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PROGRESS REPORT

ON

"Radioactive Decay Studies at TRISTAN II"

TO

MASTER

THE DIVISION OF NUCLEAR PHYSICS
U. S. DEPARTMENT OF ENERGY
OFFICE OF HIGH ENERGY AND NUCLEAR PHYSICS

Submitted by

William B. Walters, Professor of Chemistry, [REDACTED]
Phone 301-454-4421

Department of Chemistry
University of Maryland
College Park, MD 20742 ^{394 5000}

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As the Tristan facility has not yet operated sufficiently to permit a yield survey, let alone any serious experimental studies, progress for an external user has been limited to preparations for experimental operations when the system does work. To that end, the following actions have been taken:

1. Dr. Chien Chung, a recent Ph.D. in Nuclear Chemistry has been appointed as a Research Associate on our Faculty at Maryland and will devote full time to work at TRISTAN at Brookhaven National Laboratory.

2. Two hyperpure Ge detectors have been ordered, and one has been delivered to start the development of the multidetector $\gamma\gamma$ coincidence and angular correlation system. The one received is the best detector we have ever had, possessing a relative efficiency of 18% and giving a FWHM of <1.7 keV for 1332 keV γ rays. Both detectors have or will have a 25 cm endcap and are in offset dewars to permit maximum flexibility of position around the moving tape collector. Both will be located at Brookhaven National Laboratory full time once data collection begins.

We have used the one detector here in several experiments and found the high resolution quite important in studying complex spectra with many γ rays and large variations in intensities. We show in Fig. 1 the decay of a doublet with a 1.5 keV separation. As finding weak γ rays, placing all or nearly all low energy γ rays and developing complete decay schemes to test models will be important aspects of much of the work of TRISTAN, detectors of the quality indicated or even better are quite necessary for the successful completion of the work proposed.

3. A new attachment for the moving tape collector has been designed and is under construction to permit fixed position angular correlation data to be collected. This attachment will permit the detectors to be moved in as close

as possible for large angles, will hold shielding to prevent as much Compton "cross-talk" between detectors as possible, will permit three-detector operation with three detectors fixed at 90° and one movable detector, and permit four-detectors to operate at 7 cm distance, getting data at 15, 30, 45, 60, 75 and 90 degrees. The attachment will permit changes in design to be made relatively easily.

4. The principal investigator has been at Brookhaven on seven occasions and been mainly involved in the design of the coincidence channel of the data collection system. A coincidence interface to permit up to eight ADCs to be dealt with and three written on tape ($\gamma\gamma t$) has been developed by M. Stelts, R. Chrein and V. Manzella which has the potential to handle the inputs from four Ge detectors and a TAC (or six TACs) with a minimum of external modular equipment.

5. One of the theoretical developments that can be given an important series of tests is the Interacting Boson Approach. Programs to carry out IBA calculations have been developed at Brookhaven National Laboratory by Iachello, Scholton and Casten and used during the past year to begin to make some projections of nuclear structure into the $N > 83$, $Z > 50$ region.

PERSONNEL

Dr. William B. Walters
Professor of Chemistry

Dr. Chien Chung
Research Associate in Chemistry

Dr. Namik K. Aras
Visiting Professor of Chemistry
(on sabbatical leave from Middle East Technical University, Ankara, Turkey)

Ms. Janet A. Demech
Secretary II

OTHER ACTIVITIES

Additional activities not supported by U. S. Department of Energy funds under this contract include finishing work started under earlier A.E.C. and E.R.D.A. Contracts and work done at the Maryland Cyclotron which is supported by the U. S. National Science Foundation from which funds were derived for the support of one graduate student Mr. Patrick W. Gallagher, whose studies will end this Spring, as well as one month of the Principal Investigator's salary last summer.

I. Two papers were published involving work carried out here and at Livermore with A. E. C. and E. R. D. A. support.

1. "Radioactive Decay of 1.7-h ^{149}Nd to Levels of Transitional ^{149}Pm ", E. W. Schneider, M. D. Glascock, W. B. Walters and R. A Meyer, Z. Physik A291, 77 (1979).

Abstract: Sources of ^{149}Nd were produced by thermal-neutron irradiation of enriched ^{148}Nd . High resolution Ge(Li) spectrometers were used to collect gamma-ray singles and coincidence spectra in the study of decay of 1.7-h ^{149}Nd . A total of 214 gamma rays have been assigned to the decay of ^{149}Nd , and 201 of these transitions have been placed in a level scheme of ^{149}Pm involving 42 excited states.

Absolute values for the beta-group intensities were determined for transitions to the ^{149}Pm levels, and spin and parity assignments were made for many of the observed states. The experimentally determined level structure of ^{149}Pm was compared with corresponding levels in other odd-mass Pm and Eu nuclides. Interpretations were made in terms of the core-coupling model.

2. "Level Structure of Odd-mass In Nuclei and the Unified Model. II. ^{117}In Levels Populated in the Decay of ^{117}Cd Isomers", M. D. Glascock, E. W. Schneider, W. B. Walters, S. V. Jackson and R. A. Meyer, Phys. Rev. C20, 370 (1979).

Abstract: Ge(Li) detectors have been used to perform singles, coincidence, and angular correlation measurements on γ rays present in the decays of 2.5-h $^{117}\text{Cd}_g(1.2^+)$ and 3.4-h $^{117}\text{Cd}^m(11/2^-)$. A total of 112 of the 114 γ rays observed in the decay of $^{117}\text{Cd}_g$ and all 71 of the γ rays observed in the decay of $^{117}\text{Cd}^m$ have been placed in a level scheme consisting of 46 excited states. A total of 51 different γ - γ cascades were measured at 90° and 180° . The β branchings from $^{117}\text{Cd}_g$ to $^{117}\text{In}^m$ and $^{117}\text{Cd}^m$ to $^{117}\text{In}_g$ were determined to be 20.4% and $<1\%$, respectively. The thermal neutron cross sections for the production of $^{117}\text{Cd}^m$ were determined to be 43 ± 2 mb and 8 ± 1 mb, respectively. Spin and parity assignments for the levels of ^{117}In were made in many instances. The level structure is discussed in relation to the unified model calculation and possible one-proton-two-neutron configurations.

II. Work is being continued on data collected with A. E. C. and E. R. D. A. support here and at Livermore on a project involving the study of 50-min ^{133}Te decay. Of particular interest in this work are the γ -ray cascades that lead to the population of the 9-sec $19/2^-$ isomer, $^{133}\text{I}^m$ following the decay of $11/2^-$ $^{133}\text{Te}^m$. These cascades reveal the position and density of states with spins $11/2 < J < 19/2$.

III. Work is being continued on data collected here, Livermore, and Los Alamos under A. E. C. and E. R. D. A. support on the decay of 10-min ^{151}Nd to

levels of ^{151}Pm . As ^{151}Pm is the lightest $N=90$ nuclides that can be studied by (n,γ) produced radioactive decay, it can be studied in great detail and serves as a starting point for predicting properties of lower- Z nuclides with $N>90$ which can be studied at TRISTAN. It is of some interest to try to fit these with IBA calculations as the existing Corialis coupling calculations are not in good agreement with the observed negative parity levels in ^{151}Pm . Efforts will continue to try to fit ^{151}Pm and ^{149}Pm in the IBA framework.

IV. Two papers have been submitted for publication containing work performed under National Science Foundation support at the Maryland Cyclotron:

1. "Decay of a New Nuclide: ^{89m}Mo ", P. W. Gallagher, E. W. Schneider and W. B. Walters, submitted to Z. Physik.

Abstract: The half-life of the $1/2^-$ isomer in ^{89}Mo has been determined in an experiment where an enriched ^{92}Mo target was irradiated by 350 or 700 ms bursts of 60 MeV protons. Analysis of the gamma-ray spectra collected as a function of time between irradiations revealed gamma rays at 118.8 and 268.5 keV decaying with a 190 ± 15 ms half-life. The hindrance of E3 transitions in $N=47$ and $Z=47$ nuclides is discussed.

2. "Decay of the New Closed Shell Nuclide 2.0-min ^{96}Pd ", N. K. Aras, P. W. Gallagher and W. B. Walters, submitted to Phys. Rev. Lett.

Abstract: The closed shell nuclide ^{96}Pd has been found to decay with a 2.0-min half-life to a 1^+ state at 177-keV in ^{96}Rh . The $1^+ - 2^+$ separation of 125 keV can be combined with systematic data to suggest 1^+ isomers in ^{98}Ag , ^{100}In , and ^{102}In . The presence of such isomers is consistent with the studies of the decay of ^{98}Ag and ^{102}In and would make the study of parent ^{100}Sn and ^{102}Sn decay by gamma ray spectroscopy difficult.

V. Mr. Gallagher's thesis involves a study of He-ion reactions on ^{103}Rh , ^{106}Cd , ^{110}Cd and ^{116}Cd begun at the Maryland Cyclotron under E. R. D. A. support and being concluded under NSF support. The thesis will be finished before summer and the results published during the coming year.

