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Coulomb excitation of odd-A neutron-rich radioactive beams

C.-H. Yu[1,a], C. Baktash[1], J.C. Batchelder[2], J.R. Beene[1], C. Bingham[3], M. Danchev[3], A. Galindo-Uribarri[1], C.J. Gross[1], P.A. Hausladen[1], W. Krolas[4], J.F. Liang[1], E. Padilla[4], J. Pavan[1], and D.C. Radford[1]

[1] Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
[2] Oak Ridge Associated Universities, Oak Ridge, TN 37831, USA
[3] University of Tennessee, Knoxville, TN 37966, USA
[4] The Joint Institute For Heavy Ion Research, Oak Ridge, TN 37831, USA

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Abstract. A test experiment was carried out at the Holifield Radioactive Beam Facility to extend Coulomb excitation studies of heavy neutron-rich radioactive isotopes from even-even to odd-A nuclei. The experiment identified 10 and 4 gamma rays in ^{129}Te and ^{129}Sb, respectively. The $B(E2)$ value of one transition in ^{129}Sb was tentatively established. More $B(E2)$ values in ^{129}Te and ^{129}Sb will be extracted upon completion of the data analysis.

PACS. 21.10.Ky Electromagnetic moments – 25.70.De Coulomb excitation – 27.60.+j $90 \leq A \leq 149$

1 Introduction

Coulomb excitation of heavy even-even neutron-rich nuclei near ^{132}Sn has been a tremendous success [1] at the Holifield Radioactive Ion Beam Facility (HRIBF). Because of the weak intensity and isobaric contamination of the beams, as well as the low $B(E2)$ values in this region and the much more complicated level structure in an odd-A or odd-odd nucleus, extending such studies to odd-mass nuclei is in general difficult. However, studies of odd-A and odd-odd nuclei are important, since they often provide additional information on nuclear structure that cannot be obtained from even-even nuclei. This paper reports some preliminary results from the first experiment at the HRIBF aimed at studying heavy odd-A neutron-rich nuclei via Coulomb excitation.

2 Experiment

For this proof-of-principle experiment, self-supporting ^{50}Ti targets (with thicknesses of 1 and 1.5 mg/cm^2) were bombarded by a 400 MeV, $A = 129$ radioactive beam provided by the HRIBF. The $A = 129$ radioactive beam was selected because of its relatively intense ^{129}Sb and ^{129}Te components. The goal of the experiment was to extract $B(E2)$ values of low-lying excitations in these two nuclei, which were not known prior to the present experiment. Ti was chosen as the target because of its relatively high Z, which enhances the Coulomb-excitation cross-section. Targets heavier than Ti were not used in order to avoid multi-step Coulomb excitations, which would significantly complicate data analysis.

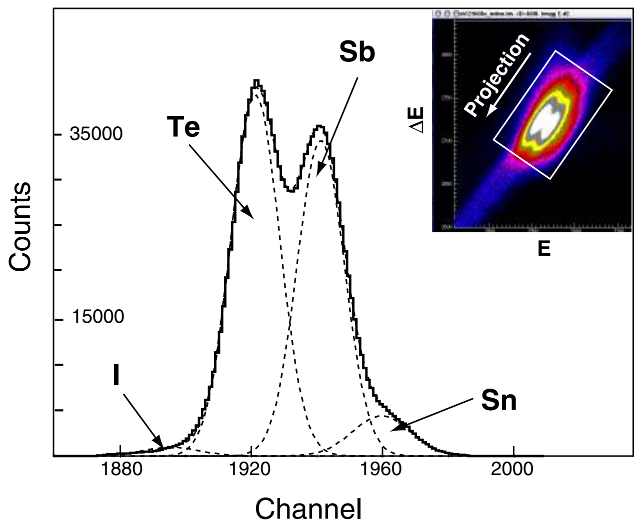

Fig. 1. Projection (solid curve) of the beam-particle ΔE-*versus*-E spectrum recorded by the Bragg detector positioned behind the target. Dashed curves are Gaussian fits of the various peaks representing the four measurable $A = 129$ isobars in the beam. The relative intensities of these isobars were used in the extraction of $B(E2)$ values. The original 2D spectrum is shown as inset at the upper-right corner, with the projection window and projection axis indicated.

The HRIBF CLARION array, which consisted of 10 segmented clover Ge detectors at the time of this

[a] Conference presenter; e-mail: chy@mail.phy.ornl.gov

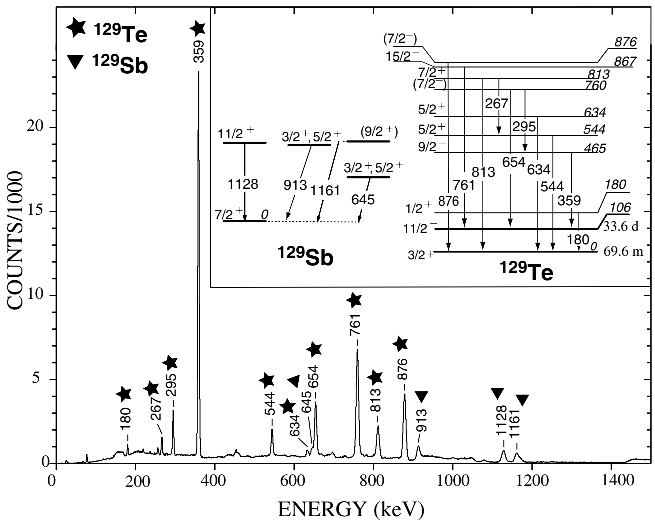

Fig. 2. Spectrum of gamma rays in coincidence with recoiling ^{50}Ti target ions that were bombarded by a 400 MeV, $A = 129$ neutron-rich radioactive beam. The gamma rays are corrected for Doppler effect event by event according to the scattered $A = 129$ beam velocity. The partial level schemes shown are based on ref. [2] and represent those gamma rays observed in the present work.

experiment, was used to detect the gamma rays. The Hyball CsI detector array [3] (absorbers removed) was used to detect scattered-beam and recoiling-target ions. A Bragg detector [4] downstream from the target position was used to monitor the beam composition. The Bragg-detector spectrum and its projection are shown in fig. 1. From this spectrum, relative intensities of the $A = 129$ isobars in the beam were determined and then used for extracting $B(E2)$ values. The average total-beam intensity during the run was about 5×10^7 ions/second, and about 45 million gamma-particle coincidence events were recorded during the 72-hour experiment. Hyball-singles events were also recorded for normalization with Rutherford cross-sections.

By gating on the ^{50}Ti particles detected in Hyball, which determines the energies and angles of detected ions, the kinematics of each scattering event could be reconstructed. Using the reconstructed kinematics information, the Doppler effect of the corresponding scattered-beam particles could be corrected event by event. The gamma-ray spectrum obtained after such Doppler corrections was then obtained and shown in fig. 2. Almost all peaks in this spectrum can be identified as decays of excited states in ^{129}Te or ^{129}Sb, which are the main components of the beam (see also fig. 1). Using the available information [2] on ^{129}Te and ^{129}Sb, these Coulex gamma rays are placed in the two partial level schemes shown as inset in the upper-right corner of fig. 2.

3 Preliminary result and discussion

A comprehensive analysis of the $B(E2)$ values of all transitions shown in fig. 2 has not yet been completed. However, the $B(E2, 7/2^+ \rightarrow 11/2^+)$ in ^{129}Sb can be quickly extracted because of its simple feeding pattern

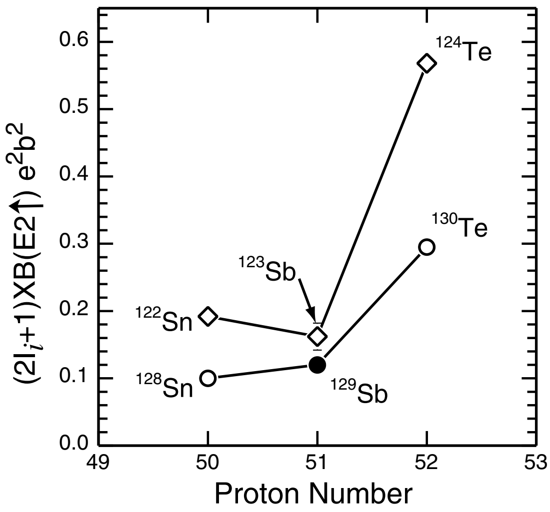

Fig. 3. Preliminary result of $B(E2, 7/2^+ \rightarrow 11/2^+)$ in ^{129}Sb (solid circle) extracted from this work and that in ^{123}Sb compared with the $B(E2, 0^+ \rightarrow 2^+)$'s of their neighboring even-even isotones. Data for ^{123}Sb is taken from ref. [5], for ^{128}Sn from ref. [1], and for other Sn and Te nuclei from adopted values given in ref. [6].

and stretched-$E2$ multipolarity. Preliminary data analysis yielded the $B(E2, 7/2^+ \rightarrow 11/2^+)$ in ^{129}Sb to be 0.015 e^2b^2, which is about 5 times the corresponding single-particle estimate. Figure 3 shows a comparison of the newly measured $B(E2, 7/2^+ \rightarrow 11/2^+)$ in ^{129}Sb with the $B(E2, 0^+ \rightarrow 2^+)$ values in its even-even neighbors (normalized by corresponding $(2I_i{+}1)$ factors). The trend is very similar to that of the $N = 72$ isotones (diamonds in fig. 3). The data indicate that the nomalized $B(E2)$ strengths for the $(7/2^+ \rightarrow 11/2^+)$ transitions in both ^{129}Sb and ^{123}Sb are smaller than the average of the $B(E2, 0^+ \rightarrow 2^+)$ values in their corresponding neighboring even-even isotones.

To summarize, a test experiment was successfully carried out at the HRIBF to study heavy odd-A neutron-rich radioactive beams via Coulomb excitation. Results of this and future experiments aimed at odd-A and odd-odd nuclei will provide important nuclear-structure information in the region of ^{132}Sn.

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References

1. D.C. Radford *et al.*, Phys. Rev. Lett. **88**, 222501. (2002)
2. R.B. Firestone *et al.*, *Table of Isotopes*, Vol. **I**, 8th edition (Wiley-Interscience, 1996) pp. 1107-1110.
3. A. Galindo-Uribarri *et al.*, to be published in Nucl. Instrum. Methods Phys. Res. A.
4. P.A. Hausladen *et al.*, to be published in Nucl. Instrum. Methods Phys. Res. A.
5. K.C. Jain *et al.*, Phys. Rev. C **40**, 2400 (1989).
6. S. Raman, C.W. Nester jr., P. Tikkanen, At. Data Nucl. Data Tables **78**, 1 (2001).