ORNL/FTR--3265

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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-3265

DATE: June 1, 1989

SUBJECT: Report of Foreign Travel of Charles R. Vane, Research Staff Member, Physics Division

TO: Alvin W. Trivelpiece

FROM: Charles R. Vane

PURPOSE: To visit PSI (formerly SIN) in Villigen, Switzerland, to discuss X-ray production in heavy-ion atom collisions and developments on very high resolution superconducting junction X-ray detectors; to present a colloquium and discuss topics on X rays emitted by heavy ions in crystals at ETH in Zurich, Switzerland; to visit CERN, Geneva, Switzerland, to discuss proposed experiments at the CERN SPS and to observe and measure apparatus located there, which will be used in these experiments; and to attend the First International Symposium on Swift Heavy Ions in Matter (SHIM '89) in Caen, France, and to present a paper on "Radiative Electron Capture by Bare- and One-Electron Ions Channeled in Silicon Crystals."

SITES VISITED:		
5/8/89	PSI, Villigen, Switzerland	A. Zehnder
5/9/89	ETH, Zurich, Switzerland	M. Suter W. Wolfli
5/11-12/89	CERN, Geneva, Switzerland	H. Gutbrod R. Schmidt I. Lund P. Grafstrom
5/16-19/89	SHIM, Caen, France	J. Remilleiux P. Armbruster

ABSTRACT: The traveler visted the Paul Scherrer Institute in Villigen located outside Zurich, Switzerland, May 8, 1989, and presented an informal seminar on high-resolution X-ray spectroscopy in heavy ion-atom collisions. He visited the EN tandem accelerator facility at ETH-Honngerberg in Zurich, Switzerland, on

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ABSTRACT (continued)

May 9, 1989, and presented a colloquium on X rays emitted by heavy ions in crystals. The traveler then visited CERN in Geneva, Switzerland, May 11-12, 1989, where discussions were carried out with CERN staff and others on ORNL proposed experiments and especially on equipment requirements for these measurements. He then traveled to Caen, France, to attend the First Symposium on Swift Heavy Ions in Matter (SHIM'89), May 16-19, 1989, where he presented a paper on "Radiative Electron Capture by Bare- and One-Electron Ions Channeled in Silicon Crystals."

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VISIT TO PAUL SCHERRER INSTITUTE
VILLIGEN, SWITZERLAND

On Monday, May 8, 1989, the traveler visited the Paul Scherrer Institute (PSI), formerly SIN, located in Villigen outside Zurich. There he gave an informal presentation on work at ORNL on chemical effects observed in high-resolution X-ray spectra generated by heavy-ion impact. Most interest centered on the ORNL high-resolution Von Hamos X-ray spectrometer used in these measurements.

Discussions were held with A. Zehnder, head of the Materials Science Section at PSI, regarding their recent development of a superconducting, tunneling junction X-ray detector. They have succeeded in producing a Sn/SnOx/Sn tunneling junction detector, which for 6-keV X rays has a measured energy resolution of 41 eV (full width half maximum), about four times better than any other solid state detector. The expected theoretical resolution limit is about 5 eV. Studies there have shown that crystal grain structure and precise design of electrical signal leads must be optimized to obtain the best resolution. However, there is still an as yet undiscovered loss mechanism which prevents them from constructing detectors with near-theoretical resolution limit. They think that there are quasi-particle loss mechanisms, which depend on the film structure of the junctions, that prevent operation at the theoretical limit. Work is proceeding on this problem.

VISIT TO ETH ZURICH
ZURICH, SWITZERLAND

On May 9, 1989, the traveler presented a colloquium for members of the ETH High Energy Physics, Atomic Physics group on "Excitation and Ionization of Heavy Ions Channeled in Crystals." The talk and subsequent discussion centered mainly on interpretation of emitted X-ray spectra as signatures for collisional processes taking place between projectile ions and target electrons. Discussions with M. Suter and W. Wolfli of ETH also involved charge-changing collisions of fast heavy ions with gases and solids. M. Suter and G. Bonani are developing a gas-filled magnet and detector system for high resolution separation of interfering isobars, e.g., Cl^{36} and S^{36}, to be used in conjunction with their Tandem Accelerator Mass Spectroscopy (TAMS) Facility at the ETH EN tandem accelerator. M. Suter showed considerable interest in learning more about recent measurements at ORNL by H. Schöne et al. on energy losses by ions suffering charge-changing collisions in gas targets. Such information, taken together with total electron capture and loss cross sections recently obtained by Suter et al., would permit more accurate prediction of ion trajectories for modeling their gas-filled magnet detector system. M. Suter will contact H. Schöne at ORNL regarding possible collaboration on the required measurements.

VISIT TO CERN
GENEVA, SWITZERLAND

The traveler visited CERN to assess the possibility of using existing equipment in their proposed measurements on electron pair production by ultrarelativistic heavy ion beams. An ORNL nuclear physics group is involved in an experiment (WA-80) at CERN using 200-GeV/c beams of sulfur ions. It has been proposed that momentum analysis and detection of pairs of electrons and positrons produced in atomic collisions of these very energetic sulfur ions on heavy (e.g., gold) targets could be performed upstream of the WA-80 experimental apparatus at the same time as measurements are being performed there. Such an arrangement would involve relatively low differential cost and effort, especially if some existing equipment (such as an analyzing magnet) could be used without substantial modification. During this visit detailed investigations were carried out on the experimental areas upstream of WA-80, on the beamline, and especially on a particular magnet in the same beam line used primarily by a NASA group for emulsion studies. Magnetic field maps were obtained, as well as all pertinent dimensions, so that preliminary designs of a suitable chamber and detector system can be prepared. Discussions were carried out with Per Grafstrom, who is in charge of the west target area at CERN-SPS, regarding operational details such as: access to the proposed area, space for electronics and data acquisition equipment, AC power availability, and stability of the proposed analyzing magnet at low field strengths.

Discussions were also held with H. Gutbrod, spokesman for the WA-80 experiment, and two other WA-80 collaborators, R. Schmidt and I. Lund, regarding aspects of possible simultaneous operation of the two experiments. In particular, certain signals generated by the WA-80 detectors would be of great help in reducing expected large backgrounds in the pair production measurements. It would be of benefit then to run simultaneously. The low magnetic field strengths necessary for electron and positron analysis would not significantly alter the trajectories of the primary sulfur ions. The target thicknesses used in the pair production experiments would be very small. No insurmountable difficulties were discovered, and it appears that parasitic running of the pair production measurements with WA-80 is feasible and would be the most effective mode of operation.

SYMPOSIUM ON SWIFT HEAVY IONS IN MATTER (SHIM '89)
CAEN, FRANCE

The traveler participated in the First International Symposium on Swift Heavy Ions in Matter held at Caen, France, near GANIL. A poster was presented entitled "Radiative Electron Capture by Bare- and One-Electron Ions Channeled in Silicon Crystals." This symposium was intended to increase communication between researchers working in the basic physics of ions in matter and researchers working in ion-solids collisions as applied to solid state physics and materials sciences. The scope of the meeting included fundamental aspects of heavy ion excitation and charge exchange, energy loss, energy dissipation and relaxation in solids, channeling and coherent effects in crystals, and ion modification of materials. It was jointly organized by CIRIL/GANIL and GSI. The meeting was composed of nine oral presentation sessions plus an afternoon poster session. Total attendance was about 150.

A wide variety of interesting new results were reported at this symposium. R. Olson (University of Missouri-Rolla) presented a review of his latest theoretical results on energy deposition mechanisms by energetic heavy ions in gases and solids. These calculations, while based on classical trajectory models, appear to agree well with experimental measurements over a wide array of projectile and target parameters. P. Mokler (GSI) presented a review of results for Resonant Transfer and Excitation (RTE) processes in heavy ion-atom collisions which emphasizes advantages of studying very heavy projectiles, an area where experimental measurements are completely lacking. H. Schmidt-Böcking (Frankfurt) presented an interpretation of stopping powers based on measurements of electron production and ionization cross sections that included saturation effects for the inner core of a projectile ion track where all target atoms might be ionized. Very interesting work at GANIL on channeling and hyper-channeling of relativistic heavy ions in crystals was presented by J. C. Poizat (University of Lyon). They measured surviving charge-state fractions and energy losses for 27 MeV/amu Xe^{35+} ions axially channeled through silicon crystals. For the "frozen charge-state" ions, i.e., Xe^{35+} exiting the crystal, their energy loss measurements indicate that only hyper-channeled Xe^{35+} ions survive. This opens the possibility of studying "the interactions of highly charged heavy ions with a dense electron gas in very precise conditions of relative velocity."

A P P E N D I X A

ITINERARY

5/6-7/89	Travel from Knoxville to Zurich, Switzerland
5/8/89	PSI, Villigen, Switzerland
5/9/89	ETH, Zurich, Switzerland
5/10/89	Travel from Zurich, Switzerland to Geneva, Switzerland
5/11-12/89	CERN, Geneva, Switzerland
5/13/89	Travel to Paris, France
5/14-15/89	Weekend and Holiday
5/15/89	Travel to Caen, France
5/16-19/89	Caen, France
5/20/89	Return to Knoxville, TN

A P P E N D I X B

LISTING OF PERSONS CONTACTED

Paul Scherrer Institute, Villigen, Switzerland

A. Zehnder

ETH-Honngerberg, Zurich, Switzerland

G. Bonani
M. Suter
W. Wolfli

CERN, Geneva, Switzerland

P. Grafstrom
H. Gutbrod
I. Lund
R. Schmidt

SHIM, Caen, France

P. Armbruster
J. Remillieux

A P P E N D I X C

LISTING OF LITERATURE ACQUIRED

1. "Nonequilibrium Model of the Superconducting Tunneling Junction X-Ray Detector," D. Twerenbold.

2. "Superconducting Sn/Sn-Oxide/Sn Tunneling Junctions as High-Resolution X-Ray Detectors," D. Twerenbold and A. Zehnder.

3. "A Microscopic Model of Superconducting Tunneling Junctions as X-Ray Detectors," W. Rothmund and A. Zehnder.

4. "Superconducting Tunneling Junctions for X-Ray Detectors," P. Jokinen et al.

5. Thesis - "Dieletronische Rekombination in Inneren Schalen Untersucht an Mittelschweren Ionen Durch Resonanten Elektroneneinfang und Anregung," S. Reusch.

6. Paul Scherrer Institute ((formerly SIN), 1987 ANNUAL REPORT, VILLIGEN, SWITZERLAND.

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