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## CERN "Yellow" Reports

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In order to release scarce resources at CERN, the ordering and distribution by the Scientific Information Service of reprints of CERN papers had to be brought to an end last year. As a consequence, the well-known monthly 'List of CERN publications' card was also discontinued.

However new publications in the CERN 'Yellow' report series, as well as the less frequent CERN-HERA reports, will now be listed in the CERN Courier. The first titles in 1988 are listed below. Copies may be obtained by writing to: CERN Scientific Information Service, CH-1211 Geneva 23, Switzerland, or by sending a bitnet electronic mail message to LIBDESK at CERNVM.

CERN 88-01, Evans, L., *The proton-antiproton collider CERN*, 11 Mar 1988. – 17 p.

CERN 88-02, Mulvey, J.H. (ed), *The feasibility of experiments at high luminosity at the Large Hadron Collider: report of the High-Luminosity Study Group to the CERN Long-Range Planning Committee*, CERN, 22 Apr 1988. – 93 p.

CERN 88-03, Verkerk, C. (ed), *1987 CERN School of Computing, Troia, 13 – 26 Sep 1987*, CERN, 8 Jun 1988. – 436 p.

CERN 88-04, Hagel, J.; Keil, E. (eds), *2nd Advanced ICFA beam dynamics workshop, Lugano, 11 – 16 Apr 1988*, CERN, 29 Jul 1988. – 236 p.

CERN 88-05, Bengtsson, J., *Non-linear transverse dynamics for storage rings with applications to the low-energy antiproton ring (LEAR) at CERN*, CERN, 1 Aug 1988. – 142 p.

CERN 88-06 v 1, Alexander, G.; Altarelli, G.; Blondel, A.; Coignet, G.; Keil, E.; Plane, D.E.; Treille, D. (eds), *Polarization at LEP, v 1*,

CERN, 1 Sep 1988. – 357 p.

CERN 88-06 v 2, Alexander, G.; Altarelli, G.; Blondel, A.; Coignet, G.; Keil, E.; Plane, D.E.; Treille, D. (eds), *Polarization at LEP, v 2*, CERN, 1 Sep 1988. – 266 p.

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## APS Committee

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For 1989, the Executive Committee of the Division of Particles and Fields of the American Physical Society will consist of: Fred Gilman (SLAC, Chairman), Ed Berger (Argonne, Vice-Chairman), Barry Barish (Caltech, Past Chairman), Adrian Melissinos (Rochester, Divisional Councillor), Bill Bardeen (Fermilab), Lowell Brown (Washington), Paul Langacker (Pennsylvania), Juliet Lee-Franzini (Stony Brook), Greg Loew (SLAC), Mike Witherell (Santa Barbara), and Bruce Barnett (Johns Hopkins, Secretary/Treasurer).

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# Luis Alvarez – a personal approach to physics

*One of the major pioneer figures and outstanding personalities of particle physics, Luis Alvarez, died on 1 September. In addition to his numerous particle physics achievements, he became famous for his ventures in archaeology, palaeontology, and astronomy, and for his inventions. As a tribute to this remarkable man, we publish here some extracts from 'Adventures in Nuclear Physics', given as the 1962 University of California Faculty Research Lecture. According to custom, this presentation is a personalized account rather than an impersonal scientific discourse.*

*(Some of this material is also included in his 1987 autobiography 'Adventures of a Physicist', published by Basic Books, New York.)*

As an undergraduate research project at Chicago my advisor suggested that I build one of the new fangled Geiger-Müller counters that he had recently read about in the German literature. He assigned me a room of my own on the first floor of the famous Ryerson Laboratory, which I soon learned had been Millikan's laboratory when he had made his historic measurement of the charge on the electron, using the oil drop technique. Of course, I had to build the metallic parts of the counters in the student shop, and then seal them into glass envelopes myself, and evacuate them on a vacuum system I had put together, while learning the art of glass blowing. The most difficult part was the amplifier, because the laboratory didn't own a cathode ray oscilloscope, a signal generator or a vacuum tube voltmeter. For the first two months, when things didn't work, I had no way of telling whether the trouble was in the

counter or in the amplifier. But finally, after making every kind of mistake you can imagine, and some that I'm sure my friends who are electronic experts would absolutely refuse to believe could be made, the counter did work. No one in the department had seen such a device before, and I was invited to demonstrate it, and talk about it at the weekly Physics Department colloquium. Actually, I was only allotted half of the hour, because it wasn't thought proper for a mere undergraduate to take up a full hour of the department's time. This was my first scientific talk, and I can remember rehearsing it several times in one of the basement rooms.

About this time, Arthur Compton took an interest in my work, and I became one of his graduate students. In my first year as a graduate student, Professor Vallarta of MIT gave a talk at Chicago in which he showed how one could tell the

# **CEBAF**

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The 4-GeV Continuous Electron Beam Accelerator Facility now under construction in Newport News, Virginia, is searching for staff scientists as members of the group responsible for data acquisition.

The experimental equipment, which includes high resolution and large acceptance magnetic spectrometers, requires state-of-the-art data acquisition systems capable of selecting and analyzing complex events at high data rates. Candidates should have an advanced degree in Physics, Electrical Engineering, or Computer Science, and several years of experience in the development of scientific data acquisition systems.

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### **ASSISTANT PROFESSORSHIPS**

The Department of Physics at the University of Virginia is seeking qualified applicants for tenure track assistant professor positions for an experimental high energy physics group now in the process of formation.

This group has a major involvement at Fermilab in heavy flavor physics in experiment E705 and in beauty physics in experiment E771.

They also have a strong interest in future beauty physics options at both Fermilab and/or the SSC. Candidates should have compatible research interests.

Interested parties should submit a resume and the names of at least three references to:

**Professor Michael Fowler, Chairman  
Department of Physics  
J.W. Beams Laboratory of Physics  
University of Virginia  
McCormick Road  
Charlottesville, Virginia 22901**

Phone: 804/924-3781

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An opportunity exists for an individual with a broad background in experimental particle accelerator physics. Activities will be directed to the operation and enhancement of the existing storage rings of the NSLS. Important areas of work are the study of beam intensity limiting effects, orbit stabilization, and the development of the related hardware and diagnostic instrumentation. The successful candidate will also be involved in the design, construction, and commissioning of a compact, superconducting storage ring dedicated to X-ray microlithography. Candidates are expected to have a strong record of accomplishment in the field of accelerator science; and the capacity for independent work and for coordinating team activities.

Applications should be sent to Dr. G. Vignola, Accelerator Physics Section Head, National Synchrotron Light Source, Building 725C, Brookhaven National Laboratory, Associated Universities, Inc., Upton, L.I., NY 11973. Equal Opportunity Employer m/f.



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## **RESEARCH ASSOCIATE**

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Applications are invited for a research associate-ship in heavy-ion collisions at ultra-relativistic energies.

The research will be carried out with a muon spectrometer within the HELIOS collaboration. Sulfur beams at 200 GeV/nucleon provided by the SPS at CERN will be used, with lead beams anticipated in the future to search for signals of the quark-gluon plasma.

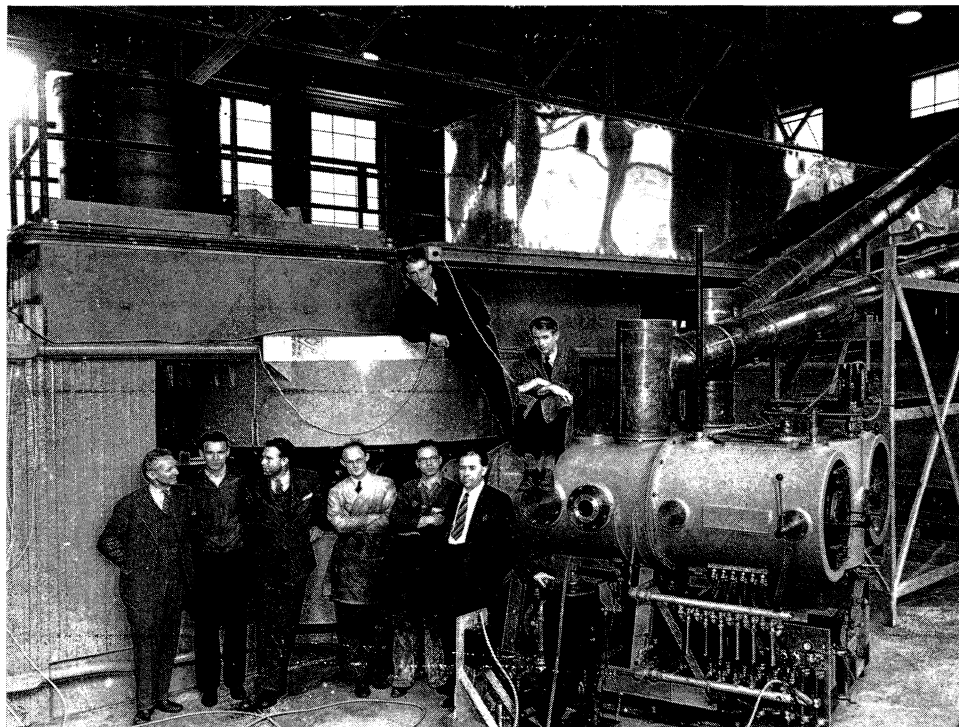
Preference will be given to candidates with strong backgrounds in data acquisition systems and analysis.

The successful applicant will be based at CERN. Appointments are made for one year but may lead to a more permanent position.

Send resume and three letters of recommendation to:

**Prof. P. Taras  
Laboratoire de physique nucléaire  
Université de Montréal  
Montréal, Québec, Canada H3C 3J7.**

*In 1939 at the Berkeley 60-inch cyclotron, Luis Alvarez showed that helium-3 was a stable constituent of ordinary helium. This 1944 picture of the cyclotron shows, left to right, Alvarez with Edwin McMillan above, with Donald Cooksey, D. Corson, Ernest Lawrence, Robert Thornton, John Backus and Winfield Salisbury below.*



sign of the electric charge of the cosmic rays, by using an arrangement of Geiger counters.

Several physicists had looked for an effect, and not found it. Vallarta pointed out with great excitement that they had all done their looking in temperate latitudes, where the magnetic field of the earth had no measurable effect on the rays. He predicted that in his native Mexico City there would be a large effect.

Arthur Compton realized at once that he had no apparatus that was directionally sensitive, so he asked me if I would like to take my Geiger counters to Mexico City. He said that Tom Johnson, a well-known cosmic ray physicist from Swarthmore had heard Vallarta's talk and planned to have a look for himself. Vallarta said he would take leave from MIT, and be our host in Mexico City. I worked feverishly to get my apparatus in shape – it had to be converted to battery operation, because the Mexican AC voltage

was notoriously variable, and stabilized power supplies hadn't been invented yet.

Johnson and I arrived in Mexico City on the same day, and set our apparatus up on the roof of a small hotel. We started measuring cosmic ray intensities a few days later, and, within a few hours of each other, had found the so-called East-West effect. We both concluded that the rays were positively charged. We published our data independently in the same issue of the *Physical Review*, and it was with pride that I saw my first serious paper signed "Alvarez and Compton".

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#### *Berkeley*

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The second stage of my scientific life was the four and a half year period I spent in Professor Lawrence's old wooden laboratory at Berkeley. It was the most stimulat-

ing experience in my career. Everyone worked long hours in the wonderful spirit of cooperation that Ernest Lawrence instilled in his co-workers by the example he set, and by the strength of his personality. As I look back through the collected reprints of the prewar Radiation Laboratory, it is hard for me to convince myself that we really did do that much scientific work, because we had none of the luxuries that are available to physicists today. Today's machines are operated and serviced by professional crews. We serviced the cyclotron ourselves, and when the tank was removed from the magnet for repairs, which was frequently, we did the repair work on a 24-hour basis. We took turns operating the cyclotron, while other members of the laboratory staff made measurements on their individual pieces of apparatus. We built our own apparatus, both mechanical and electronic. The reason I find it hard to believe that I turned out a substantial amount of physics in those days is that any time my mind flashes back to that period, I see myself standing at a lathe, hunting for vacuum leaks in the cyclotron system, cleaning out a tar-filled heat exchanger, or wiring up an electronic chassis.

When Felix Bloch and I made the first measurement of the magnetic moment of the neutron in 1938 and 1939, we ran on the 37-inch cyclotron for weeks at a time, with time off only when the machine was used to treat cancer patients, or to prepare radioactive samples for the experiments of other members of the laboratory staff. The recording counters, and the control mechanisms for that experiment were set up close to the cyclotron control desk, so that I could operate the cyclotron myself, and take

## Divisional Fellow In Theoretical Particle Physics

The Lawrence Berkeley Laboratory is seeking an outstanding theoretical particle physicist for appointment as Divisional Fellow in its Physics Division. The position has a term of up to five years, with the expectation that the Fellow's professional accomplishments may lead to promotion to Senior Scientist.

Applicants will be considered from all areas of theoretical high energy physics. Theorists with interests in experimental particle physics or with interests in more formal or mathematical areas are invited to apply. Two or more years of post doctoral experience is preferred. The successful applicant is expected to contribute substantial original research to the theoretical program at LBL.

The monthly salary range for Divisional Fellows is \$3300 — \$5800.

Please send inquiries with professional resume, list of publications and names of four references to: **Dr. Piermaria Oddone, Director, Physics Division, c/o Gloria Bayne, Job #B/4945, Lawrence Berkeley Laboratory, #1 Cyclotron Road, Bldg. 90-1012, Berkeley, CA 94720.** Applications should be received before **FEBRUARY 15, 1989.** An equal opportunity employer, m/f/h.



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## UNIVERSITY OF VIRGINIA EXPERIMENTAL HIGH ENERGY PHYSICS

### POST DOCTORAL POSITIONS

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This group has a major involvement at Fermilab in heavy flavor physics in experiment E705 and in beauty physics in experiment E771. The UVa group also has a strong interest in future beauty physics options at both Fermilab and/or the SSC.

Interested parties should submit a resume and the names of three references to:

**Professor B. Cox  
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J.W. Beams Laboratory of Physics  
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## LAL ORSAY ASSOCIATE PROFESSOR in Accelerator Physics

The Laboratoire de l'Accélérateur Linéaire (LAL) at Orsay (Université de Paris-Sud) is involved in a program of research and development in the field of electron linacs: generation of short and intense bunches, RF structures at high fields.

It is planned to enlarge the accelerator research program particularly in collaboration with CERN and other laboratories interested in the development of techniques required for the construction of future  $e^+e^-$  linear colliders. The laboratory has excellent technical expertise for building  $e^\pm$  accelerators (ACO and DCI storage rings, LIL injector for LEP, linac for CLIO free electron laser) and a good general support.

We are therefore looking for candidates with a solid background in accelerator physics to fill a tenured position at the Associate Professor level. It is expected that such a person would generate novel ideas, stimulate and lead new research projects, and supervise students. In addition, he or she would be involved in teaching activities in the physics department.

Any inquiry should be addressed to:

**Professor Michel DAVIER  
Laboratoire de l'Accélérateur Linéaire  
Université de Paris-Sud  
Bâtiment 200  
91405 ORSAY CEDEX, France  
Tel. (1) 64 46 83 01  
Bitnet: DAVIER at FR LAL 51**

Applicants should send their curriculum vitae, a statement of research interests, a publication list and arrange to have letters of recommendation sent to the above address.

## Sincrotrone Trieste

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for the Elettra Project

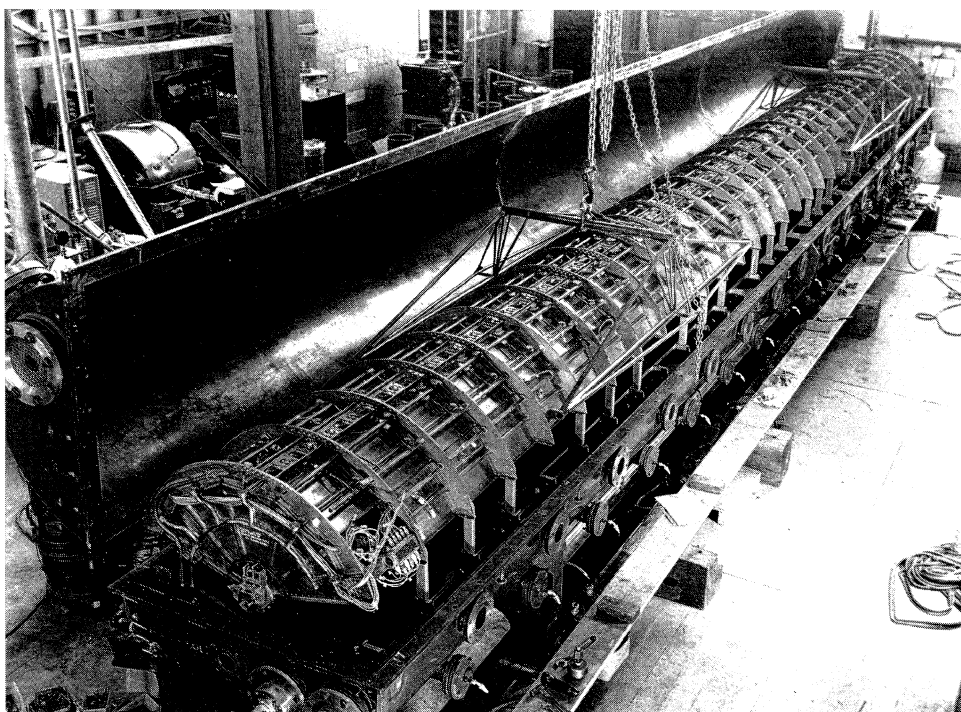
Elettra is a third generation synchrotron radiation source currently under construction in Trieste, Italy.

The task will be to contribute to the final design of the project and to follow the construction phase with theoretical work and numerical calculations as well as to contribute to the preparations for the commissioning. Besides his/her theoretical involvement, the candidate should be interested in the practical aspects of accelerator construction.

**Sincrotrone Trieste  
Padriciano, 99  
34012 Trieste — Italy**

Ref.: N. AW/TC/02

*The 40-foot radiofrequency cavity of the Alvarez proton linac, built in less than two years after Alvarez returned to Berkeley in 1945.*



experimental data at the same time.

Soon after I came to Berkeley, Lawrence raised \$ 50,000 to build a 60-inch cyclotron. He told me one day, that he wanted me to design the best magnet to fit into that budget. When I said that I didn't know anything about magnets, he merely said, "You'll learn".

The shielding for the 60-inch cyclotron couldn't be designed until the machine was finished and operating, because no one could predict how penetrating the radiation from such a machine would be. Until the shielding was fabricated, the machine couldn't be used for most of its normal purposes, which required high intensity beams. During this period of enforced idleness as an operating cyclotron, one of my graduate students, Robert Cornog, and I converted the machine into a sensitive mass spectrometer, and discovered helium-3.

Until 1932, hydrogen was believed to consist of a single isotope of atomic mass one, and helium was believed to consist of a single isotope weighing 4 atomic units. Then Harold Urey, acting on a suggestion of our own Professor Birge, found the rare isotope of hydrogen, with mass two, now known as deuterium. A year later, Rutherford and his co-workers in Cambridge discovered the famous fusion reactions. The British group found that when two deuterons reacted, the final products of the reactions contained either a helium nucleus of mass three, or a hydrogen nucleus of mass three. These newly discovered nuclei could only be observed when they were moving at high speed, so no one knew what happened after they slowed down and picked up the one or two electrons they needed to turn themselves into atomic systems.

Two independent arguments convinced everyone that helium-3 was radioactive, and that hydrogen-3, or tritium as it is now called, was stable. Stable tritium should therefore occur naturally in water, along with ordinary hydrogen and deuterium. We went on to show that these arguments were wrong.

Lord Rutherford's last published paper, just before his death, dealt with a search for stable tritium in a highly concentrated sample of heavy water. He searched the sample for tritium, using the most sensitive mass spectrometer then available, and found none present. Had there been the slightest question in his mind about the possible radioactivity of tritium he would have put the sample near a Geiger counter, and seen it go wild. Professor Libby found the old concentrated sample in the Cavendish Laboratory mu-

seum in Cambridge after the war, and even then, ten years after Rutherford's death, it made a counter rattle with its radioactivity!

I made one major goof, because I didn't realize how important a certain observation would be. As soon as fission was discovered, (and Ken Green and I verified it the day it was announced in the daily papers), everyone guessed that neutrons would be emitted at the same time, and these would make the chain reaction possible. My neutron time-of-flight apparatus seemed an obvious way to find these neutrons, if they existed, because it could yield a flux of pure thermal neutrons; something that no one else in the world had available at that time. I went over to the

*Alvarez (second from right) and colleagues with bubble chambers built over the years.*





chemistry storeroom, and signed out for a few pounds of uranium oxide. I put this near my big counter, and looked for the secondary neutrons. When I didn't see any effect in a couple of minutes, I merely said, "Too bad", and went back to what I was interested in at the time. There is no doubt that had I taken an hour off to move the counter closer to the cyclotron, and to collect some more uranium, the counts would have been there.

After five years of wartime science and engineering, I returned to Berkeley in 1945, to begin another phase of my career. While at Los Alamos, I had decided that when I returned to Berkeley, I would build a high energy linear electron accelerator, employing the techniques I had learned in my radar work, and using the huge store of surplus radar equipment that would be flooding the peacetime market. My tentative plans were well along, when Ed McMillan told me of the synchrotron, which he had invented the day before. It was so obviously better than what I had

in mind, that I immediately dropped all plans for accelerating electrons and decided to do a similar job on protons. General Groves gave the laboratory a blank cheque to rebuild its facilities after the war, so the only problems were technical. I assembled a hard working team of former colleagues, and in just under two years, we had a beam from the 32 million volt proton linear accelerator. In this period of time, we learned how to solve some new and difficult technical problems in the field of radiofrequency engineering, and put together the highest energy Van de Graaff generator then attempted. Our 32 million volt protons held the high energy record in their field for over a year, until the 184-inch cyclotron was converted to accelerate protons to 350 million volts.

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#### *Bubble chambers*

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I met Don Glaser at a meeting of the Physical Society, and heard about his wonderful invention of

the bubble chamber. I went away with a resolve to try liquid hydrogen as soon as I got back to Berkeley, and to try to build large chambers to use at the Bevatron. The story of our progress from very small hydrogen chambers is *physics history* (ed).

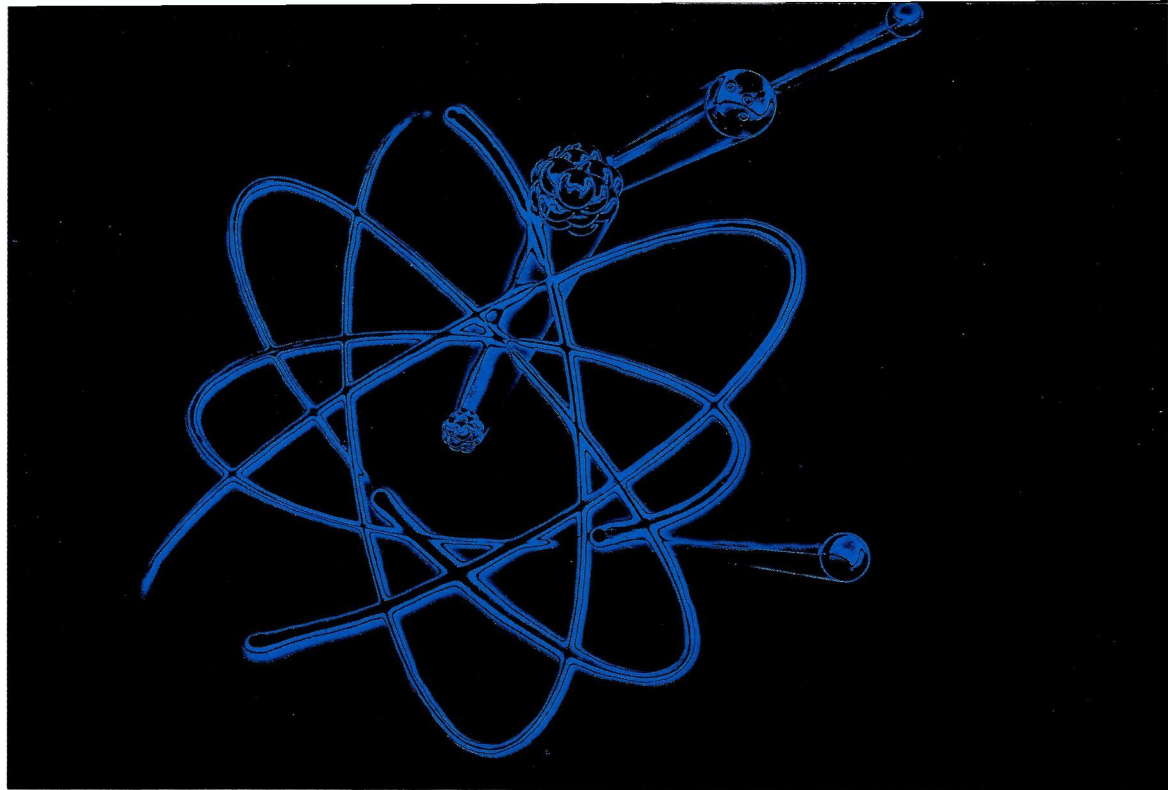
I am naturally much prouder of the important physics that has come from our family of hydrogen bubble chambers than I am of the chambers themselves. If I had to single out one discovery that was made possible by the chambers, I would talk about the catalysis of fusion reactions by mu mesons. I had the pleasure of being a working physicist on the ten-inch bubble chamber experiment at the time this quite unexpected reaction showed up. The fact that it was quite unexpected, and that it took our keenest powers of observation to find it, are the qualities that put it in the adventure class, as far as I am concerned. However this has to do with my personal taste in physics.




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March 24, 1959, first operation of the Berkeley 72-inch hydrogen bubble chamber at Berkeley. With Alvarez (left) are Bob Gow, Bob Watt and Paul Hernandez.

(Photos LBL)



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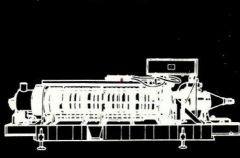
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