BROOKHAVEN BULLETIN
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BROOKHAVEN NATIONAL LABORATORY

Brookhaven Chemists Discover Cluster Fusion

Fusion — induced by cluster-ion impact at surprisingly low energy — has been achieved at BNL.

In a series of experiments, to be described in the September 18 issue of *Physical Review Letters,* chemists Robert Beuhler, Gerhart Friedlander and Lewis Friedman of Brookhaven's Chemistry Department observed the release of three-million-electron-volt (3 MeV) protons, 1-MeV tritons and helium-3.

These three "signatures" prove that the researchers have indeed achieved fusion — the production of tremendous nuclear energy through the merging of the nuclei of deuterium, a hydrogen isotope.

Natural fusion occurs when stars burn. Thus, by achieving extreme temperatures and pressures under controlled conditions, the researchers have observed nuclear reactions that are essentially stellar in nature. This discovery has provided a new technique for studying these nuclear reactions in the laboratory.

Though the thrust of the BNL group's work was purely basic research, the word "fusion" inevitably provokes thoughts of an alternative approach for generating useful energy on a controllable scale. For this to be achieved, however, there will have to be considerable effort in the area of basic research.

As Chemistry Department Chairman Norman Sutin said, "This is a very nice piece of work, and we are very excited about it. Its success derives mainly from Friedman, Beuhler and Friedlander having the imagination to bring their collective expertise on cluster-ion impacts and nuclear chemistry to bear on the fusion problem, and DOE having the foresight to provide long-term support for our chemical sciences and other programs. This observation of cluster ion-induced fusion raises many interesting questions and looks very promising."

A Very Different Concept

Cluster-ion induced fusion is a very different concept from the cold-fusion idea introduced by B. Stanley Pons, University of Utah, and Martin Fleischmann, University of Southampton, England, last March 23. Though hundreds of research teams worldwide attempted to duplicate Pons and Fleischmann's tabletop experiments to produce fusion at room temperature, their results remain unconfirmed.

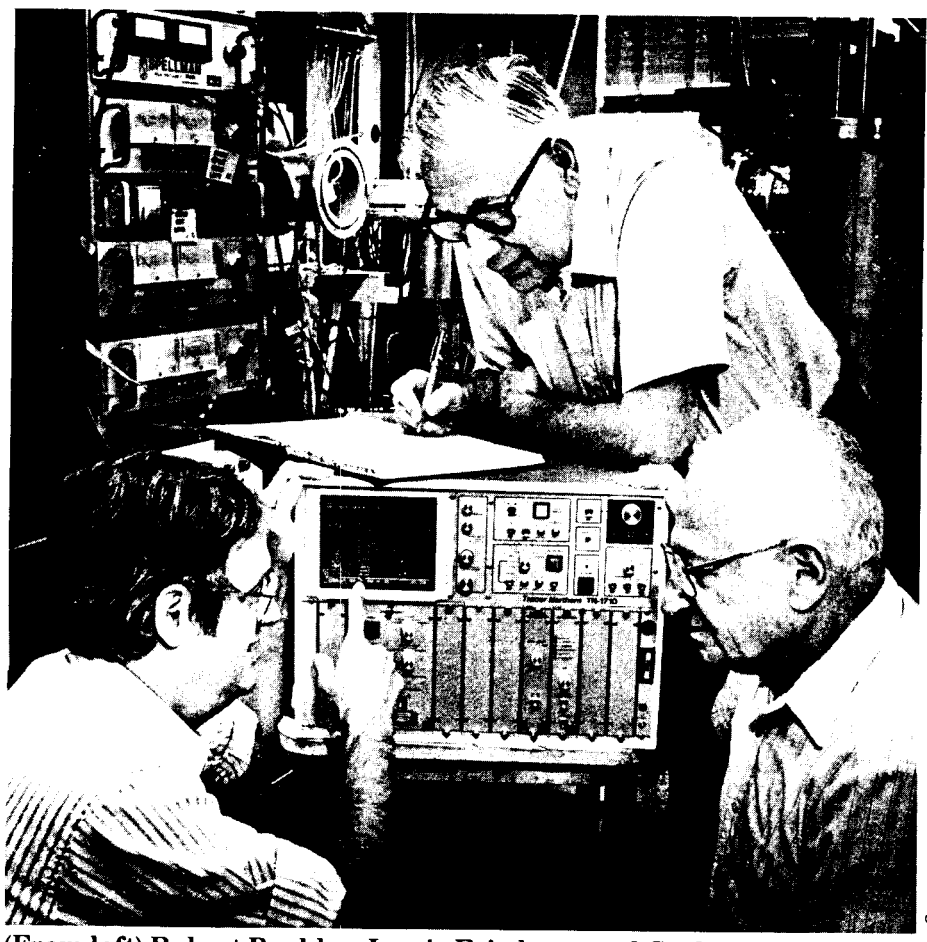
In contrast to the idea of cold fusion, cluster ion-induced fusion generates high temperatures and high pressures — surprisingly high, considering that, at the point of impact, each particle in a cluster ion carries a relatively low energy.

Cluster ions are charged, chemically bound groups of atoms that act as a single unit. So a cluster containing thousands of molecules can have a single charge shared between all of them. Thus, many cluster ions can travel in a beam without repelling each other too strongly.

In the Brookhaven experiments, a cluster-ion beam of heavy-water molecules, which contain deuterium, was directed at a solid target, containing deuterium. Among the targets used were titanium deuteride, zirconium deuteride and polydeuteroethylene. This was done at room temperature at energies ranging from 200 to 325 thousand electron volts (keV).

As Beuhler explained, "The target 'sees' an incoming cluster of 100 molecules of heavy water, not as a single entity with energy of 300 keV, but as 200 deuterium atoms, each at only 300 electron volts, and 100 oxygen atoms with the remainder of the energy."

Therefore, instead of the cluster projectile penetrating to a depth characteristic of a 300 keV atom, the smaller velocity of the cluster atoms generates a rather shallow depression that has a much larger cross-sectional area. In other words, in hitting the target, a cluster behaves, not like a nail piercing wood, but rather like the head of a hammer compressing the wood when the nail is missed.



Roger Stoutenburgh

(From left) Robert Beuhler, Lewis Friedman and Gerhart Friedlander observe the results of the impact of a cluster-ion beam of heavy water molecules on a deuterium-containing target. In the center of the oscilloscope screen is a peak representing three million-electron-volt protons resulting from the fusion of deuterons; the peak on the left represents tritons.

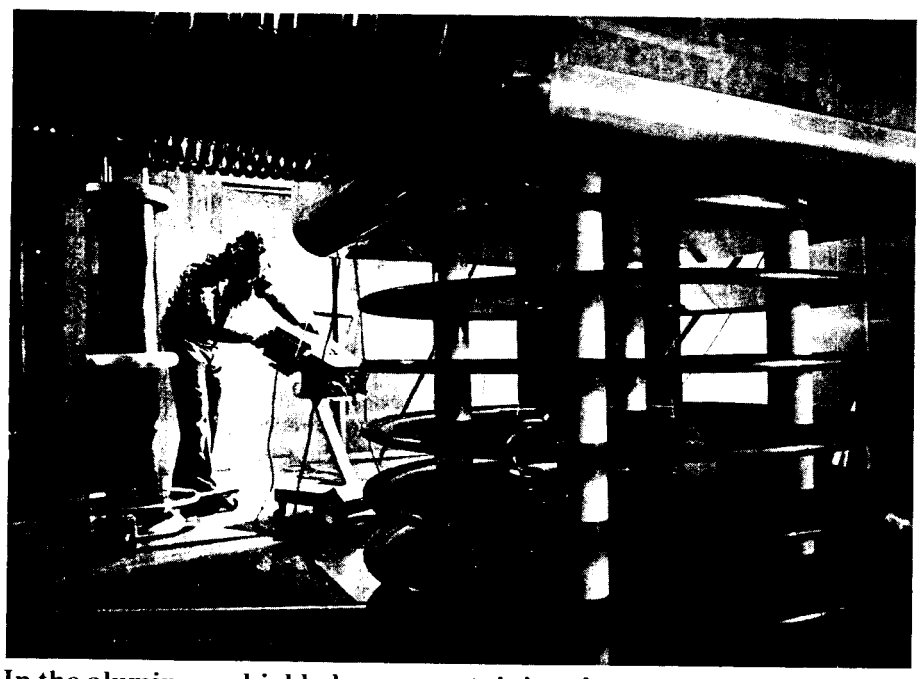
No Overnight Success

The background work for the experiments culminating in this discovery began over a dozen years ago. Said Friedman, "This was no overnight process — it took fifteen years of basic research on clusters and their properties. When we first saw the results in late April of this year, we were all pretty elated."

In this long-term effort, the team had expert technical support from Chemistry's Stephen Howell and Walter Kunnmann; and the Instrumentation Division's David Potter, who designed the electronics.

Though energy through fusion has been produced in the explosion of hydrogen bombs, scientists have yet to find a way of using fusion as a

(Continued on page 2)



Mort Rosen

In the aluminum-shielded room containing the apparatus used for the fusion-producing, cluster-ion impact experiments, Lewis Friedman checks data patterns on an oscilloscope.

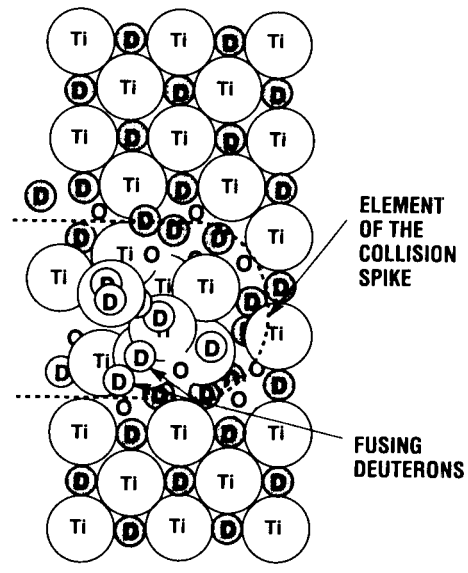
The D-D Fusion Reaction

To produce fusion in their laboratory, BNL chemists Robert Beuhler, Gerhart Friedlander and Lewis Friedman begin with a cluster-ion beam of heavy-water molecules. Each cluster contains a number of heavy-water molecules, each of which consists of two deuterium atoms (D) and an oxygen atom (O).

At an energy of between 200 and 325 thousand electron volts (keV), the cluster-ion beam is directed at a target containing deuterium, in this case titanium deuteride, in which titanium (Ti) and deuterium (D) atoms alternate.

The impact of each cluster on the target causes a depression in the Ti-D lattice and the merging of atoms from both the cluster and the target.

The energy lost as the incoming beam hits the target is transferred to the compressed region. This shock wave of energy creates high pressure and high temperature. The assembly of atoms within this environment is known collectively as a collision spike. Within the collision spike, fusion takes place as the deuterium nuclei (D), known as deuterons, react.



Whitey Caiazza

Artist's conception of an element of the collision spike.

Each deuteron consists of a positively charged proton (p) and a neutron (n), which has no charge. The fusion reaction has two important channels, both resulting from the jumble of the components of two deuterons:

First channel: D + D → p + pnn (triton)

Second channel: D + D → n + ppn (helium-3)

Each of these products would be expected to be observed traveling at a certain energy: 3 million electron volts (MeV) for protons, 1 MeV for tritons, 2.5 MeV for neutrons, and 0.8 MeV for helium-3. When researchers observe these reaction products at these rates and energies, they call them the "signatures" of fusion.

In their solid-state detector, the BNL scientists were able to collect the signatures of the charged products, observing the 3-MeV proton, the 1-MeV triton and the 0.8-MeV helium-3 signatures — convincing evidence that fusion had occurred.

— Anita Cohen

BNL Lecture: Boron Neutron Capture Therapy of Brain Tumors

After being diagnosed with the types of brain tumors known as malignant glioma or glioblastoma, patients have average residual life expectancies of only eight to 14 months — although this duration of survival seems to be increasing year by year as a variety of new therapies are brought to bear on the disease.

With the goal of improving these expectations and, ultimately, of eliminating such tumors altogether, some researchers at BNL and elsewhere have long focused on a technique called boron neutron capture therapy (BNCT).

As in much medical research, practically every step forward in this 38-year BNCT quest has required researchers to overcome stumbling blocks. The paths of this history and how they have led to present BNCT research at BNL will be discussed by pathologist Daniel Slatkin, Medical Department, the first speaker in the 1989-90 Brookhaven Lecture Series.

In the 254th Brookhaven Lecture, "Boron Neutron Capture Therapy of Brain Tumors," Slatkin will speak about why there is a need for improving brain tumor therapy and why BNCT may meet that need. His talk will begin at 4:30 p.m. on Thursday, September 21, in Berkner Hall. Slatkin will be introduced by Scientist Ralph Fairchild, Medical Department.

In experimental neutron capture therapy, a stable isotope of boron — boron-10 — is incorporated chemically into one of several molecules currently under study. When injected into the subject, the molecules transport boron-10 to the brain tumor, which accepts the boron-carrying molecule more readily than do normal brain tissues.

An external source of slow neutrons is then directed toward the head in the general area of the tumor. The slow neutron beam alone has relatively little effect on the irradiated tissues. However, because boron-10 has a high affinity for slow neutrons, it absorbs the slow neutrons and self-destructs — splitting in two and releasing its own radiation, enough to damage nearby cells.

Because boron-10-enriched compounds are expensive and because this procedure at present requires irradiation of the subject at a reactor, BNCT may not be practical for malignancies that can be treated effectively by more readily available forms of radiation therapy, such as gamma radiation. Slatkin believes that BNCT seems most suited for treating localized brain tumors such as malignant gliomas that are quite resistant to gamma radiation therapy.

That was also the thinking in 1951, when BNCT was pioneered during a collaboration between the Massachusetts General Hospital and BNL, using the Brookhaven Graphite Research Reactor (BGRR) to treat an initial group of ten brain tumor patients with what Slatkin calls "reasonable results." This was followed by a second series of experiments in the mid-1950s, in which the BNCT increased the average longevity of nine patients, but seriously damaged the skin in the irradiated zone.

This skin damage was largely avoided in the next therapeutic trial, later in the 50s, when the boron-bearing drug was injected into the carotid artery feeding the brain tumor, rather than intravenously. As Slatkin will recount, in part to meet the perceived need to repeat these irradiations in a shorter time interval

Roger Stoutenburgh

Daniel Slatkin

than was feasible at the BGRR, the Brookhaven Medical Research Reactor (BMRR) came on line in 1959. The fourth trial, the first at the BMRR, turned out to be a disappointment, although some patients responded remarkably well to the treatment.

What can be learned from the Brookhaven experience? Armed with the wisdom of hindsight and knowledge of subsequent BNCT research, Slatkin will review the reasoning that the early BNCT researchers used. He will take his audience across the same rocky path that BNL and other BNCT researchers have trod, showing the stumbling blocks as well as the open roads that have led to current studies.

He will describe how BNL scientists are now working with a newly developed epithermal neutron beam and newly synthesized boron-10 compound to overcome difficulties uncovered in previous trials of BNCT for brain tumors.

With these new tools for BNCT, the researchers will try to improve the outlook for patients who may have no alternative for cure, by drawing on procedures that they have already used successfully at Brookhaven in rats with malignant brain tumors — to greatly prolong the lives of the animals or to cure them. Slatkin will also describe Japanese efforts in this field that have led to at least one known long-term control, probably cure, of human glioblastoma.

Daniel Slatkin earned both his B.Sc. and his M.D. from McGill University in his native Montreal, in 1955 and 1959 respectively. He received postgraduate training in anatomic pathology and in biochemistry.

In 1973, Slatkin came to BNL as Attending Pathologist in the Hospital of the Medical Research Center. He has been Attending Pathologist and Scientific Supervisor of the Clinical Research Center's clinical laboratory since 1985. In 1988, Slatkin also became Associate Clinical Professor of Pediatrics and Neurological Surgery at the the Albert Einstein College in the Bronx.

Slatkin is a diplomate of the American Board of Pathology in anatomic pathology. He is a member of the New York Academy of Sciences, the Radiation Research Society, the American Association of Pathologists and the International Society for Neutron Capture Therapy.

After the lecture those attending are invited to join the speaker for discussion and hors d'oeuvres. In addition, anyone interested in joining the lecturer for dinner at a restaurant off site should call Naomi Pappas, Ext. 3699.

BNL Discovery of Cluster Fusion (cont'd)

peaceful research or energy source. "What is needed," said Friedlander, "is a micro-explosion technique that can be contained without destroying the container."

Until now, the scientific community's search for this "micro-explosion technique" has proceeded along two pathways. One is magnetic confinement, in which the nuclei are trapped in a magnetic field until they fuse; researchers have long tried to do this in large and complex devices called tokamaks. The other is inertial confinement, in which small spheres containing deuterium and tritium are bombarded with laser light or particles.

Cluster ions offer a promising new approach. In repeated experiments, the cluster beam hit a target, heating and compressing it enormously at the point of impact — for fractions of a trillionth of a second. And particles shot out at about 3 MeV.

Charged Products Observed

Said Friedlander, "We measured the particles' energy in a solid-state detector and proved them to be 3-MeV protons — one of the four expected products of fusion. We clearly observed the other two expected charged products — tritium, and helium-3. Neutrons, which have no charge, are not observable with this detector."

"However," Friedman added, "a 3-MeV proton, a 1-MeV triton and a slightly lower energy helium-3 together are conclusive evidence that fusion is taking place."

Still, the experimentalists viewed their result skeptically at first. So they followed up with several different critical experiments. In one important set of tests, they searched for the presence of beam impurities, which could have produced the results they had observed. The tests showed that only the clusters could have been responsible for the fusion events.

Of their success, Friedman said, "This is a unique and unusual energy transfer process, something we don't fully understand. We were like prospectors during the Gold Rush. We started with enough information to point the way, but not enough to tell us whether we would find gold by digging in a particular spot."

To Break Through the Barrier

What the three chemists did know is that, in the fusion process, the atomic nuclei are positively charged and repel each other in what is called a Coulomb repulsion. A barrier of about 1 MeV exists between the nuclei, holding them apart.

But, since deuterium nuclei have wave as well as particle properties, they can occasionally leak, or tunnel, through the barrier. This ability is related to the distance separating them. So, if the atoms are compressed and the distance separating them is shortened, they will more readily penetrate the barrier and cause fusion.

Roger Stoutenburgh

Gerhart Friedlander (left) and Lewis Friedman

Roger Stoutenburgh

Robert Beuhler holds the target assembly, which, during a cluster-ion impact experiment, is inserted in the vacuum chamber behind him. The cluster-ion beam enters the chamber from the hole on the bottom of the assembly and hits the target, which is angled at 45 degrees to the beam. The solid-state detector, which records the energetic particles produced in the fusion reaction, is shown to the left of the target.

In the conventional approach to inertial compression, in order to heat and squeeze the deuterium, a small sphere containing deuterium is bombarded from all directions with projectiles such as laser light.

Alfred Mashke, while on the BNL staff in the early 1980s, was one of the first to propose heavy atomic ions as projectiles to induce fusion by heating a deuterium-containing target. A major difficulty in this approach, however, is that the individual ions' charges repel each other so strongly that it is difficult to focus a beam of sufficient intensity.

The Cluster Advantage

Friedman and Beuhler realized that the answer to the charge repulsion might lie in cluster ions. Since a cluster containing thousands of molecules can share a single charge, many cluster atoms can travel in a beam without repelling each other too strongly — unlike heavy ions.

The researchers spent five years investigating this field and were awarded two patents while gaining an extremely specialized knowledge of how to make clusters of almost any chosen size and how to accelerate them to a chosen speed.

Their research also showed that certain properties of clusters allow them to transfer energy in a very efficient way for igniting fusion reactions.

Much Work Ahead

While the recent set of experiments have successfully demonstrated fusion reactions at surprisingly low energy, much research remains to be done before it can be known whether this method leads to useful energy production.

The three chemists have planned a program of further exploration to be carried out during the coming months with the much higher energies available at the 750-keV Cockcroft-Walton at BNL's Alternating Gradient Synchrotron and at the Lab's Tandem Van de Graaff Accelerator.

Concludes Friedman, "These cluster ion-induced fusion reactions are a new scientific tool. This is likely to stimulate a lot of theoretical work, because we've discovered a phenomenon we don't fully understand. And the special properties of cluster ions will be a valuable aid in studying processes taking place at very high transient pressures and energy densities. That's more than enough for any researcher — but if they also lead to a new energy source, that would be tremendously exciting."

— Anita Cohen and Liz Seubert

Note to Employees:

Attendance at lectures, meetings and other special programs held during normal working hours is subject to supervisory concurrence.

Exhibit Extended

The on-site exhibition of *Standard Model (Abandoned)*, a 40-foot-long, steel and glass sculptural installation, has been extended through Saturday, September 23. You can view the artwork by Stephen Rueckert at the Collider Center, Bldg. 1005S, Wednesdays, Thursdays and Fridays through September 22, from 11 a.m. to 2 p.m., and Saturdays, September 16 and 23, from 11 a.m. to 4 p.m.

PSI Meeting

"Tying Up Loose Ends" will be discussed by Katherine McDermott, fashion coordinator with Passeport Boutique, at the next monthly meeting of the Upton Chapter of Professional Secretaries International (PSI), on Thursday, September 21, at 6 p.m., in Berkner Hall, Room A.

McDermott will demonstrate how to wear scarves and jewelry, including scarf clips, to update and enhance a wardrobe quickly and inexpensively.

Equipment Demo

The following product lines represented by Jones & Auerbacher, Inc., will be on display in Berkner Hall on Thursday, September 21, from 10 a.m. to 3 p.m.:

- Imperial Eastman — instrumentation valves, tube fittings, tubing tools and plastic tubing.
- ASCO — solenoid valves, and pressure and temperature switches.
- WIKA — pressure gauges in brass and stainless steel, and test gauges.
- Snap-Tite — quick disconnect couplings.

ANS Meeting

"Radiation Oncology in the Multimodal Management of Cancer" will be discussed by Allen Meek at the next dinner meeting of the Long Island Section of the American Nuclear Society (ANS), on Wednesday, September 27.

Meek is the chairman of the Department of Radiation Oncology, School of Medicine, State University of New York at Stony Brook, and he has spearheaded the collaboration between BNL and Stony Brook to construct a linear electron accelerator at Brookhaven for the treatment of cancer. His talk will include a brief history of the application of radiation therapy, followed by a specific description of its use in the management of breast and prostate cancer.

Meek will be introduced for his 8 p.m. talk by Herbert Susskind of BNL's Medical Department.

The meeting will be held at the Bavarian Inn, Lake Ronkonkoma. The talk will be preceded by cocktails at 6 p.m and a buffet dinner at 7 p.m. For more information or to make reservations, call Ellie Mitchell, Ext. 7328, by Friday, September 22. Nonmembers are also welcome.

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Dine! Dance! Watch a Show!

Don't forget to buy your tickets for the BERA Special Event — a gala evening of fashion show, dinner, theater and dancing to an oldies band or dee-jay music, on Saturday, October 21, in Berkner Hall. Tickets are $27.50 per person, on sale on a first-come, first-served basis from 11 a.m. to 1 p.m., Thursdays and Fridays in the Cafeteria.

More information can be obtained from BERA Special Events Committee chair Rosalie Piccione, Ext. 3160, or member Betty Pergan, Ext. 2937.

English Classes To Be Held on Site

Classroom instruction in English as a second language is available on-site to Laboratory employees, guests and their spouses. Registration will be held on Tuesday, September 19, at 7 p.m. in the Personnel Training Room, Bldg. 459.

At the recommendation of the instructor, participants will be enrolled in either a beginner or intermediate class. Beginners will meet on Saturday mornings at 9 a.m. Intermediate classes will be held on Tuesday evenings at 7 p.m. Classes are free and will emphasize conversational English, with some instruction in grammar and written language.

Vistors Tour Lab In Record Numbers

Over the eight days of this year's Summer Sunday Tour Program, 8,440 people flocked to BNL — almost double the number who came last summer — and the Exhibit Center/Science Museum and Berkner Hall were almost filled to capacity.

Janet Tempel, head of the Tour Program in the Public Affairs Office, attributed the increased attendence to the "Whiz-Bang Physics Show," which was on the summer schedule for the first time this year. This educational and entertaining program presented by local classroom teachers Christopher Ryon, Fred Sawicki and Clayton Hudson was such a hit that Tempel plans to bring it back for another run next summer.

Volleyball News

The first Volleyball League captains' meeting will be held on Wednesday, September 20, at noon, in Room 300, third floor, Chemistry, Bldg. 555. General organization of the leagues will take place at this time.

For teams to enter, their representatives must attend the meeting and submit preliminary rosters. Roster sheets will be sent to last year's captains. To form a new team, or if you wish to play but do not have a team, contact Kathi Barkigia, Ext. 7661, or Karen Savino, Ext. 3513.

Look! Limericks!

'Twas Upton, with soldiers encamped in,
A little northwest of Westhampton,
Became (legends tell)
Our own BNL
With many a theory revamped in.
— Morris Strongson
Computing & Communications

AGS, SSC or RHIC
Are just some of the letters to pick.
If in doubt, you can shout,
"What's BNL all about?"
And a scientist answers you quick!
— Cindy Morgan
Alternating Gradient Synchrotron

Keep Those Cans and Boxes Coming!

Roger Stoutenburgh

August was another good month for the BNL Food Drive, with 1,500 pounds collected for needy residents of Brookhaven Town. Helping Food Drive Chair Carole Kerr (back, center) with last month's collection were members of the Supply & Materiel Division: (back, from left) Jerry Quigley, Bob DiLello; (front, from left) David Woodson and Ganga Ghimiray. They'd like to collect even more this month, so don't forget to bring in your donations during the September Food Drive next week. If you cannot shop yourself but would like to contribute, you may send a donation to Kerr, Bldg. 490, Ext. 7100. When your shopping is done, you'll get a receipt.

Jennings to Speak At BWIS Meeting

Glenn Jennings, Assistant to the Director for Affirmative Action, will be the guest speaker at the next Brookhaven Women in Science (BWIS) luncheon meeting. He will talk about "Building Alliances: Women and Minorities," on Monday, September 18, in Room A, Berkner Hall, at noon.

Elections of officers for fiscal year 1990 will be held at this meeting.

On Sale Now: Islander Tickets

Tickets for the New York Islander preseason home games are on sale *now* at the BERA Sales Office in Berkner Hall, at the price of two-for-one. There will be four preseason games — the first on Sunday, September 17, against the N.Y. Rangers.

Tickets for the regular season home games will go on sale Thursday, October 5, at 8 a.m. in the BERA Sales Office. A complete schedule is there today and will be published in a future edition of the Bulletin.

Microcomputer Club

Ralph Fullwood of the Department of Nuclear Energy will give an introduction to the subject of desktop publishing at the next meeting of the BNL Microcomputer Club. The meeting will take place at noon on Thursday, September 21, in the main conference room, Bldg. 475. All are invited to attend; bring your lunch if you wish. For more information, contact Frank Salzano, Ext. 4458.

BERA Needs Lifeguard

A lifeguard for the BERA swimming pool is needed between the hours of 10:30 a.m. to 2:30 p.m., Monday through Friday. Red Cross certification is required. Interested applicants should call M. Kay Dellimore, Ext. 2873, for an application or further information.

Cafeteria Menu

Monday, September 18		
Soup: Lentil	(cup)	.75
	(bowl)	.95
BBQ chicken w/pot. or veg.		3.10
Stir-fried beef Oriental		3.10
Lite-line: Broiled chicken w/pot. or veg.		3.10
Hot deli: Grilled ham & assorted cheeses on a tortilla		2.85
Tuesday, September 19		
Soup: Tomato beef	(cup)	.75
	(bowl)	.95
Chicken breast Florentine w/pot.		3.10
Crab cakes & linguini		3.10
Lite-line: Sliced melon w/cottage cheese		2.85
Hot deli: Veal Parmesan hero		3.10
Wednesday, September 20		
Soup: Sauerkraut	(cup)	.75
	(bowl)	.95
Turkey burritos over rice		3.10
Veal scaloppini w/pot. or veg.		3.10
Lite-line: Cucumber tuna boat		3.10
Hot deli: Hungry-man bologna & cheese hero		2.85
Thursday, September 21		
Soup: Cream of chicken	(cup)	.75
	(bowl)	.95
Jumbo Swedish meatballs over egg noodles		3.10
Choice of assorted fish fillets w/pot. or veg.		3.10
Lite-line: Taco salad		3.10
Hot deli: Pastrami		2.85
Friday, September 22		
Soup: Deluxe Manhattan clam chowder	(cup)	.75
	(bowl)	.95
Peel-n-eat shrimp w/pot. or veg.		3.10
Lasagna w/garlic bread		3.10
Lite-line: Broiled white fish w/pot or veg.		3.10
Hot deli: Double-decker patty melts		3.10

Softball Dinner

The Softball dinner will take place on Friday, September 29, at the Rock Hill Golf & Country Club from 6:30 to 11:30 p.m. Tickets are $15 each for all attending. They must be ordered by Friday, September 22, through team captains, who will purchase the tickets through their league representatives.

Bowling

White League

High games were bowled by Ken Riker 213, John Niemczyk 209, Mary Addessi 191, Caryl MacDougall 191/184; Gerry Riker 183.

Purple League

Terry Strelecki had a 193, Gail Schuman 184, Karen Vogel 180, Ellie Adams 180.

Red/Green League

K. Riker had a 223, R. Mulderig 222; P. Ouvrard 215, N. Parrinello 214, M. Guacci 212, W. Kristiansen 210, N. Combatti 203, J. Morris 202.

Arrivals & Departures

Arrivals

David M. Atwood .....Physics
Joseph A. Hriljac .....Physics
Igor J. Malik .....Chemistry
Jialin Xie .....NSLS

Departures

This list includes all employees who have terminated from the Laboratory, including retirees:

Robert R. Mele .....Plant Eng.
Charles J. Sirico .....Reactor

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 and/or appropriate bargaining unit, with preference to those within the immediate work group; (2) present employees within the Laboratory as a whole; and (3) outside applicants. In keeping with the Affirmative Action plan, selection decisions are made without regard to age, race, color, religion, national origin, sex, handicap or veteran status.

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.

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 Employment Manager, Ext. 2882.

The vacancies listed below have been exempted by the Director's Office from the current freeze on open requisitions.

LABORATORY RECRUITMENT - Opportunities for Laboratory employees only.

4103. TECHNICAL POSITION - Requires an AAS in electronic technology or equivalent and two to four years' experience troubleshooting electronic equipment to the component level. Responsibilities will include the maintenance and calibration of various radiation detection and environmental monitoring instruments. Safety and Environmental Protection Division.

OPEN RECRUITMENT - Opportunities for Laboratory employees and outside applicants.

4104. SCIENTIFIC ASSOCIATE POSITION - Requires BS/MS in chemistry with knowledge of HPLC, NMR and bio-organic chemistry. Will synthesize tungstate and gold clusters for use in scanning transmission electron microscopy (STEM) and medical applications. Biology Department.

Motor Vehicles & Supplies

89 TRANS AM GTA - 500 mi., flame red, every option, T-top, leather interior, showroom cond., must sell. Bob, 331-2136.

87 OLDS CALAIS - a/t, p/s, p/b, tilt wheel, am/fm cass., power antenna, wire wheels, a/c, red, mint cond., $7,000. 475-2271.

87 MITSUBISHI CONQUEST - turbo, 30k mi., Technica package, 5-spd., silver/burgundy leather int., $9,200. 467-5978 eves. & wknds.

87 TOPAZ GS - 2-dr., 5-spd., p/s, p/b, a/c, p/w, stereo, 27.5k mi., 5 yr. warranty, mint cond., $5,500. Ext. 5143 or 474-1482 eves.

86 OLDSMOBILE - 6-cyl., all power, excel. cond., $5,900. JoAnn, Ext. 4120 or 689-7963.

86 CHEVY SPRINT - 2-dr., 5-spd., body damage, best offer over $500. Joe, pager 0925 or 728-1859 eves.

85 FORD BRONCO II XLS - loaded, 54k mi., excel. cond., $10,000. Ext. 2926 or 281-0268.

85 CHEVY CELEBRITY - 4-dr., p/s, am/fm, 74k mi., clean, very good cond., must see to appreciate, $3,300. Joe, 447-9677.

85 NISSAN 300ZX - 2+2, 41k mi., warranteed to 55k, digital, T-top, excel. cond., $9,500. Sue, Ext. 7235, 395-3529, or Peter, 281-7035, message.

84 EAGLE - 4+4, 4-dr. wagon, a/t, p/s, a/c, am/fm cass., 42k mi., $4,900. 473-2473.

84 OLDS OMEGA - 65k mi., 2-dr., p/s, p/b, a/c, am/fm cass., good cond., $3,500. Jim, Ext. 4606 or 654-5049 after 6 p.m.

84 FORD TEMPO - a/c, p/s, am/fm stereo, 68k mi., very good cond., asking $2,400. Ext. 3222.

84 FORD LTD - V-6, 68k mi., 4-dr., gray, p/s, p/b, tilt, am/fm cass., a/c, cruise, good cond., moving, $3,200. Ext. 4795.

84 OLDS CIERA - 4-cyl. sedan, 52k mi., loaded, very good cond., warranteed to Jan. 1990, moving, $3,300. Tom, Ext. 3531.

84 SUZUKI RM250 DIRT BIKE - new parts, hardly used, never raced, beautiful cond. Glenn, Ext. 4612.

84 CHEVY CAVALIER - clean in & out, runs well, needs pressure plate, asking $800. Phil, 744-5079.

84 VW RABBIT - 62.5k mi., a/c, sunroof, very good cond., $3,200. Pat, Ext. 2880 or 399-1679 eves.

83 PONTIAC - p/s, p/b, a/s, a/c, 78k mi., sporty, good cond., asking $2,800. Xuan, Ext. 3677.

82 TOYOTA TERCEL - 2-dr. sedan, 4-spd., fwd, blue, very good cond., $1,600. Ext. 2733 or 878-8491.

80 BLAZER - 70k orig. mi., red & white, no rust, p/s, p/b, a/t, a/c, centerlines, excel. cond., asking $6,500 or best offer. 289-4732.

79 DODGE ST. REGIS - new brakes, muffler, 68k orig. mi., $1,500 or best offer. Ext. 4162 or 345-3060.

79 TOYOTA LAND CRUISER - good for parts, $45. Paul, 689-2829.

79 DODGE TRUCK - stepside, 6-cyl., a/t, excel. mech. cond., very reliable, good work truck, $750. Glenn, Ext. 4612.

79 FORD BRONCO - 84k mi., needs p/s box, many new parts, good cond., $3,000. Neal, 286-2435.

78 MERCEDES 240D - very good running cond., needs body work, $2,000. Ext. 4162 or 345-3060.

78 HONDA CR-125 - new boot-gasket kickstarter, left side plate, good cond., $399. 281-7935.

78 GMC TRUCK - 4x4, 350 c.i., 4-spd., w/7½' Meyers power-angle plow, runs well, needs body work, asking $2,500. Steve, 744-8422.

78 CADILLAC ELDORADO CLASSIC - mint, triple white, low mi., orig. owner, garaged since new, $3,395. 423-2327.

77 OLDS CUTLASS - p/s, p/b, a/t, a/c, runs well, $525. Morris, Ext. 4192.

77 VW RABBIT - needs work, $50. Ext. 5012.

77 FORD PINTO - 4-cyl., a/t, p/s, p/b, body good cond., mech. sound, needs exhaust, tires, good cond., $300. Tim, Ext. 3496.

77 PONTIAC FIREBIRD BE400 - TH350 posi, rear, mech. sound, very fast, all additional parts included, asking, $4,500. Tim Jochen, 281-7873.

77 TOYOTA CORONA - rusty but many good parts, 4 new tires, $200. 878-2040 after 6 p.m.

77 OLDS - new tires, am/fm, 8-cyl., all power, runs well, $200. Ken, 395-6235.

76 DODGE DART - 6-cyl., it runs, $50; '62 Olds F-85, doesn't run, free. 928-5684 eves.

76 FORD GRANADA - runs well, $555. Michael, Ext. 3790.

76 TOYOTA CORONA - reliable old high-miler, good station car, great for hauling, new brakes, clutch, $50. Paul, Ext. 7697 or 689-2829.

75 MALIBU - 8-cyl., p/s, p/b, runs well, $550. JoAnne, 981-0048 after 5 p.m.

75 F-250 PICKUP - 4wd, rebuilt a/t, new alternator, battery & regulator, best offer. 369-0517.

69 VOLVO 1800S - sports car, red/black int., dual carb., 4-spd., w/O.D., good cond., $2,500. 924-6619.

65 MUSTANG - for parts. 727-0082 after 7 p.m.

AIR-FLOW BOX - Nissan, for fuel injected cars, paid $450, will neg. Janet, Ext. 2345.

VOLVO RIMS - two 15", $20. Bill, Ext. 3369 or 929-6442.

ENGINE - 350 cu. in., out of car, runs well, $200 neg. Ken, 395-6235.

SUNLINE TRAVEL TRAILER - 21', 1979, sleeps 6, new tires, battery & brakes, excel. cond., $4,300 neg. Artie, Ext. 4987 or 325-0743 eves.

Boats & Marine Supplies

29' ULRICHSON - flybridge, FWC, 327, runs well, sleeps 5, galley w/range & oven, elec. head, refrig., excel. cond., must sell, $3,500. Jack, 732-2754.

28' SLOOP KIT - 90% completed, dark blue hull, Holman & Pye design, solidly built, sacrifice, $18,000. Jim, Ext. 4584.

22' TYLERCRAFT SLOOP - c/b, 2 suits of sails + furling jib, 6-h.p. Evin., sleeps 4, in water, $2,300 neg. Sue, Ext. 7235, 395-3529 or Pete, 281-7035.

22' U.S. YACHT - 1983, well equipped for cruising, sleeps 4+, can sail single handed, excel. cond., $5,990 neg. Bernie, Ext. 4842.

21' BAYLINER - 1984, Trophy, 125-h.p. Volvo, swim platform, s/s rod holders, extras, excel. cond., moored in Port Jeff. Donna, 928-2076.

17' SAF-T-MAKE BOAT - fiberglass, 1976, 80-h.p. Mercury engine, galvanized trailer, $800. 698-6436.

17' MFG BOWRIDER - 115-h.p. Evinrude, Teenee trailer, extras, in water, $2,900. Joe, Ext. 2975.

Furnishings & Appliances

REFRIGERATOR - Westinghouse, side-by-side, 25 cu. ft., excel. cond., $200 firm. Lenny, Ext. 4467.

DISHES - Stoneware, beige/brown casual classic design, ovenproof, service for 6, extra pieces, $35. 286-0295.

LADDER-BACK CHAIRS - 6, stripped & caned; Gibson upright freezer; Singer sewing machine, in cabinet, excel. cond. 363-7032.

CORDLESS IRON - Westbend, orig. $50, sell for $20. Pete, 399-2813 after 5 p.m.

DORM FURNITURE - end table, $10; walnut storage hamper, $20; 36" lamp, $18; walnut chair, $20, TV stand, $20. Kathy, 744-2203.

LIVING ROOM FURNITURE - sofa, taupe, contemporary, 3 piece, loveseat, armchair, 2 months old. Ext. 3793.

BEDROOM SET - double bed, triple dresser, night stand, mirror, oak, $600. Gerry, Ext. 2924 or 281-8296.

MATTRESS - & boxspring, Stearns & Foster, twin, excel. cond., $150. Susan, Ext. 7716.

RECLINER - Lazy Boy, rust, good cond., $75. Ext. 3309.

MOVING - bunk bed; dresser; dining room table w/4 chairs, 2 loveseats; sewing machine; BMX bike; pool table, much more. 399-1868.

SOFA SLEEPER - & chair, $125; sofa & chair, $100; twin bed w/drawers & desk, $125. 924-7916.

OAK CHAIRS - 4, $15/each; couch, loveseat & chair, Colonial style, very good cond., $250. A. Lopez, Ext. 5768.

REFRIGERATOR - 4.2 cu. ft., great for student use in dorm, $80. Larry, Ext. 4295.

KITCHEN TABLE - yellow formica, 6 chairs, extra leaf, good cond., $25. 475-4891.

BEDROOM SET - 5-piece, Paul Bunyan, dark pine, 4-poster bed, excel. cond., like new. Nancy, Ext. 3309.

CARPET - nylon, orange, 11' x 10', $25. Bill, Ext. 3369.

Tools, House & Garden

TOP SOIL - fine, screened, delivered, 5-yard min., $20/per yard, also sand & gravel, delivered. 696-6011.

STORM DOORS - one 32⅜" x 79½", one 30¼" x 79½", $25/each. Bill, 472-4684.

LAWN SWEEPER - Lambert Libra, model MT-319, 31", good cond., $50. Rick, Ext. 3932.

KEROSENE HEATER - Sears, 22,000 Btu, used twice, $50; oxygen & acetylene tanks w/cart, $125; snow plow, asking $500. 474-5715.

BULLDOZER - Allis Chalmer H-3 w/attach. for trailer, very good cond., $6,500. 654-1350.

Sports, Hobbies & Pets

VIOLINS - ¾ German, $270; ⅛ Suzuki, $100, both very good cond. Ext. 7687 or 744-1112.

TREADMILL - new, manual, must sell, $50. Donna, 331-7873.

PIANO - Lester Betsy Ross, spinet, excel. cond., w/bench, $700. Tony, Ext. 3658 or 929-4903 after 6 p.m.

COCKATIELS - 6 weeks old, hand fed, adorable, must see. 472-9772.

VIOLIN - full size, 1912 German Imperial Amati-style, carved scroll, new bow & case, very good cond., $650. 751-5868.

GOLDEN RETRIEVER PUPS - 7 weeks old, parents both AKC registered, papers for pups on the way, $200. Tirre, 281-0360.

GOLF LH PUTTER - Slotline, like new, orig. $70, sell for $20. Tony Monte, Ext. 2050.

SKI BOOTS - size 3, Raichle, used 3 times, $30. Joe, Ext. 4139.

GOLF TRAVEL BAG - Spaulding, new, never used, red, $20. Pat, Ext. 2452.

SKIIS - 190cm, Dynamis UR27 w/Salomon 747 bindings, $75 or best offer; Nordica & Koflach boots, make offer. Ext. 2914 or 286-3742.

COCKATIELS - 2, $30/pair; Radio Shack TR-80 computer, w/games, $75. 281-7935.

DRYSUIT - Poseidon, man's large, like new, must sell, asking $500. 474-5715.

BIKE - Schwinn, 20", pink & white, excel. cond., $65. Paul, Ext. 4156.

Audio, Video & Computer

COLOR TV - Panasonic, 13"; Sony TV, 17"; Sony R7 stereo, am/fm. Ext. 4162 or 345-3060.

COMPACT DISC PLAYER - Sony CDP 310, single disc w/remote control, $100. Karl, Ext. 7977.

STEREO - Sony HP510 compact stereo, wood cabinet, turntable built into top, works very well, $125. Jim, Ext. 4584.

Miscellaneous

JACKET - blue fox, size medium, hardly worn, $225 neg. Lisa, Ext. 2276.

BABY CARRIAGE/COACH - $25; wicker dressing table, white, 3 drawers, $20, both good cond.; GE Space Maker coffee maker, $15. 281-7935.

CLOTHES - fall maternity clothes, size 10-14, very cheap. Miriam, 744-8868.

BABY CLOTHES - playpen, $19; walker, never used, $12; swing, $15. Annie, 331-7350.

BABY CRIB - & car seat; rocking chair. Ext. 4162 or 345-3060.

DOLLS - vinyl "Classical Children" by Hildergard Günzel, porcelain "Collectibles" by Phyllis Parkins, Cassandra, Butterfly Babies. 286-3623.

Free

PUPPIES - 7 weeks old; mother, Golden Retriever, father unknown, all black.

MERCEDES PARTS - 1967 200D diesel, extra engine parts, extra other parts. Cadwell, Ext. 2934 or 744-2816.

Real Estate

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

For Rent

BELLPORT - 3-bdrm. furn. ranch, l/r, d/r, eik, 2 baths, den, gar., bsmt., avail. immed., $1,100/mo. + util., 1 mo. sec. Fred, Ext. 3155.

BELLPORT VILLAGE - South, charming, secluded home, steps to golf & tennis, French doors, decks, outside hot tub, furnished, $1,200 + util. Susan, Ext. 2888 or 286-0422.

MEDFORD - room w/priv. ent., bath, single person, no pets, nonsmoker, utils. included. 475-7250.

MEDFORD - l/r, bdrm., kitch., full bath, no children, no pets, nonsmoker, priv. ent., prof. couple preferred, $650/mo. + one mo. sec. 475-7250.

NORTH PATCHOGUE - 1-bdrm. apt., 1st floor, patio, carpet, cable, quiet, single person, $600 all. 654-5607.

EAST SETAUKET - room, priv. ent., bath, prof., nonsmoker, $75/wk. incl. util. 689-9234.

SHIRLEY - 4-bdrm. Colonial, igp, gar., bsmt., fdr, eik, fam. rm., den, woodburning stove, $1,300/mo., $400/bdrm. 399-1868.

SHIRLEY - 1-bdrm. apt., l/r, eik, full bath, w/w, for single working adult, no pets, $575 + sec., incl. utilities, avail. 10/1. 281-1840 after 6 p.m.

STONY BROOK - studio, full bath, kitchen/bdrm. combo, priv. ent., separate heat & a/c, w/w, $600/mo. incl. all, sec. required. Mitch, Ext. 4561 or 751-8873.

STONY BROOK - 1-bdrm. upper level, priv. ent., avail. Nov. 1st, $675 includes all. John, Ext. 4120 or 689-7963.

YAPHANK - restored Victorian house, large, treed property, 4-bdrms., 10 min. to Lab, avail. Oct. 1, $950/mo. 924-4872, 924-3066 or Ext. 4342.

HILTON HEAD, SC - 2-bdrm. condo, sleeps 6, 2 baths, tennis, golf, beach, pool, Sept. & Oct. openings, $425/wk. Guy, Ext. 3147.

For Sale

MASTIC - 3-bdrm. ranch, ¼ acre, 1½ baths, den, fin. bsmt., deck, appl., house fan, 3 ceiling fans, shed, fence, near school, shopping, 15 min. to Lab, ask. $115,000. 265-2366 after 6 p.m. wknds.

MASTIC BEACH - 3-bdrm. ranch w/detached gar., Florida rm., f/p, 80'x100', low taxes, alum. siding, full financing avail., $94,900. Sue, Ext. 7235 or 395-3529.

MIDDLE ISLAND - Lake Pointe, 2-bdrm., cac, gas heat, l/r-d/r combo, wood deck off master bdrm., tennis, pool, clubhouse, asking $81,000, neg. Bob, 924-7316.

MIDDLE ISLAND - Coventry Manor, 3-bdrm. townhouse, 2 baths, kit., l/r, d/r, laundry rm., 5 app., cac, pool, tennis, encl. patio, $106,000. Rosalie, Ext. 3160 or 289-5704 after 5:30 p.m.

MIDDLE ISLAND - 3-bdrm. ranch, 18'x24' great room, l/r w/fp, d/r, eik, 1½ baths, skylights, i/g pool, sprinklers, deck, more, 5 min. to Lab, mint, $152,900. 924-8426 eves.

PORT JEFFERSON - 4-bdrm. Colonial, full bsmt., 2-car gar., 2 baths, cac, all oak floors, walk to harbor, village, mint cond., priced to sell. 474-1482 eves.

ROCKY POINT - 3-bdrm. high ranch, l/r w/brick fp, cath. ceiling, d/r, large kit., 2 baths, bsmt., cac, deck, 2-car gar. w/elec. doors, beach rights, 0.34 acre, $162,900. Kochman, 744-1057.

ROCKY POINT - 4-bdrm. cape, l/r, large eik, 1 bath, new appl., wood floors, full bsmt., new cedar siding, deck, 100x100 lot, beach rights, $129,990, eves., after 7 p.m. Jay 369-8374.

SHIRLEY - 4-bdrm. Colonial, igp, gar., bsmt., fdr, eik, f/r, woodburning stove, fenced, $150,000. 399-1868.

SHIRLEY - 3-bdrm. cape, a/g pool, ¼ acre, 2 full baths, bsmt., l/r, d/r, kitchen, ceiling fans, etc., $113,500 neg., principals only. Nelly, 399-6151, leave message.

HOLIDAY, FL - Sandpiper, 3-bdrm., 2 baths, 1½ car gar., sprinkler, corner lot, cathedral ceilings, clubhouse facilities, close to beach, shopping, asking $76,900. 474-5715.

MADERIA BEACH, FL - 1 week timeshare in Commodore Beach Club, pool, Gulf view, jacuzzi, sleeps 4 adults, asking $5,000. 474-5715.

ST. CROIX, U.S., VI - ½ acre, undeveloped, mountain view, cleared, $75,000; studio condo, water view, furn., new paint. floors, asking $52,000. Ext. 2816 or 878-0480, leave message.

Yard & Garage Sales

WADING RIVER - Sept. 16 & 17, 9-3, 40 years' accumulation, multi-family, tools, antiques, priced to go, Overlook Drive. 929-4688.

Lost & Found

FOUND - 20-Year BNL gold pencil. Contact E.W. Grohse, Ext. 3451, Vera Meier, Ext. 5064.

FOUND - black case w/prescription glasses in Bldg. 475B. Kay, Ext. 2873.

FOUND - pin in Exhibit Center. Ext. 2345.

Wanted

STUDIO APT. - to rent within 10 miles of BNL for 1-2 years. Ext. 3583.

HOUSEMATE - to share 3 bdrm. furn. house in Mastic Beach, w/absent tenant, 15 min. from Lab, $480. Daniel, 281-4372.

TRAINS - Lionel & American Flyer & accessories, top dollar paid. Carole, Ext. 7100.

OUTBOARD - 10-15 h.p. in good cond., can be older model, prefer Johnson/Evinrude. Paul, 689-2829.

BICYCLE RIDERS - noon-time training rides, 18-20 m.p.h. for 12 miles, leave from Bldg. 701. Joe, Ext. 5131.

PORTABLE TYPEWRITER - manual or electric, reasonable. Barbara, Ext. 5165.

BABYSITTER - p/t to care for 1-yr.-old, my home, experienced & reliable. 878-4724.

ROOMMATE - to share 2-bdrm. house in Sound Beach, 12 miles to Lab, security, refs. Bob, 821-2875.

BILLIARD PLAYERS - interested in forming BERA club, both male and female. Ext. 7874.

ROOM-SIZE CARPET - free, will pick up. Ernie, Ext.. 3357.

STEREO COMPONENTS - old, tubed Marantz or Mcintosh, working or not. Jim, Ext. 4584.

BABYSITTER - needed on site during aerobic classes on Tues. and Thurs. evening. Sue, Ext. 3388, or Ruth, Ext. 3007.

FEMALE PROFESSIONAL - to share 2-bdrm. condo, 4-min. to Lab, $450/mo. + ½ util. 751-8351.

Ads left out of this issue due to lack of space need not be resubmitted to appear in the next issue.