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Progress Report: DOE Contract No. DE-AS05-79ER10495
Study of Transitional Nuclei at TRISTAN

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I. Introduction

At present there are six decay studies at TRISTAN in which the Oklahoma group has a major participation. These involve the decay of ^{99}Sr, ^{145}Cs, ^{147}La, ^{99}Rb, ^{101}Sr and ^{101}Y. These projects are in varying stages of completion and will be discussed individually below. The first two of these have furnished the basis for a PhD thesis. During the first third of this contract year (6/1/82 - 10/1/82) time at TRISTAN was devoted to ion-source and other facility development. Two new ion sources were developed and tested, a surface ionization source with a Ta ionizer and a FEBIAD-type plasma source. Both worked very well and with excellent reliability. In addition some work was done toward developing a surface ionization ion source for negative ions of Br and I, which are of special interest to the Oklahoma project. Further development of this source was postponed in favor of production runs with the other two, and a variety of new possibilities for future work have become available from these sources.

II. Time Commitments by the Investigators

In the contract period from 6/1/82 to 1/31/83 the principal investigator spent 80% of his time in residence at BNL. This was made possible by the granting of a one-year sabbatical leave by the University of Oklahoma with half salary support and an inclusion of half salary in the present DOE contract. Most of the remaining 20% of the PI's time was also spent in work related to projects at TRISTAN. One graduate student, H. Dejbakhsh, spent approximately one month in residence at BNL during this period. The remainder of her time was spent in thesis preparation.

III. Technical Progress

A. Br and I isotopes.

Once again the experiments originally proposed, the study of very neutron-rich Kr and Xe isotopes through the decay of Br and I, have been postponed until development

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of a negative surface ionization source. From a survey with the new FEBIAD source we can conclude that the problem of hold-up time plus interference from direct production of the more abundant Kr and Xe isotopes precludes the study of these nuclides with the presently available sources. Some progress was made in testing a negative-ion source, and it is hoped that sometime during this contract year a LaB_6 ionizer can be installed and tested.

B. ^{99}Sr decay.

Experimental work on this nuclide that is presently possible at the TRISTAN facility has been completed, and a paper on this work is nearly complete at this writing.

C. ^{145}Cs decay.

A fairly detailed level scheme strongly supported by coincidence data has been established for ^{145}Ba. 80% of the 108 gamma transitions assigned to the decay of ^{145}Cs have been placed in a scheme that contains 30 levels. The original data for this decay was taken with a poor ion source in a mode that was actually optimized for ^{145}Ba decay, and many problems have arisen in the analysis that need clarifying. Because one of the new ion sources provides a beam of essentially pure ^{145}Cs (free from primary production of ^{145}Ba), we are proposing to repeat the coincidence and some of the singles measurements prior to preparation of this work for publication. It is expected that this work should be completed and prepared for publication sometime this calendar year.

D. ^{147}Ba decay.

The departure from TRISTAN of the primary participant in this work (M. Shmid) has slowed the preparation for publication. Most of the data analysis is complete, and a manuscript should be forthcoming in calendar 1983.

E. ^{99}Rb decay.

The study of this decay represents a new project made possible by the development of a surface ionization source with a Ta ionizer. Data were taken in August 1982. Data analysis is nearly complete, and a report has been submitted for the APS

Baltimore meeting this spring. The structure of ^{99}Sr represents an odd neutron coupled to the same core as the odd proton in ^{99}Y(^{98}Sr or ^{100}Zr). These nuclei are of particular interest since the core is expected to be strongly deformed in contrast to the lighter isotopes of these elements which appear to be rather spherical.

F. ^{101}Sr and ^{101}Y decays.

In a TRISTAN run completed shortly before this writing, the decay of previously unobserved ^{101}Sr has been studied. A preliminary halflife of γ 0.1 s has been determined, and gamma-ray measurements including coincidences have been made. A cursory look at the data indicates a remarkable similarity with the ^{99}Sr decay results with the likelihood we are seeing a ground-state rotational band in ^{101}Y built on exactly the same proton Nilsson level identified in ^{99}Y. A report on these results will be made at the Baltimore APS meeting.

Simultaneously with the ^{101}Sr decay study, the decay of ^{101}Y was also studied. A preliminary halflife of 0.5 s was found compared to a reported value of 1 s. No other information exists in the literature for this decay. Gamma-ray singles and coincidence data also include lines associated with this decay.

G. Other Activities of the Oklahoma Group.

The principal investigator has been involve in a number of development projects at TRISTAN including ion source testing and survey, implementation of the conversion-electron spectrometer, development of plastic scintillation detectors for fast timing beta-gamma coincidence measurements, and some minor computer software development both at BNL and OU.

H. Dejbakhsh spent most of the latter half of calendar year 1982 in thesis preparation. She completed the thesis and passed her final oral exam on December 17, 1982. She is now employed in a postdoctoral position at Texas A&M University.

IV. Future Plans

A proposal has already been submitted to the TRISTAN staff for time to restudy ^{145}Cs decay with the new Ta surface-ionization ion source. A proposal has also been

submitted to study the decay of ^{101}Zr. Only a halflife and two gamma lines have been reported in the literature for this decay. A new downstream beta and gamma counting station will be used in this experiment. This station was designed by the Oklahoma group and incorporates a new 4π beta detector for more efficient beta gating of very low-yield gamma spectra. Use of this station should increase data collection rates by a factor of 5-10 over the previously used beta gating system at the parent port.

It is essential in the study of nuclear structure through these decay studies to be able to determine spin and parity assignments for the levels constructed. In the even-even nuclei with good yields from TRISTAN gamma-gamma angular correlations have been used quite successfully to establish the I^{π} for low-lying levels, and especially to search for the important 0^+ excited states. Such measurements are much more difficult and their interpretation more ambiguous for odd-A nuclides. A more useful tool is the measurement of conversion electrons. To this end a conversion-electron spectrometer will soon become available at TRISTAN. A proposal has been submitted for beam time to test this spectrometer. If this test is positive, then a proposal will be submitted to study conversion electrons in all of the odd-A nuclides listed above. In addition fast photomultipliers and appropriate tube bases are being acquired for the 2π beta detector at the parent port and the downstream 4π detector to make possible the measurement of some selected level lifetimes through beta-gamma or conversion-electron-gamma fast coincidences. These lifetimes provide further detailed information on the character of individual levels that can be compared to hoped-for theoretical calculations.

Another project for which beam time will be requested is the study of the decay of ^{148}Cs. This study would extend the even-even Ba systematics to N=92, an important addition to the study of the spherical to deformed shape transition.

Also in the future is a request to test a negative surface-ionization ion source with a LaB_6 ionizer to see if usable beams of Br and I isotopes can be obtained as mentioned earlier.

It is hoped that at least a start can be made on all of these projects by the end of the 1983-84 contract year.

V. Publications and Presentations

As yet no papers have been submitted for publication. A manuscript on ^{99}Sr decay is nearly complete and will be submitted to Physical Review this spring. Papers on the decays of ^{99}Rb, ^{101}Sr, and ^{101}Y should follow fairly rapidly, hopefully in the 1983 calendar year. Work on ^{145}Cs and ^{147}La decays is proceeding somewhat more slowly because of their complexity but should be completed within a year provided the requested beam time becomes available.

Two abstracts have been submitted for the APS Baltimore meeting in April on work in which the Oklahoma group has a major involvement:

1. The Decay of ^{99}Rb and the Level Structure of ^{99}Sr.
   R.F. Petry, J.C. Hill, Z. Berant, R.L. Gill, and M. Shmid.

2. Structure of Deformed ^{101}Y from the Decay of ^{101}Sr.
   J.C. Hill, F.K. Wohn, R.F. Petry, R.L. Gill, R.E. Chrien and C. Chung.

In addition there was minor involvement in a third experiment to be reported at the same meeting:

3. g-factor of the $7/2^+$, 1264.4-keV Level in ^{97}Zr.
   Z. Berant, R.L. Gill, M.N. Rafailovich, R.E. Chrien, J.C. Hill, F.K. Wohn, R.F. Petry, C. Chung, G. Peaslee, and M. Mohsen.