

## BNL's Search for the Science of Superconductivity

# Part I: Superconductivity Meets No Resistance at BNL

Like the phenomenon of perpetual motion, superconductivity has long intrigued scientists and lay people, with its promise of resistance-free electricity — if only superconducting materials could be kept cold enough, economically enough, to warrant their everyday use.

Over the past year, the attention of the world has shifted to the recently discovered, high temperature superconductors — which offer the hope of being more economical to use than the older, lower temperature superconducting materials.

What is Brookhaven's experience with superconductivity? How has the discovery of high temperature superconductors affected superconductivity research at BNL? What are scientists here doing to understand this phenomenon and to improve superconducting materials?

The answers to these questions will be explored in a four-part series of articles that begins in today's Bulletin.

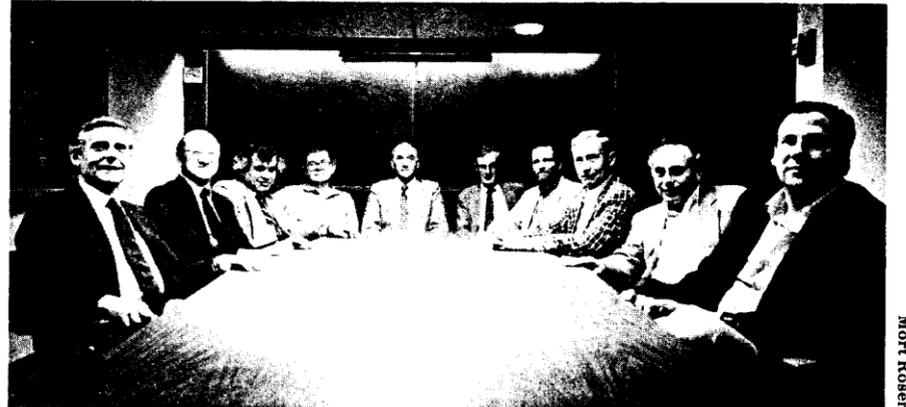
The 1987 Nobel Prize in Physics went to the two scientists in Switzerland who discovered high temperature superconductivity a half century ago — but another Nobel Prize in Physics could be waiting for the scientists who explain how it works.

Superconductors are materials totally lacking resistance to the flow of electricity. Materials become superconducting at different critical tem-

peratures ( $T_c$ ); through 1985, the highest  $T_c$  was  $-418^\circ\text{F}$  or 23 kelvins (K). On January 27, 1986, the record high  $T_c$  jumped to 35 K, and in January of this year, it leaped up to 90-100 K.

The second 90-100 K, high temperature superconductor was discovered at BNL in February 1987.

Brookhaven's solid state researchers — experimentalists and theorists, staff and visitors — are not waiting



Mort Rosen

**Members of BNL's Interdisciplinary Task Force on High Temperature Superconductors: (from left) Eric Forsyth, Accelerator Development Group; Myron Stringin, Physics Department; William Sampson, ADD; Task Force Chairman Victor Emery, Physics; Pierre Grand, Department of Nuclear Energy; David Welch, Department of Applied Science; Per Dahl, ADD; Frank Salzano, Office of Research & Technology Applications; and John Larese, Physics.**

for someone else to figure out how these new materials superconduct at such relatively high temperatures. Understanding the mechanism of high  $T_c$  superconductivity has become their obsession.

The much desired explanation of superconductivity will be found by basic research — a Brookhaven strength and commitment. Since late last winter, BNL's complementary tools for basic scientific inquiry — the High Flux Beam Reactor (HFBR), the National Synchrotron Light Source (NSLS) and the Alternating Gradient Synchrotron (AGS) — have brought forth three experimental firsts in the search for the one answer to the high  $T_c$  question:

- **Supercurrent electrons:** Electrons farthest from the atomic nucleus not only bond atoms together into molecules and compounds, including the new superconductors, but they also can move freely from atom to atom in a current. In a superconductor, these conduction electrons are paired to distant partners, and all these weakly bound pairs move together in a supercurrent.

At the NSLS, BNL researchers were the first to discover from which atoms in these high temperature compounds the supercurrent electrons come.

- **Antiferromagnetism:** Atoms and electrons, for example, have characteristics such as mass, charge and spin, which is the angular momentum of a particle. The spins of individual atoms in a solid can become correlated; if the spins line up in an alternating up-down-up-down array, the solid is considered antiferromagnetic.

Antiferromagnetism in the new materials was discovered first and subsequently confirmed by researchers at the Lab, using the HFBR.

- **Quantum spin fluid:** The spins of individual atoms in the new superconductors do line up in up-down-up-down, antiparallel order to make the material antiferromagnetic, but they are only correlated briefly — for  $10^{-15}$  seconds.

Antiferromagnetism that is intermittent has been termed quantum spin fluid — new physics that was uncovered for the first time at Brookhaven by scientists also using the HFBR.

### Task at Hand

"Understanding the basic science of high temperature superconductivity is crucial right now," says BNL solid state theorist Victor Emery, Senior Scientist, Physics Department. Emery is Chairman of BNL's Inter-

disciplinary Task Force on High Temperature Superconductors. Because Brookhaven's own research on the new materials ranges from basic to applied, and because of the influx of visiting scientists to utilize the Lab's big machines for their own high  $T_c$  research, BNL Deputy Director Martin Blume set up the nine-member task force.

Since its establishment in June, the task force has been coordinating superconductivity research to meet the demand of staff and guests.

Says Emery, "At Brookhaven, we are both pioneering and fostering an understanding of high temperature superconductivity, as much as at any other laboratory." That understanding includes Emery's theory for a non-

(Continued on page 2)

## In Hot Pursuit of New Superconductors

The news media's hyperbole regarding the immediate usefulness of the new superconducting materials contrasts with the understatement of the September 1986 publication in a German journal announcing the miraculous birth of high temperature superconductivity.

Because that journal is not usually read by reporters, the high  $T_c$  story wasn't picked up by the media until January 1987, a year after the discovery itself. Then the story quickly went from the science to the business section, as venture capitalists thought they should be investing in yttrium futures.

As well, many scientists did not pay attention to the first report, because the great  $T_c$  leap was a giant leap of faith: In the past, their hopes had been raised to higher transition temperature, only to be dashed when the results were not repeatable.

The story actually began on January 27, 1986. After many months of testing oxides, brittle ceramic compounds that usually do not conduct electricity at all, Karl Alex Müller and Johannes Georg Bednorz, of IBM Zurich Laboratory, uncovered high temperature superconductivity in lanthanum-barium copper oxide (La-Ba-Cu-O) at  $-396.4^\circ\text{F}$  or 35 K, 12 K above the old record.

For this discovery, the two were awarded the 1987 Nobel Prize in Physics.

The new superconductor is made by doping a parent compound, the insulator lanthanum copper oxide (La-Cu-O), with barium (Ba). That is, barium, an alkaline-earth element, is substituted for some of the lanthanum, a rare-earth element. While the parent compound is not superconducting, its doped offspring is.

After the publication of the higher  $T_c$  breakthrough, the critical temperature chart climbed sharply and rapidly upward. In February, Ching-Wu Chu of the University of Houston, Texas, doped the parent compound with strontium (Sr), another alkaline earth element, to make a second offspring, La-Sr-Cu-O, which raised the record  $T_c$  to  $-362.2^\circ\text{F}$  or 54 K.

Chu and his colleagues outdid themselves by making a grandchild of the non-superconducting parent La-Cu-O. By doping second-generation La-Ba-Cu-O with another rare-earth element, yttrium (Y), they created Y-Ba-Cu-O, having the repeatable record of  $-283^\circ\text{F}$  or 98 K.

This February 27, the second such 90-100 K high temperature superconductor was found at BNL by Physics Associate Arnold Moodenbaugh and Senior Metallurgist Masaki Suenaga, Metallurgy & Materials Science Division, Department of Applied Science. Substituting the rare earth lutetium (Lu) for some of the lanthanum in La-Ba-Cu-O, they hit  $-297.4^\circ\text{F}$  or 90 K with Lu-Ba-Cu-O.

While announcements of room temperature superconductivity are circulating throughout the solid state physics community, so far no reports of superconductivity above  $-189.4^\circ\text{F}$  or 150 K or of superconductivity-related effects above  $-27.4^\circ\text{F}$  or 240 K have been published. However, Y-Ba-Cu-O is considered to still hold the high  $T_c$  record, as its results are consistently repeatable, even in demonstrations performed by high school physics students.

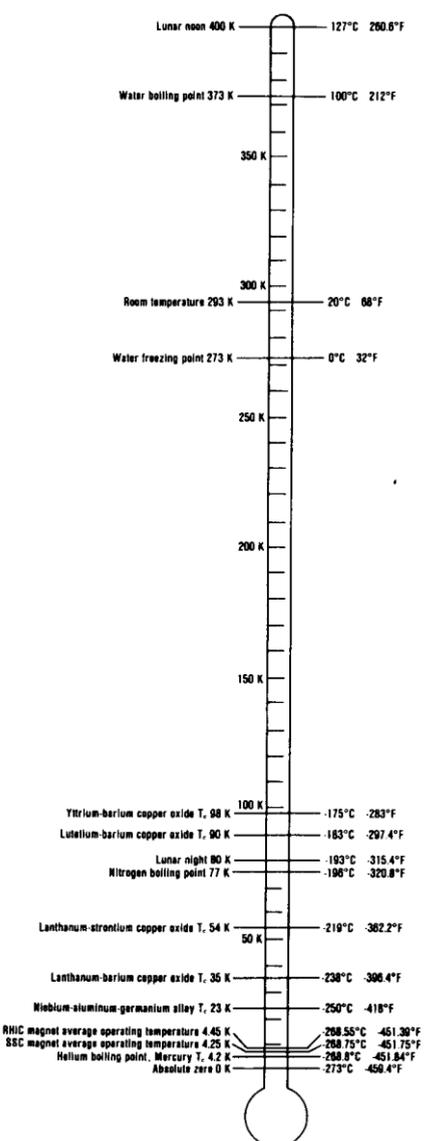
— Marsha Belford



Masaki Suenaga (left) and Arnold Moodenbaugh

Mort Rosen

## Comparative Temperatures



## Centering on Nuclear Reaction Data

Worldwide, a total of eight nuclear data centers have joined in agreements to exchange nuclear reaction data. Representatives of these centers gathered at the National Nuclear Data Center at BNL, October 27-29, for the ninth in a series of meetings sponsored by the International Atomic Energy Agency (IAEA) in Vienna. The meetings are held every two years to discuss the latest ideas and developments in how best to exchange data on neutron, charged particle and photon reactions. These data have such uses as fission and fusion reactor design, biomedical research and space applications.

Pictured at the meeting are: (standing, from left) Akire Hashizume, RIKEN Institute of Physics & Chemical Research, Japan; John Hubbell, National Bureau of Standards; Felix Chukreev, I.V. Kurchatov Institute, USSR; Zhuang Youxiang, Institute of Atomic Energy (IAE), China, and currently at BNL; Vasili Manokhin, Fiziko-Energeticheskiy Institut, USSR; Victoria McLane, BNL, Conference Organizer; Hans Lemmel, IAEA, Conference Scientific Secretary; Edward Siciliano, Los Alamos National Laboratory; Wang Gongqing, Institute of Nuclear Research, China, and currently at BNL; Sol Pearlstein, BNL; Stephan Warshaw, Lawrence Livermore National Laboratory; (seated, from left) Cai Dunjiu, IAE, China; Josef Schmidt, IAEA; Charles Dunford, BNL, Conference Chair; Claes Nordborg and Nigel Tubbs, Nuclear Energy Agency, France; and Norman Holden, BNL, Conference Local Secretary.



Mort Rosen

## Superconductivity (cont'd)

phonon mechanism for high  $T_c$  superconductivity, one of about nine proposed by theorists in the field worldwide to date.

"In answering the high temperature superconductivity question, the interplay between experimentalists and theorists is very important and very apparent at BNL," comments Emery.

He adds, "Without the kinds of complementary experiments done at BNL, theorists would have no idea what is going on inside high  $T_c$  superconductors — we could only guess, and that is not the way to come up with a comprehensive, predictive theory about anything. The importance of BNL's facilities is that they are providing a fundamental understanding and eliminating the guesswork."

### Lack of Resistance

Superconductivity was discovered

in 1911 by Dutch physicist Heike Kamerlingh Onnes. While studying the change in electrical resistivity as the temperature changed, Onnes found that the electrical resistance of mercury disappeared at  $-451.84^\circ\text{F}$  or 4.2 K. In other words, mercury became the first known superconductor, with a  $T_c$  of 4.2 K.

That transition temperature is cold — within a few degrees of absolute zero (0 K), the lowest temperature attainable and the temperature at which almost all motion ceases.

Since the initial discovery, over two dozen metallic elements and thousands of compounds and alloys have been found to superconduct. Until the recent high temperature discoveries (see box), critical temperatures ranged from a low of about 0.001 K to a high of  $-418^\circ\text{F}$  or 23 K, for an alloy of niobium, aluminum and germanium discovered in 1973.

Though resistance-free electrical

conduction is a reality, superconductors are not practical for use in everyday devices: It is very expensive to keep these materials cold enough to superconduct.

The most commonly used refrigerant for low temperature superconductors is helium, which liquefies at 4.2 K. However, at about \$4 per liter, liquid helium is expensive. In addition, it costs a lot in energy to keep liquid helium that cold, and the apparatus for maintaining that low temperature is also costly.

Thus, superconducting materials are used only for devices that perform functions in the superconducting state that cannot be done at all or more economically at room temperature. Superconducting devices include small electronics used in computers and detectors, and large-scale applications for physics, power generation and transmission, and mass transportation.

### High $T_c$ Fever

Because they superconduct above  $-320.8^\circ\text{F}$  or 77 K, the temperature at which nitrogen liquefies, the higher  $T_c$  compounds, including the BNL superconductor, can be cooled more economically using liquid nitrogen. It costs less than a nickel per liter.

Thus, if these brittle ceramics can be made into the appropriate wire capable of carrying high current, electronic devices made of the new materials would cost less to operate than those made from the conventional, low temperature superconductors.

Right now, that is a big if and a technical problem that will not be solved overnight. As pointed out by BNL's Eric Forsyth, Chairman of the Accelerator Development Department and a task force member who headed BNL's Superconducting Power Transmission Project, there are other economic factors besides operating costs that must be considered in future decisions about replacing low with high temperature superconductors.

Superconductivity above the temperature at which nitrogen liquefies is a significant jump in  $T_c$ , but the big question is: Can the transition temperature go any higher? Can superconductivity exist at room temperature,  $68^\circ\text{F}$  or 293 K?

The present phonon theory of conventional superconductivity cannot answer this question. While it does not restrict the phenomenon to low temperature, the low  $T_c$  theory can only explain and predict superconductivity below 30 K.

So, a new theory is needed to explain the mechanism of high  $T_c$  superconductivity. Concludes Emery, "Such an explanation will only come about by a close interaction between experimentalists and theorists."

At BNL, that kind of interaction is evident: Victor Emery has developed a theory of high temperature superconductivity, which has guided some of the experiments performed at Brookhaven. In turn, the results from those experiments has furthered the evolution of and lent support to Emery's theory. Next week, the second in this four-part series will begin to examine this feedback between high temperature superconductivity theory and experiments. — Marsha Belford

## BNL's Fabulous Forty



Bob Walton, life number 536, joined the Lab on April 2, 1947, as a photographer in the Photography & Graphic Arts (P&GA) Division, and is now Photography Supervisor. This photo was taken as Walton (left) began a 1948 assignment to take aerial photos of the Lab site. The Piper Cub he was about to board was owned and piloted by duck farmer Ed Kaloski. They took off from what was then an emergency air strip and is now the Brookhaven Airport. Walton, who is pictured in the insert as he looks today, is holding an Air Force K-9, a standard aerial photography camera of the day.

During the Lab's 40 years, over 18,650 employees have been issued life numbers. And sure enough, many of them have spent major parts of their lives here. These photos focus on two BNL employees who have grown with the Laboratory.

Portraits  
by  
Mort Rosen.

Paul Zahra (curly-headed boy, standing) was only 15 months old when he attended BERA's second annual Operation Get-Together in August 1959. He was there with his mother Joan, life number 3,703, who had been a secretary in the Classified Library until 1958, and his father John, life number 428, who retired from his position as a storeskeeper with the Supply & Materiel Division in 1984. After the picnic, Zahra grew up and went to school, then came back to BNL in August 1981, as an electronics technician in the Safety & Environmental Protection Division. For Zahra (see insert), life number 16,520, BNL today remains a family affair: His wife Debra works in P&GA, where her supervisor is Bob Walton, who took Zahra's photo 28 years ago.



## Coming Up

Robert Adair, Associate Director for High Energy and Nuclear Physics, will deliver the next Brookhaven Lecture, the third in a series of four lectures planned this fall to commemorate the Lab's 40th anniversary. He will speak about "Landmarks in Particle Physics at Brookhaven," on Wednesday, November 18, at 4:30 p.m., in Berkner Hall.

# Talking Pumpkin Joins UFOs To Raise Funds for United Way



Mort Rosen

When it comes to helping the United Way, money talks — and so do pumpkins. This Talking Pumpkin, flanked by two UFOs (Unidentified Fundraising Organizers), visited the cafeteria last week to accept any contributions of spare change and to remind BNL'ers to return their pledge cards as quickly as possible.

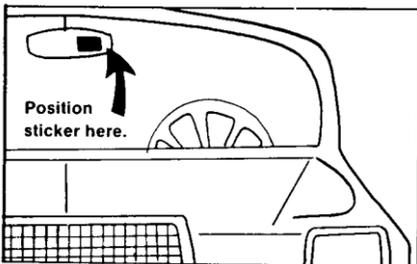
The brain under the pumpkin belongs to Frank De Rosa, Sign Painter in the Plant Engineering (PE) Division. He designed and built the table, which balances on his shoulders with the pumpkin over his head. De Rosa himself is sitting on a chair under the tablecloth and using his white-gloved hand (coming up from another hole in the table) to hand pledges to (from left) Slim Blevins, PE, and William Rabatin, Safety & Environmental Protection Division.

So far, funds pledged to the United Way stand at \$32,000. To reach the BNL goal of \$87,000 in 1987, \$55,000 more is needed.

## Vehicle Stickers Available Soon

Vehicle stickers for 1988 will soon be available. The red stickers will be affixed to the windshield side of the rear-view mirror, so they are visible from the front of the vehicle (see drawing). As the stickers are printed on Scotch-lite paper, they will be clearly visible in the dark.

Shortly, all employees will receive a memo with registration cards. Stickers and instructions for applying them will be distributed after the cards are returned to the Safeguards and Security Division. For more information, call Hank Raimondo, Ext. 7258.



## AAGC Fall Fling

As a scholarship fund-raising event, the Afro-American Culture Club will host a "Fall Fling" dance on Saturday, November 14, at the Recreation Building, from 9 p.m. until 2 a.m. Music will be by E.T., and snacks and food will be available.

Tickets are \$3 if bought in advance and \$4 at the door. For ticket information, call Bruce Penn, Ext. 7213; Frances Ligon, Ext. 3709; or April Donegain, Ext. 2459.

# BROOKHAVEN BULLETIN

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## Computer Seminar

Several topics will be covered by a representative of Businessland who will speak in the AMD Seminar Room, Bldg. 515, on Thursday, November 12, at 1 p.m. Topics will include "The Emerging Standard in Networking and PC-Mainframe/Mini Connectivity," and the representative will answer questions on desktop publishing and current developments from IBM, Compaq and Apple.

## WIS Meeting

Sherie Michaile, Medical Department, will be the guest speaker at the next luncheon meeting of Brookhaven Women in Science, scheduled for noon on Monday, November 9, in Room A, Berkner Hall.

Michaile, who holds a Ph.D. in Chemistry from the State University of New York at Binghamton, will speak on "Study of Kinetics and Mechanism of Ferrocenophanes."

All are invited; please bring your own lunch.

## Runners' Corner

Seven BNL women runners were among the 280 women registered for the 3rd Annual Shelter Island Women's 5k Run on October 18.

The 3.1 mile course started with two miles of hills, then dropped to sea level for a flat, fast finish. The day, which sported a warm sun and light winds, was perfect for Marilyn McKeown, who not only earned first place in her age group (60+), but also won a bottle of wine and a two-piece warm-up suit in the post-race raffle. Another raffle winner was JoAnn Langan, who won a \$25 gift certificate for heating oil.

Individual times were:

Sharon Zuhoski	20:39
Diane Hatton	21:04
JoAnn Langan	26:35
Kathy Hauser	26:40
Joan Congemi	27:38
Marilyn McKeown	31:54
Ronnie Evans	32:04

If you would like to share some fun and luck with our runners, either in training or in upcoming races, please contact JoAnn Langan, Ext. 2132, or Skip Medeiros, Ext. 2665.

## Swim Lessons For Adults

Registrations for an adult swimming course are now being accepted at the pool. Lessons are scheduled to begin on Wednesday, November 18, at 5:15 p.m., and will continue for eight consecutive Wednesdays. The course is open to employees and their adult dependents (spouses and children over 18). A fee of \$20 will be due at the time of registration. Checks should be made payable to BERA.

Register early! No more than 15 students will be accepted.

## Golf

Sixty-three golfers braved the cool weather to play in the final tournament of the BGA season held at the Fox Hill Country Club. Winners of the low gross and low net prizes in each flight were: Flight A — John Usher (85) and Ron Webster (74); Flight B — Mike Zguris (88) and Bob Jansson (75); Flight C — Bob Jones (105) and John Nagy (76); and Flight D — Glaister Fraser (100) and Tom Dilgen (64). The closest-to-the-pin contests on the second and eleventh holes were won by Jack Fontana and Paul Mohn, respectively. John Millener won both long drive contests.

The end of the season awards for the best year-round performances in the BGA tournaments went to John Usher (gross score competition) and Joe Carbonaro (net score competition).

## Give to the Kids

As you plan for the holidays, don't forget the "1987 Interface Toys-for-Kids Drive," which will begin on Monday, November 16, and continue until Friday, December 11. This drive is an annual project organized by the Town of Brookhaven to provide happy holidays for needy young people in our local communities. For the past three years, Lab employees have given their time and contributions with willing and generous spirits. Let's do it again for year number four!

Please drop off all donations at the BERA Sales Office between 9 a.m. and 2 p.m., Monday through Friday. New toys and gifts are preferred and are needed for children of all ages — infants through teens.

Volunteers are needed during noon hours. To volunteer, call the Recreation Office, Ext. 2873.

## Bowling

### Red/Green League

High games were bowled by J. Ferrante 236/209, R. Mulderig 225/205/204/634 scratch, A. Warkentien 221, L. Jacobson 216, K. Riker 209.

### Purple League

Ed Meier rolled a 211, Karen Jacobs 188/185.

### White League

Ken Asselta had a 211, Jim Petro 214/201, Jim Griffin 209/202, Rich Scheidet 200, Sandy Asselta 190, Pat Manzella 187, Jeannette Thiede 180. For the prior week, Rick Murgatroyd bowled a 249.

### Pink League

Renie Rosati had games of 200/185/180 for a 565 scratch, Sandy Asselta 185, Maryann Reynolds 176.

## Farmers' Market: Down Wednesday, Up on Thursday

As the Laboratory will be closed on Wednesday, November 11, in observance of Veterans Day, the Farmers' Market will be held next week on Thursday, November 12. The following week, on Wednesday, November 18, local farmers will bring their produce to the Lab for the last time this season.

## Service Awards

The following employees received service awards during the month of October:

### Forty Years

Harold H. Hicks ..... Sup.&Mat'l.  
Robert A. Lindgren ..... Physics  
Bernard Manowitz ..... DAS  
Paul W. Roman ..... Chem.  
Joseph C. Trebing ..... Instr.

### Thirty-five Years

Helen R. Connell ..... DNE  
Herbert J. Kouts ..... DNE  
Rita F. Straub ..... Medical

### Thirty Years

J. Robb Grover ..... Chem.  
Robert L. Monaghan ..... AGS  
Robert Smol ..... DAS  
Arie Van Steenberg ..... Light Source  
Robert G. Wilson ..... DAS

### Twenty-five Years

Charles Briening ..... Accel. Dev.  
Ralph Brown ..... AGS  
Jacob L. Haufman ..... AGS  
Rodger A. Hubbard ..... AGS  
John T. Keane ..... Light Source  
Alfred Mahlmann ..... Plant Eng.  
Viola D. Malloy ..... Fiscal  
Mario A. Manni ..... Physics  
Otto R. Medeck Jr. .... S&EP  
Francis J. Mottl ..... AGS  
Nicholas F. Pisco ..... Applied Math  
Alan R. Schmidtchen ..... P&GA  
Frank Toldo ..... AGS

### Twenty Years

Fern M. Coyle ..... Physics  
Barbara D. Gaer ..... Instr.  
Alfred C. Saulys ..... Physics  
Benno P. Schoenborn ..... Biology

### Ten Years

Cordell J. Anderson ..... Staff Svcs.  
James B. Boomer ..... Plant Eng.  
Gregory P. Borsella ..... Chem.  
Joseph J. Fortunato ..... Plant Eng.  
John M. Galayda ..... Light Source  
Michael M. Goldman ..... Director's Ofc.  
Audrey L. Karzenski ..... Accel. Dev.  
Arnold R. Moodenbaugh ..... DAS  
William E. O'Grady ..... DAS  
Ronald E. Ondrovic ..... DCP  
Edwin S. Rodger ..... AGS  
Barbara Ann Simpson ..... DCP  
John G. Skora ..... Light Source  
Leonard A. Slatest ..... Applied Math  
John F. Svandrlík ..... DNE  
Bruce A. Weatherell ..... Applied Math

## Social Club

There are still some double rooms available for the Austrian winter vacation, February 19-27. A cash deposit of \$200 is required no later than Monday, November 9. For more information, call Doris Terry, Ext. 2228.

## Cafeteria Menu

### Week of November 9

#### Monday, November 9

Potato leek soup	(cup) .75
	(bowl) .95
Braised brisket of beef w/gravy & 1 veg.	2.95
Broccoli & cheddar cheese quiche w/1 veg.	2.85
Buffalo hot chicken wings	2.85
Hot deli: Chili dogs	(each) 1.25

#### Tuesday, November 10

Garden vegetable soup	(cup) .75
	(bowl) .95
Savory baked quartered chicken w/1 veg.	2.95
Beef stew w/buttermilk biscuits	2.85
Chef salad cold plate (lite-weight)	2.25
Hot deli: Corned beef	(bread) 2.65
	(roll) 2.75
	(hero) 2.85

#### Wednesday, November 11

French onion soup	(cup) .75
	(bowl) .95
Pork chop Oriental w/1 veg.	2.95
Sauerbraten & potato pancakes w/1 veg.	2.95
Baked fresh fish fillet w/1 veg. (lite-weight)	2.85
Hot deli: Grilled Reuben	2.85

#### Thursday, November 12

Minestrone	(cup) .75
	(bowl) .95
Meat loaf w/vegetable gravy & 1 veg.	2.95
Fettuccine Alfredo w/1 veg.	2.75
Top-your-own baked potato	(each) 1.35
Hot deli: Roast beef	(bread) 2.65
	(roll) 2.75
	(hero) 2.85

#### Friday, November 13

New England clam chowder	(cup) .75
	(bowl) .95
Baked ziti w/meat sauce & garlic bread	2.85
Beef & vegetable stir-fry over rice	2.95
Baked fish w/lemon butter & 1 veg.	2.85
Hot deli: Fried fishwich on a bun	2.85

# Arrivals & Departures

## Arrivals

Concetta Angilella ..... Con. & Proc.  
Alison J. Davenport ..... DAS  
James Giacalone ..... Plant Eng.  
Donald A. Pinelli ..... Physics  
Nelson E. Tyler Jr. .... AGS  
Jimin Xu ..... DNE

## Departures

This list includes all employees who have terminated from the Laboratory, including retirees:  
Christopher W. Beattie ..... AGS  
John J. Loper ..... DAS  
Lorillard G. Smith Jr. .... Appl. Math  
Benjamin M. Turner ..... Sup. & Mat'l

## 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.

**LABORATORY RECRUITMENT** - Opportunities for Laboratory employees only.

2718. SECRETARIAL POSITION - Requires AAS in secretarial science or equivalent experience. Will provide varied secretarial support, maintain automated reactor access system and perform receptionist duties. IPAP/J-CARS data entry system and IBM/PC experience desirable. Ability to obtain DOE "L" Clearance required. Reactor Division.

**OPEN RECRUITMENT** - Opportunities for Laboratory employees and outside applicants.

2719. TECHNICAL POSITION - Requires an AAS degree in environmental science or equivalent experience. Will be responsible for the collection and analysis of environmental samples taken in and around the BNL site. Duties will include sample collection, measurement of chemical parameters in the field and routine analysis in the laboratory, and maintenance of appropriate records. Safety and Environmental Protection Division.

2720. ENGINEERING POSITIONS (2) - Requires BS/MSEE with a minimum of three years' experience in the design of analog circuits, feedback systems and instrumentation techniques. Experience with multikilowatt supplies desirable. Will be involved with Booster instrumentation and power supply development. Accelerator Development Department.

2721. ACCOUNTING POSITION - Requires AAS in accounting, BS preferred, a minimum of two years' working accounting experience, and excellent communication skills. Responsibilities will include assistance in various areas of General Accounting, i.e. A/R, inventories, capital equipment and other accounting analyses. Fiscal Division.

2722. RESEARCH SERVICES ASSISTANT - Responsibilities will include the production, testing and shipment of special strains of rats. Knowledge of laboratory animal science helpful. (Term position through 9/30/88.) Medical Department.

2723. DATA SERVICES ASSISTANT (part-time) - Requires AAS in data processing or equivalent experience and accurate keyboard skills. Will provide varied support services in the hazardous waste management group. Responsibilities will include preparing and entering data, running established programs, maintaining files and records. Data base experience desired. Safety and Environmental Protection Division.

### Motor Vehicles & Supplies

81 CITATION - 6 cyl., 4 dr., excel. cond., \$1,600; 74 Plymouth Scamp, 6 cyl., \$400; 68 Volks van, good for parts, \$100. Ext. 4070 or 475-7272 eves.

77 FIREBIRD - white, a/t, a/c, p/s, runs well, excel. cond. Dennis, Ext. 4028 or 765-3136.

MOTOR FAIRING - Vetter Quicksilver, black w/gold pinstripe, full lighting, excel., \$95. Henry, Ext. 5110.

77 BUICK SKYLARK - tan, needs timing chain, has a dent, runs well, \$600. 399-0537 eves.

REAR STEP BUMPER - fits 1973-87 Chevy pickup, new, \$75. Chevy repair manuals for car & truck, \$25. Tony, Ext. 2462.

78 CONCORD - p/s, a/t, 6 cyl., am/fm, low mi., good cond., \$950. Ext. 4638 or 281-0360 eves.

76 LINCOLN CONTINENTAL - classic, 41k orig. mi., full power, 4 dr., excel. cond., \$5,000. M. Kinney, Ext. 3431 or 924-3783.

80 RENAULT Le CAR - runs well, any reasonable offer. Ext. 2578 or 821-9834, leave message.

TIRES - 2, P175/80, snows, on 13" Toyota rims, \$40/each, 1, F78-15, \$30. Ext. 4259.

77 DODGE ASPEN - wagon, 6 cyl., a/t, good cond., \$500. Dan, Ext. 4987 or 698-7322.

65 MUSTANG - a/t, all orig., excel. in/out, many extras, \$3,500. 929-4701.

78 LTD - 4 dr., V8, full power, a/c, low mi., leather int., excel in/out, \$1,500. 589-2681.

82 CAMARO BERLINETTA - T-tops, p/s, p/b, p/w, a/c, am/fm stereo cass., 38k mi., \$6,200. 924-8260 eves.

84 MONTE CARLO CL - deluxe int., p/s, p/b, p/w, a/c, am/fm stereo cass., 35k mi., \$7,500. 924-8260 eves.

76 JEEP CJ7 - 4wd, runs well, best offer. Ext. 4688 or 474-1963.

78 YAMAHA 400 - 14k mi., inspected, good cond., \$400. 473-9223 eves.

75 CHEVY IMPALA - wagon, 9 passenger, \$400 in recent repairs, new battery, excel. tires, Arnold, Ext. 2050 or 473-6432.

WHEEL RIMS - 13", \$5/each. Ext. 4267.

78 280Z - gray, 5 speed, am/fm, p/s, p/b, a/c, \$2,300. 567-8645 after 5 p.m.

72 PONTIAC - p/s, p/b, a/c, dependable; 4 tires, new, H78-15, glass-belted bias ply, Sears, white wall. Matt, Ext. 5215.

TIRES - 4, Dick Cepek, radial X-C, 33x12.5x15, mounted on Chevy 6-lug superior alum. mags, like new, \$400. Bob, Ext. 5222 or 744-3289.

79 SAAB - 4 dr., hatchback, runs well, good cond., \$1,950. Al, Ext. 2377 or 796-4186.

81 FIREBIRD - p/s, p/b, a/c, a/t, new tires, must see, excel. cond. Andy, 878-4177.

75 DODGE DART - good engine, good tires, high mi., make offer. Ext. 4333 or 923-6384 eves.

75 FORD LTD - V8, p/s, p/b, a/c, good mech. cond., new tires, am/fm cass., \$900. Ext. 5165.

84 HONDA CIVIC - 4 dr. sedan, 5 speed, 36 mpg, clean, 74k mi., \$3,600. Ext. 2054 or 283-6409 Sat. or after Nov. 11.

70 POP-UP CAMPER - sleeps 6, stove, sink, \$600. 286-4805.

73 CHEVY CAPRICE HT - a/t, a/c, am/fm, high mi., new starter, distributor, battery, 400 cu. in. engine, 40/60 seats, \$325. Ext. 4030 or 878-2484.

79 FORD FAIRMONT - wagon, 6 cyl., a/t, p/s, a/c, high mi., \$550. Sang, Ext. 2014 or 3193.

69 PLYMOUTH BELVEDERE - Satellite, Road Runner; GTX parts. Ted, Ext. 4052 or 928-1445 after 6 p.m.

79 THUNDERBIRD - black, full power, am/fm, a/t, p/s, p/b, excel. cond. Jerry, Ext. 7427 or 475-5591 eves.

82 BUICK CENTURY - 6 cyl., 4 dr., p/s, p/b, am/fm, a/c, vinyl roof, tilt, tinted glass, excel. cond., \$3,900 neg. Ext. 2683 or 751-2469.

77 CHEVY CAPRICE - a/c, p/w, am/fm cass., new tires, very good cond., \$1,300 neg. Ext. 7915 or 744-0722.

77 MERCURY GRAND MARQUIS - 2 dr., 92k mi., garaged, very good cond., \$600 neg. 744-2805.

75 OLDS CUTLASS SUPREME - 8 cyl., a/t, p/s, p/b, runs well, \$600. Kim, Ext. 2183 or 3096 eves.

77 LINCOLN CONTINENTAL - green, 4 dr., \$2,000; 77 Cadillac Eldorado, red & white, 2 dr., \$1,500, both for \$3,000. 727-4041.

77 TOYOTA CELICA GT - 115k mi., new tires, new brakes, runs well, \$600. Jurg, Ext. 3423.

76 FORD LTD LANDAU - 8 cyl., a/t, a/c, p/s, p/b, cruise, p/seats, 94k mi., good cond., \$950. Ray, Ext. 7205.

79 CHRYSLER LeBARON - 4 dr. sedan, 83k mi., \$1,495; 75 Plymouth Valiant, 4 dr. sedan, high mi., runs well, \$595. 277-4091.

80 CHEVY CITATION - 4 cyl., a/t, 2.5 liter engine; 82 Ford EXP, 4 cyl., a/t, 2 dr., hatchback, 55k mi., both excel. cond. Joan, Ext. 2266 or 331-9264.

79 150 FORD VAN - parting out, 6 cyl., a/t, reasonable. Dick, Ext. 3499 or 589-9103.

81 DATSUN 310 - 4 speed, sunroof, am/fm, new transmission, clutch, \$2,100. 475-9131 after 5 p.m.

74 NOVA - runs, needs work, good for parts, \$300 or best offer. Ext. 4666 or 924-8143 after 5 p.m.

71 VOLKS SUPER BEATLE - red, 4 speed, many new parts, many extras. Ext. 3536 or 289-7615.

80 JEEP CJ7 LAREDO - 4 speed, new tires, 2 tops, good cond. Gary, 929-6031 after 6 p.m.

77 MUSTANG - low mi., no rust, runs well, 4 speed, new clutch, muffler, best offer. Gary, 758-5592 eves.

80 VW RABBIT - 4 speed, great run-around car, \$600. 567-9362.

75 CAMARO - 6 cyl., rebuilt engine, wire wheels, raised lettered tires, radio, \$1,500. Ext. 2529 or 588-7989 eves.

### Boats & Marine Supplies

26' OWENS - wood, good shape, runs very well, make offer. Roger, Ext. 2384.

19' BAYLINER CAPRI BOWRIDER - 1984, Volvo I/O, trailer, must see, mint, \$7,000. Ext. 2981 or 473-7809 eves.

20' O'DAY - 1974, 3 sails, furler/reefer, VHF, 7 1/2 Merc, complete mooring, new trailer, extras, \$5,500. Gene, 265-4376.

12' 11" ZUMA - 1985, fiberglass sailboat, 18' aluminum mast, 65 sq. ft. sail, \$975. Medina, Ext. 7636 or 744-8790.

### Miscellaneous

DRAPES - pale green, lined, 108"x72", \$25. 744-6292.

LAWN MOWER - 21" LawnBoy, good working cond., \$65. Chuck, Ext. 4483.

FIREWOOD - seasoned oak, delivered, \$130/cord. 732-2849.

MATTRESS - long twin size, Stearns & Foster, \$15. Ext. 2981 or 473-7809.

SLIDE PROJECTOR - Caracell projector screen; air conditioner, used one season, \$10; backdrop screen, 7'8" wide. 475-1254.

AMPLIFIER - Marshall Studio 15, all tubes, 1-12" speaker, \$200; selling assorted effects also. Dave, Ext. 4256.

LAWN MOWER - ride-on, Sears Craftsman, 6 h.p., 26" cut, A-1 cond., \$250. Dan, Ext. 4987 or 698-7322.

UNICEF XMAS CARDS - & gifts. Ext. 2022 lunch-time or 744-8386.

HUMIDIFIER - Edison, woodgrain console, 4 gal., \$40. Tony, 698-9274.

MAJOLICA PITCHER - fair cond., approx. 80 yrs. old, \$20. 475-1826 after 6 p.m.

POTBELLY STOVE - old, cast iron, 22" high, \$40; crib, like new, \$20; gem tumbler, new, \$30. 878-6637.

BRIDAL GOWN - size 10, white satin, contemporary design w/train, beautiful, asking \$550. Eva, Ext. 2197.

TWIN BED FRAME - w/bookcase headboard, good cond., \$15. Ext. 7505.

RUNNING SUIT - Hellytech, woman's small, waterproof, breathable, equivalent to Goretex, \$90 orig. \$140. Elaine, Ext. 5329.

PERSIAN LAMB COAT - gray, full length, good cond., \$850. Ext. 3701.

WALNUT DESK - large, 3 drawers, one filing size, solid, good cond., \$50. Ext. 2007 or 751-1474.

COAL STOVE - Surdiac #520, good cond., \$225; 2 storm windows, alum., 36"wx39" h, \$10/ea. Walter, Ext. 3397 or 567-9025 eves.

SOFA - & loveseat, Colonial pine, removable cushions, excel. cond., \$125 or 473-6546.

RANGE HOOD - 30", white, still in box, \$30; rug shampoo floor polisher, Hoover F4143, brand-new, \$50. Ext. 4727.

ROWING MACHINE - DP300, hardly used. Arun, Ext. 5614.

ELECTRIC CLOTHES PRESSER/IRON - \$20; hockey game, \$5; 27" man's 10 speed, almost new, \$25. Ext. 3536 or 289-7615.

FREEZER - upright, 14 cu. ft., Sears Coldspot, needs freon; automatic ironer, Mangler, good cond., \$50. 368-1133.

PINE TEA CART - small table, chairs, oak chair, old Windsor chair, all \$35; Care Bear high chair, \$25; old oak buffet, \$75. 475-4199.

CONVECTION OVEN - Faberware; men's skis, 205 cm, 200 cm, boots, 10 med.; woman's skis, 185 cm, boots, 7 & 8. 475-0509.

KEROSENE STOVE - Radiant King, & 5 gal. can, \$35; light fixtures, \$5/ea.; bath scale, \$5. 924-2726.

DRAPES - triple width, insulated, 84", off white/beige, like new, \$50. Sue, Ext. 7235 or 395-3529.

PING PONG TABLE - net & paddles, \$25; lawn mower, 4 cycle, \$20; Scott spreader, \$10; Cyclone spreader, \$10. Gene, 265-4376.

VIVITAR - 28-85mm Macro Focus 200M lens skylight filter & case, fits Nikon FE or FM body, new cond., \$75. Ext. 3872.

COPIER - needs adjust., \$15; couch/loveseat, \$100; table, \$20; coffee table, \$35; wood etagere, \$10; Oriental rug, 9x12, \$25. 689-7259 after 6 p.m.

FISH TANKS - 6, 10 gal. w/gravel, pumps, filters, heaters, light hoods & more. Ray, Ext. 3536 or 289-7615.

B&W TV - 13", \$20; baby items, stroller, \$10; baby swing, \$5; walker, \$5, car seat, \$10; mini cycle, \$5. Sang, Ext. 3193.

MAN'S BIKE - Puch, 10 speed, 27" wheels, \$75. Joe, Ext. 2898.

WASHER - GE, heavy duty, 12 mo. old, cost \$380, sell \$230. 345-3557.

COMPUTER MONITOR - monochrome for Tandy 1000 or any computer w/RCA connector, orig. \$140, now \$70. John, Ext. 3292 or 286-1348.

COPY MACHINE - Cannon PC-25, like new, \$425. Tim, Ext. 3436 or 727-7741.

WOODEN SWING SET - cannister type vacuum cleaner, other items, make offers. Ext. 2051 or 689-8685.

OAK DESK - \$50; folding dining table, \$25; chairs, \$15; floor lamp, \$10. Jerry, Ext. 5506.

SWEATERS - made of pure wool, beautiful designs. Angela, 475-7569.

WOOD STOVE - Scandia 200, airtight, cast iron, 50,000 Btu, free-standing, flue pipe, wood carriers, \$250. Gary, Ext. 4095 or 758-5592.

MOVING - 3 bdrm. sets, dining rm., lawn mower & equip., 2 desks, chairs, tables, 26" bikes, deck furn., sewing machine, TV, fur, must sell. 277-4091.

ELECTRIC TRAIN - 8x4 ft. HO track, \$200; 10 speed Concord bike, \$100; 5 speed woman's bike, \$75. Ext. 7740 or 928-6389.

DRAPES - 2 pair, floor length, 10' wide, insulated, light gold color w/shears, \$45. Walt, Ext. 7154.

### Free

KITTENS - adorable, clean, litter trained, 8 wks. old, one all white, one mixed colors. 924-5192 after 5 p.m.

KITTENS - 8 wks., fluffy, black w/white whiskers & paws. Eve, Ext. 4923.

PHOTO MAGAZINES - & small leather camera cases. 475-1254.

FAN - 2-way, 3 speed, working cond. Ext. 7505.

### Car Pools

MELVILLE/HUNTINGTON - one opening available. Joe, Ext. 2186 or Giuliano, Ext. 2949.

### 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 Sale

EAST QUOGUE - newly renovated ranch on landscaped 1/2 acre, 3 bdrm., 2 baths, eik, full basement, oak floors, many extras, \$152,000. 653-9514 eves. or wknds.

MIDDLE ISLAND - co-op apt., quiet, upstairs, 1 bdrm., new w/w, cent. a/c, low monthly maintenance includes heat, taxes, pool, tennis, more, excel. cond., \$66,900. Ext. 3396 or 924-7283.

STONY BROOK - Long Hill, cape, 4 bdrm., 2 baths, d/r, den, l/r, f/p, full basement, \$204,000. 751-8240 eves.

SHOREHAM - 3 bdrm. ranch, den, fireplace, garage, 1/2 acre, cul-de-sac, SWR schools, \$134,000. Ext. 7708 days or 744-0903 eves.

MONTAUK - Gurney's Inn spa timeshare, sleeps 4, lifetime vacation, 15th week Easter/Passover, \$12,500. Ext. 3144 or 698-5046.

HILTON HEAD, SC - 3 bdrm. condo, sleeps 8, 2 baths, washer/dryer, wet bar, 6 tennis courts, 3 pools, whirlpool, golf, ocean view, asking \$89,000, will rent. 929-8912.

MILLER PLACE - North of 25A, 3 bdrm. custom ranch, entertainment area, l/r, family rm., custom f/p, 24' x 26', 2-car garage, finished basement, and much more. Ext. 3353 or 473-5786.

### For Rent

BROOKHAVEN HAMLET - room, share entire house w/2 other professionals, 4 bdrm., 2 baths, 1/4 acre wooded, \$350 includes all. 286-4028.

SHIRLEY - male or female to share large 4 bdrm., 3 baths, 2-story deluxe modern waterfront view house w/3 males, \$350/mo. + utilities. Ext. 3310 or 395-4627.

MIDDLE ISLAND - 1 bdrm. apt., 3 min. from BNL main gate, priv. driveway, entrance & patio, kitchen, bath, den, large bdrm., year-round outdoor hot tub privileges, non-smoker, no pets. 924-3855.

MIDDLE ISLAND - 3 bdrm., 2 baths, eik, f/p, 2 story on wooded 2 acres, carpet, avail. Nov. 15, \$900/mo. Ext. 3675 or 924-3528.

HAMPTON BAYS - 2 bdrm. house, furn., avail. Nov. to May 15, 1987, \$440/mo. + utilities. 728-2104 eves.

CATSKILLS - chalet on top of mt., 2 bdrm., kitchen, l/r, wood stove, TV, VCR, deck w/view, near Deer Run, Windam, Hunter, 4wd needed in winter, rent wknd., wk., mo., season. Ted, Ext. 4052 or 928-1445 after 6 p.m.

MASTIC - 1 bdrm. apt., eik, \$450 includes all. 281-1198.

SPRING HILL, FL - west coast, 2 bdrm. house, furn., avail. weekly or monthly, Nov., Dec., first 2 wks. in Jan. Ext. 4530 or 261-2719.

HILTON HEAD, SC - 2 bdrm. condo, sleeps 6, beach, pool, tennis, golf, winter rates, \$300/wk. 585-9149.

### On-Site Services

FRIENDLY BROOKHAVEN GULF SERVICE - weekly special: power flush radiator, plus 1 gal. antifreeze, \$26.95. Ext. 4034.

### Wanted

PHOTOGRAPHIC ENLARGER - for 35mm film. Marty, Ext. 3843.

HOUSE OR APT. - to rent, Port Jefferson, Dec. 1 to July '88, excel. references. Ext. 7740 or 928-6389.

DOMESTIC HELP/BABYSITTER - Port Jefferson, Dec. Jan. & Feb., or sooner. Annie, 331-7350.

HOME FOR CAT - young, female, spayed, shots, black/white, affectionate, litter trained. Lois, Ext. 2959 or 751-5150.

SEAMSTRESS/TAILOR - to sew slipcover for club chair, material provided. Sandy, Ext. 4550 or 281-0843 after 5:30 p.m.

SLIDE-IN CAMPER - from 8' to 9 1/2' long, must be clean. Ext. 4312.

TRAINS - Lionel, American Flyer, accessories, any cond. brings good price. Carole, Ext. 7100 or 924-4097 eves.

### Services

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

KENTO-POOL WINTER CLOSINGS - power vacuuming, all repairs, special rates for Lab employees. Ext. 7597 or 758-7853.

ROOFING/RE-ROOFING/REPAIRS - free estimates, lic. & insured, lab discounts. 732-4679.

RESIDENTIAL/COMMERCIAL CLEANING - rugs, windows, floors w/dry cleaning method, no water. 725-9072.

BABYSITTER - will babysit in my home, Coram area. 331-2027.

RUG SHAMPOOING - clean your rugs for the holidays, very reasonable, Lab discount. 924-6019, leave message.

JEWELRY REPAIR - gold & silver, rings, chains, etc. Dan, Ext. 2319.

CALLIGRAPHY - for all occasions, envelopes, invitations, place cards, etc. Andrea, 821-0260.

SPACKLING - free estimates. Kevin, 563-1189.

BABYSITTER - Middle Island mother will babysit your child, my home. 924-3655.

SPACKLING SUSPENDED CEILINGS - free estimates, excel. work, reasonable prices, basements, studios, dens, bdrms. John, 281-3342 after 6 p.m.

ROTOTILLING - Troybilt, custom work, yards & gardens. Bob, 732-9517.

PAINTING - small cars painted, reasonable. 281-756