, the well-known New York University economist and co-inventor with John von Neumann of game theory, gave us a cost/benefit analysis of the space shuttle, arriving at a negative conclusion. **Robert Ardrey**, author of such best sellers as *African Genesis* and *Territorial Imperative* and a self-educated anthropologist, spoke on the biology of behavior. **J. Tuzo Wilson**, eminent geophysicist from the University of Toronto and a pioneer in resuscitating and developing the concept of plate tectonics, reviewed the recent physical study of the Earth and the revolution it has caused. And **Carrol M. Williams** of Harvard University told us of some new approaches to pest control via such sex- and species-specific chemicals as pheromones, which selectively combat targeted insects, unlike such broad-gauge pesticides as DDT, which kills the guilty and innocent alike.

1973—Distinguished ophthalmologist **Arnall Patz** of the Johns Hopkins School of Medicine, now head of the Wilmer Ophthalmological Institute, outlined photocoagulation procedures made possible by a special-purpose laser (developed jointly with APL's William Liben and Bernard Hochheimer) for the treatment of retinal diseases. **Estelle Ramey**, endocrinologist from Georgetown University's School of Medicine and one of the most articulate, effective, and charming speakers, gave a forceful yet witty talk on facts and fiction in sex differences and their impact on women's lives. **Joseph Weber** from the University of Maryland returned to give us an update on his gravitational radiation experiment. **Julian C. Stanley** of JHU spoke to us about his recently initiated study of mathematically precocious youngsters. **Peter Parker** of Yale University described the solar neutrino puzzle: that only about one-third as many neutrinos are observed from the Sun as are expected. **Abraham J. Sachs** from Brown University discussed the deciphering of Babylonian astronomy. **Carl Fichtel** from Goddard Space Flight Center reported on gamma-ray astronomy results from the APL-built SAS-B satellite. APL's **Robert E. Fischell** described his recently developed rechargeable, implantable cardiac pacemaker. **A. D. Moore**, professor emeritus from the University of Michigan, who at age 78 was driving a station wagon jam-packed with electrical equipment on his annual 67,000-mile lecture tour, gave a *tour-de-force* demonstration on electrostatics in action. **Christopher H. Scholz** from Columbia University's Lamont–Doherty Geological Observatory described some recent advances in the physics of earthquakes and prospects for earthquake prediction. **Ernest S. Starkman**, vice-president for environmental activities at the General Motors Technical Center, talked on the automobile and the environment in an era of conflicting demands. **Donn B. Parker** from the Stanford Research Institute, one of the first to recognize the future problems of computer theft and security, discussed computer abuse. And **Irving S. Cooper** of the St. Barnabas Hospital in The Bronx, New York, described the potential uses of brain pacemakers.

1974—**Harold Masursky**, chief scientist of the U.S. Geological Survey's Center for Astrogeology, presented a report on the exploration of Mars, richly illustrated with pictures from the Mars Mariner. **Owen M. Phillips**, eminent oceanographer from JHU, told us about the mathematical theory of the breaking of waves and ocean white caps. APL alumnus **James A. Van Allen** from the University of Iowa, discoverer of the Van Allen Belt and 1989 winner of the highly prestigious, recently established Crafoord Prize (intended to honor scientists in fields not covered by the Nobel prize), described the Pioneer 10 encounter with Jupiter. **David J. Rose** returned from MIT to join **Warren A. Roberts** from the Phillips Petroleum Corporation and **John W. Wilson**, an energy consultant, in a panel discussion on oil resources and energy policy. **Theodore B. Taylor**, formerly with the Los Alamos National Laboratory and then at the International Research and Development Corporation, gave a sobering account of the risks of nuclear theft. **Amar G. Bose** from MIT, inventor, developer, and manufacturer of the highly regarded Bose speaker system, discussed the recording and reproduction of music.

Alvin W. Trivelpiece, then at the U.S. Atomic Energy Commission, later chief scientist at the Department of Energy and chief executive officer of the American Association for the Advancement of Science, and currently director of the Oak Ridge National Laboratory, described progress toward controlled thermonuclear fusion. In September, a mini-symposium was held as part of the colloquium series on results of the 5E series of satellites, which were undertaking various research missions in support of the Transit navigational satellite program. The occasion was the 11th anniversary of the 5E-1, an interval chosen so as to encompass a complete solar cycle. Speakers included **Richard B. Kershner, George F. Pieper, Carl O. Bostrom, Donald J. Williams, Thomas A. Potemra, John Dassoulas,** and **Andrew M. Smith**, variously from APL, Goddard Space Flight Center, and NOAA. Topics included studies of the inner and outer Van Allen Belt, the Starfish artificial electron belt, the magnetosphere, solar protons, and field-aligned currents. Results of stellar ultraviolet measurements also were discussed. Finally, **Derek Bryceson**, member of the Tanzanian Parliament and director of the Tanzania National Parks, spoke on research in those parks and in the Serengeti Plain.

1975—**Norman C. Rasmussen** from MIT, author of the Atomic Energy Commission's 1975 Nuclear Reactor Safety Study, spoke on that subject. **Verner E. Suomi** from the University of Wisconsin described the Mariner 10 spacecraft encounters with Venus and Mercury. **Wernher von Braun**, for many years at NASA's Huntsville Laboratory and then at Fairchild Industries, spoke on the relationship between space science and the needs of man. **Gerald K. O'Neill** from Princeton University presented a highly imaginative but (perhaps) technically feasible scheme for the colonization of space. **Roy R. Johnson** from KMS Fusion, Incorporated, described the laser-driven compression of tritium pellets and the prospects of inertial thermonuclear fusion. **Bernd T. Matthias** from the University of California at San Diego, then the world's foremost expert on superconducting materials, spoke on various approaches to high-temperature superconductivity. **Paul E. Garber**, historian emeritus, former head curator, and Ramsey Fellow at the National Air Museum, came here at age 76 to present a charming lecture on kites and boomerangs.

Eugenie Clark from the University of Maryland gave an illustrated lecture on the Mexican "sleeping" shark, amazing us all with her dauntless study methods. **Steven M. Stanley**, the eminent JHU paleontologist, talked on the pattern and process of large-scale evolution. APL's **Helen S. Hopfield**, still active at age 75, told of her work on the effect of tropospheric refraction on satellite range measurements. **Ralph E. Gibson**, Director-Emeritus of APL since his "retirement" in 1969, in a special colloquium on the origin and growth of the Laboratory, used his usual wit and scholarship to charm his audience. **Virginia Trimble**, a remarkable and vivacious astronomer who divides her time between the University of Maryland and the University of California at Irvine, spoke on cosmology. **George W. Clark** from MIT discussed X rays from gravitationally collapsed bodies, observed by the APL-built SAS-C satellite. **E. Bright Wilson**, the noted chemist from Harvard University, examined the frequent, unintended consequences of new technology. And **Arthur E. Hess**, former deputy administrator of the Social Security Administration, reported on the danger of future bankruptcy for the Social Security Trust Fund.

1976—**Howard A. Glickstein** from Harvard University, on the occasion of Martin Luther King, Jr.'s, birthday, talked about the decade-old Title VII program. **Alan R. Hoffman**, an aide of the Senate Committee for Commerce, discussed his experiences as a scientist on the congressional staff. **S. Fred Singer**, still at the University of Virginia, returned to tell us about supersonic transport aircraft, ozone, and skin cancer. **David T. Harrje** from Princeton University spoke about energy conservation in the home. **Charles W. Misner** from the University of Maryland discussed black holes and space-time curvature. And **Maxine F. Singer** from NIH, now president of the Carnegie Institution of Washington, explored the scientific, social, and ethical issues raised by the then-new recombinant DNA research.

1977—**J. Otto Scherer** from APL's neighbor, Hydronautics, Incorporated, gave a scholarly lecture on the physics of sailboat propulsion. JHU's **Abel Wolman**, spry and active at 85 (he remained active until his very recent death), returned to APL to tell us about his lifelong, worldwide work on solid waste disposal. **Robert M. May**, who divides his time between Princeton University and Imperial College, London, showed us how chaos, the important and only recently recognized property of many nonlinear systems, can explain the complicated dynamics of some seemingly simple ecological models. **E. G. D. Cohen** from the Rockefeller University spoke of the age-old quest for the absolute zero of temperature. **Vernon B. Mountcastle** of the Johns Hopkins School of Medicine described how the brain manages to focus attention on movement. **James L. Weiss** from the same institution told us about echocardiography, which he had pioneered together with APL's John B. Garrison (deceased) and David G. Grant. **Mark J. Goldberger** from the Maryland Department of Health and Mental Hygiene reported on how the cause and course of Legionnaire's disease had been tracked down after its recent outbreak in Philadelphia. And **Norman A. Augustine** of the Martin Marietta Corporation (of which he is now the chief executive officer), one of the finest speakers from the corporate world, projected future defense potentials under the rubric "Augustine's Laws."

1978—**Edward R. Harrison** from the University of Massachusetts discussed the question of whether the Sun has an undiscovered companion star. APL's **Robert R. Newton** described the strong evidence he had uncovered that Claudius Ptolemy—whose *Almagest* (a compendium of astronomical observations) was considered the greatest product of ancient Greek astronomy—had in fact fabricated much of his data to make them agree with his theories. The publication of Newton's proof in *The Crime of Claudius Ptolemy* generated intense controversy among historians of astronomy. **Ronald L. Rivest** from MIT told us about new encryption methods he had developed that would enable anyone to send a coded message, but only to those with the key to decode it. **Stanley Corrsin** from JHU discussed the aerodynamics of bird flight. **Biruté Galdikas–Brindamour** from the L. S. B. Leakey Foundation gave a beautifully illustrated lecture on orangutans that she and her photographer husband had over the previous six years been studying in the remote jungles of central Borneo. **Paul C. Lauterbur** from SUNY at Stony Brook, father of the now-mature technique of magnetic resonance imaging, told us of the early scientific and technological development of that method. **Noel Vietmyer** from the National Academy of Sciences showed us how certain curious plants such as the jojoba and the guayule could be used to supplement scarce resources such as sperm whale oil and rubber. **John Imbrie** from Brown University described his theory that ice ages are caused by various slow precessions of the Earth's orbit. And **W. Ross Adey** from the Veterans Administration Hospital in Loma Linda, California, surveyed the effect of weak electromagnetic fields on brain tissue.

1979—**Herbert Friedman** from the Naval Research Laboratory returned to talk about neutron stars, black holes, and whether the universe is open or closed (it is still not known). **Paul B. MacCready** of Aerovironment, Incorporated, spoke on man-powered flight about a year and a half after his human-powered *Gossamer Condor* had made the first-ever sustained, controlled flight (for which he won the $100,000 Kremer Prize). **Sergei Kitaigorodskii**, an eminent oceanographer who had been able to leave the Soviet Union and had found a new home at JHU, discussed the spectrum of wind waves in the ocean. Nobel Laureate in chemistry **Ilya Prigogine**, who divides his time between the University of Brussels and the University of Texas, examined possible connections between deterministic and probabilistic descriptions of physics. **Gareth Green** from JHU's School of Hygiene and Public Health discussed the use of science and technology in environmental medicine. **Banesh Hoffman** from Queens College, City University of New York, and a collaborator of Albert Einstein's, talked about that great scientist in the centenary year of his birth. **Max Dresden** from SUNY at Stony Brook discussed the thermodynamics of black holes. Senator **Paul S. Sarbanes** of Maryland spoke to us on current issues in Congress. **Alvin M. Weinberg** of the Institute for Energy Analysis at Oak Ridge National Laboratory, where he had previously been director, gave us his thoughts on what he called the "energy wars," especially in the light of the recent Three Mile Island accident.

Donald A. Henderson, Dean of JHU's School of Hygiene and Public Health and a leader in the World Health Organization's campaign that succeeded in eradicating smallpox, reported on the problems with immunization in the developing world. **Aaron Wildavsky** of the Institute for Policy and Management Research talked on risk analysis and how attempts to minimize risk within a narrow context can sometimes produce much more dangerous situations within a wider context. **Bradford A. Smith** from the University of Arizona gave a spectacularly illustrated talk on Voyager's encounter with Jupiter. **Norman C. Rasmussen** of MIT, who four years earlier had spoken to us about nuclear safety, returned to tell us what light the Atomic Energy Commission's official 1975 Nuclear Reactor Safety Study, of which he was the main author, could shed on the accident at Three Mile Island. **Bernard J. Carr** from Cambridge University discussed the anthropic principle he had formulated, namely, that the existence of human life determines the magnitude of the physical constants. **Dorothy Nelkin**, a distinguished sociologist from Cornell University, examined science and technology as sources of political conflict, illustrating with the politics of nuclear power. **James A. Yorke** from the University of Maryland, one of the founders of the theory of chaos in dynamical systems, talked about the relationship of that subject to fractals. And **Kenneth M. Case** from Rockefeller University discussed the origin and behavior of solitons, a subject that had lain dormant for over 120 years and had only recently been revived.

THE EIGHTIES: KOSSIAKOFF CENTER

The most significant change that occurred during this decade was the opening of the Kossiakoff Center in 1983. This beautiful new facility adjacent to the duck pond has an acoustically excellent auditorium seating 500 and unmatched projection equipment. The projection "booth" is really a suite. The projection screen extends across the entire front wall of the auditorium, so that large images of two slides or viewgraphs can be projected simultaneously. Of course, large images of movies and videotapes can also be shown.

The use of the new auditorium was phased in slowly, principally because we wanted to schedule there only those lectures for which we believed the audience would exceed the capacity of Parsons Auditorium. We did not want any speaker to have to address a sparsely filled hall. Generally, we have succeeded in anticipating the size of the audience. We held 5 colloquia in the Kossiakoff Center in 1983 and 12 to 15 colloquia each year between 1984 and 1988. Because of its large seating capacity, the Kossiakoff Center encourages people to attend who would stay away from the more popular lectures in Parsons.

Another innovation was adopted in 1984. On an initiative by Robert H. Grauel from APL and Irene Chamish, coordinator of the Instructional TV Facility on the Homewood Campus, all APL Colloquia have been transmitted by microwave link to the campus, where they can be viewed live on TV monitors in Maryland Hall. The name of the speaker and the title of his talk are listed each week in the *Gazette*, making our colloquia available to anyone at Homewood. Whereas typically only a handful of people watch, the practice has been considered sufficiently valuable to continue.

Our colloquium speakers during the eighties included three Nobel Laureates, a Pulitzer Prize winner, the director of the Soviet Institute for Space Research, an American statistician deemed by many to be the father of Japan's emergence as an industrial superpower, and many more. Thumbnail sketches of some outstanding talks are presented below.

* * *

1980—**James N. Galloway** from the University of Virginia made us aware of the effects of acid rain when the dangers posed by that phenomenon were just beginning to be realized. **Philip E. Leakey**, member of the Kenyan Parliament and assistant minister of Natural Resources and Environment, spoke of participating with his parents in the digs at Olduvai Gorge and Laetoli, Tanzania, which led to the discovery of significant fossil remains of early man. **Norman C. Pickering**, engineer-in-charge of the Ophthalmological Laboratory of Southampton Hospital, New York, and an acoustic physicist specializing in the analysis and construction of stringed instruments, told us about the physics of violins. **Kosta Tsipis** from MIT explained why he was opposed even then, three years before President Reagan's famous "Star Wars" speech, to the development of particle-beam weapons. **Daniel Nathans** from the Johns Hopkins School of Medicine discussed the new genetics and, in particular, the role of restriction enzymes in dissecting and recombining portions of DNA and RNA. The development and use of this technique had won him the Nobel Prize for physiology or medicine. **Douglas R. Hofstadter** from the University of Indiana, the author of *Gödel, Escher, Bach: An Eternal Golden Braid* (a remarkable book that, despite its deep mathematical content, was on the best-seller list and later gained him a Pulitzer Prize), gave a brilliant lecture on how Gödel's famous but often misunderstood theorem can be explicated and illustrated in fields as diverse as logic, music, and art.

Walter E. Massey, then director of the Argonne National Laboratory, now president of the American Association for the Advancement of Science, spoke on the role of the National Laboratories (Argonne, Brookhaven, Livermore, Los Alamos, and Oak Ridge). **Joseph H. Taylor** from the University of Massachusetts at Amherst discussed the relationship between the variation in the pulse arrival rate from a recently discovered pulsar (part of a binary system) and the energy loss it suffers because of the gravitational radiation it emits while orbiting its companion. A most unusual speaker was **Tepilit Ole Saitoti**, who spoke about his life. Until the age of eight he was raised conventionally as a Maasai in Tanzania. Chosen to attend a government school, he entered the "modern" world, where he has achieved outstanding success. He starred in the National Geographic Society's film, *Man of Serengeti*, and has written a book, *Maasai*. **Samuel J. Williamson** from New York University discussed evoked magnetic fields of the human brain and how they can be used to study the relation between the brain and the mind. **Thomas C. Von Flandern** from the Naval Observatory reviewed evidence indicating that the gravitational constant, G, is slowly changing with time, a proposal first put forth by P. A. M. Dirac in 1937. And **Frank J. Tipler**, a highly regarded cosmologist from the University of Texas, presented cogent evidence for the theory that the universe did indeed start from a singularity (i.e., with infinite mass density), as predicted by general relativity.

1981—**Bradford A. Smith** from the University of Arizona returned to tell us of the continuing adventures of Voyager I, this time its encounter with Saturn. **W. Edwards Deming** is a remarkable man; statistician by training, he became perhaps the most influential consultant to industry in Japan, where he is viewed as a national hero. Still a commanding figure at 81 (and even today), he presented a fiery lecture with a message: To improve productivity, American industry must build quality into its products from the ground up. Former APLer **James Van Allen** from the University of Iowa returned to report on what we had learned in recent years about the magnetospheres of the planets from the various spacecraft and satellite probes. **Peter R. Greene** from JHU showed us how studies of the biodynamics of running have helped design better tracks. **William M. Fairbanks**, a highly skilled experimental physicist from Stanford University, described his observation (as yet unconfirmed) that his superconducting niobium samples sometimes carried a fractional charge of one-third the electronic charge—the same as the charge of the postulated quark. **David N. Schramm** from the University of Chicago discussed the possibility that the so-called "missing mass" in the universe consists of the finite-mass neutrinos that grand unified theories of elementary particles require. **Paul K. Seidelman** from the Naval Observatory reviewed the history of the serendipitous discovery of the planet Pluto and described current research according to which that planet's computed mass keeps diminishing.

Carlton M. Caves from the California Institute of Technology described "quantum nondemolition" schemes for the possible detection of gravitational radiation. **Solomon H. Snyder** from the Johns Hopkins School of Medicine, recent winner of the Lasker Prize, presented his discovery of the brain's natural opiates, neurotransmitters that he called enkephalins, and of the receptor sites to which they bind. **Robert B. Pond** from JHU reviewed and illustrated the new technology of ultra-rapid solidification and discussed its potential uses for making alloys with unusual nonequilibrium properties. **Alan G. MacDiarmid** from the University of Pennsylvania described a new organic battery using the polymer polyacetylene, which promised to revolutionize battery technology. **Elliott W. Montroll** from the University of Maryland, the brilliant physicist–chemist–mathematician with a renaissance breadth of interest who was a long-time friend of APL, spoke only two years before his premature death about the parallel he had noticed between the evolution of sociotechnical systems and phase transitions in physical systems. Nobel Laureate in chemistry **Melvin Calvin** from the University of California at Berkeley described some attempts to capture the Sun's energy by synthesizing substances that function like natural chloroplasts. And JHU's **Hans Goedicke** outlined his theory that the Exodus coincided with the volcanic eruption of the Greek Island of Thera (Santorini), and that the Biblical "parting of the sea" caused by the resulting tidal wave left the pursuing Egyptian army destroyed, while the fleeing Israelites watched from safe higher ground.

1982—**Larry W. Sumney**, then director of the Physics Program Office of the Office of the Undersecretary for Research and Development at the Department of Defense, talked about the Department's Very High Speed Integration (VHSIC) program for circuits on chips needed in weapons-oriented applications. **J. Thomas August** from the Johns Hopkins School of Medicine described some uses of monoclonal antibodies. **Donald S. Coffee**, also from the medical school, reviewed some recently discovered details of DNA replication. **S. Fred Singer** from the University of Virginia came back to predict the future of world oil. He had the audacity to predict without equivocating that oil prices would soon fall to $20 per barrel and below, and that even $10 to $15 was possible. **Akira Hasegawa** from the Bell Telephone Laboratories told us about the transmission of optical solitons in glass fibers and the improvement in the rate of information transport that this scheme makes possible. JHU's **Steven M. Stanley** spoke about a modification of Darwin's model for (gradual) evolution: the punctuational model of occasional rapid evolutionary episodes, which can explain the absence in the fossil record of so many "missing links."

Arthur Ashkin from the Bell Telephone Laboratories showed us how the light pressure in focused laser systems can be used to trap, focus, and otherwise manipulate micron-sized dielectric particles and individual atoms. **Michael S. Turner** from the University of Chicago described some recent developments in the grand unified theories of elementary particles and their relation to cosmology. **David Hannah, Jr.**, founder and then-president and chief executive officer of Space Services of America, Incorporated, the first private enterprise in the United States to enter the space-launch-vehicle industry, talked about that company's prior successes with its Conestoga I booster rocket and plans to launch a communications satellite in 1984. **Walter J. Doherty** from IBM's Thomas J. Watson Laboratories presented a stimulating lecture on interactive computing at IBM. And **John C. Mather** from Goddard Space Flight Center described the design for COBE (Cosmic Background Explorer) for measuring the cosmic background microwave radiation at 3 K.

1983—**William D. Phillips** from the National Bureau of Standards described a powerful new technique for cooling atoms by absorption of laser radiation. **M. King Hubbert** (retired from the U.S. Geological Survey), who had foreseen the energy crisis long before it occurred in the seventies, returned to APL at age 80 to describe his long-held view of the world's evolving energy system. **Hans M. Landsberg**, senior fellow at Resources for the Future, discussed the issues and policies that will affect the future of energy in the United States. **Ernest W. Kent** from the National Bureau of Standards described the work being carried out

there on the vital new field of providing robots with artificial brains. **Riccardo Giacconi**, director of the Space Telescope Science Institute, reviewed the construction, potentials, and mission of the Space Telescope. **Richard S. Potember** from APL spoke about the revolution that could occur if organic molecular devices could be fashioned into computer elements. **D. Bryant Cramer** and **Paul C. Rambaut** from NASA Headquarters told us what had been learned about the physiology of weightlessness and the limits it imposes on manned space travel. **Louis F. Libelo** from the Harry Diamond Laboratory described the effects of the electromagnetic pulse generated by a high-altitude nuclear burst. **George Schmidt** from the Stevens Institute of Technology discussed the transition that occurs in some nonlinear dynamic systems from order to chaos, via a complicated periodic region where frequencies suddenly double, quadruple, and so on. **Hans Mark**, son of the chemist who had talked to us 20 years earlier on polymers, and who was then deputy administrator of NASA, discussed NASA's long-range plans for the space shuttle. And **Eugenie Clark** from the University of Maryland, who had previously presented such a marvelous talk about Mexican sleeping sharks, returned to tell us more about her encounters with those and other sea "monsters."

1984—**Richard A. Carrigan** from Fermilab reported on as yet unsuccessful attempts to corroborate a single event in a Stanford University laboratory that had been interpreted as the observation of a magnetic monopole. **Edward Anders**, eminent cosmochemist from the University of Chicago, discussed the origin and history of presolar matter in meteorites, recognizable by its anomalous isotopic composition. **Peter M. Rentzepis** from the Bell Telephone Laboratories surveyed progress made with picosecond chemistry and its application to complex chemical and biological reactions by studying the short-lived chemical intermediates. **Richard F. Mushotzky** from Goddard Space Flight Center shed some light on the question of whether there are giant black holes at the center of quasars and other active galaxies. **Marvin Wunderlich**, then at Northern Illinois University and now at NSA, described the factoring of large integers by massively parallel computers, a field of pure mathematics that had long lain dormant but that had become vital for safeguarding the recently developed encryption codes that depend for their security on the practical impossibility to factor sufficiently large integers. **Henry N. Wagner** from the Johns Hopkins School of Medicine described the remarkable progress in imaging dopamine receptors in the human brain by the newly developed technique of positron emission tomography.

Also in 1984, **J. Richard Gott** from Princeton University showed how some apparently multiple quasars were in fact multiple images of a single quasar as seen through a "gravitational lens," a region of intense gravitational field produced by a large galaxy located on the line of sight. **Lawrence M. Lidsky** from MIT, an early pioneer and enthusiast of controlled thermonuclear fusion, described the reasons for his slowly evolving skepticism about whether deuterium-based fusion reactors, even if they could overcome the current technical problems and be made to work, would ever be competitive with alternative power sources such as existing fission reactors. **Nils Salveson** from Science Application, Incorporated, told us how the Australians had used extensive computer modeling to design the revolutionary sailboat that had, for the first time in 132 years, beaten the American entry and taken the America's Cup away. **David J. Rose**, who had left the harsh MIT winters for the milder climate of the East-West Center in Honolulu, and who was so incapacitated by advanced emphysema that he needed oxygen and a wheelchair even during his lecture, returned (a year before his death) to talk about the potential role of benign energy technologies in slowing down the global concentration of carbon dioxide and delaying the onset of the greenhouse effect. **Erica Jen** from the University of Southern California and the Los Alamos National Laboratory, daughter of APL's recently retired Chih K. Jen, discussed the role of "strange attractors" and their dimensionality in chaos theory.

Other outstanding speakers that year included **Stamatios (Tom) Krimigis** from APL, who described the AMPTE program for emitting plasma-containing barium and other tracer elements from a satellite into the Earth's magnetosphere to study the penetration, acceleration, and trapping of solar wind and plasma in the Earth's magnetic field. He also discussed the creation of an artificial comet and the formation of its plasma tail. Admiral **Bobby Inman**, then president and chief executive officer of the recently formed Microelectronics and Computer Technology Corporation, a joint venture of 14 U.S. corporations to develop the technology of computer chips and regain U.S. leadership in that field from the Japanese, told us how that venture was faring. **John H. Hopfield**, then at the California Institute of Technology, son of two former APL scientists and winner two years later of a coveted MacArthur Prize, discussed the physics of biological memory. **Rolf W. Landauer** from IBM's Thomas J. Watson Research Center reported some fundamental physical limitations on the computing process, such as the minimum energy requirements per elementary logic step and the maximum available immunity to noise. **Michael J. Frankel** from the Defense Nuclear Agency discussed the status of the nuclear winter hypothesis. **Steven M. Girvin** from the National Bureau of Standards described the recently discovered quantum Hall effect (for which the German physicist Klaus von Klitzig would shortly be awarded a Nobel Prize), one of the few consequences of quantum mechanics observable at a macroscopic level. **Michael R. Rampino** from Columbia University's Lamont-Doherty Geological Observatory presented his statistical analysis of large-scale extinctions of species that occurred at various times in the past, and the evidence it provides for cyclical recurrences of those extinction episodes. **S. Fred Singer**, then at George Mason University, returned to discuss the problem of high-level nuclear waste disposal and in particular the implications of various disposal policies for nuclear proliferation, public health and safety, resource conservation, and economic efficiency. **H. Eugene Stanley** from Boston University told us about the recently recognized concept of fractals. And **Howard Brody** from the University of Pennsylvania presented an instructive and amusing account of the physics of tennis.

1985—**Julian L. Simon**, a controversial economist from the University of Maryland, defended his thesis that life on Earth is getting better, not worse, as is almost universally believed by other economists. **Richard L. Garwin** from IBM's Thomas J. Watson Research Laboratory, a former nuclear weaponeer who had become a technical expert in arms control, discussed the technology available and projected for the Strategic Defense Initiative, as well as some of the possible countermeasures. **Joseph Weber** from the University of Maryland returned after more than a decade to give us another update on his experiments to detect gravitational radiation. **Mark Fuller** from the Patuxent Wildlife Research Center reported to us on tracking birds by means of signals from APL-developed bird-borne radio transmitters that can be received by polar-orbiting satellites. **Linn F. Mollenauer** from AT&T Bell Laboratories described new developments that would soon make possible an inexpensive, repeaterless, high-bit-rate, all-optical long-distance telecommunication system by transmitting femtosecond optical soliton pulses generated by a newly developed soliton laser. **Gareth M. Green** from JHU's School of Public Health returned to describe what he had learned as a member of a four-man environmental health advisory team dispatched by the Center for Disease Control to the disaster in Bhopal.

Harold Brown, Secretary of Defense during the Carter Administration, who the previous year had joined the faculty of JHU's School for Advanced International Study, discussed his perception of the link between technology and national security from the vantage point of one who had contributed so much to both fields. **Richard S. Fiske**, director of the Smithsonian Institution's National Museum of Natural History, presented a lecture about the massive volcanic eruption of Krakatau, about which he had written a book commemorating its centenary two years earlier. **Juri Toomre** from the University of Colorado told us how observations of solar oscillation modes have been used to probe the Sun's interior structure. And **Eugene Rasmusson** from NOAA described the "El Niño-Southern Oscillation" phenomenon, which reappears every few years in the equatorial regions of the Pacific Ocean and causes major worldwide climate variability as well as catastrophic effects on the prolific marine ecosystems along the west coast of the Americas.

1986—**Fred L. Scarf** from TRW Systems described observations from the International Cometary Explorer satellite of the newly discovered comet Giacobini-Zinner, particularly the detection of electromagnetic whistlers and other plasma waves generated near the bow shock associated with the comet's passage through the interplanetary medium. **Robert A. Frosch**, former head of DARPA and administrator of NASA, and now director of the General Motors Research Laboratories and vice-president of General Motors, returned to explain the inner workings of an industrial laboratory and its interaction with the corporation it serves. **Victor A. McKusick** of JHU's School of Medicine described the progress made during the previous 10 to 15 years in methods for locating the sites of genes in the human chromosome. **Jack Wisdom** from MIT told us that chaos lurks everywhere, even in that pro-

totype of predictable systems, the solar system, where chaos determines the structure of the asteroid belt and Saturn's satellite Hyperion tumbles unpredictably. **Kenneth Laws**, a professor of physics at Dickinson College (and near-professional dancer with and director of the college's ballet company), gave a lecture, with illustrations by a live dancer, on the physics of dance.

We also heard from **Richard E. Slusher** of AT&T Bell Laboratories, who explained how a newly developed technique, "squeezing the vacuum" in an optical cavity, makes possible measurements of an accuracy so great as to apparently violate the uncertainty principle. **Horst Stormer**, also from AT&T Bell Laboratories, described and explained the fractional quantized Hall effect that he had recently discovered. **Paul W. Klipsch**, at age 82 still the active president of Klipsch & Associates in Hope, Arkansas, and designer of the Klipsch horn, gave a delightful talk about distortion in loudspeakers, a subject whose study he pioneered as early as 1943. **Jerome B. Wiesner**, formerly president of MIT (where he is now institute professor) and President Kennedy's science advisor, spoke on the work going on in MIT's Media Technology Laboratory. **Harold C. Deutsch**, a historian recently retired from the Army War College, told us about the role in World War II of ULTRA, the machine that broke the German code, and its Pacific counterpart, MAGIC. **Lawrence A. Soderblom** from the U.S. Geological Survey gave us a remarkable look at Uranus through the eyes of the Voyager 2 spacecraft. Ten satellites, as well as a complete ring system, were discovered. The surface of the planet and its satellites were for the first time observed with great resolution. **David M. Pepper** from the Hughes Research Laboratory explained the new technique of optical phase conjugation and described some of its applications in quantum electronics, real-time adaptive optics, image processing, and optical computing. **Akira Hasegawa** from AT&T Bell Laboratories returned to discuss his new suggestion for controlled thermonuclear fusion: magnetically insulated confined fusion.

Alvin M. Weinberg, former director of the Oak Ridge National Laboratory and then the director of the Institute of Energy Analysis, returned to discuss the probable effects of the nuclear accident at Chernobyl on the future of fission electrical generators. **Herbert A. Simon**, a Nobel Laureate in economics from the Carnegie-Mellon University, gave a psychological account of scientific discovery. **Paul J. Steinhardt** from the University of Pennsylvania discussed the existence of "quasicrystals," which are based on the strictly forbidden fivefold planar symmetry or icosahedral symmetry in three dimensions, but which circumvent those prohibitions by exhibiting only quasisymmetry instead of strict symmetry. **Harold P. Furth**, director of the Princeton Plasma Physics Laboratory, recounted progress toward a tokamak fusion reactor. **Vera C. Rubin** from the Carnegie Institution's Department of Terrestrial Magnetism described her observations from which the existence within galaxies of "dark matter" can be convincingly inferred from stellar and galactic dynamics. **John R. Dudeney** from the British Antarctic Survey reviewed some scientific studies and experiments in geophysics, ionospheric and magnetospheric physics, and astronomy being conducted in Antarctica. And APL's **Robert E. Fischell** described his newest medical invention, the Programmable Implantable Medication System.

1987—**Terrence J. Sejnowski** from JHU spoke about his highly stimulating work on neural networks and some of the remarkable results he achieved by "training" a network to perform such varied tasks as identifying sonar targets and pronouncing English text. **Gloria Lubkin**, editor of *Physics Today*, the American Institute of Physics' successful house organ for dispensing physics news and publishing important general scientific articles on the subject, told us about the nuts and bolts of such an operation. **Francis Halzen** from the University of Wisconsin speculated on the mechanism by which the unusual star Cygnus X-3 appears to accelerate charged particles to astounding energies as high as 10^{11} GeV. **Jeffrey A. Brinker** from the Johns Hopkins School of Medicine described the rapidly increasing use of balloon angioplasty to replace bypass surgery in the treatment of heart disease. **Thomas B. Cochran** from the Natural Resources Defense Council told about the implementation of a recent agreement between the NRDC and the Soviet Academy of Sciences to establish three seismic monitoring stations around the principal nuclear weapons test site of each nation, to demonstrate that verification is not an obstacle to a comprehensive nuclear test ban.

Larry L. Smarr, director of the National Center for Supercomputing Applications at the University of Illinois, described new technologies of computer visualization for the solution of complex problems. **John F. McCauley** from the U.S. Geological Survey and Northern Arizona University showed us how the imaging radar on the space shuttle had penetrated the extremely dry drift sands and dunes in the central Sahara and had revealed a Paleozoic drainage system quite different from today's rivers. **Richard F. Voss** from IBM's Thomas J. Watson Research Laboratory described how irregular shapes in nature are best represented by fractals, and illustrated this by a series of computer-generated "landscapes" that bore an uncanny resemblance to real landscapes. **Alan C. Walker** from the Johns Hopkins School of Medicine, a 1988 recipient of a MacArthur award, showed us some of the new fossil evidence he and his colleagues had uncovered in African excavations of two hominid species, *Homo erectus* (a direct ancestor of modern man), known for nearly a century, and an extinct large-toothed species. APL's **Kishin Moorjani** described the incredible developments during the previous year in the field of high-temperature superconductivity. He also told about APL's very recent contributions, particularly, a cold-processing laser ablation method for depositing a superconducting thin film on substrates and a new, highly sensitive test for superconductivity.

H. Kent Bowen from MIT surveyed the great variety of engineering uses of ceramics, the most recent being their completely unexpected role as high-temperature superconductors. **Samuel J. Williamson** from New York University returned to discuss the uses of neuromagnetism to ascertain the location of neuron activity in response to various visual, auditory, and somatic stimuli, and eventually to produce a "neuromagnetic image" of various brain functions. **Joel Primack** from the University of California at Santa Cruz reported on the constraints on cosmological models and on the large-scale structure of the universe imposed by the observational evidence that the "dark matter" must exist but is not hot. **Raold Z. Sagdeev**, director of the Soviet Institute for Space Research, head of the newly formed Supercomputing Institute, and Gorbachev's right-hand man for science, described the Soviet space program. **Thomas F. Zuck**, director of the University of Cincinnati's Hoxworth Blood Center, discussed new strategies for detecting the AIDS virus on the basis of DNA hybridization and amplification of viral DNA sequences, which will be important to assure the safety of the donated blood supply. And **Richard T. Greene**, a consultant who spent nine years in Japan and was working at the Matsushita Research Laboratory, shared with us his insights concerning Japanese techniques in artificial intelligence research, education and research administration, and how these affect the American competitiveness problem.

1988—Historian **Jeffrey Greenhut** from the U.S. Army Center of Military History discussed the role that weather has played in warfare and described the effect it had on battles and the tides of war. **Jene Golovchenko** from Harvard University described some uses of the scanning tunneling electron microscope for studying the surfaces of materials on an atomic scale. **Myron L. Weisfeldt** from the Johns Hopkins School of Medicine discussed some current strategies in the treatment of heart attacks, in particular the use of the recently FDA-approved drug TPA and its ability to reduce the injury that often occurs to a blocked blood vessel when the clot is dissolved and the blood flow resumes. **Owen P. Bricker** from the U.S. Geological Survey recounted the history of and current research on acid rain, noting that, while it has recently become a more serious problem, it is hardly new. In fact, it was recognized as early as the 13th century in Europe. **Rustum Roy** from the Pennsylvania State University described to us his ingenious methods for producing materials by design (e.g., nanometer-sized particles distributed within a medium, zero-expansion ceramics, and metastable crystalline diamond films). **Gregory B. Bulkley** from the Johns Hopkins School of Medicine told us how free radicals are implicated in the major damage from ischemic diseases of such organs as the heart and the kidneys and how to prevent the damage with new drug therapies. **Mark R. Schoeberl** from Goddard Space Flight Center gave us an overview of the Antarctic ozone "hole" as measured by a NASA/NOAA aircraft mission during the summer of 1987, and presented the evidence that it is caused by increasing global chlorofluorocarbon pollution. **Robert P. Kirchner** from Harvard University described the observations of and discussed the preliminary conclusions from Supernova 1987A in the Large Magellanic Cloud, which had first been detected a year earlier.

Also in 1988, **Howard Simons**, curator of Harvard University's Niemann Foundation and former managing editor of *The Washington Post*, described how newspapers view and report on science, and how

scientists can help improve the process. **Alan Sandage** from JHU and the California Institute of Technology reviewed the ideas of the grand unification theory for the known forces of nature and the cosmological implications of that theory. **Douglas G. Mose** from George Mason University delineated the indoor radon problem areas in Maryland and Virginia and discussed ways to help people deal with the problem. **David Savitz** from the University of North Carolina described his epidemiological studies that have shown a link between childhood cancers and the magnetic fields from electric power lines. And **John N. Bahcall** from the Institute of Advanced Study at Princeton and the Space Telescope Science Institute brought us up to date on the solar neutrino problem, namely, why the measured solar neutrino flux is only about one-third of what is predicted.

CONCLUSION

In contemplating the course of the APL Colloquium over the past four decades, a natural question arises: What has made it such a success?

Perhaps the most important reason has been our effort to secure lecturers who, in addition to being experts in their respective fields, were known to be outstanding speakers as well. Evidence of our success in this regard is the continuing large attendance at the colloquia. Not only do many Laboratory staff members take the time to hear the speaker, but numerous visitors travel many miles to attend. This confidence in the overall high quality of our lecturers has created a feeling of trust that the audience will be intellectually entertained as well as instructed, so much so that even on the rare occasions when the talk is dull or incomprehensible, people are generally not deterred from attending the following week.

Another reason for the success of the colloquia has been our long-standing record of arranging lectures on potentially important, emerging areas of science, technology, and sometimes esoterica. This early exposure maximizes the impact on the Laboratory staff. Part of our strategy also has been to have each subject presented by the most appropriate, not necessarily the most famous, speaker available. An enthusiastic young researcher in the thick of developing a burgeoning field is sometimes more desirable as a lecturer than the older, more eminent director of a program.

We do not, of course, avoid the renowned. On the contrary, we believe that it is beneficial to offer an opportunity to the Laboratory staff to hear great scientists, engineers, and scholars, to mingle with them at the tea afterwards, and sometimes to spend extended periods of time with them in one-to-one discussions. Over the years we have had 14 speakers who were then, or later became, Nobel Laureates. We also have had such world-renowned figures as Margaret Mead, Louis B. Leakey, Milton S. Eisenhower, Wernher von Braun, and Jerome B. Wiesner. We are convinced that these contacts have been valuable to the Laboratory, not only by inspiring the staff, but also by making the speaker more familiar with APL; at times, this has led to further contacts and even collaboration with some of our staff.

Highly prized are the invitations to lunch with the colloquium speaker. Each Friday the APL Colloquium chairman organizes a small group of 8 to 12 staff members to interact with the speaker at lunch before the lecture. The group is selected on the basis of interests in common with the guest or sometimes on the basis of a personal relationship with him or her. We try especially to involve the younger staff members.

A lecture series such as the APL Colloquium not only informs the staff of new developments in their own or related fields of expertise, but also broadens their base of knowledge and interest, and thereby fulfills one of the most vital roles of education. An additional desirable consequence is the forging of intellectual links between staff members who might not otherwise interact.

We believe that the APL Colloquium has made significant contributions to enhancing the stature of the Laboratory in the scientific, technical, and cultural world.

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THE AUTHORS

ERNEST P. GRAY was born in 1926 in Vienna, Austria. He received a B.A. in physics and mathematics in 1947 and a Ph.D. in physics in 1952, both from Cornell University. He joined APL in 1951 as a member of the Research Center, where he conducted research on electromagnetic propagation and scattering, surface and internal fluid waves, statistical mechanics, and atomic physics. Dr. Gray also spent a decade as a member of APL's Plasma Dynamics Group, studying the interactions of a variety of plasma waves. He is now a member of the Space Department. For many years, he has been the Chairman of the Colloquium Committee. He has been a William S. Parsons Fellow, and twice a William S. Parsons Professor (in the Department of Physics and the Department of Earth and Planetary Sciences) at The Johns Hopkins University, where he taught several courses. For many years, Dr. Gray has taught courses in the Continuing Professional Programs (and its progenitors) of the G.W.C. Whiting School of Engineering.

ALBERT M. STONE held several positions at APL before retiring in 1987. At various times, he was Technical Assistant to the Director, head of the Plasma Dynamics Group in the Research Center, head of the Technical Information Branch (which included the Library, the Technical Publications Group, and the External Relations Group), Director of Advanced Research Programs, and, finally, Senior Fellow. He was a member of the former Program Review Board and founded the *APL Technical Digest*, the progenitor of this journal.

Born in Boston in 1913, he studied physics as an undergraduate at Harvard and as a graduate student at MIT. He received the Ph.D. degree in 1938. Dr. Stone is a Fellow of the American Physical Society, a Fellow of the AAAS, and an original Fellow member of the Hudson Institute. He is now a member of the Advisory Board of the Federal Emergency Management Agency.