

25 Years of AGS Research Starring: ν_μ , CP, Ω^- , J/ ψ and Λ_c^+

The Alternating Gradient Synchrotron (AGS) is 25 years old, but its age is not the primary reason for celebration. Its age is important only in light of the contributions the AGS has made to high energy physics.

Laurence Trueman, theoretical physicist in the Physics Department, says, "The AGS has made many important contributions to high energy physics. For example, many new particles and 'resonances' have been discovered there. Among all those accomplishments, however, a few stand out as stellar things."

Derek Lowenstein, chairman of the Alternating Gradient Synchrotron Department, names five AGS discoveries as the stars: the muon-neutrino (ν_μ), the Omega-minus particle (Ω^-), CP violation, the J/psi (J/ ψ) particle, and the charmed baryon (Λ_c^+). Lowenstein's criteria for choosing these five is that "these discoveries have made a major difference in our thinking about physics."

"This is why it was such great fun — because it was very pioneering, so significant, and, because of the very small signal to noise, a hard experiment by a very talented though small assemblage. And it was successful."

— Gordon Danby

1962, on Columbia/BNL team that discovered the muon-neutrino.

1985, senior physicist in the AGS Department.

Less than two years after the AGS first reached its design energy of 30 GeV, the discovery of the muon-neutrino was announced in July 1962 by a Columbia/BNL collaboration led by Melvin Schwartz, Leon Lederman and John Steinberger, then of Columbia, and which included BNL's Gordon Danby.

Neutrinos are associated with the weak interaction, the force responsible for radioactivity and nuclear

decay. Until the discovery at the AGS, only one neutrino was known, and it was part of the "first family" of four fundamental particles, the others being the up and down quarks and the electron.

A fundamental, or elementary, particle is not made up of other particles. Today, quarks, which are always held together in pairs or triplets by the strong interaction, are believed to be fundamental particles, as are the members of the lepton family (electrons, muons, neutrinos, etc.), which do not feel the strong interaction.

With earlier discoveries by others of the muon and the strange quark, evidence had begun to mount for a second family of four fundamental particles. The muon-neutrino accounted for the third member of this family.

Says Trueman, "This established the existence of different particle families, although it wasn't completely recognized until later. It also established a conservation law of the quantum numbers, like electric charges of electrons and muons, as opposed to just the overall conservation of lepton number which existed before. Whether or not this law is exact is still uncertain, and experiments are going on at the AGS now to test it more precisely."

"We didn't know it would be there, but we were able to look at these decays much more sensitively than others before us. And we were lucky in the sense that, there it was."

— James H. Christenson

1963, graduate student on team that discovered CP violation.

1985, professor of physics at New York University and member of AGS experiment 789.

In late October 1963, an experimental team at the AGS, which included physics professors James Cronin, University of Chicago, and Val Fitch, Princeton; James Christenson, a

the guiding principle behind most accelerators today. For his role in the discovery of alternating gradient focusing, as well as in other aspects of AGS design, Ernest Courant was singled out for recognition at the AGS party.

"There's just one person here today that we'd like to honor — Ernest Courant — Mr. AGS," said Lowenstein. "We're giving him the standard AGS present — a backwards running clock from the Sparrow Clock Works." (Paul Sparrow, an AGS operator, began building backwards clocks almost 20 years ago, in honor of the AGS, in which the protons go counterclockwise.)

In accepting the gift, Courant said, "I hope that time does indeed run backwards because there's all kinds of things I would like to do again. It was a tremendous year, 25 years ago, when this whole thing began to run, and I was just as excited as anybody might be. It's just too bad that so many of the people who were involved then are no longer here."

Many of those people were recalled as partygoers looked over a display of photographs and news clippings commemorating the historic events of 25 years ago, prepared by Ron Clipper, technical supervisor at the AGS.



Derek Lowenstein (left) presents Ernest Courant with a backwards-running clock, symbolizing both the direction particles go in the AGS and the time that has passed since the AGS began operations, 25 years ago.

Peter Horton

graduate student of Cronin's; and Rene Turlay from Saclay in France, finished its measurements and were left with what Fitch has called "a suspicious-looking hump for which we waited to go away."

The hump never went away. It represented CP violation and, for its discovery, Cronin and Fitch received the 1980 Nobel Prize in physics.

CP is related to the theorized symmetry of the universe: When all particles are replaced by their antiparticles (charge conjugation, or C), while all their motions are replaced by their mirror images (parity, or P), the physics should remain the same. Under such a symmetry, neutral K mesons could not decay into two pions. But this team found that, two-tenths of one percent of the time, K mesons violate CP invariance and decay into two pions.

"This poses a fundamental problem for theory," Trueman acknowledges. "How CP violation is to be incorporated into the theory is still unresolved. The answer will probably be an important constraint in understanding what is the next level of theory that we go to."

"CP violation requires that the principle of time reversal invariance be violated as well," continues Trueman. "This was in contradiction to all the known equations of motion and made it difficult to accept the idea. But experiments ruled out alternative explanations, so in a fairly short time it was accepted. Since then, many experiments have looked for time reversal violation, but results were null." Other current experiments, some at the AGS, try to determine where CP violation is coming from

and the sizes of the parameters that define it.

Though CP violation is not yet fully understood, Christenson notes that "the significance of the experiment has taken on a broader view in recent years, because CP violation is now seen to help explain the fact that the universe is primarily matter, and not antimatter."

"This was a great undertaking — a brand-new chamber, a brand-new beam, and we were looking for something exciting. We were especially interested in it because of our interaction with Murray Gell-Mann at the CERN conference of 1962, where we had produced evidence for the discovery of the Ξ (1530), which is in the same multiplet as the Omega-minus."

— Nicholas Samios

1963, head of the New Group, which found the Omega-minus.

1985, Director of Brookhaven National Laboratory.

In December 1963, a BNL group led by Nicholas Samios began the first AGS experiment using the new 80-inch bubble chamber, designed by Ralph Shutt. By the end of January 1964, 133,000 bubble chamber photographs had been taken. In less than two weeks, they revealed a new particle made up of three strange quarks: the Omega-minus.

"The discovery of the Omega-minus was a capstone of the SU(3) theory," says Trueman. One aspect of that theory is the existence of groups of particles (multiplets) with similar properties. In one group of ten, the first nine particles are very unstable and decay quickly into lighter particles. But, says Trueman, "The patterns theorists were seeing predicted

(Continued on page 2)

A Party for the AGS

BROOKHAVEN, L.I., July 29 — Six years of effort were proved in one second here at 4:13 p.m. today as a gigantic atom smasher — newest and most powerful in the world — brought a four-foot-long, pencil-sized beam of atom particles 150,000 miles in that time.

With these words, Robert C. Toth, writing in the New York Herald Tribune of Saturday, July 30, 1960, chronicled the occasion on which BNL's Alternating Gradient Synchrotron (AGS) first reached its design energy of 30 billion electron volts. The Tribune is now long gone, but the AGS is celebrating its silver anniversary and looking forward to a future as bright as its past.

In celebration of these facts a 25th anniversary party was held at the AGS on Friday, March 22. Physicists, technicians, researchers, operators and others for whom the AGS is far more than a "facility," gathered at ringside to commemorate the events that preceded that exciting July day. As recounted by Derek Lowenstein, chairman of the AGS Department, the very first proton was injected into the AGS from the Linac on March 17, 1960, and, by March 29, protons from the Linac achieved 100 turns in the AGS ring.

A distinguishing characteristic of the AGS is alternating gradient (strong) focusing, which has become



Well-wishers crowd the AGS experimental floor at the party celebrating the accelerator's 25th anniversary.

Peter Horton

Rapid Access To Nuclear Data

The National Nuclear Data Center (NNDC) in the Nuclear Energy Department has an on-line computer system accessing nuclear data derived from its various data bases. The data consist of nuclear level, radiation and other selected properties of interest to both basic and applied research scientists. Also available on-line is the index to the bibliography on nuclear structure data published three times a year; the computer data base is updated weekly. The information can be retrieved on the basis of selection criteria supplied interactively by the user.

The data retrieval system is being offered to BNL users and can be accessed through a terminal reserved for such retrievals at the NNDC, Bldg. 197D, or through terminals with dial up capability. For details, contact Jag Tuli, Bldg. 197D, Ext. 5080 or 2901.

A Trial Run

In the summer of 1979, BNL tried gasohol and instituted gas rationing for government vehicles because of an energy crunch. Gasohol was not a success. Filters plugged up, hoses leaked, cars and trucks refused to run. But rationing worked. BNL gasoline consumption decreased in excess of 20% and this amounted to a savings of almost 40,000 gallons and \$21,160 at 1979 prices.

As gasoline became more plentiful, it also became more expensive. Proposals to cease rationing gas were not implemented because 40,000 gallons has represented about \$40,000 per year over the past several years.

Currently, BNL gas is 85¢ per gallon and management has decided to cease rationing on a trial basis, effective April 1. However, it does not intend to lose the money saved. A short-term increase is expected in April due to the filling up of tanks, instead of the usual five or ten gallons, but, after that time, if consumption increases without obvious cause, rationing will be reimplemented on a long-term basis.

Service Awards

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

Thirty Years

William Bornstein ... Nuclear Energy
Joseph Forrest ... Applied Science
Robert B. Gottschalk ... Accel. Dev.

Twenty-Five Years

Antone B. Chituk, Jr. ... Medical
Ronald L. Clipperton ... AGS
Peter T. Fallon ... Applied Science
Christian H. Harbach ... Accel. Dev.
Walter L. Hensel ... AGS
Russell F. Lowell ... AGS
Kenneth E. Robins ... Accel. Dev.
Gaylord N. Wall ... Safety & Env. Prot.

Twenty Years

William E. Anderson ... AGS
Kenneth R. Asselta ... Physics
Clarence E. Barrett ... Chemistry
Charles W. Carlson ... Physics
Horst W. Foelsche ... AGS
Eugen Johe ... Central Shops
Robert A. Lucas ... Central Shops
Daniel P. Mahalic ... Central Shops
Frank P. Martin ... Plant Eng.
David W. Niebuhr ... Applied Math
John T. Niemczyk ... Plant Eng.
Gary A. Smith ... AGS
Marguerite L. Stoeckel ... Fiscal
Albert L. Velasco ... Central Shops
Charles Zein, Jr. ... AGS

Ten Years

Mattie L. Brown ... Supply & Materiel
Elizabeth A. Mogavero ... Physics
Antonino Realmuto ... S&E Svcs.
Margaret H. Thompson ... Medical
Alois M. Wallner ... Safety & Env. Prot.



Mort Rosen

General William W. Hoover, Assistant Secretary for Defense Programs, DOE, visited the Lab on March 22 for a briefing on BNL research and a look at some of our major facilities. Here, at the HFBR, are (from left) Lab Director Nicholas Samios; Edward Cumenty, Assistant Manager for Lab Management, DOE Chicago; Associate Director Vincent O'Leary; General Hoover; Gerald Kinne, head of the Reactor Division; (behind Kinne) Associate Director Seymour Baron; and Deputy Director Martin Blume.

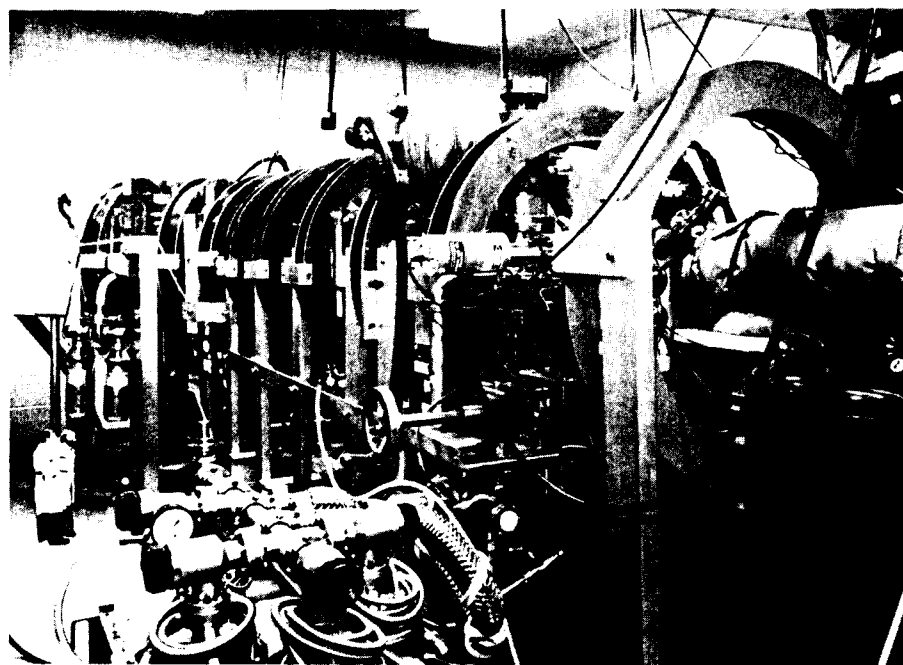
African Relief

The Afro-American Culture Club has concluded its drive for African relief and wishes to thank all those employees who contributed. Bruce Penn, the Club's special events chairman, advises that \$2,025 was collected at BNL and the check has been sent to UNICEF, which is coordinating relief supplies.

All film badges will be changed tomorrow. Please place your badge in its assigned rack space before leaving work today.

Coming Up

The Panocha String Quartet will give a concert at Berkner Hall on Thursday, April 11, at 8:30 p.m. The program includes works by Mozart, Beethoven and Dvořák. Tickets are \$8 for adults, \$5 for students and those over 65, and \$3 for those under 18. Tickets may be purchased at the door.



Mort Rosen

In their never-ending quest to produce more and more positrons, Kelvin Lynn and Mike Carroll (lower left-hand corner, right to left) built this larger-than-life positron beam line, which they affectionately refer to as the Annihilator. Over 16 feet high, 12 feet wide and 40 feet long, this one-of-a-kind positron factory sits upstairs in the Physics department. Since positrons go backwards in time, Lynn is using this beam to study things before they happen. Positrons are classified as antimatter or, in Lynn's terminology, "doesn't matter" because he claims that positrons aren't matter that really matters, while others claim that his research with the Annihilator doesn't matter. Regardless, the positron beam slowly depletes the matter making up the beam line. Therefore, Lynn and Carroll must rebuild this beam line every so often. This beam has shown that antimatter will levitate in a matter world, i.e., that positrons can overcome gravity and float in a vacuum. As a result of this research, Lynn and Carroll have built an anti-gravity machine (not pictured), for which a patent is currently pending. The positron beam line is currently down because all the positrons, under threat of arrest for parity violations, formed a suicide-murder pack with electrons and committed pair annihilation.

April Fool!

AGS

(Continued)

that there should exist another particle with a strangeness of minus three and a particular mass, which would not decay as quickly as the others in the group. The discovery of that particle, right where it was expected, established the theory as being the correct one, and this formed a solid foundation for the development of the quark theory."

According to "The Omega Particle Comes of Age" by Christine Sutton (New Scientist, 9/6/84), "Now...physicists can produce beams of the Ω^- , and one team...has measured the subtleties of the various ways in which the particle can decay. Such observations provide vital pieces of information in our understanding of quarks, the supposed building blocks of the Ω^- and other particles of matter, and of the nuclear forces that allow the quarks to change from one variety to another."

"When we first saw it, we knew something important, something new, something exciting had happened. But I didn't imagine, in the beginning at least, how big the impact was going to be."

— Y. Y. Lee

1974, BNL member of team that discovered the J particle.

1985, physicist at the AGS Department.

In November 1974, an MIT/BNL team headed by Samuel C.C. Ting of MIT was intrigued by a peak that dominated the data they had collected at the AGS. The peak indicated a new particle. Ting's team, which included Y. Y. Lee of BNL, called this the J particle. Meanwhile, at the SPEAR storage ring at SLAC, a group led by Burt Richter, using a different technique, had found a new particle they called the psi. When the researchers compared notes, it was obvious that they had discovered the same particle, now called the J/psi. Two years later, Ting and Richter shared the 1976 Nobel Prize in physics.

Recalling the discovery, Trueman says, "It came as a great surprise to find a resonance as narrow as what Ting found. There was a flurry of alternative explanations of what J/psi might be, so it gave theorists a lot of fun. But I think that, in our hearts, we all thought it was what it was, and the alternatives were soon ruled out."

The J/psi was confirmed to be a particle composed of a charmed quark bound to its antiquark. This finding, then, was the first clear indication of the existence of the charmed quark that was hypothesized as being necessary to complete the "second family" of fundamental particles.

The significance of this finding was summed up by Frank Close in his article, "Quarks and Their Forces"

(New Scientist, 11/8/84): "The discoveries of November 1974 and the ensuing months led to a fundamental step forward in our understanding of the strong nuclear force that binds the atomic nucleus together. [This] opened the way to incorporating this force with other basic forces in the so-called grand unified theories. Moreover, it revealed a window to a new view on the big bang and the origin of all matter in the Universe. Theorists in the mid-1980s now have a far rounder picture of the nature of the fundamental particles and forces, though there are still puzzles that remain to be solved."

"It took less than nine months from finding it to publishing it, and Bob Palmer and I were especially happy with this, in that we published it at a time when people were having doubts about charm being the explanation for the J/psi, because of the non-observance of strange particles at SPEAR."

— Nicholas Samios

1975, led the Omega Group, which found the charmed baryon.

1985, BNL Director.

Though the J/psi particle indicated the existence of charm, Trueman explains, "It was then important to see charm in a bare state, in which you had a hadron [a particle composed of quarks] which carried only one charmed quark, rather than a charm and an anticharm."

In 1975, a BNL group, which included Samios and Robert Palmer, now Associate Director for High Energy Physics Research, began searching for such a hadron in neutrino interactions that took place within the confines of the seven-foot bubble chamber at the AGS. From 100 events seen during the analysis of 62,000 bubble chamber pictures, one stood out in the spring of 1975. It turned out to be the first charmed baryon, a hadron made up of three quarks, one a charmed quark. This finding reinforced the interpretation of the J/psi particle and, says Trueman, "was another important step in establishing that we had a new member of the quark family."

Together, these five AGS experiments have left an indisputably valuable legacy to high energy physics theory, and many AGS experiments today are building on that foundation. Perhaps observations of rare K decays will shed light on the nature of CP violation, or neutrino oscillation experiments will answer questions about the exact conservation of muon or electron quantum numbers, or studies of Omega-minus production and decay will increase our understanding of quarks. But whether they yield significant surprises or small increments of knowledge to confirm existing theories, all are contributing to the further understanding of high energy physics.

— Anita Cohen

BROOKHAVEN BULLETIN

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NYC Train Trip

In addition to the regular Wednesday LIRR trips to New York City, the Hospitality Committee will sponsor a group trip to the city on Saturday, April 6. Departure will be at 8:31 a.m. from the Patchogue LIRR station. Round-trip fare for adults is \$6.50; children under five years ride free.

Reserve a ticket by sending your fare through the U.S. mail to BNL, P.O. Box 322, Upton, New York 11973. Please do not send cash. Checks or money orders, payable to BNL, must be received no later than Thursday, April 4. Put the date of the trip, your telephone number, and your BNL life number on your check. Reservations will be accepted on a first-come, first-served basis. Your tickets will be given to you on the train.

New Store Hours

The BERA Sales and Service Office in Berkner Hall will now be open from 11:00 a.m. to 4:00 p.m. This change will become effective Monday, April 1.

For quick processing service, exposed film must be brought to the Sales Office by 1:30 p.m.

Egg Hunt

The Suffolk County Farm & Education Center's 2nd annual Easter Egg Hunt will take place on April 6 from 11 a.m. to 2 p.m. Children ages 3-4 will gather eggs beginning at 11 a.m., 5-7 year-olds will start at noon, and ages 8-9 will collect eggs at 1 p.m. Parents will only be permitted to accompany the youngest group on the hunt. Specially marked eggs will designate winners of Easter baskets filled with goodies. The Farm is located in Yaphank. For directions, call 924-4535, Ext. 507.

Hospitality News

The Hospitality Committee's next monthly get-together will be held Tuesday, April 2, from 9:30 to 11:30 a.m. at the Brookhaven Center.

Wives of Laboratory employees and guests are welcome. Please come and bring the children; babysitting will be provided free of charge. Coffee, tea and danish will be served.

As part of this get-together, Adrienne Usher, a BNL tour guide and member of the Hospitality Committee, will conduct a tour of the Laboratory site and Exhibition Center. If you are interested in taking the tour, the bus will leave the Brookhaven Center at 10 a.m.

Arrivals & Departures

Arrivals

Michael L. Knotek NSLS

Departures

This list includes all employees who have terminated from the Laboratory, including retirees:
Thomas E. Williams, Jr. Pl. Eng.



Peter Horton

As of Wednesday morning, this is how the Danish House looked. As pictured, the stacks of tiles are ready for Mason Ole Hauerberg to lay on rows of timber strips that sit over an underlay of reinforced plastic foil. The window at right is that of a bedroom; the floor to ceiling window on the left is for the living room. Over the house flutter the American and Danish national flags, and the banner of Hosby, the Danish corporation that designed and prefabricated the house. The five Danish housebuilders began putting the house on its foundation on Wednesday, March 20, with Foreman Tage Steffensen and Carpenter Frank Petersen responsible for most of the construction. The house was erected by March 22, and the workmen are now doing the finishing.

BERA News

BERA Board Election Winners



Lois Marascia



Bernie Silverstein

Lois Marascia and Bernie Silverstein won the 1985 BERA Board election held last week. On May 1, they will replace outgoing Board members Sandi Lane and Jim Roesler, and join incumbents John Connelly, Mickey Haller, Ken Sutter and Ed Taylor.

The Board would like to thank all those who contributed to the success of the election: the nominating committee for its selection of an outstanding slate of candidates, the four candidates for agreeing to accept the nominations, and of course, the voters for taking the time to cast their ballots.

The Board would also like to remind employees that Board members are elected by you to act as your BERA representatives. You are encouraged to talk to them about suggestions or complaints you may have relating to Lab recreation activities.

Hispanic-American Society

A meeting of the BNL Hispanic-American Society will be held Wednesday, April 3, at 11:45 a.m. in Room A of Berkner Hall. New members are welcome.

R/C Airplane Club

The regular meeting of the R/C Model Airplane Club will be held on Tuesday, April 2, at noon in Room D, Berkner Hall. Everyone is welcome.

Radio Club

The BNL Amateur Radio Club will meet at noon, on April 3, at the club station which is located on the second floor of the Recreation Building. The discussion will include radio club communications, support of an upcoming BNL Runners event and other items.

Basketball

First Game

Hollywood - 63

R. Domenech	1
G. Grigg	6
R. Kowalski	2
G. Mack	11
E. Meier	18
D. Nordstrom	14
A. Richardson	11

Runaways - 59

S. Gilbert	15
T. James	23
T. Mooney	4
G. Shepherd	12
G. Smith	2
S. Woodson	3

Second Game

Coasters - 78

K. Cosgrove	10
R. Doty	21
H. Fulkerson	2
F. Malone	14
B. Allen	21
L. Smith	6
A. Washington	2
M. Williams	2

Longshots - 74

J. Gaffney	8
J. Garrison	17
L. James	21
R. Rowley	10
E. Taylor	6
L. Walcott	12

Pool Shutdown

The swimming pool will be closed for building repairs during the months of April and May.

Holders of season tickets (valid to May 5) will have the option of receiving a cash refund amounting to one-quarter the value of the ticket, or have that amount held as credit for the purchase of a new season ticket when the pool reopens.

Refunds will be distributed the first two weeks in May. Ticket holders are asked to call Ext. 2873 to inform the Recreation Office of the option they selected.

Swim Club

Since the BNL pool will be closed, the April 4th meeting of the Swim Club will be held at the Brookhaven Town/Mastic YMCA pool. It will be an informal practice session. The order from Ocean Pool has arrived. To pick up your equipment, contact Barbara Fleck, Ext. 3052. She also has extra nose clips at 75¢ and hand paddles at \$2. For general information, call Marsha Belford, Ext. 3327, or Mark Catan, Ext. 2504.



"I didn't say you were a hypochondriac. I merely said, not many people have monogrammed pills of their very own."

