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BROOKHAVEN NATIONAL LABORATORY

Accelerator

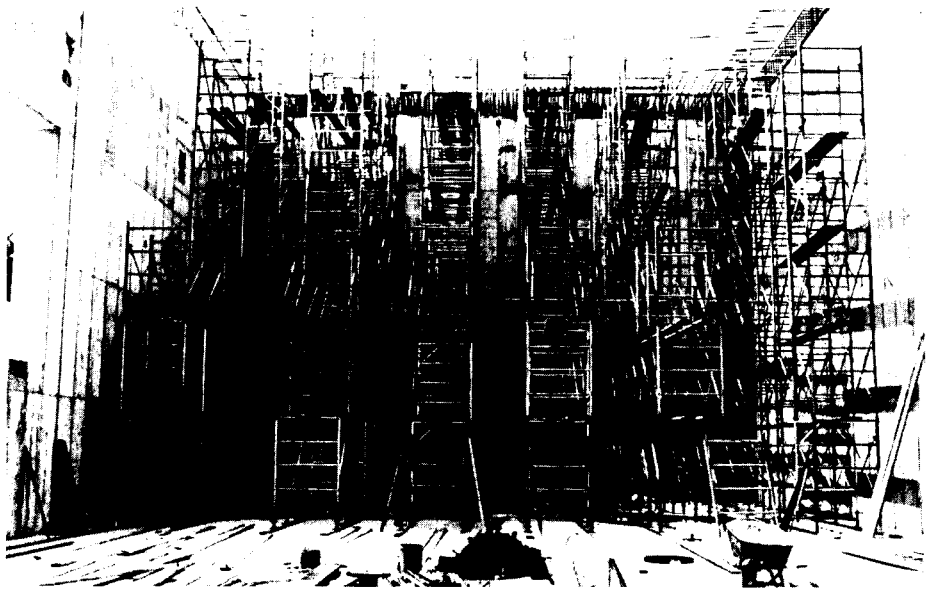
At the AGS, protons continue to be accelerated to 30,000,000,000 electron-volt energy, and many different secondary beams can be selected from collisions between the protons and stationary target nuclei. The most commonly studied secondary particles are π mesons, K mesons, antiprotons and neutrinos. Neutral K mesons from the AGS were used in 1964 in the famous experiment for which Fitch and Cronin were awarded the 1980 Nobel Prize for Physics.

ISABELLE, now two years into construction, will be an Intersecting Storage Accelerator. Two proton beams rotating in opposite directions will provide head-on collisions of much higher energy, making new types of experiments possible. Taking protons from the AGS initially, acceleration to 400,000,000,000 electron-volts in each beam is the objective, so that matter and forces can be studied at much smaller distances than before, and correspondingly greater particle masses produced. Thus ISABELLE and AGS combine to provide the future high energy physics facility.

ISABELLE

Conventional construction work by A.D. Herman Construction Company, J.F. O'Healy Construction Corporation and Lasker-Goldman Corporation is progressing well. Nearly all the 2-1/2 miles of magnet enclosure ring is in place, and two-thirds is covered with dirt piled 13 feet over the top of the tunnel for radiation shielding.

About 1100 superconducting magnets will be required to guide the two proton beams. The magnets must have very accurate magnetic field shape, and specifications set a maximum field value of 50 kilogauss, nearly four times that of the conventional magnets in the AGS. Magnet research and development received an intensive effort during 1980, and the problems of meeting exacting specifications have proved to be greater than expected. Much has been learned, and dipole magnet MK 18 reached fields above 50 kilogauss. Over 15 magnets were assembled and tested. More work remains, however, to achieve design and production methods that will assure satisfactory quality for a large number of magnets.



ISABELLE Wide Angle Hall

Superconducting magnets must be maintained at liquid helium temperatures, which can be achieved by special cryogenic refrigerators. The "Production And Testing" refrigerator, PAT, and the "R&D Refrigerator" have been in service throughout the year, providing liquid helium temperatures for the magnet test program, and practical experience which helps to establish the design of the much larger ISABELLE refrigeration plant. Design of the cold box for this refrigerator has been proceeding at Helix Process Systems.

The protons will circulate in an evacuated tube, and for ISABELLE the vacuum must be far better than in the AGS. Very exacting ultra-high vacuum techniques are required. In the "First Cell" a prototype system is available to test cryogenic techniques, UHV vacuum techniques, and other methods as well. Pressures between 1×10^{-11} and 2×10^{-11} Torr have been achieved, indicating that vacuum techniques are adequate to meet requirements.

For ISABELLE magnets, over 400 accurate power supplies are required to maintain the right currents in many different windings. They must change during acceleration from 30 GeV to 400 GeV in proper synchronism, while power is fed into the circulating protons by radio-frequency electrical systems. Control and coordination is to be established by local smart controllers and a control computer network. Design of this complex system made good progress during 1980, and many developmental components have been built and tested.

Among the most delicate aspects of the ISABELLE operation are the injection and ejection of protons. Beam lines from the AGS and special deflecting kickers and septum magnets are needed to get the protons into the right orbits, and to dispose of them safely into the beam dumps. These designs have received a great deal of effort during 1980.

The ISABELLE project staff increased in size at a moderate rate during 1980. Kjell Johnsen became Technical Director with responsibility for the accelerator and its related systems while the Project Director, James Sanford, retains direct responsibility for administration, building construction and other matters.

AGS

During 1980, the AGS was limited by the budget to 18 weeks of operation, with slow external beam for eleven experiments with electronic detectors and 7-1/2 weeks of the neutrino beam, much of which was for bubble chamber running. The remaining time was utilized for introducing improved modes of operation, better particle beams, and installation of new experiments.

Eleven experiments were run and seven were completed, concerned with many properties of elementary particles and resonant states. The experimental program involves investigators from many universities as well as Brookhaven, and pursues many different topics.

A new switchyard for the slow external beam was one of the major improvements of the year. The beam loss during extraction is reduced by a factor of about 6, and more flexibility is available. The fast external beam will also be improved by a newly completed kicker magnet. The improved beam quality will help neutrino experiments in the future and will be necessary for successful injection into the ISABELLE rings. Development work on the H^- ion source should lead to a brighter beam for ISABELLE injection and for polarized protons in the AGS.

Thus, a great deal of effort has gone into preparations for providing the AGS beam parameters that are needed for injection into ISABELLE. Beam transport from AGS to ISABELLE is the next requirement.

At the same time, major efforts have been required to set up new experiments, such as the large blockhouse for the next generation of neutrino investigations, the future D target station, and the 6 Tesla dipole magnets for the D line. New drift chambers and improved electronics for the MPS were developed as well as FASTBUS components for a Yale/ BNL experiment.

(Continued on page 3)

1980 In Review

National Synchrotron Light Source

This past year was one of great accomplishment, under conditions that often required both grit and skill on the part of many NSLS staff members. The plan was to move into the nearly finished parts of the building even as the contractor worked to complete other sections and systems. This meant temporary water and power and no heat or other amenities.

In September, NSLS occupied the Linac and Booster areas. The linear accelerator was moved into place from Building 925. A stream of booster and transport line components emerged from various cubby holes around the Laboratory where they were manufactured, assembled and tested. Magnets, power supplies, vacuum, r.f., and diagnostic systems were installed in their final positions and the commissioning process began. On November 26, a significant milestone was reached when electrons were injected into the Booster Synchrotron and a number of electron orbits were achieved.

Late in 1979 and early in 1980, the Vacuum Ultra Violet (VUV) storage ring was constructed. Now, with completion of the Linac and Booster Synchrotron injector combination, efforts have shifted towards connecting the Booster to the VUV storage ring. Plans call for the Linac-Booster-VUV ring to be integrated as a system by January 1981. During early 1981, regular machine studies will be scheduled to commission both the Booster Synchrotron and VUV ring.

Last October and November NSLS took possession of the Control Room, the second floor Administrative Area, the Computer Room, and the X-ray Experimental Area. Again components emerged from a half dozen places around the Laboratory. Portions of the computer and control console were installed. The large dipole magnets and multipole magnet assemblies for the X-ray Storage Ring were moved into the building. Meanwhile, work continues to complete the manufacture and testing of vacuum chambers, the r.f. system, and other magnetic elements of the X-ray Storage Ring. The year ended on a high note when part of the staff moved from the Accelerator Department Building to new quarters on the second floor of the NSLS.

The high level of activity in the machine-related domain was matched in the experimental area. Numerous formal and informal meetings were held with future users of the facility, most of whom are from university, government and industrial laboratories. Proposals for experiments were submitted and reviewed by the Program Advisory Committee which approved thirty X-ray and eighteen VUV experiments from participating research teams. The optical designs for the beamlines, which are the responsibility of NSLS scientists, have been completed. A number of VUV monochromators, mirror boxes, and associated beamline hardware are in various stages of fabrication, as is a prototype assembly of a double crystal X-ray monochromator.

Physics

High Energy

It is now generally believed that hadrons are made up of smaller constituents called quarks, which interact through the exchange of gluons. The mathematical description of this interaction, known as quantum chromodynamics, is too complicated to be solved exactly, but it can be mapped into an equivalent problem in statistical mechanics. This new problem can be studied on a computer by introducing a space-time lattice and varying the field variables at each lattice site until the simulated system reaches "thermal" equilibrium. Various quantities of interest can then be measured and extrapolated to zero lattice spacing.

Several members of the BNL theory group have carried out such calculations in the past year, producing strong evidence that quantum chromodynamics has the right qualitative features to describe the real world. Specifically, they find that the force between quarks grows linearly with separation, meaning that free quarks can never be produced, in agreement with experiments. They also find that at short distances the interaction between quarks becomes weak, thus explaining the success of the description of short-distance interactions in terms of free quarks. This work is continuing with the hope of calculating the masses of quark and gluon bound states.

Several experiments at the AGS have been devoted to searches for baryonium, resonances in nucleon-antinucleon scattering near threshold. Such resonances had been reported previously by several experiments and had generated considerable interest. It was thought that they represented a new class of particles formed from two quarks and two antiquarks, whereas all other mesons are made from just one quark-antiquark pair. However, the new experiments show that there is no evidence for such resonances. While this is a negative result, it still has significant implications for the understanding of quark dynamics.

Perhaps the least understood aspect of particle physics is the breakdown of time reversal (T) invariance. (While the direction of time is quite obvious for macroscopic systems, the fundamental laws governing them are generally invariant under reflection in time.) T violation was first discovered at the AGS in 1964 through observation of the decay $K_L^0 \rightarrow \pi\pi$; Fitch and Cronin received the 1980 Nobel Prize for that experiment. Since then, no evidence for T violation has been found outside of the K^0-$\bar{K}^0$ system. The original superweak model and several more recent ones predict observable effects only in that system, while the milliweak models predict additional effects just below present limits. Therefore, a Yale/BNL group has undertaken a series of elegant, precision experiments to improve the limits on T violating effects. This year they published results on the transverse polarization of the μ^+ in $K_L^0 \rightarrow \pi^-\mu^+\nu$, (which if it existed would indicate T reversal violation) finding $P_\perp = 0.0017 \pm 0.0056$. This is consistent with zero but does not yet rule out milliweak models. They are presently doing an even more sensitive experiment on $K^+ \rightarrow \pi^0\mu^+\nu$.

(Continued on page 2)

Physics (Continued)

A BNL/CCNY collaboration used the Multiparticle Spectrometer at the AGS to study the production of two ϕ mesons in π^-p interactions. The production of single ϕ mesons was known to be small. This can be understood qualitatively from the fact that the ϕ is made of a strange quark and a strange antiquark, while the initial state contains no strange quarks. Thus, one might have expected $\phi\phi$ production to be very small. In fact the experiment observed a surprisingly large cross section (23 nb). One possible explanation is that the $\phi\phi$ channel is fed by a new resonance, perhaps one made from gluons rather than quarks. A new experiment is planned to explore if this latter interpretation is correct and, therefore, heralds the opening of a new spectroscopy.

Solid State

At a temperature of 2.17 K liquid ^{4}He undergoes a remarkable phase transition. Boiling ceases and a zero-viscosity liquid phase — known as the superfluid phase — appears. This liquid is one of the great scientific curiosities of our time. Sixty years after its discovery it remains an enigma, a challenge to our understanding of the collective behavior of condensed matter on the most basic terms.

Years of painstaking experimental study have provided an essentially complete documentation of the macroscopic properties of the bulk superfluid but only the most rudimentary insight into its underlying microscopic character. Thus, a new experimental approach to the study of superfluids which offers prospects of progress towards a microscopic theory —the investigation of few-atomic-layer adsorbed helium films — has been accorded a warm welcome by both theorists and experimenters. Adsorbed films, being effectively two rather than three-dimensional in character, are far easier to treat theroretically and encouraging recent advances have been made in relating their macroscopic properties to theory. One of the more striking current experimental developments in this area has been the discovery, at the High Flux Beam Reactor, that the excitation spectrum of superfluid films differs noticeably from that of the bulk liquid (normally described in terms of phonons, i.e.sound waves, and a second type of excitation, unique to superfluid helium, called the roton). Inelastic neutron scattering studies of helium overlayers on graphite reveal evidence of a mode propagating along the boundary between liquid and solid layers of the film. From its behavior, this mode has been tentatively identified as a two-dimensional roton. Such modes will almost certainly be more amenable to theoretical description than their three-dimensional counterparts. Thus, a realistic microscopic theory of the two-dimensional superfluid may be within grasp.

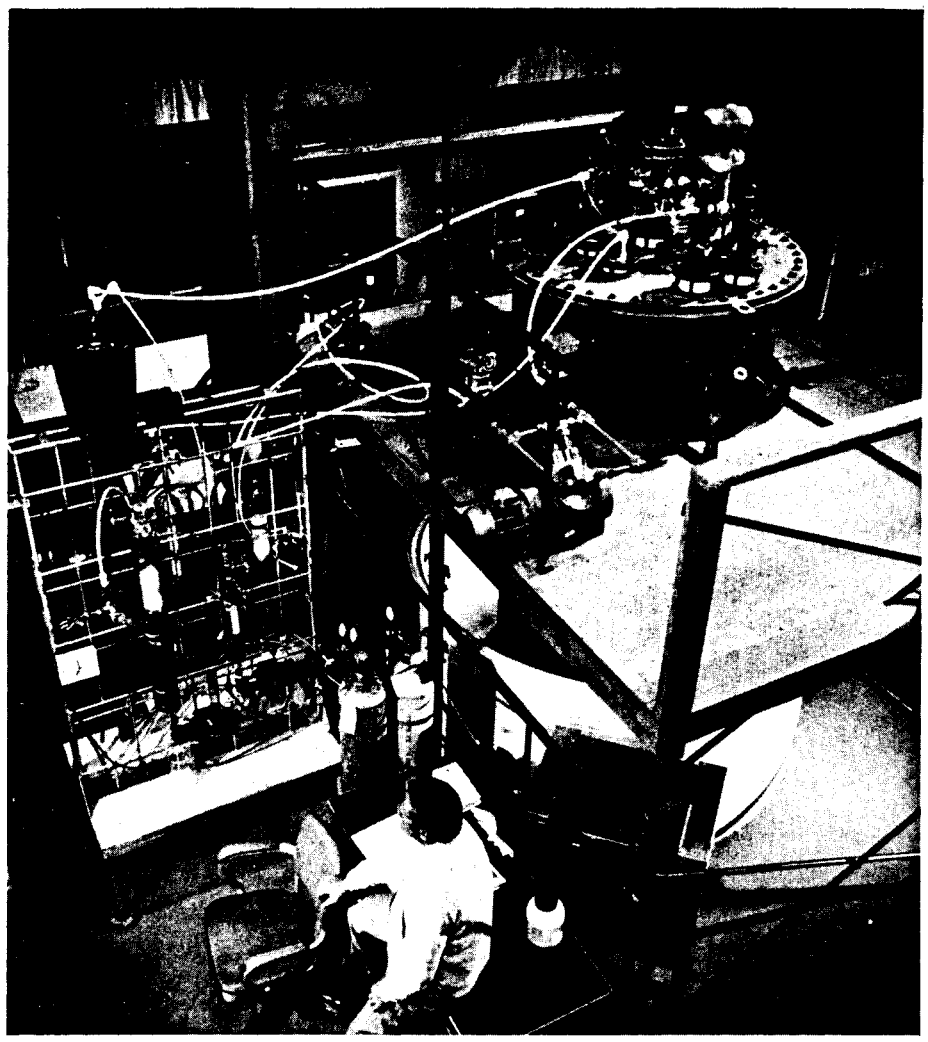
These experiments are part of a broadly-based research program designed to understand the melting of solids, superconductivity in metals, the mechanisms of chemical reactions and a variety of other phenomena in films adsorbed on surfaces.

Nuclear

A prime goal of experimental nuclear physics is to create nuclei not seen in nature. Very often the study of such unusual species provides surprising illumination of the entire subject, severely testing theoretical models for example. One search for exotic structure during the past year was a set of experiments on so-called hypernuclei by the Medium Energy Nuclear Group. Another quite different path was followed in the discovery of the element oxygen-21 by experimentalists at the Tandem Facility.

In experiments at the AGS last summer, a group collaborating with university scientists observed two new examples of hypernuclei; Λ-oxygen-18 and Λ-nitrogen-14 and, moreover, produced these nuclei, as well as Λ-carbon-13, in a rich variety of excited states. Hypernuclei were created in this instance by shining a rather unusual secondary beam of K^- mesons onto targets consisting of normal nuclei. The "strangeness" property possessed by the K^- meson is transferred to a neutron in the target nucleus, thus converting the neutron into a related but somewhat heavier particle, the Λ-hyperon. The existence of a relatively long-lived Λ-nucleus bound state is then signalled by the detection of a "normal" π^- meson of well defined energy. Such a spectrum of π^- observed from a ^{12}C target is shown in the accompanying graph. An initial conclusion drawn from these experiments, that the added hyperon only slightly alters nuclear properties, does not hold up under deeper theoretical analysis and further study of these and perhaps even more exotic hypernuclei is anticipated.

The second experiment at the Tandem produced an extraordinary nucleus by disturbing neutron and proton numbers in nuclei from their normal stable confines. The discovery of oxygen-21, a nucleus possessing thirteen neutrons but only eight protons, completed a set of off-stability light nuclei extending in mass from phosphorus-35 downwards. The successful experiment employed nuclear collisions between beryllium-9 and oxygen-18 nuclei, as well as delicate detection techniques developed in previous searches. The accurate predictions of the mass and decay properties of the undiscovered isotope of oxygen by a BNL theorist pinpointed the area of investigation and also indicated the inadequacies of earlier theories.



The pilot radiochemical gallium solar neutrino detector was built in the Chemistry Dept. to test chemical procedures and determine cosmic ray backgrounds. Eventually, 30 tanks will be needed and will be placed underground in a mine. The solar neutrino project is a joint effort of the Max Planck Institute for Nuclear Physics, the Weizmann Institute, The Institute for Advanced Study, the University of Pennsylvania and BNL.

Chemistry

Members of the Chemistry Department are engaged in basic research related to energy production, conversion, storage, and utilization.

In photosynthesis, the transformation of sunlight into chemical energy proceeds through the rapid production of oxidizing and reducing compounds, by means of electron transfer. The design criteria for building molecules that undergo such reactions rapidly and efficiently are being investigated on the picosecond (10^{-12} second) time scale, by spectroscopic methods. Several molecular complexes have been found capable of transferring an electron from one molecular subunit to another in less than 6 picoseconds, while storing over 90 percent of the energy from the incident light. In current experiments, more subunits are being added to these primitive "molecular solar cells," in order to control further the electron transfer path.

The department has recently started a research program in the field of organometallic chemistry, at the interface between organic and inorganic chemistry. A major area of interest is homogeneous catalysis, with both reactants and catalyst present in the liquid phase. Nitro complexes of transition metals are currently being synthesized and examined for their ability to effect industrially important catalytic oxidations selectively and efficiently.

A new crystallographic facility at the National Synchrotron Light Source, together with existing neutron diffraction installations at the High Flux Beam Reactor, will provide unique opportunities for structural research in chemistry. The X-ray beam line at the NSLS is being developed in collaboration with the BNL Physics Department, the NSLS project, and outside investigators. It will allow very rapid analysis of molecular structures, to unprecedented resolution. Projects include the structural analysis of transition-metal hydrides — structures of which are relevant to the development of hydrogen-storage media — and of simple compounds such as nitrogen oxides.

Current theories indicate that the neutrino "oscillates" — that is, different kinds of neutrinos are interconverted as the neutrinos travel away from a source. Recently, controversial claims for the observation of neutrino oscillations have been made, and a radiochemical experiment now being planned by investigators in the Chemistry Department should give a definitive answer.

To prepare for a radiochemical solar neutrino experiment using 50 tons of gallium as a detector, a pilot experiment with 1.3 tons of gallium has been in operation in the basement of the Chemistry Building. The gallium, in the form of a concentrated gallium chloride solution, is contained in an 800 gallon tank, and the object is to remove and measure trace amounts of germanium-71 (11-day half life), the product of neutrino capture by gallium. In the pilot experiment, quantitative removal of the germanium has been successfully demonstrated, and cosmic-ray production of Ge-71 from Ga-71 has been measured.

The next step is to mount a 10-ton experiment with a man-made neutrino source in a mine deep enough to eliminate the cosmic-ray background. The source will be a radioactive nuclide (chromium-51 or zinc-65) at the megacurie level, and the gallium chloride solution will be arranged in two zones surrounding the source at different distances. If neutrino oscillations take place over a distance comparable to the zone length, different amounts of Ge-71 will be produced in the two zones and detected.

Medical

Virtually all research programs in the department are now firmly based on effects of energy-related pollutants, toxicology, and research designed to improve medical diagnoses in nuclear medicine. The department efforts continue to be supported by DOE, EPA and NIH in addition to grants from the private, non-profit, or industrial sectors.

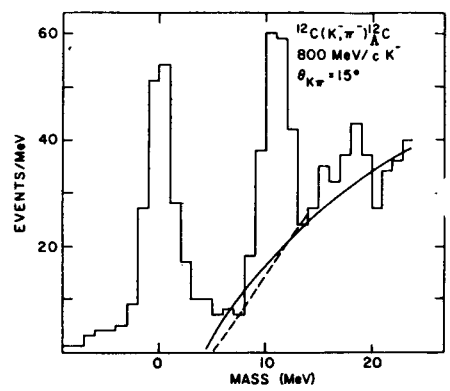
Improvement of nuclear imaging and studies of brain metabolism in health and disease were continued in collaboration with the BNL Chemistry Department, the New York University School of Medicine, and the School of Medicine, University of Pennsylvania. It is planned that the study of new neutron radiotherapeutic procedures for tumors using incorporated boron will continue. The procedure shows promise as a therapy which will permit selective irradiation of cancer cells. New radiopharmaceuticals using ruthenium-97 are being developed for use in standard nuclear medicine imaging procedures, offering a wide range of synthetic compounds, lower dosage to the patient, and excellent image quality. Xenon-127, made in the Brookhaven Linac Isotope Producer, was distributed to more than 35 institutions.

Xenon-127 is used by the Nuclear Medicine Division to examine patients taking part in the pulmonary research program. In this clinical program, 20 coal miners from West Virginia have been studied in collaboration with Marshall University School of Medicine. These studies will lead to a better understanding of respiratory physiology and perhaps to earlier diagnosis and insight into the pathology related to Coal Workers' Pneumoconiosis (CWP), also known as "black lung disease."

Complementary to these clinical studies are animal exposure experiments which are conducted in small animals in the Inhalation Toxicology Facility exposure chambers, and by nose-cone inhalation in sheep in the Large Animal Facility. In large animals, effects of inhalation of atmospheric pollutants on local expression of pulmonary immune responses against inhaled microorganisms are examined. These studies, which progress to the cellular level, are aided by nuclear medicine techniques which assess those portions of the lung affected by the inhaled pollutant. Free radical studies of sheep macrophages, under these exposure conditions, should shed light on the *in vivo* activation and reaction of phagocytic cells, providing a basis for assessing the contribution of these cells to lung damage, possibly through the production of the hydroxyl radical, ·OH.

Diet studies were continued during 1980 and a great many pounds were shed in efforts to determine the loss of lean body mass during weight reduction under various dietary regimens. The study of the relationship of diet and nutrition to cancer has continued, in collaboration with the Long Island Jewish-Hillside Medical Center, using *in vivo* prompt-gamma neutron activation analysis of whole body nitrogen. Thus far, 60 cancer patients have been studied.

Using nuclear resonance scattering of gamma rays, *in vivo* measurement of body iron is being developed in efforts to apply the technique to clinical evaluation of organ burdens of the metal in the condition known as Thalassemia. In this technique, photons (847 keV) are emitted from a gaseous $^{56}MnCl_2$ source (prepared in the BNL Medical Research Reactor). These photons are scattered resonantly from ^{56}Fe present in the liver and the heart.



π^- Energy Spectrum for Hypernuclear States in $^{12}_{\Lambda}$C

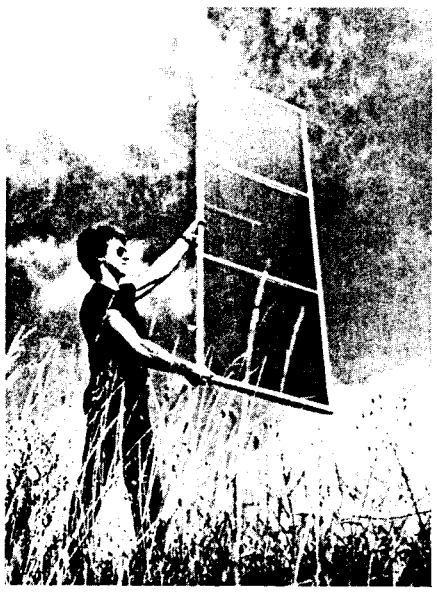
Energy & Environment

Energy science has been involved in several programs. DOE has funded a proposal submitted by universities, industry and BNL's Metallurgy Division for an Extended X-ray Absorption Fine Structure beam line for the National Synchrotron Light Source, and design work is proceeding. Diagnostic amorphous silicon solar cells, prepared by plasma decomposition of silanes have been prepared with a 3% efficiency.

Absolute rate measurements for a number of combustion related elementary reactions that involve atomic oxygen and a variety of organic compounds (fuels and intermediates) were made over an unusually wide temperature range (~400-1100 K) using two direct and complementary experimental techniques.

Semi-conductor electrodes are being widely studied as possible transducers of light energy into electrical or chemical energy. Theory has been developed to describe the effects of laser light pulses impinging upon various semi-conductor electrode surfaces.

Two types of polymer concrete have been developed. One, containing furtural alcohol and sand aggregate, can be used for rapid patching of U.S. Air Force runways under combat conditions. The other, organosiloxane polymer concrete, has application in cementing geothermal well



Inexpensive, lightweight, durable and stable — these were the results obtained by DEE for the Brookhaven solar collector developed under its Energy Technology Program.

casings to withstand hydrothermal conditions up to 350° C. Production quantities of portland cement pellets have been successfully prepared by a wet agglomerating technique and have been tested in a simulated fluidized bed coal combustor for removal of the SO_2 pollutant.

In the **environmental sciences** area, an extensive body of data was accumulated in a study devoted to understanding of the chemical changes which can occur during the dispersion of a power plant plume in the atmosphere. The rate of oxidation of sulfur dioxide to sulfate was almost always less than 1% per hour and no significant variation could be observed irrespective of changes in meteorological conditions.

Comparison of carbon budgets of the coastal food webs in the New York Bight, Gulf of Mexico, Bering Sea, and off Peru suggests that half the plant production of these shelves may be exported offshore to deeper water. Such an export may represent a significant organic carbon sink in global CO_2 budgets as a result of anthropogenic nutrient addition to the coastal zone. During 1980, initial analyses were made by BNL researchers of the nutrient and pollutant loading to the New York Bight from the Hudson, Delaware, and Chesapeake estuaries. Other field trips took researchers to the Gulf of Mexico and the mouth of the Amazon River to study terrestrial or marine origin of sediments and to the southeastern Bering Sea to analyze interannual variability in Alaska pollock yield.

Results of simulated acid rain application to field-grown soybeans and beets indicated that these crops may be injured either at current levels of acidity or by slight increases in acidity of rain.

Studies were initiated of movement of human viruses through the L.I. groundwater aquifer as part of an overall assessment of the quality of L.I. drinking water.

Advances in **energy technology** include the Brookhaven solar collector, which consists of a plastic glazing and a plastic aluminum foil laminated absorber, both acting as stressed membranes attached to a lightweight aluminum frame with an overall weight of less than half a pound per square foot, including insulation.

General Electric, a subcontractor to BNL's hydrogen program, demonstrated a successful scale-up of water electrolysis technology. Preliminary designs have been completed in a joint project with the NY Energy and Research Development Authority and the Village of Potsdam, N.Y. to restore a small scale hydro-power site for the combined production of electric power, and electrolytic hydrogen for sale as a chemical commodity.

In the zinc electrode project which is related to the nickel-zinc near term electric vehicle battery, the work at BNL has identified the effect of additives and has led to the development of a high rate insoluble zinc electrode with promising cycle life.

The passive solar house designed under BNL's program in energy conserving architecture was built at the Lab site and instrumented to verify its thermal performance. It utilizes thermal storage in masonry walls covered by south-facing glass.

In the area of **energy analysis,** regional energy and environmental assessments were completed for the three federal regions in the northeast. MOSES (Matrix Oriented Simulator for Energy Systems), a computer model, accounts for refined oil product differentiation, and distinguishes between existing capital stock and that which must be added to meet some scenario requirement.

A large Siting Methods project for the NRC was completed. This project established guidelines for decisionmakers to follow when selecting sites for nuclear energy facilities. BEAM, the Brookhaven Energy/Economic Assessment Model, was developed this year. It projects gross output by energy sector, i.e., oil or natural gas for industry, private sector, etc.

NCAES completed an assessment of electricity demand curtailment planning in the United States and an estimate of the socioeconomic cost of long-term electricity supply shortages. An in-depth analysis has been made in the Biomedical and Environmental Assessment Division of four photovoltaic technologies.

Safety & Env. Protection

The Safety and Environmental Protection Division conducts research in areas related to both occupational and environmental safety. Ionizing radiation, strong magnetic fields and toxic materials are currently being studied in laboratory and field work.

In 1978, the Marshall Islands Radiological Safety group within the division assumed responsibility from the Medical Department for continued radiation protection guidance for some of the atoll populations affected by the United States nuclear weapons testing programs, which ceased in the Marshall Islands in 1958. Inhabitants were relocated away from their home atolls for periods from several months to many years in order to accommodate the testing program or because of accidental contamination of their environment.

After returning, these people were exposed to chronic low level ionizing radiation. Over the years body radioactivity has been studied using a whole body counter with lead shielded bed or chair.

The Radiological Safety group has also developed methods to determine dietary radioactivity intake, which is related to radioactivity in coconut tree products and is used in making dose estimates. Predictions can be made for persons who are expected to return to Enue Island, Bikini Atoll where current measurements of radioactivity in coconut are available.

Nuclear Energy

The Department of Nuclear Energy has been working with the Nuclear Regulatory Commission (NRC) to identify and analyze safety problems for nuclear power plants, both operating and under construction. Assuring safe operation of a nuclear power plant requires an understanding of behavior of components of the plant and their interactions during a wide range of normal and off-normal conditions. This includes using experimental information and mathematical models of plant components. In some instances, it is necessary to incorporate experimental data and models into computer codes to simulate the response of the plant to normal and abnormal occurrences. Effects of modifications of the plant, the control system, and the mode of plant operation are also considered. A multi-disciplinary staff is involved in almost all aspects of nuclear power plant safety.

A structural analysis program is aimed at providing solutions to specific seismic evaluation problems using computer codes. The work includes development of criteria for dynamic loadings on piping systems, methods to evaluate load combination of earthquakes, and development of soil-structure interaction methods.

A new program in nuclear waste management provides technical assistance and confirmatory research to NRC in areas of high level waste, transuranic waste, unprocessed spent fuel, and low level waste. The program is directed toward assisting NRC in developing criteria and standards for the best method of isolating high level and low level radioactive waste. For high level wastes, the program deals with the regulation of the performance of the waste package in a mined geologic repository. (In this context, the waste package refers to the physical form of the waste, its container [canister], and any overpacks or engineered barriers.) Another aspect of this program deals with the current technological problems being generated by the decontamination of the Three Mile Island-2 facility.

A major area of involvement is in the development, modification and operation of extensive computer codes which simulate significant portions of nuclear power plants. The work includes improvements to codes already in use, such as additions to the IRT code for pressurized water reactors (PWRs). It also includes adaptation of new codes, such as the RAMONA code for boiling water reactors (BWRs), to new classes of transients such as the small pipe break loss of coolant accident. Further, the department has pressed forward in the completion and validation of versions of the computer code SSC, which is designed to evaluate the safety of LMFBR plants.

The Technical Support Organization TSO) acts as an advisory group to DOE, providing advice on a spectrum of safeguards activities, both domestic and international. Advanced reactor systems development continued during the year as engineering assistance was provided in fusion reactor materials, magnetic systems, synthetic fuels and fusion blanket technology.

Work continued on a new reactor concept, the Fast-Mixed Spectrum Reactor (FMSR). The FMSR design has attractive nonproliferation aspects and has the potential for significantly extending uranium resources.

The National Nuclear Data Center (NNDC) continued to provide improved reference nuclear data to the basic and applied research communities, including data on neutrons, charged particles, and nuclear structure and decay. At the request of DOE and Oak Ridge National Laboratory (ORNL), the NNDC has assumed responsibility for the data base and publication activities previously performed by the ORNL Nuclear Data Project.

Accelerator (Cont'd)

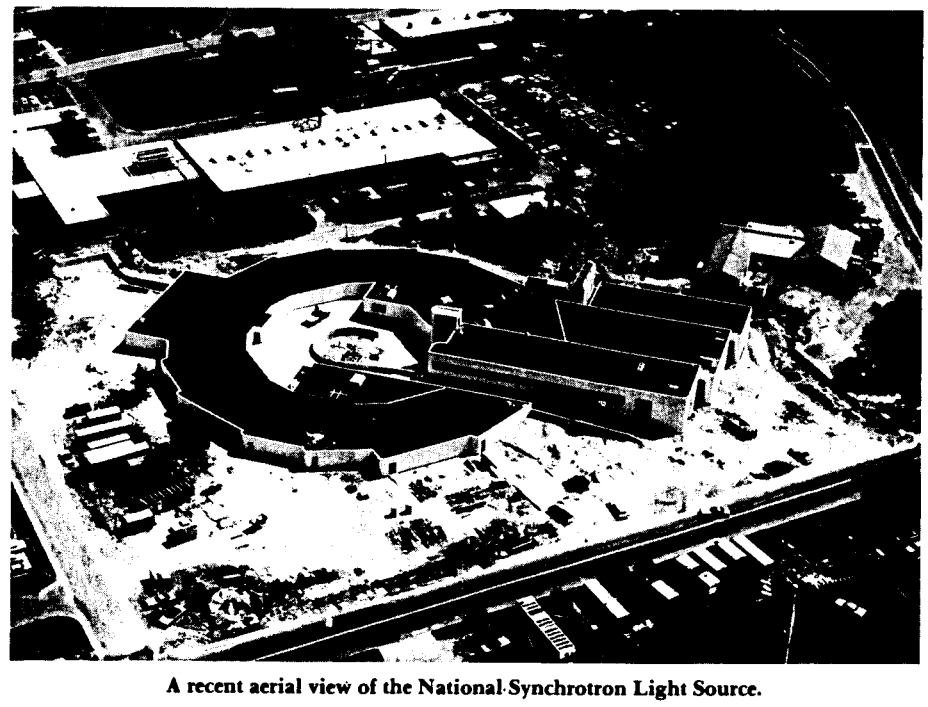
Other Activities

The Neutral Beam Development Group is working on multiampere negative ion beams that may be applicable to deuterium atom injectors for plasma heating in fusion reactors. The new features of ion sources being studied result in dramatic improvements in power and gas efficiencies and a reduction in cathode power density. A novel concept of plasma injection from a hollow cathode discharge into a standard magnetron is especially promising.

MEQALAC, an acronym for Multiple Electrostatic Quadrupole Array Linear Accelerator, is a new approach to the acceleration of charged particles, making use of planar arrays of electrostatic quadrupoles instead of the usual single beam channel. The maximum number of the charged particles accelerated by a channel is limited by space charge force. The MEQALAC utilizes the fact that the space charge limited current is independent of the size of the channel. The devices can be produced in very small sizes, which is economical, and the multiplicity of beams essentially removes the space charge limit. MEQALACs have many desirable features.

The first operating MEQALAC was built in 1979 and verified the space charge calculation. Another, under construction during 1980, is designed to be a replacement for the AGS 750 kV Cockcroft-Walton pre-injector. It has four beams, each of 1.5 mm radius.

The Division of Advanced Technology Applications has two development programs in the field of underground power transmission. The largest project is the development of a superconducting system using flexible cables with niobium-tin superconductor. A full-power demonstration system with a rating of 1000 MVA has been constructed at Fifth Avenue. The length of the cable is about 100 m. A cable-taping "factory" has grown in Building 820 in order to fabricate prototype cables. The present schedule calls for installation of the cables and terminations at the test facility in the summer of 1981.



A recent aerial view of the National Synchrotron Light Source.

Biology

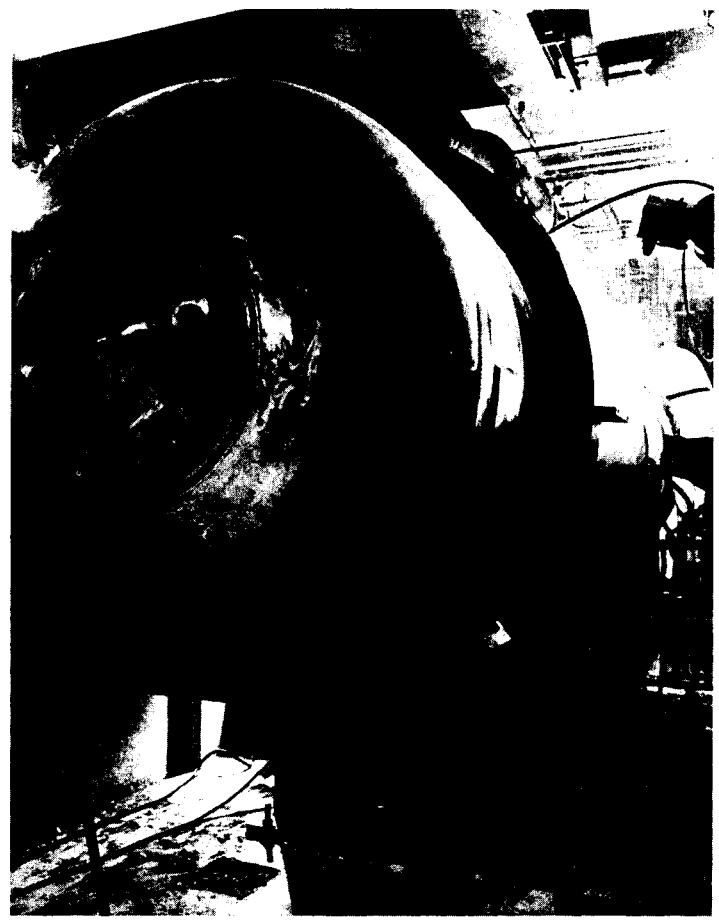
The Biology Department's research focuses on understanding the cellular structure and function of biological systems, from viruses to human skin and plants. Some of this research is explained in these paragraphs.

The nature of plant gene structure is being investigated in mutants created by movable genetic sequences called "transposable elements." These elements are regulatory portions of the chromosomal DNA which can move to any position in any of the chromosomes. When they insert into a gene, they disrupt or modify gene activity and this can be expressed as a new phenotype, or mutation. A sequence complementary to a portion of the gene for sucrose synthetase in corn has been amplified by cloning in a bacterial plasmid and used as a probe to compare the DNA structure of the sucrose synthetase locus in both normal and mutant plants. Such studies will locate the positions of insertion, identify regions of functional importance, and provide information on how such elements can move about and regulate gene activity.

When a plant cell divides, each daughter cell inherits an identical set of genes that are located in the DNA of the chromosomes. In pea, each of the diploid cells has 14 chromosomes and each chromosome has two DNA molecules about 17 cm long. Work in the Biology Department has shown that several hours before cell division, the long molecules are replicated in an organized, step-wise fashion by units called replicons. At the onset of replication groups or clusters of about 18 replicons, aligned in tandem on the same molecule, begin producing a new DNA chain. Each replicon of a cluster starts nearly simultaneously, as if responding to a particular signal. Meanwhile, other clusters, flanking the active one, remain quiescent until they too are signaled to start. The cascading, ordered activity of the clusters continues until a new replicate of the 17 cm molecule is nearly complete. Then, the unattached DNA chains between neighboring clusters and replicons are joined end-to-end producing a contiguous DNA molecule ready to be folded into a chromosome and eventually distributed to a daughter cell.

The structure and function of the DNA photoreactivating enzyme (PRE) has been studied *in vitro* and *in vivo*. This enzyme acts specifically, in a light-dependent reaction, to monomerize UV induced cyclobutyl pyrimidine dimers in DNA. The enzyme from *E. coli* requires an RNA for its activity, and loses activity stoichiometrically upon its removal. A method was developed for inserting this enzyme into mammalian or bacterial cells low in endogenous enzyme. The activity of the PRE in resting and mitogen-stimulated human lymphocytes has been examined. Although the enzyme is detectable in resting lymphocytes, stimulation with a mitogen increases enzyme production. After human skin is exposed to a sunlamp, pyrimidine dimers are formed in the cellular DNA. The dimers are removed rapidly by excision repair, and, in the presence of photoreactivating light, removal proceeds at an enhanced rate. This indicates that both excision and photoreaction remove dimers in human skin DNA. A determination was made of the relative efficiency of UV light of different wavelengths in transforming human cells to anchorage-independent growth, a model for solar oncogenesis in man. The data indicate that DNA is the principal target for transformation of human cells.

Genetic and biochemical studies of a simple bacterial virus, T7, are discovering how this virus is organized, and how it goes about infecting a cell. The genetic information of the T7 virus is contained in its DNA, a single molecule 40,000 base pairs long; the sequence of over half of these 40,000 base pairs has now been determined. The sequence of base pairs is being examined to understand how the T7 genes are laid out in the DNA molecule and what determines when and how much of each T7 protein is made during the infection process. Recent work shows that the T7 DNA molecule passes from the virus particle into the bacterial cell in stages, and that this phased entry is an important part of the way gene expression is controlled.



One of two heat exchangers which allow the reactor to operate at 60 megawatts.

High Flux Beam Reactor

During the first few weeks of 1980, installation of a pair of larger heat exchangers in the reactor coolant loop was successfully completed. These heat exchangers will permit the reactor to be operated at a power level of 60 megawatts with an accompanying 50% increase in the neutron flux of the reactor. Actual operation of the reactor at this new higher power has been deferred, pending completion of an exhaustive safety review of the reactor operation by the Department of Energy. The new higher flux at 60 megawatts, which should be available later this year, will not only permit more experiments to be done in a shorter time, but will also allow certain experiments to be performed which are now only marginally feasible.

Installation of the Cold Neutron Facility was completed in April, and the first beams of cold neutrons were produced at that time. Preliminary tests showed a gain in cold neutron flux by a factor of from 5 to 10 for neutrons having wavelengths longer than 4 Angstroms. Neutrons of this wavelength are extremely useful as probes in studies, for example, of long range ordering in atomic lattices, and the structure of large biological molecules.

Installation of the TRISTAN II Facility for on-line production of radioisotopes was also completed during 1980. The production rate exceeded expectations, with the output available from this facility being a factor of 10 greater than that available anywhere else in the world today. Even higher production rates are anticipated as future improvements to the design are made. Meanwhile, many scientists from other laboratories and universities will be using the new facility for the study of radioactive decay of the short lived isotopes which it produces.

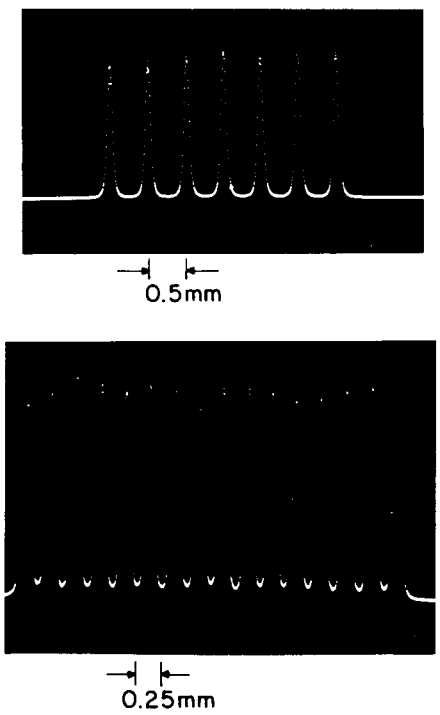
Instrumentation

The Instrumentation Division conducts research and development in scientific instrumentation. Principal areas of research activity are the detection of charged particles, neutrons and photons with gaseous and liquid detectors and with semiconductors, processing of signals from detectors, low-noise electronic devices and circuits, systems for acquiring data and for control of scientific experiments, and application of nuclear and atomic techniques in elemental analysis. In addition, the division provides some special services in electron microscopy, vacuum deposition technology, printed circuit board fabrication, scientific instrument repair, and maintenance of computerized on-line data acquisition and experiment control systems.

In 1980 further advances were made in the development of position sensitive particle and photon detectors. Results of this work will be used in detectors for research at the High Flux Beam Reactor, the National Synchrotron Light Source and ISABELLE.

A class of new position sensitive detectors of the gas proportional type for x-rays has been developed. These detectors are intended for use with synchrotron radiation in low angle scattering studies of molecular and crystal structures. They will also be used for plasma diagnostics in experiments at the Plasma Physics Laboratory at Princeton. The main properties of these x-ray detectors are high position accuracy of one part per thousand of the detector length, position resolution of 100 micrometers and a capability to count photons at rates in excess of 2×10^5 per second.

1980 was also a fruitful year in the development of data acquisition and experiment control systems. A system for monitoring of the Superconducting Power Transmission Line has been developed and brought into operation. A system for control of numerous motors to be used in spectrometers and photon beam lines of some experiments at the NSLS has been developed. Significant progress has been made in the development of a large system for monitoring and controlling experiments and animal chambers at the Inhalation Toxicology Research Facility.



The oscillograms illustrate the position resolution of high precision position sensitive gas proportional detectors (active area 10X2 mm²) for x-rays developed for scattering studies of molecular and crystal structures.

Applied Mathematics

The objective of the Applied Mathematics Department is to ensure that the best possible resources and expertise in the areas of mathematics, statistics, and computing are made available to the research programs at the Laboratory. To achieve this, its activities comprise three components: a basic research program, a consulting and applications program, and the Central Scientific Computing Facility.

A major area of interest is the study of partial differential equations and numerical methods for solving them. Studies range from the formal theoretical properties of various types of equations to the development and testing of specific computer codes for practical applications. The computation of magnetic fields and the behavior of nuclear reactors are among the varied scientific tasks which have benefited from some of these developments. The mathematical theory of image reconstruction is another area of current interest. New results in this area have immediate significance for medical and materials studies using tomographic techniques.

In statistics, the interest is similarly divided between the development and use of new methods, as well as conventional ones to explore new types of problems. A large number of these problems arise in health related research in the medical and environmental areas, where the fact that the objects under study are human beings leads to considerable restrictions on the manner and extent of data collection.

Computer related research has focused on two lines of development which will be increasingly important over the next few years. The networking of multiple computer systems is becoming widespread at all levels, from tightly coupled processors exchanging data at high speeds, to loose geographically distributed networks. Many questions about the optimum way to plan, implement and operate such networks remain poorly understood. In another direction, the application of computers to problems of engineering design, especially of complex digital circuits, is being actively pursued.

The balance of effort between the provision and management of centralized computer facilities and the provision of expert assistance in making use of such facilities is shifting to the latter. For the first time statistical application support is being provided, and more effort is being placed on providing and assisting in the use of high-level software packages. As mini- and micro-computers make more and more powerful computational resources available in association with data acquisition systems or other special purpose computers around the site, the coordination of purchase, maintenance, and systems management can lead to substantial savings.

The major part of the department's resources remains devoted to the Central Scientific Computing Facility. An important step is under way in the procurement of a Large Mass Storage system. This will provide a long-needed expansion of the amount of on-line data storage available to the system. More importantly, it will provide in its file storage and management capability, a network capability allowing in time access from arbitrary computers at the Laboratory.

BROOKHAVEN BULLETIN

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BROOKHAVEN BULLETIN

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BROOKHAVEN NATIONAL LABORATORY

DOE Retiree

Leonard Belkin, chief of DOE's Office of Patent Counsel, located at BNL, retires January 9, 1981, with 30 years of government service. His career in government began when he joined the U.S. Patent Office in 1950. In 1955, he became a patent advisor with the U.S. Navy. Belkin came to AEC in 1958 and assumed his present position in 1972. In this capacity, he has been responsible for over 200 major patent applications, including the High Flux Beam Reactor at BNL and methods for making parasexual reproduced plants, which antedated by several years the man-made, living microorganisms upon which a patent was recently upheld by the Supreme Court.

French Club

Are you one of those people who looks at pictures in the travel section of the *New York Times* and says "Oh, yes, I remember that"? If so, you'll have a chance to test your memory at the next meeting of *Le Cercle Français de BNL*, on Tuesday, January 13, at 8 p.m. in Room B of Berkner Hall.

The evening will be devoted to a sort of do-it-yourself travelogue. Slides taken by various members of the group will be projected, without identification, and the object will be to identify each scene. The person who is most successful at this will receive, in addition to the adulation of the crowd, a bottle of wine (French, of course).

If you would like to mystify, as well as to be puzzled yourself, you can enter your own slides in the contest by calling Ralph Weston, Ext. 4373 or Julia Walenta, 928-4926. Refreshments will also be served during the evening. Those attending who are not members of the French Group will be asked for a donation of $2 ($1 for students).

Cooking Exchange

If rising food prices are a concern, attending the next meeting of the Cooking Exchange may provide some relief. On the agenda for January 14 are experiments with economy meals.

Meetings are held in the Recreation Building from 12:30 to 2:30 p.m. Admission is $1; babysitting is provided at 25¢ a child.

Anyone with questions or recipes should call Adrienne Usher, 289-7658, or Ruth Fernow, 928-8465.

Walk on Water

The Mountain Club trek to Old Inlet on Fire Island across the frozen bay will take place on Saturday, January, 10 starting at 10 a.m. from the Bellport Dock. Bring a lunch and a thermos, and a sled with a blanket if you are bringing small children. Call Don David, 286-2267, if you have any questions.

Motorcycle Club

The Motorcycle Club will hold its monthly meeting on Monday, January 12 at 5:15 p.m. in the Recreation Building. All interested persons — riders and would-be riders — are invited to attend.

Volunteers Needed

Volunteers are needed for a new research project in the Medical Department. The study consists of the intravenous administration of tin-pyrophosphate, a material generally used in nuclear medicine for bone imaging and red blood cell labeling, followed by the obtaining of several blood samples over a one-week interval. No radiation to the subject is involved. There will be a remuneration of $50 for participation in the study. For further information, call S. Srivastava at Ext. 4459 or Margaret J. Matkovich at Ext. 3672.

Nursery School

The Upton Nursery School has openings for new enrollment, particularly in the three-session-per-week class for three year old children.

The Nursery School offers preschool experience for a child whose parent or relative is an employee of BNL or is a Laboratory visitor. There are separate classes for three- and four-year old children. Classes meet two or three mornings per week. An established car-pool system is in operation. Tuition fees are $40 per month for the three-day classes and $27 per month for the two-day classes.

Interested parents should call Karen Brunschwig, enrollment chairperson, at 924-0030, or Colin Stewart, President, at Ext. 4154 or 286-9616 for more information.

Postal Note

Effective January 1 all international air and surface postage rates have been increased. For instance, airmail to Colombia, Venezuela, the Caribbean and Central America is now 35¢ per ½ oz., up from 25¢. To all other parts of the world, except Mexico and Canada, air mail is 40¢ per ½ oz., up from 31¢. Airmail postcards cost 28¢ and aerograms are 30¢.

Fly Tying Club

The Fly Tying Club will meet on Tuesday, January 13, at 5:30 p.m. in Building 490. For information, call John McCafferty, Ext. 2075, or Dick Stoner, Ext. 3601.

The Joys of Apartment Living

Doug Humphrey

All is not perfect in at least one apartment advertising "6 Rms Riv Vu." In this scene from Bob Randall's comedy, the next presentation of the BERA Theatre Group, Ruth Basile, as the tenant in apartment 4A, tries to impress Joseph Indusi, as Eddie the superintendent, with the severity of her problem. Her sink, she shouts, "has been leaking since Eisenhower was President!" The outcome of this confrontation will be revealed in the performances scheduled for Friday and Saturday, January 16 & 17 and 23 & 24 at 8:30 p.m. in Berkner Hall. Tickets are $2 for persons under 18 or over 65 years of age, $3 for other adults. For reservations, call Ext. 3940 or 286-9584.

Symposium Next Week In Honor Of Tape

A symposium on "The Role of Long-Range Research in the National Energy Program" has been convened to honor Gerald F. Tape who retired as president of Associated Universities, Inc. last October 10th. Sponsored by BNL and its sister laboratory, the National Radio Astronomy Observatory, the symposium will be held on January 14, from 2 to 5 p.m. at Berkner Hall.

An impressive list of speakers will include W. Bowman Cutter, Executive Associate Director for Budget of the Office of Management and Budget; Edward David, President of Exxon Research and Engineering Co.; John Foster, Vice President, Science and Technology, of TRW; and Edward Frieman, Director of DOE's Office of Energy Research. Robert E. Hughes, AUI President, will moderate the symposium.

The program will be held in conjunction with a meeting of the Board of Trustees. Staff members are cordially invited to attend this special session.

Registration Today

Registration for on-site courses being offered by Suffolk County Community College for the spring 1981 semester takes place today, from noon to 3 p.m. in Berkner Hall. Counselors will be available.

The tuition fee is $30 per credit and there is no additional school fee. Master Charge or VISA cards will be accepted.

If there are any questions, call Y. Renee Flack, Ext. 3316.

PINY Courses

Registration for PINY/BNL extension courses in nuclear engineering will be held from 6 to 7 p.m., Wednesday, January 21, in the conference room of Bldg. 318. PINY courses tentatively scheduled for the spring semester are: NU-607 — Reactor Licensing and Safety, and NU-927 — Energy Policy Issues. Final determination will depend upon student response at the time of registration.

Professor John Lamarsh, Head of the PINY Nuclear Engineering Department, will be here during registration to advise prospective students. These courses are available to BNL employees under the tuition refund policy. They are also available to guests and collaborators, and to a limited number of persons not affiliated with the Laboratory.

CSCF Courses

The Central Scientific Computing Facility (CSCF) of the Applied Math Department is offering the following data processing courses:

DBMS at the CSCF (starts January 19)
Introduction to Update (starts January 20)
Intermediate Fortran - (starts January 27)
Introduction to the CSCF - starts February 10)

Course details are published in the latest CSCF Newsletter, available at the CSCF Manual Library.

In Memoriam

Eleanor Rewt, Senior Executive Secretary in the Physics Department, died on January 5 after a long illness. Fifty-eight years old, she had been affiliated with the Laboratory since 1947, becoming a permanent member of the Physics Department in 1965.

Mrs. Rewt, who lived in Remsenburg, is survived by her husband, George, and two children, Bonnie Mirbach and George Rewt, Jr.

Arrivals & Departures

Arrivals

Marcie H. DuBrul ..... Plant Engrg.
George R. Eleazer ..... Plant Engrg.
John J. DeMichele ..... Medical
Ronald Franklin ..... Plant Engrg.
Daniel T. Huang ..... Energy & Env.
Arleen N. Lancsarics ..... Energy & Env.
Thomas R. LeMaire ..... Director's Ofc.
Robert L. McGraw ..... Energy & Env.
James M. Meier ..... Accelerator
Mark Raynor ..... Safety & Env. Prot.
John J. Reany ..... Accelerator
John R. Skaritka ..... Accelerator
Gordon L. Smith ..... Plant Engrg.
Kent Snyder ..... Personnel
Leonardo P. Sotomayor ..... Central Shops
Claudia E. Sykes ..... Fiscal
Kevin M. Tisch ..... Safety & Env. Prot.
Abass Wessen ..... Plant Engrg.

Departures

Anthony C. Finocchio ..... Accelerator
Martin H. Garrell ..... Energy & Env.
Rowland F. Hautsch ..... Energy & Env.
Kenichi Harigaya ..... Medical
Sarah Leah S. Isaacs ..... Chemistry
Mahendra P. Jamuar ..... Medical
Timothy S. Kehoe ..... Accelerator
David E. Kraus, Jr. ..... Accelerator
Arthur L.Y. Lau ..... Biology
James J. Mosca ..... Physics
Stewart C. Malloy ..... Energy & Env.
Charles N. Sponheimer, Jr. ..... Accelerator

Volleyball

Standings as of 1/5/81

A Division	High Society	6-0
	No Names	5-1
	Mixed-Ups	3-3
	Nuts & Bolts	3-3
	Las Bolas	1-5
	Kings Court	0-6
B Division	Leftovers	6-0
	TNT	4-2
	Semi-Tough	3-3
	LEMUFs	2-4
	Oh No's	2-4
	Puff & Stuff	1-5

Note: On January 14, the Open League will play another Round Robin Tournament.

Free Pamphlet

A free copy of the pamphlet "Solar Hot Water and Your Home" can be obtained by sending a postcard to the Consumer Information Center, Dept. 605F, Pueblo, Colo. 81009.

Cafeteria Menu

Week Ending Jan. 16, 1981

Monday, January 12

Beef Barley & Mushroom soup	(cup)	.55
	(bowl)	.65
Western omelet & 1 veg.		1.50
Roast top round of beef & 1 veg.		1.65
Hot Deli — Pastrami	(on bread)	1.65
	(on roll)	1.75

Tuesday, January 13

Potato leek soup	(cup)	.55
	(bowl)	.65
Grilled liver w/onions & 1 veg		1.55
Spanish rice & 1 veg.		1.50
Hot Deli — Italian sausage hero		1.70

Wednesday, January 14

Split pea & ham soup	(cup)	.55
	(bowl)	.65
Veal pattie parmesan & 1 veg.		1.55
Roasted breast of turkey w/stuffing & 1 veg.		1.60
Hot Deli — 8-foot hero		.75 per inch

Thursday, January 15

Hot Russian borscht soup	(cup)	.55
	(bowl)	.65
Country fried steak w/1 veg.		1.65
Spaghetti & meat balls		1.50
Hot Deli — Chili dog		1.70

Friday, January 16

New England clam chowder	(cup)	.60
	(bowl)	70
Tuna noodle casserole w/1 veg.		1.60
Sauerbraten & potato pancakes		1.65
Hot Deli — Smoked, baked ham	(on bread)	1.65
	(on roll)	1.75

Join The Chorus

The BNL Singing Group is looking for people who want to sing. Rehearsals are every Tuesday, at noon in Berkner Hall.

Come to a rehearsal if you are interested in joining the group. For more information, call Arnold Feltman, Ext. 4673, or John Weeks, Ext. 2617.

Classified Advertisements

Placement Notices

The Laboratory's placement policy is to select the best-qualified candidate for an available position, with consideration given to candidates in the following order of priority: (1) present employees within the department, with preference to those within the immediate work group; (2) present employees within the Laboratory as a whole; and (3) outside applicants.

The determination of the best-qualified candidate for available positions will be based upon education, experience and other job-related criteria. Such factors will be evaluated and measured against the demonstrable requirements of the available vacancy, as well as the Laboratory's Affirmative Action objectives.

The Laboratory is committed to a policy of Equal Opportunity in its selection and placement of personnel. Its objective is equality of opportunity in employment, training, and promotion without regard to race, color, religion, national origin, sex or handicap.

Each week, the Personnel Office lists new personnel placement requisitions. The purpose of these listings is, first, to provide open placement information on all non-scientific staff positions; second, to give employees an opportunity to request consideration for themselves through Personnel; and, finally, for general recruiting purposes. Because of the priority preference policy stated above, each listing does not necessarily represent an opportunity for all candidates. As a guide to readers, the listings are grouped according to the anticipated area of recruitment, as indicated below. Except when operational needs require otherwise, positions will remain open for one week following publication date.

For further information regarding a placement listing, contact the Personnel Placement Supervisor, Ext. 2882.

LABORATORY RECRUITMENT: Opportunities for present Laboratory employees.

1538. LAMP CLEANER - Plant Engineering Division.

1539. FIREFIGHTER - Previous substantial firefighter experience is required. Completion of New York State EMT course and possession of training certificate is highly desirable, if not, completion of course within one year is required. Must be willing to work shifts at the completion of a thirteen week training period. Safety and Environmental Protection Division.

1540. CLERICAL POSITION - Requires good typing skills. Will primarily be responsible for maintaining statistical records in the Circulation Section of the Research Library and the shelving of books and journals. Technical Information Division.

OPEN RECRUITMENT: Opportunities for present Laboratory employees and outside applicants.

1541. TECHNICAL POSITION - Requires AAS degree in mechanical technology or equivalent background. Will assist in low-temperature measurement of superconducting wire. Responsibilities will include fabrication of experimental apparatus, use of furnaces to heat-treat wire, use of cryogenic liquids, and fabrication of superconductors. Should be familiar with simple machining and possess basic knowledge of electrical systems and some knowledge of vacuum systems. Department of Energy and Environment.

Autos & Auto Supplies

72 CHEVY VAN - V8, no rust, many extras, mach. perfect, inside finished. $2,400. Jack, Ext. 4100.

RIMS — 15" Ford, excel cond. $7. Bill, Ext. 2906 or 929-6189.

SNOW TIRES - (2) Goodyear A78-13 polyglass suburbanites, excel cond, fits most small cars. $50. $50. Bob M. 757-3128 or Ext. 2514.

72 IMPALA - good tires, excel cond, a/c, p/s, p/b, tinted glass. $895. Bill, Ext. 7772 or 281-0557.

WHEELS - GMC 5 lug 7"x15", G78-15, w/usable tires mtd, asking $15 ea. Ralph, Ext. 7623.

71 DATSUN - wagon 210, good transp, many new parts. Ext. 3688 or 363-7032.

72 FORD - Sta. wgn, p/s, p/b, new brakes, battery, starter, 53,000 mi. on engine, some dents but excel mechanically. Ext. 2606.

YAMAHA 400XS - 50 plus MPG, 10,000 mi, just tuned up, ready for spring rides. $950. George, Ext. 7672 or 878-4383.

MOTORCYCLE SADDLEBAGS - black, A.B.S. w/turn/tail/stop lights. Sears Cat. price, $90. My price, $40. Dick, Ext. 3273.

73 VEGA - Sta. wgn, a/t, a/c, p/s. $800; also 1975 FIAT 128 - 2 dr, 4 spd, good on gas. $1,650. Rick, 281-9671 days or 281-7486 eves.

69 CHEVY NOVA - 6 cyl, a/t, 4 dr., runs good, needs body work. $700. Bob, Ext. 3654.

74 DODGE DART - a/c, a/t, p/s, p/b, high mileage, some body damage, orig. owner, reg. gas. $500. Bob, Ext. 3370.

TIRE - (1) G78-15 belted w/w, new. Walt C, Ext. 3254.

VW FRONT SEATS - (2) white, highback style, for squareback or fastback, good cond. Ext. 7110 or 589-5490.

CAR RADIO - Plymouth Dodge a.m. radio, excel cond. Dalal, Ext. 7790.

Boats & Marine Supplies

PORTA POTTI - heavy plastic, very good cond. $50. Joe, Ext. 7961 or 727-2470 eves.

Miscellaneous

VW RADIO - AM-FM, pushbutton tuning. One year old. $25. Ext. 3335.

DISHWASHER - Kitchenaid, excel cond, under counter model. $35. Ext. 4664 or 744-8779. Ask for Roy.

CAMERA - Exakta VX1000, f2/50 mm w/35 mm wide angle, 400 mm tele, 2X and 3X converter, extender. $99. Firm. Ext. 3705 days or Ext. 3090 eves.

KITCHEN CABINETS - and counter top, wall oven and counter-top stove. $800. Ext. 7785.

FRANKLIN STOVE - cast iron American made Washington Foundry, will burn wood or coal. $99.95. Jack, Ext. 4447 or Joan, Ext. 4112 or 744-3919 after 5:30.

FREE - blue-eyed Siberian Husky, female, 1 yr. old and brand-new doghouse. 665-2423.

GUITAR - "Harmony" w/steel strings, good cond. $40; fireplace grate, $4. Greg, Ext. 7960.

CHANDELIERS - beautiful crystal, others; dresser or buffet, large, good cond; desk and chair, $75; kitchen or dinette set, $40. 277-4091.

FIREPLACE — free standing, black sheet metal, 27"w x 23"d x 26½h, 7" flue, used one year, includes some pipe, elbow and damper. $75. Ralph, Ext. 7623.

DOUBLE KITCHEN SINK - white, $15; white toilet, $20; Welbuilt range, 4 top burner and lower oven, good cond. R. Rosenka, Ext. 3815 or 924-5329 after 6 p.m.

FLASH BULBS - AG-1B, $1.25 per dozen. Ext. 2041.

DOUBLE ETAGERE - wall unit, 6 shelves, light pine, for TV and stereo. $40. Ext. 2498.

SKIS - Rossignol Jr 120 fiberglass Tyrolia bindings, excel cond. $40. 929-4741.

TAPE DECK - B.I.C. model T2, 2 spd stereo cassette deck, 5 mos. old, perfect cond. still under warranty, originally $350. Asking $185. 732-5829.

SNOW THROWER - Gravely 2 stage, like new. Cash or barter. Ext. 3688.

FREE- Shepard/collie mix puppies, very gentle natured. Irene, 369-2600, ext. 238.

MAGNAVOX - Hi fi 54" am/fm phono, excel cond. $175. Ext 2979 or 286-1975.

BOOKCASE - 6'x7' dark pine, opening for TV, cabinets on bottom. $50. Ext. 2498.

MEN'S BIKE - 3 spd, 26" wheel, excel cond. $45. Ext. 3106.

SKIS - Head 190 cm, good cond, w/bindings, best offer. Carol, Ext. 4398.

BRIDES TO BE - beautiful new sample wedding dresses, all under $100. 475-0037.

STOVE - Columbia wood, coal and gas, solid cast iron stove, white porcelain w/covers, $275; Farfisa portable organ, excel cond. $525. 281-9671.

AIR TIGHT - wood burning stove, American made, excel cond, heats 1500 sq. ft. $275. Bob, Ext. 4551 or 289-2159.

PERUVIAN FUR TAPESTRY - or rug. $225. Vicky, 289-8182 after 6 p.m.

MATTRESS - Sealy king size, excel cond., used 1 yr. 744- 9746 eves.

CHICKERING PIANO - upright, rosewood, excel cond. $1,500. Ext. 7667 or 751-4985.

FURNITURE - small desk, chest, metal bed frame, mattress. All $40. 929-4741.

Real Estate

Real Estate advertised for sale or rent is available without regard for the race, color, creed or national origin of the applicant.

For Sale

CENTER MORICHES - 100 yr. old Victorian, 2 baths, 4 bdrms, d/r, patio, alum. siding, 1 acre landscaped, beautiful area, walk to school, stores, church. ½ mi. to Bay. $55,000. George, Ext. 7672 or 878-4383.

BROOKHAVEN HAMLET - 5 bdrm, l/r, d/r, fam. rm w/fp, large kit, 2 baths, fin. bsmt, 2 car garage, pool, fenced yard, 1000 gal. oil tank, A1 trim, many extras. $64,500. 277-1284.

WESTHAMPTON AREA - Mobile home, 12'x60', 2 bdrms, eik, stove, refrig, washer/dryer, laundry rm, 2 tool sheds, porch, patio, wooded landscaped plot. $11,000. 325-1112 after 5 p.m.

For Rent

YAPHANK - 2 bdrm ranch, l/r, d/r, eik, double garage, 10 min. from Lab. 924-7484 after 6 p.m.

E. PATCHOGUE - 3 bdrm. furn. house, gas heat, Feb. 1 to June 30, 1981. $250/mo. plus util negotiable. J. Olson, Ext. 3382 or 289-8629 after 7 p.m.

POCONO'S - Chalet in priv. community, Ski Tanglewood. Rent by week or weekend. Ext. 4551 or 289-2159.

N. SHIRLEY - attractive apt, furnished, priv. entr, util. incl, excel location, 5 min. from Lab and stores, mature working gentleman, security. $285. pays all. 281-8044.

CENTEREACH - 1 bdrm furn. apt. available for rent immediately. $225/mo. incl. util. 585-0276 after 7 p.m.

MIDDLE ISLAND - 1 bdrm, 5 mi from Lab, excel cond, pool, central heat and air, wall to wall. $300/mo to sublet immediately. Ext. 2437 or 924-7909.

Wanted

GAS STOVE - Good cond. Ext. 7713.

BUSINESS ASSOCIATES - Flexible hours, excel income potential, no investment required. Mike, 698-5861 after 7:30 p.m.

BABYSITTER - who lives on site. Mon. to Fri. 8:30 to 5:00 for 10 mo. old. Mona, Ext. 2347.

APARTMENT - 1 bdrm unfurnished in Stony Brook area for quiet single person. Please call S. Ghoshroy, Ext. 4641 days.

ICE SKATES - boy's shoe size 5 and girl's size 3. Joan, Ext. 3135.

Car Pools

CENTER MORICHES - 8:30 to 5:00 p.m. car pool; wish to join. Hewitt Ave. G. Wyant, Ext. 2902/2904.

Services

Services are listed as a courtesy to BNL employees. They are neither screened nor recommended by the *Bulletin*.

DOMESTIC HELP - and/or child care, will live in, experience, reliable, mature, daily, weekly. Noreen, 281-7873.

CHILD CARE - my home, for working mothers, experienced, 4 mi. from Lab. ESTA, 924-0380.

LIMO SERVICE - Luxury chauffered driven, for Weddings, Proms, all occasions. 698-2266 or 698--2268.

CARPETS INSTALLED - repaired, quick dependable service, free estimates. Jim, 821-0187 after 5 p.m.

EUROPEAN AUTOS - Porsche, Audi, Mercedes. Big savings, you pick up. Ext. 7932 or 475-0065.

FIREWOOD SPLIT - seasoned oak 4'x16'x18". $110. Delivered. 924-4284 or 924-3919.

Classified Ad Policy

Deadline is 4:30 p.m. Friday for publication Friday of the following week.

1. The Brookhaven Bulletin's classified section may be used only by active and retired Laboratory employees.
2. All items for sale or rent must be the advertiser's property.
3. Ads for material acquired for resale in association with a full or part-time business cannot be accepted.
4. Ads for the sale or trade of firearms will not be accepted.
5. Ads not carried because of space restrictions will be held for publication in the next issue.
6. Ads are run only once and must be resubmitted if they are to be repeated. One ad per person per week.
7. **Property for sale or rent cannot be accepted on this form. Special Real Estate Ad Forms are available at the office of the Brookhaven Bulletin, Building 134.**

☐ For Sale: Autos & Auto Supplies ☐ For Sale: Boats & Marine Supplies ☐ For Sale: Miscellaneous ☐ Car Pools ☐ Lost & Found ☐ Services ☐ Wanted

Please print your ad below in 15 words or less using one word per block. Include name and phone number to call.

Note: The following must be completed for your ad to appear.

NAME (Please Print).....

Employee's Signature..... Life No. ..... Ext. .....

Send to: Brookhaven Bulletin, Building 134 (Ext. 2345).