

# Lawrence Berkeley National Laboratory

## Recent Work

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NUCLEAR SCIENCE DIVISION NEWSLETTER  
Lawrence Berkeley Laboratory  
Berkeley, CA 94720

**For Reference**

**Not to be taken from this room**

Vol 5, No. 1 January 1980

Associate Director: Joseph Cerny

Editor: Jeannette Mahoney

Single Overhead Plan Adopted

The decision has now been made to absorb divisional overhead into the Lab overhead, simultaneously eliminating support burden, for FY'81. FY'80 will not be affected, but on October 1, 1980, the Lab will switch to the single overhead system.

Diamond, Stephens Awards

Dick Diamond and Frank Stephens have been awarded the Tom Bonner Prize in Nuclear Physics of the American Physical Society for their contributions to the understanding of high spin states of nuclei. The citation reads, "Their studies of multiple Coulomb excitations with heavy ions, of multiple gamma ray cascades, and of the effects of the Coriolis coupling in rotational spectra are important ingredients in our understanding of rapidly rotating nuclei."

The award will be presented at the Washington meeting in April.

Winter Workshop

A small conference has been organized for the week of March 17-21 at Granlibakken at Lake Tahoe. It is titled the Winter Workshop on Nuclear Dynamics, and will deal mainly with the macroscopic aspects of nuclear collisions at low, medium and high energy. There will be morning and evening sessions, leaving the afternoons free for private discussions, skiing, or simply enjoying the mountain air. Similar conferences have been very successful in Europe, and it is hoped that the winter workshop will become an annual event. The organizers are Bill Myers, Jorgen Randrup and Gary Westfall.

Visitors in March

The Visiting Committee will be at LBL on Thursday and Friday, March 6 and 7.

Orientation Lectures

Environmental Health and Safety orientation talks are being given every Friday from 9 to 10 o'clock in the Bldg. 70A conference room. All those not familiar with safety procedures are urged to attend.

NSD members are reminded about the restrictions on transportation of radioactive materials. EH&S services should be used for transportation of all radioactive samples, regardless of level, and private autos or commercial transportation should not be used under any circumstances.

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ARRIVALS AND DEPARTURES

Steffan Bohrmann from the Max Planck Institute arrived in January to spend one year with the Theory group.

Luo Cheng from the Institute of Atomic Energy in Beijing has joined the Seaborg group for a year and a half.

Seiji Kadota of Hiroshima University will be working with Herb Steiner until November of this year.

Walter Loveland is visiting the Seaborg group for three months.

David Bullmore has left the lab to travel around the world. He has been working on the ISEE data for the past year with the Heckman/Greiner group.

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SEMINARS

NSD Monday seminars, 4:00 p.m., 70A-3377

- Feb. 4            E. L. Alpen (LBL)  
                  Bevalac Biomedical Science
- Feb. 11           Barry Berman (LLL)  
                  Coulomb Dissociation of  $^{18}\text{O}$
- Feb. 18           Cornelius Noack (Bremen and LBL)  
                  Cascade Calculations of High Energy Nuclear Collisions
- Feb. 25           STUDENT TALKS

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REPORTS

Copies of these reports can be obtained from Idola Davis in the NSD office. In addition, a copy of each can be found in the Bldg. 88 Library.

- LBL 8407        A Non-Equilibrium Statistical Mechanical Approach for Describing Heavy Ion Reactions  
                  Joseph Sventek
- LBL 9878        Current and Future Directions in the Study of Light Nuclei Employing an On-Line Mass Separator  
                  Juha Aystö and Joseph Cerny
- LBL 9979        Use of A Streamer Chamber for Low Energy Nuclear Physics  
                  K. Van Bibber, W. Pang, M. Avery, and E. Bloemhof
- LBL 10054      Imaging and Identification of Relativistic Projectile Fragments with Lexan Spectrometry  
                  J. D. Stevenson, P. B. Price, and M. P. Budiansky

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RESEARCH

In compliance with the DOE directive to cut back on energy use, the winter shutdown of the Bevalac and SuperHILAC will be extended to about mid-March or the first of April. In order not to lose running time, however, the summer running period will be extended into August and September.

Bevalac News

Cherchez La Femme, or Has a Body Been Found?

At a joint Bevalac Research Meeting/Nuclear Science Division Seminar on Jan. 14 and 15, Erwin Friedlander compared his role with that of a police inspector trying to determine whether a crime had been committed 26 years ago on the basis of evidence produced at the time and in intervening years. In the metaphor, his current efforts are an attempt to produce a body.

In 1954 at a conference in Italy, the first presentation was made of cosmic ray data which showed an apparent shortening of the mean free path of particles passing through an emulsion. From a stack that had been placed in a balloon and flown at high altitude, the experimenters had observed five collisions in 10 cm, where one could expect perhaps one. Similar behavior was seen by other experimenters over the next period of years, but because of the uncertainties associated with cosmic rays, none of it was taken very seriously. One thing was certain, however, from this data, and that was that where mean free paths of tens of centimeters should have existed, mean free paths of centimeters seemed to be found, resulting in an enhancement of one order of magnitude in cross section for a lot of interactions.

In a collaborative effort, Barbara Judek and M. E. Stott of the National Research Council (NRC) in Ottawa and a Berkeley group consisting of Harry Heckman, Roy Gimpel, E. Ganssaue, Hester Yee, Yasha Karant and Friedlander exposed stacks of emulsions to Bevalac beams and analyzed the results. The NRC stacks were exposed to beams of  $^{16}\text{O}$  at 2.1 GeV/A in the early 70's when these beams were first available, and the LBL researchers used the first available Fe beam at 1.88 GeV/A. All primary tracks were followed and the results were based on the total track lengths observed in one method, called method A, and on concrete distributions of interaction lengths in method B. At NRC the tracks were followed until they either had an interaction or left the stack; at LBL, where the stacks were shorter, until they had a collision or left the plate. When an event occurred from a primary track, each relativistic fragment from that collision was followed until it in turn interacted or left the stack and subsequent collisions were treated in the same way. At NRC fragments of charge  $\geq 2$  were selected, and at LBL, charge  $\geq 3$ . All the projectile fragments are produced in a narrow cone of about 6 degrees and they frequently interacted within one 600-micron thick pellicle.

At LBL interactions were found up to the 5<sup>th</sup> generation and at NRC up to the 7<sup>th</sup>. The primary interactions were in the thousands and there were still over 500 events in the third generation, a large increase of statistics over the cosmic ray data. The charge resolution of the emulsions were sufficiently good to avoid ambiguity. The mean energy of each secondary and tertiary particle at the point of interaction was about 1.8 GeV/A for the O beam and 1.5 GeV/A for the Fe beam.

The key observation of the experiment is that the tertiary fragments had mean free paths about 15% lower than those of the primaries and secondaries of the same charge. Because the detectors were of finite size, there was no simple way to represent geometrically by graphs the distances between interactions; but it was necessary, and possible, to establish probabilities for such interactions using conventional statistical methods.

In method A, where all tracks were considered, the experimenters found the shorter mean free paths found to have a probability of about  $10^{-3}$ , had they been measured using primary beams. The B method, where only interacting tracks are considered, had the effect of producing an "enriched" sample. With this method, statistically meaningful results could be obtained with fewer statistics, and likelihood curves were extracted that showed indications of short mean free paths that were not due to chance fluctuations. Monte Carlo calculations were performed and treated as though they were real data; when a few percent of particles with a mean free path of about 3 cm (about one order of magnitude shorter than normal) was mixed into the calculations, everything fell into place and there was no contradiction between the modified Monte Carlo and the experimental results.

The conclusions were that tertiary particles have been observed with mean free paths shorter than those of the primaries and secondaries and that the probability of these being chance fluctuations is very low. The experimenters now want to repeat their studies with statistics at least four times better in order to identify the body, and then maybe the criminal.

The Bevalac Users' Association Meeting will be held Friday and Saturday, February 22 and 23. Friday morning there will be a general session dealing with status reports, and a session on VENUS. In the afternoon there will be talks on HISS, and workshops which will continue on Saturday morning. A Plenary Session and a combined Nuclear Science and Biomedical Session will be held on Saturday afternoon. There is a \$6 registration fee to cover refreshments, which include a wine tasting at the LBL cafeteria from 5:30 to 7:00 pm Saturday evening, and the cafeteria will serve a buffet lunch on Saturday at a cost of \$4 per person. Additional information can be obtained from Gary Westfall or Howel Pugh.

### SuperHILAC News

Because of the change in operating schedule, the next SPAC meeting will be held on March 26-27, and the deadline for proposals has been postponed until February 22.

### 88-Inch Cyclotron News

Angular Momentum Transfer in Heavy Ion Reactions at 7.5 to 22.4 MeV/A

G. J. Wozniak, L. W. Richardson, D. J. Morrissey, C. C. Hsu, G. U. Rattazzi and L. G. Moretto

In two recent experiments at the 88-Inch Cyclotron, we bombarded a  $^{181}\text{Ta}$  target with 7.5, 10.0, 17.2, and 22.4 MeV/A  $^{20}\text{Ne}$  beams. These measurements were part of an excitation function to study the Q-value dependence of the gamma ray multiplicity,  $M_\gamma$ , for peripheral collisions as they go through the transition from the low energy one-body dissipation regime to the higher energy two-body dissipation regime. In the first phase we intend to use beams of 10 - 35 MeV/A at the 88-Inch Cyclotron, and in the second phase, beams of 35 - 100 MeV/A at the Low Energy Beam Line of the Bevalac.

At very low bombarding energies ( $< 10\text{MeV/A}$ ),  $M_\gamma$  is strongly correlated with angular momentum transfer, which in turn is strongly correlated with mass transfer in a one-body mean field. As the bombarding energy is increased the effective interaction time decreases, and in addition the orbital angular momentum available for transfer into intrinsic spin becomes large. If the transfer does occur, one could conceivably use deep-inelastic reactions at about 20 MeV/A to produce nuclei at very high spins near the liquid drop limit.

A preliminary analysis of the  $^{20}\text{Ne}+^{181}\text{Ta}$  data averaged over projectile-like fragments with  $Z = 3$  to 13, indicates that for all bombarding energies the average gamma multiplicity increases smoothly as the Q-value becomes more negative, but that the slope of the increase is much flatter for the 22.4 MeV/A data. For bombarding energies between 7.5 and 17.2 MeV/A, the maximum value of  $M_\gamma$  increases monotonically and is consistent with the rolling limit values. However, at 22.4 MeV/A,  $M_\gamma$  drops precipitously to a small fraction of the rolling limit value. This precipitous drop may be evidence that a change has occurred in the reaction mechanism, i.e., the onset of projectile fragmentation. Furthermore, the fact that the sticking limit value is never reached over the angular region studied indicates that the interaction times are very short. These findings must be considered only tentative, until the dependence of  $M_\gamma$  on the mass transfer in the reaction has been extracted from the data and more backward angle data at 22.4 MeV/A have been obtained.

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### NSD NEWSLETTER

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