**COVER SHEET
FOR TRIP REPORTS SUBMITTED TO THE
OFFICE OF ENERGY RESEARCH**

Destination(s) and Dates for
Which Trip Report Being Submitted: Nara, Japan, November 10-17, 1990
Tokyo, Japan, November 19, 1990

Name of Traveler: O. H. Crawford

Joint Trip Report ☐ Yes
☒ No

If so, Name of Other Traveler(s): _____

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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-3832

DATE: December 5, 1990

SUBJECT: Report of Foreign Travel of O. H. Crawford, Analytic Dosimetry and Surface Physics Group, Health and Safety Research Division

TO: Alvin W. Trivelpiece

FROM: O. H. Crawford

To attend the 13th Werner Brandt Workshop on the Interaction of Charged Particles with Matter, held in Nara, Japan, on November 12-16, 1990; to conduct collaborative research with Professors Y. Yamazaki and K. Komaki at Tokyo University, November 19, 1990.

SITES

VISITED:	11/12-16/1990	Nara Women's University Nara, Japan	F. Fujimoto
	11/19/1990	Tokyo University Tokyo, Japan	Y. Yamazaki K. Komaki

ABSTRACT: This report covers the activity of the traveler participating in a workshop entitled The 13th Werner Brandt Workshop on the Interaction of Charged Particles with Solids and conducting collaborative research with two physicists at Tokyo University. The Werner Brandt Workshops are organized by members of the traveler's group, led by Dr. R. H. Ritchie, with advice from an international committee. The traveler participated in planning for the next in the series of workshops, which will be held in or near the traveler's home base, Oak Ridge, Tennessee, in early 1992. He interacted with scientists from Japan, Spain, USSR, Israel, and other countries, initiated plans for a new collaboration with a Japanese scientist, and renewed existing collaborations. At Tokyo University, the traveler performed collaborative research with Professors Y. Yamazaki and K. Komaki on two topics of importance to the traveler's programs with the Department of Energy (DOE).

MASTER

THE 13TH WERNER BRANDT WORKSHOP ON THE INTERACTION OF CHARGED PARTICLES WITH MATTER

The Werner Brandt Workshop is a series of meetings of considerable importance to the traveler's programs with the Department of Energy (DOE). The workshop, held almost annually, is organized by members of the traveler's group (chiefly by Dr. R. H. Ritchie), and the topics covered are central to the traveler's DOE programs. The next meeting in the series will be held in or near Oak Ridge, Tennessee, early in 1992. Members of the traveler's group are carrying out collaborations with scientists from Japanese universities. It was because of our work with these colleagues, the high level of interest in this research area in Japan, and the desire of a leading professor there (Professor F. Fujimoto) to host the meeting that the 13th Werner Brandt Workshop took place in Japan. This was one of the larger workshops in this series to date, with 51 presentations from 10 countries.

While in Nara, the traveler spent some time in discussions with Dr. H. Nitta of Tokyo Gakugei University, one of several bright Japanese physicists working on, among other subjects, resonant coherent excitation of channeled ions. [Note that this phenomenon was first discovered by Oak Ridge National Laboratory (ORNL) experimental physicists in a collaboration that includes the traveler, and the phenomenon continues to be both an object of study and a unique research tool here at ORNL.] Plans were initiated for Dr. Nitta to come to ORNL and conduct collaborative theoretical research work with the traveler for approximately six months, provided the necessary support is obtained from sources in Japan. If this comes to pass, it will allow the traveler (with Nitta) to analyze the results of an international collaborative experiment performed at ORNL last year.

The traveler's DOE research has long involved the interactions of swift ions with solids. In this context, he has become interested in a new phenomenon that involves the same interactions, but presents some surprises. The discovery of cluster-impact fusion was reported for the first time in September 1989 at the 12th Werner Brandt Workshop by L. Friedman and coworkers from the Brookhaven National Laboratory. It was reported that nuclear fusion of deuterons is observed when large clusters of deuterated water, accelerated to an energy of a few hundred keV, impact deuterated solids. The surprise is that enough deuterons attain high enough energy for fusion under these conditions. The trip to Japan provided the opportunity for the traveler to discuss ideas and speculate on possible explanations with a number of physicists working on this and related problems. The traveler gave a paper at the workshop showing that although a certain set of binary collision sequences can be expected to lead to high deuteron translational energies, the end result is still a fusion rate much lower than the reported experimental one. If the Brookhaven experiments are correct (and this is not yet certain), other clever ideas are required to explain the results. The consensus is that an independent attempt or attempts must be made to reproduce the experiment. The subject was pursued again in the traveler's visit to Tokyo University (see below).

Several experimentalists and theoreticians at the workshop reported new results concerning a host of phenomena occurring in glancing-angle reflection of swift ions with solids. Atomic, molecular, and even cluster ions were employed. It was especially interesting to learn of measurements and theoretical calculations of convoy electrons emitted under such conditions. The energy spectrum of such electrons is shifted to higher energies than first expected, which is now being interpreted as due to acceleration of these electrons by the surface image potential. The traveler and Dr. J. Pitarke (University of the Basque Country) plan to collaborate in studies of near-surface interactions of swift charged particles with solids.

RESEARCH AT TOKYO UNIVERSITY

The traveler visited Professors K. Komaki and Y. Yamazaki at Tokyo University and spent a day in collaborative research on two topics of mutual interest. The first of these is the number distribution of multiply emitted secondary electrons produced by ion impacts on thin foils. These workers have new experimental results on these number distributions in the cases of impact of both molecular and atomic ions, He_2^+ and He^+ , on thin carbon foils. By detecting electrons and ions in coincidence, they find a slight enhancement of the electron yield when the molecular ion enters the foil oriented with its axis parallel to its velocity, but not when the axis is perpendicular to the velocity. The main problem at present is that their theoretical calculation, performed in collaboration with Dr. R. H. Ritchie of ORNL and the traveler, underestimates the secondary-electron yield by a factor of three or more. The calculation was examined in some detail during the visit, and ways to improve it were suggested. These include the use of a better form for the initial energy spectrum of secondary electrons, a more complete consideration of cascade electrons, and a realistic treatment of electron range in the solid.

The second topic covered during the visit was the attempt being planned by Professors Komaki and Yamazaki to observe cluster impact fusion. As discussed above, this fusion is a surprising result that has been observed in only one laboratory and is badly in need of independent confirmation (if possible). We went over the traveler's predictions of fusion yields, which place upper limits on the permissible amount of beam contamination by small clusters in attempts to measure fusion from large clusters. It was agreed to keep in close touch on the progress of the experiment.

SUMMARY

This was a successful trip. Arrangements were initiated for a Japanese physicist, Dr. H. Nitta of Tokyo Gakugei University, to visit ORNL to perform collaborative research relevant to the traveler's DOE programs for a period of some six months, if funded from Japanese sources. With the international committee, planning was carried out for the 14th Werner Brandt Workshop on the Interaction of Charged Particles with Matter, to be held near ORNL in 1992. Information of direct benefit to the traveler's programs with the DOE was exchanged, and existing collaborations were renewed.

ITINERARY

1990

- 11/8-10/90 Travel from Oak Ridge, Tennessee, to Nara, Japan
- 11/11/90 Sunday
- 11/12/90 Attended informal dinner sponsored by the Workshop, and discussed plans for future workshops with other members of the International Committee
- 11/13-16/90 Participated in the 13th Werner Brandt Workshop on the Interaction of Charged Particles with Matter
- 11/17-18/90 Weekend; travel from Nara, Japan, to Tokyo, Japan
- 11/19/90 Collaborative research at Tokyo University
- 11/20/90 Travel from Tokyo, Japan, to Oak Ridge, Tennessee

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LITERATURE ACQUIRED

Conference abstracts
 One preprint

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