

SECTION 2

**PUBLICATIONS, THESIS TITLES, OUTREACH,
AND VISITORS**

PUBLICATIONS

PAPERS

(a) Physical Review Letters

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The Use of Radioactive Nuclear Beams to Study the Equilibration of the N/Z Degree of Freedom in Intermediate Energy Heavy-Ion Reactions; S.J. Yennello, B. Young, J. Yee, J.A. Winger, J.S. Winfield, G.D. Westfall, A. Vander Molen, B.M. Sherrill, J. Shea, E. Norbeck, D.J. Morrissey, T. Li, E. Gualtieri, D. Craig, W. Benenson, and D. Bazin, *Phys. Lett.* **B321**(1994)15

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Coexistence of Chaos and Regular Undamped Motion in Giant Nuclear Oscillations; W. Bauer, Tenth Winter Workshop on Nuclear Dynamics, Snowbird, Utah, January 16-22, 1994.

Isomer Production in Fragmentation Reactions; W. Benenson, *ibid.*

On the Mean Free Path of Pions and Kaons in Hot Hadronic Matter; K. Haglin, *ibid.*

Nuclear Disassembly in Symmetric Heavy-Ion Collisions at Intermediate Energies; W.J. Llope, *ibid.*

Fragmentation from Neck-Like Structures; C.P. Montoya, *ibid.*

Evolution of Multi-Fragmentation in $^{84}\text{Kr} + ^{197}\text{Au}$ Collisions at 35-400 A MeV; C. Schwarz, *ibid.*

Nuclear Structure and Reaction Studies Using Radioactive Beams at the NSCL; B.M. Sherrill, *ibid.*

The Disappearance of Flow; G.D. Westfall, *ibid.*

Facets of Collective Expansion in Central Heavy-Ion Collisions; P. Danielewicz, International Workshop on Gross Properties of Nuclei and Nuclear Excitations XXII, Hirschegg, Austria, January 17-22, 1994.

Fast Multifragmentation from Expanding Systems; C.K. Gelbke, *ibid.*

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Fragmentation of Neck-Like Structures; W.G. Lynch, XXXII International Winter Meeting on Nuclear Physics, Bormio, Italy, January 24-30, 1994.

- Onset and Decline of Multifragmentation in Central Collisions; M.B. Tsang, *ibid.*
- Ground State Properties of Exotic Heavy Isotopes; B.M. Sherrill, Workshop on Nuclear Physics Far Off Stability, Darmstadt, Germany, February 1994.
- Radioactive Beam Facilities at MSU; S.M. Austin, Ion Source Accelerator (ISAC) Workshop, Lake Louise, Canada, February 17-21, 1994.
- Problems in the Structure of Light Nuclei; B.A. Brown, International Symposium on Frontiers of Nuclear Structure Physics, Osaka, Japan, March 2-5, 1994.
- Measurements of Spin-Isospin Strengths with Stable and Radioactive Heavy Ions; S.M. Austin, International Symposium on Spin-Isospin Response and Weak Processes in Hadrons and Nuclei, Osaka, Japan, March 8-10, 1994.
- Gamow-Teller Strengths in Nuclei with $N=Z$ from ^{12}C to ^{100}Sn ; B.A. Brown, *ibid.*
- Nuclear Structure Studies Far from Stability with High Energy Radioactive Beams; D.J. Morrissey, American Chemical Society Division of Nuclear Chemistry and Technology Symposium on Novel Approaches to Astrophysics, San Diego, California, March 13-16, 1994.
- Intensity Interferometry in Heavy-Ion Collisions; C.K. Gelbke, 31st Holzau Meeting on Nuclear Physics, Holzau, near Dresden, Germany, April 11-15, 1994.
- The Mass and Structure of ^{10}Li and ^{11}Li ; W. Benenson, Spring Meeting of the American Physical Society, Crystal City, Virginia, April 18-22, 1994.
- Computation of High Order Fringe Field Effects in Spectrographs; G. Hoffstatter, *ibid.*
- Present Status and Future Possibilities at MSU-NSCL; R.C. York, *ibid.*
- Gamow-Teller Strength and Nuclear Correlations; B.A. Brown, The Harmony of Physics Symposium, in honor of the 70th birthday of Professor Spartak Belyaev, Philadelphia, Pennsylvania, May 9-11, 1994.
- Two-particle Correlation in Heavy Ion Collisions; W. Bauer, Second International Symposium on Nuclear Physics at Storage Rings, St. Petersburg, Russia, May 1994.
- Multifragmentation in Central Collisions; W.G. Lynch, *ibid.*
- Fragmentation in Exclusive Measurements; W.G. Lynch, Fifth International Conference on Nucleus-Nucleus Collisions, Taormina, Italy, May 30 - June 4, 1994.
- Nuclear Structure Studies Using Radioactive Beams; B.M. Sherrill, *ibid.*
- Review of Electron Cyclotron Resonance Ion Sources for Multiply-Charged Ions; T.A. Antaya, International Conference on Plasma Science, Santa Fe, New Mexico, June 6, 1994.
- Soft Mode Dynamics in Transitional Nuclei; V.G. Zelevinsky, International Conference on Perspectives for the Interacting Boson Models on the Occasion of its 20th Anniversary, Padova, Italy, June 16, 1994.
- Symmetric Collisions at Intermediate Energies: Nuclear Disassembly Mechanisms; W.J. Llope, 1994 Nuclear Chemistry Gordon Research Conference, New London, New Hampshire, June 19-24, 1994.
- Particle-Particle Correlation Studies; S. Pratt, *ibid.*
- Excitation of the GDR Built on Highly Excited States with Inelastic α -Scattering; M. Thoennessen, *ibid.*
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Coupling the K500 and K1200 Superconducting Cyclotrons; F. Marti, 29th European Cyclotron Progress Meeting, Dubna, Russia, June 20-23, 1994.

Study of the Giant Dipole Resonance Built on Highly-Excited States via Inelastic Alpha-Scattering; M.R. Thoennessen, Fourth International Conference on Selected Topics in Nuclear Structure, Dubna, Russia, July 5-9, 1994.

Present Status of Shell Model Calculations in Medium Mass Nuclei; B.A. Brown, Two lectures at the Holifield Radioactive Ion Beam Facility Summer Study Program on Radioactive Ion Beam Physics, Oak Ridge National Laboratory, July 11-29, 1994.

Coupling of Intrinsic and Continuum States; Chaos and Order in Many-Body Wave Functions; V.G. Zelevinsky, three lectures, *ibid.*

Statistical Properties of Shell Model Nuclear States; V.G. Zelevinsky, Program on Application of Chaos in Many-Body Quantum Physics, National Institute for Nuclear Theory, Seattle, July 20, 1994.

Electromagnetic Excitation of ^{11}Li ; A. Galonsky, Symposium on Nuclear Structure and Reactions: The Interface, Meeting of the American Chemical Society, Washington, D.C., August 21-26, 1994.

High Energy Gamma Rays as a Probe for Dynamical Effects in Fusion Reactions; M. Thoennessen, *ibid.*

Vector Mesons at Nonzero Temperature; K. Haglin, Physics with PHENIX at RHIC, Brookhaven National Laboratory, Upton, New York, August 29 - September 1, 1994.

Flow of Nuclear Matter; P. Danielewicz, Second International Workshop on Multiparticle Correlations and Nuclear Reactions, CORINNE II, Nantes, France, September 6-10, 1994.

n-n Correlations with Exotic Nuclei; A. Galonsky, *ibid.*

Lifetime Information from Correlation Functions Selected by Directional Cuts; C.K. Gelbke, *ibid.*

Differential Algebraic Description and Analysis of Spin Dynamics; M. Berz, Conference on Spin Physics, Indiana University, Bloomington, Indiana, September 19-22, 1994.

Personalized Problem Sets in Large Classes Enhance Cooperative Learning; D.J. Morrissey, ACS Division of Chemical Education Symposium on Cooperative Learning, Washington, D.C., September 21-25, 1994.

Nuclear Fragmentation: Dynamics, Statistics, Phase Transitions; W. Bauer, Cluster '94, Strasbourg, France, September 1994.

Transport in BUU; W. Bauer, Workshop on Hot and Dense Nuclear Matter, Institute for Nuclear Theory, Seattle, Washington, September 1994.

Towards Fully Rigorous Bounds for Long-Term Stability; M. Berz, Conference on Nonlinear Problems in Accelerators, Arcidosso, Italy, September 1994.

Rigorous Estimates of Long-Term Stability in Dynamical Systems; M. Berz, Workshop on Verified Computation, Karlsruhe, Germany, September 1994.

The STAR Electromagnetic Calorimeter; G.D. Westfall, Fifth International Conference on Calorimetry in High Energy Physics, Upton, New York, September 1994.

A Knowledge Server for Physics; S.M. Austin, American Physical Society E-Print Workshop, Los Alamos, October 14-15, 1994.

Dynamical Effects in Fission of Hot Nuclei; M. Thoennessen, 1994 Division of Nuclear Physics Fall Meeting, Williamsburg, Virginia, October 26-29, 1994.

Structure of ^{10}Li and ^{11}Li ; W. Benenson, Brazilian Physical Society Annual Meeting, Brazil, October 1994.

Modern Map Methods for Charged Particle Optics; M. Berz, Fourth Charged Particle Optics Conference, Tsukuba, Japan, October 3-6, 1994.

Shell Model As Testing Ground for Quantum Chaos; V.G. Zelevinsky, Midwest Nuclear Theory Get Together, Argonne, Illinois, October 14, 1994.

Structure of ^{10}Li and ^{11}Li ; W. Benenson, International Symposium on Physics of Unstable Nuclei, Niigata, Japan, October 31 - November 3, 1994.

Production and Decay of Heavy Proton Drip-Line Nuclei; D.J. Morrissey, *ibid.*

Recent Astrophysical Measurements at NSCL; M. Hellström, 13th International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, November 7-10, 1994.

Studies of Light Nuclei Beyond the Particle Driplines: The Two-Proton Emitter ^{12}O ; R.A. Kryger, *ibid.*

MSU THESIS TITLES

Jim Bailey, "Phase Selection and Measurement in a Superconducting Cyclotron."

Jong Won Kim, "An Eight Tesla Superconducting Magnet for Cyclotron Studies."

Lung-Sheng Lee, "Extraction Studies for the MSU K500 Conversion to a Proton Cancer Therapy Synchrocyclotron."

Georg Hoffstätter, "Rigorous Bounds on Survival Times in Circular Accelerators and Efficient Computation of Fringe-Field Transfer Maps."

THESES AT OTHER UNIVERSITIES BASED ON EXPERIMENTS PERFORMED AT THE NSCL

Karl Hanold at the University of California at Berkeley, "Heavy Residues from Very Mass Asymmetric Heavy Ion Reactions."

Michael Hencheck at Ohio State University, "Nucleosynthesis during the Rapid Hydrogen Burning Process and the Abundances of ^{92}Mo and ^{94}Mo ."

Ákos Horvath at the Eötvös Loránd University, Budapest, "Population Temperatures from the $^{36}\text{Ar} + \text{Ag}$ Heavy Ion Collision at 35 MeV/nucleon Bombarding Energy."

Kent Scheller at the University of Notre Dame, "The Beta-delayed Neutron Decay of the Exotic Nuclei ^{18}N , ^{17}C , and ^{18}C ."

NSCL PHYSICS OF ATOMIC NUCLEI PROGRAM, SUMMER 1994

E. Kashy, W. Bauer, B.A. Brown, A. Galonsky, C.K. Gelbke, W. Lynch, D.J. Morrissey, and R. Ronningen

The outreach program of the NSCL included a program for pre-college teachers and students. The goal of this NSCL program was to provide teachers and students the opportunity to learn and understand some basic Nuclear Physics, and to carry out some simple nuclear experiments that they would not be able to carry out in their own institutions. It was aimed principally but not exclusively to serve participants from groups that are under-represented in the physical sciences, i.e., women and minorities.

This first week was "Teacher's Week", during which the teachers went through the program without any students present. During the second week, the students took part in the same program, and the instruction was divided among the participating teachers. They were in charge of conveying the information to the students who came to the MSU campus for the program. This format was designed to insure that the teachers, who were asked for input and suggestions for working with the students, would see most of the materials twice: once with their fellow teachers, and then again as they helped run the program during the second week.

The first week's program included several hours of 'Experiments/Demonstrations of Physics Fundamentals' (EK) and were repeated the second week. In addition, informal discussion sessions were held for the teachers with the MSU-NSCL Faculty in various areas of Nuclear Physics. These included:

- 'Neutrons' with A. Galonsky
- 'Conversation about Nuclear Chemistry' with D.J. Morrissey
- 'Radiation in our environment' with R. Ronningen
- 'Nuclear Theory: some basic ideas', with W. Bauer
- 'Nuclear Reactions' with C.K. Gelbke

At the end of the first week's program, discussion with teachers led to the suggestions that a career workshop be held for the students during the following week. T. Rogalski, from the career placement office at MSU, held a lively session with lots of discussion and excitement. We expect we will repeat this session in the 1995 program.

In addition to the measurement of optical spectra of hydrogen as part of the physical fundamentals program, four other hands-on laboratory experiments were conducted under the direction of W. Lynch and B.A. Brown. The experiments were taken from the ISP 209L physics laboratory course designed for non-science majors. The titles of the experiments were

- Probability vs. Average
- Human Reaction Times
- Radioactive Background and Common Sources of Radiation
- Neutron Activation of ^{109}Ag and Radioactive Decay of ^{110}Ag

In order to buttress learning and understanding, a set of problems was specifically assembled for this program. The problems dealt with fundamental concepts in Nuclear Physics, and required several weeks of computer work by one of MSU's REU [1] students during summer '93, S. Wolfe, working with NSCL faculty (EK, DJM) to be entered into the CAPA [2] system. The teachers had the opportunity to answer the problems using MSU's CAPA system. Three problem sets (a total of 40 problems) reinforced their understanding and helped to lower the level of apprehension of the teachers faced with the task of having to solve problems. This allowed them to do so in a friendly, non-judgmental environment. The following week, the teachers supervised and helped the students with these problems, thus further confirming their own understanding.

The summer '94 program included 6 teachers for two weeks and 27 students during the second week. The comments from teachers and students were highly positive, and several of their suggestions will be included in subsequent programs.

Dr. O. McHarris and Ms. T. Keehn of the NSCL, were responsible for getting information about the program to teachers and students, for selection of participants, and for administration of the financial aspects of the program.

1. This Research Experience for Undergraduates program was sponsored by the National Science Foundation.
2. CAPA, a Computer-Assisted Personalized Approach for homework, quizzes, and examinations.

ALL-UNIVERSITY OUTREACH SCIENCE CHALLENGE FOR HIGH SCHOOL STUDENTS

E. Kashy, D. J. Morrissey, Y. Tsai, S. L. Wolfe

The outreach program of the NSCL included a program for high school teachers and students. The primary goal of the newly created Michigan State All-University Outreach Science Challenge for High School Students was to develop a program in collaboration with participating high school teachers to motivate and challenge students from across the midwest to improve, and then demonstrate, their understanding of science. It also provided high school teachers and students an opportunity to become familiar with the Internet and to use CAPA, a software tool to implement a Computer-Assisted Personalized Approach for homework assignments, quizzes, and examinations, which was developed at Michigan State University.

The 1994-5 Science Challenge included providing both challenging problems and physical puzzles to the teachers and students. The problems were developed and chosen during two teacher workshops at Michigan State University. There were 40 problems prepared, coded, and tested for the challenge by the participating teachers and the NSCL faculty and staff for both chemistry and physics. The physics and chemistry problems sets shared a common introductory set of problems focusing on mathematical skills, while the second set was restricted to the particular science. Both quantitative and qualitative, conceptual problems were included.

During the workshops the physical puzzles were selected from an assortment already developed. Three physical experiments were chosen as puzzles by the participating high school teachers with the goal of having students perform (and repeat) the experiments, observe the phenomena and then propose explanations. The students were free to seek information from ANY source and consult anyone other than the participating teacher in order to formulate their answer. The puzzles chosen this year were:

- Model of the Forces in Nuclear Fusion
- Image Formation and Rotational Motion
- Curie Point (temperature) of iron

This year's program included 7 teachers and 331 students from Michigan, Ohio, and Illinois. The comments from teachers and students were very positive, and many of their suggestions will be included in subsequent programs. This coming fall, all 7 teachers will participate again, along with approximately 13 more teachers and all of their students.

T. Keehn was responsible for getting information about the program to teachers and students and administering many of the financial aspects of the program.

NSCL/JACKSON HIGH SCHOOL: CAPA PILOT PROJECT

G. Perkins^a, J. Bronson^b, D.J. Morrissey, E. Kashy, Y. Tsai, S.L. Wolfe

The outreach program of the NSCL included a pilot project to use CAPA, a software tool to implement a Computer-Assisted Personalized Approach for homework assignments, quizzes, and examinations, in an on-site local-area-network. Jackson High School (JHS) (Jackson, Michigan), the site of the pilot project, has a student population that is about 40% minority. CAPA problems for chemistry developed by J. Bronson in collaboration with NSCL and Michigan State University faculty and staff will be used in her high school general and practical chemistry classrooms. This project is also the basis for J. Bronson's masters thesis.

The Jackson High School CAPA trial uses approximately two dozen Intel 8088-based Zenith personal computers as student terminals (with some spares in case of hardware failure, a not-unlikely occurrence considering the age of these units) and an Intel Pentium-based Gateway personal computer as a CAPA network session server. The latter was provided by JHS.

All of the PCs were equipped with ethernet cards, and were networked via BNC "tee" connectors on a single 10Base2 (thin coaxial) ethernet segment, which supports a maximum of 29 connections with an end-to-end maximum cable length between 50-ohm terminators of 185 meters (the actual cable length used in this case was about 100 meters). As the local area network was isolated from other network traffic, and the CAPA system's current interactive mode is not very bandwidth-intensive, the relatively slow 8-bit ethernet cards and CPU speed of the 8088-based Zenith PCs were not a major drawback for this trial.

The Zenith PCs ran MS-DOS as an operating system, with FTP Software's PC/TCP version 2.05 for TCP/IP network support (specifically the rloginvt program, allowing connection to the server in the VT100 terminal mode used by the current CAPA system) and a customizable menu software package for ease of use by the students. Since the VT100 terminal mode is entirely text-based, the original monochrome monitors and video cards could be used without sacrificing any functionality, and the relatively low CPU speed of the PCs was not an issue.

The Gateway PC operated in a dual-boot mode, with two 350 MB partitions its 700 MB hard drive allowing a choice of booting up under MS-DOS to operate as a standalone system for the use of certain MS-Windows-based software packages, or of booting up under the NeXTStep 3.3 operating system for its duties as CAPA server.

J. Bronson will first use CAPA in her classroom this coming fall. Other high school teachers have expressed an interest in implementing CAPA at their high schools and grant funds to support such projects are being pursued.

- a. Department of Physics and Astronomy
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