

MINIBALL Workshop and Users meeting

Report of Contributions

Contribution ID: 0

Type: **Submitted**

Detection of X rays in the Neutron-Deficient Polonium Coulomb Excitation Experiments

Friday, 25 October 2013 10:50 (20 minutes)

Coulomb excitation experiments in inverse kinematics using heavy postaccelerated radioactive ion beams often result in multiple step Coulomb excitation whereby several low-lying excited states are populated. At REX-ISOLDE, the Miniball gamma spectrometer is used for the detection of gamma rays originating from electromagnetic transitions in the investigated nuclei [1]. The nuclear levels populated by Coulomb excitation do not always necessarily decay to a lower-lying energy level by emitting a gamma ray, but also by conversion electrons. Conversion and $0^+ \rightarrow 2^+_{g.s.} + 1$ E0 transitions are important in the neutron-deficient lead region due to the high proton number and nuclear structure arguments [2]. Hence, observed gamma ray intensities do not suffice to analyze Coulomb excitation data in the neutron-deficient lead region in a correct way: the decay from populated levels involving electrons should be included as well.

The vacancy created in an atomic shell by the electron is filled by another atomic electron, accompanied by the emission of a characteristic X ray. The Miniball gamma spectrometer can be used to detect the more energetic K X rays. Conversion and E0 transitions are not the only sources of X rays at Miniball. The beta decay of a fraction of the radioactive ion beam scattered in the neighborhood of Miniball can give rise to the detection of X rays and the REX linear post accelerator yields a broad spectrum of 'room background' X rays. These processes are random as they are not related to a beam particle hitting the target. This hints to the fact that it is crucial to do a proper prompt to random scaling when considering the particle gamma coincidences. As the amount of random gammas is large in the X-ray region and the time behavior of these 'random' events in the X-ray region is different than for the atomic X rays from the beam and conversion, the amount of X rays is very sensitive to the prompt to random scaling factor.

A last source for X rays is the creation of a K vacancy induced by the collision of the heavy ion beam with the target. This process gives rise to prompt and Doppler broadened X rays as they are created in the interaction of the projectile with the target. These prompt X rays cannot be distinguished from X rays originating from nuclear effects. In order to determine the number of E0 transitions the cross section for the collision-related X rays has to be estimated. The total cross section for K-shell ionization can be inferred from a theoretical prediction [3]. In the Hg coulex analysis ^{188}Hg is used as a reference point since no E0 transitions are expected there. All the detected X rays, corrected for converted E2 transitions, can then be attributed to the collision between projectile and target [4].

In both the 2009 and 2012 experimental campaigns of the Coulomb excitation of the neutron-deficient polonium isotopes X rays were detected at Miniball. A similar role as ^{188}Hg can be played by ^{206}Po where no E0 transitions are expected.

In this presentation the X-ray evaluation will be discussed in the Coulomb excitation data on $^{196,198,200,202,206}\text{Po}$.

[1] N. Warr et al, Eur. Phys. J. A 49 (2013) 40.

[2] J.L. Wood, K. Heyde, Rev. Modern Phys. 83 (2011), 1467.

[3] C.M. Romo-Kröger, Phys. Scripta T118 (2005) 9.

[4] N. Bree, to be published.

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Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: 1

Type: **not specified**

Preliminary results from ^{140}Sm Coulomb excitation experiment

Friday, 25 October 2013 09:40 (20 minutes)

The open-shell nuclei with $Z > 50$ and $N < 82$ are known to have some of the largest ground-state deformations in the nuclear chart. The shape of the nuclei in this region are expected to be prolate, except for a small island of nuclei with $Z > 62$ and $N \approx 78$, which are predicted to be oblate. Nuclei near ^{140}Sm are therefore expected to be located in a transitional region between deformed and spherical shapes (as a function of neutron number) and between prolate and oblate shapes (as a function of proton number), and shape coexistence may be expected to occur. Indeed, a low-lying excited 0^+ state was tentatively assigned in ^{140}Sm , which could be interpreted as a sign for shape coexistence. The measurement of spectroscopic quadrupole moments and transition strengths represents a sensitive test for theoretical predictions in this region. Due to the occurrence of two isomeric 10^+ states of

$\pi(h_{11/2})^2$ and $\nu(h_{11/2})^{-2}$ configuration the lifetimes of low-lying states are completely unknown.

A Coulomb excitation experiment with a ^{140}Sm beam on a ^{94}Mo target was performed at ISOLDE with the typical setup comprising Miniball and a DSSD in June/July 2012. The laser-ionized beam of ^{140}Sm was quasi-pure with an average intensity of $2 \cdot 10^5$ particles per second. At least three excited states in ^{140}Sm were populated during the experiment: the 2^+ and 4^+ states of the ground-state band and the tentatively assigned 0^+ state at 990 keV excitation energy. The statistics collected during the experiment allows the analysis of differential Coulomb excitation cross sections as a function of scattering angle. Experimental details and first preliminary results obtained in the analysis with GOSIA2 will be discussed.

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Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: 2

Type: **not specified**

Quadrupole Collectivity in neutron-rich Cd isotopes

Friday, 25 October 2013 09:20 (20 minutes)

The neutron-rich cadmium nuclei with a proton number of $Z=48$ are some of the most interesting isotopes in nuclear structure physics due to the proximity to the proton and neutron shell closures at $Z=50$ and $N=82$ respectively. The excitation energy of the 2_1^+ -states shows an irregular behaviour when approaching the neutron shell closure. From ^{124}Cd to ^{126}Cd the energy is only slightly increasing and from ^{126}Cd to ^{128}Cd even a drop can be noticed. So far this finding can not be reproduced by shell-model (SM) calculations although the shell closure is near. Only Beyond-Mean-Field (BMF) calculations with a resultant prolate deformation agree with the low excitation energy of ^{128}Cd . The transition strength $B(E2, 0_{\text{gs}}^+ \rightarrow 2_1^+)$ in the even isotopes $^{122}\text{--}^{128}\text{Cd}$ was measured in Coulomb excitation experiments (IS411, IS477) with MINIBALL at REX-ISOLDE (CERN). Since the values for $^{122},^{124}\text{Cd}$ coincide with BMF calculations with a resultant prolate deformation ^{126}Cd is better described via SM calculations. Results of the more recent experiment on ^{128}Cd will pursue the picture of the behaviour of the transition strength towards the neutron shell closure. A closer insight into the onset of collectivity and the roles played by different orbits can be obtained by the investigation of the odd isotopes. We started this program with the examination of ^{123}Cd (IS524) where already discrepancies to the literature were evidenced. In this contribution the latest results of the investigation of the $B(E2, 0_{\text{gs}}^+ \rightarrow 2_1^+)$ values of the even $^{122}\text{--}^{128}\text{Cd}$ nuclei as well as first findings from the recently performed measurement of ^{123}Cd via Coulomb excitation will be presented. This project is supported by BMBF (No. 06 DA 9036I and No. 05 P12 RDCIA), HIC for FAIR, EU through EURONS (No. 506065) and ENSAR (No. 262010) and the MINIBALL and REX-ISOLDE collaborations.

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Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: 4

Type: **not specified**

Coulomb excitation of neutron-deficient radon isotopes

Friday, 25 October 2013 11:10 (20 minutes)

The region of proton rich nuclei close to $Z=82$ is well known for shape coexistence with competition between different spherical, oblate and prolate minima. Data on the light radon nuclei e.g. $^{198-206}\text{Rn}$ is rather limited and largely restricted to information on near-yrast states as inferred from in-beam studies. These studies seem to indicate a change from a largely vibrational behaviour around ^{212}Rn to the onset of deformation around ^{198}Rn . The level schemes are complex and much information is missing.

In order to obtain more detailed information on collectivity in these nuclei, an experiment was performed at REX-ISOLDE to carry out Coulomb excitation of ^{202}Rn and ^{204}Rn . At the time of the experiment, these were the heaviest ISOL beams ever accelerated. The choice of radon nuclei was motivated both by the underlying Physics but also the ability to produce pure, intense beams of these isotopes using a cooled transfer line to remove isobaric contamination. The analysis of the data obtained has been completed and the data have been used to extract matrix elements using the Coulomb excitation code, GOSIA.

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Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: 5

Type: **not specified**

Coulomb excitation of ^{26}Na with MINIBALL at REX-ISOLDE

Thursday, 24 October 2013 14:30 (20 minutes)

Excited states of ^{26}Na were the subject of a Coulomb excitation experiment at REX-ISOLDE employing a radioactive ^{26}Na beam with a final energy of 2.82 MeV/u. De-excitation gamma-rays were detected by the MINIBALL gamma-spectrometer in coincidence with scattered particles in a CD-shaped segmented Si-detector. Reduced transition matrix-elements for the excited states of ^{26}Na at 233 keV and 407 keV were determined for the first time. The obtained values are compared to theoretical predictions from updated shell model calculations using USDA/USDB interactions.

Supported by BMBF (05P09PKCI5) and ENSAR (262010)

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Session Classification: Status of ongoing MINIBALL experiments Part I

Contribution ID: 6

Type: **not specified**

Coulomb excitation of $^{29,30}\text{Na}$

Thursday, 24 October 2013 14:05 (25 minutes)

Nuclear shell effects in neutron-rich Na nuclei at the border of the island of inversion around $N=20$ were studied by measuring reduced transition probabilities, i.e. $B(E2)$ and $B(M1)$ values. To this end Coulomb-excitation experiments, employing radioactive $^{29,30}\text{Na}$ beams with a final beam energy of 2.85 MeV/u, were performed at REX-ISOLDE, CERN. De-excitation gamma rays were detected by the MINIBALL gamma-ray spectrometer in coincidence with scattered particles in a segmented Si detector. The measured $B(E2)$ values agree well with shell-model predictions, supporting the idea that in the Na isotopic chain the ground-state wave function contains significant intruder admixture already at $N=18$, with $N=19$ having an almost pure $2p2h$ deformed ground-state configuration.

This work has been supported by the German BMBF, by the FWO-Vlaanderen, by the IAP Belgian Science Policy (BriX network), by the UK STFC, by the EURONS, and by the ENSAR.

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Session Classification: Status of ongoing MINIBALL experiments Part I

Contribution ID: 7

Type: **not specified**

Welcome

Thursday, 24 October 2013 14:00 (5 minutes)

Presenter: GARCIA BORGE, Maria Jose (CERN)

Session Classification: Status of ongoing MINIBALL experiments Part I

Contribution ID: 8

Type: **not specified**

Probing the semi-magicity of ^{68}Ni via one and two-neutron transfer reactions using TREX+MINIBALL

Thursday, 24 October 2013 14:50 (30 minutes)

Presenter: FLAVIGNY, Freddy (Katholieke Universiteit Leuven (BE))

Session Classification: Status of ongoing MINIBALL experiments Part I

Contribution ID: 9

Type: **not specified**

Multiple Coulomb Excitation with high intense ^{72}Zn beam at ISOLDE

Thursday, 24 October 2013 15:20 (20 minutes)

Presenter: MUECHER, Dennis (Technische Universitaet Muenchen (DE))

Session Classification: Status of ongoing MINIBALL experiments Part I

Contribution ID: **10**

Type: **not specified**

Coulomb excitation of ^{72}Kr - a shape study

Thursday, 24 October 2013 15:40 (20 minutes)

Presenter: Dr NARA SINGH, B.S. (University of York, Department of Physics)

Session Classification: Status of ongoing MINIBALL experiments Part I

Contribution ID: 11

Type: **not specified**

Recent highlights from ALTO and ORGAM

Thursday, 24 October 2013 16:30 (30 minutes)

Presenter: MATEA, Iolanda (Institut de Physique Nucleaire (IPN)-Universite de Paris-Sud 11)

Session Classification: MINORCA MINIBALL experiments at ORSAY

Contribution ID: 12

Type: **not specified**

Opportunities for the spectroscopy of fast neutron-induced reactions using Miniball and the Licorne directional neutron source

Thursday, 24 October 2013 17:00 (20 minutes)

Presenter: LE BOIS, Mattieu (Institut de Physique Nucléaire d'Orsay)

Session Classification: MINORCA MINIBALL experiments at ORSAY

Contribution ID: 13

Type: **not specified**

Recoil Distance Doppler Shift measurements using the OUPS plunger

Thursday, 24 October 2013 17:20 (20 minutes)

Presenter: GOASDUFF, Alain (IPHC)

Session Classification: MINORCA MINIBALL experiments at ORSAY

Contribution ID: 14

Type: **not specified**

Geant4 simulations of the MINORCA setup and MINIBALL Anti Compton shields

Thursday, 24 October 2013 17:40 (20 minutes)

Presenter: LJUNGVALL, Joa (CSNSM Orsay)

Session Classification: MINORCA MINIBALL experiments at ORSAY

Contribution ID: 15

Type: **not specified**

Present status of MINORCA installation and some ideas of possible physics cases.

Thursday, 24 October 2013 18:00 (30 minutes)

Presenter: GEORGIEV, Georgi (CSNSM Centre de Spectrometrie Nucleaire et de Spectrometrie de)

Session Classification: MINORCA MINIBALL experiments at ORSAY

Contribution ID: 16

Type: **not specified**

Cluster-transfer reactions with radioactive ^{98}Rb and ^{98}Sr beams on a ^7Li target

Friday, 25 October 2013 09:00 (20 minutes)

Presenter: BOTTONI, Simone (Università degli Studi e INFN Milano (IT))

Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: 17

Type: **not specified**

Coulomb excitation of ^{142}Sm

Friday, 25 October 2013 10:00 (20 minutes)

Presenter: STEGMANN, Robert (Technische Universität Darmstadt (DE))

Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: **18**

Type: **not specified**

Preliminary results on 221Rn and the status of Spede

Friday, 25 October 2013 11:30 (20 minutes)

Presenter: O'NEILL, George Genghis (University of Liverpool (GB))

Session Classification: Status of ongoing MINIBALL experiments Part II

Contribution ID: 19

Type: **not specified**

Overview and Status of MINIBALL at the Munich Tandem Laboratory

Friday, 25 October 2013 11:50 (45 minutes)

Presenter: MUECHER, Dennis (Technische Universität München (DE))

Session Classification: MINIBALL experiments at MLL, Munich Part I

Contribution ID: 20

Type: **not specified**

A short status on lifetime measurements following the $^{14}\text{N}(d,p)$ and $^{14}\text{N}(d,n)$ reactions

Friday, 25 October 2013 14:00 (15 minutes)

Presenter: MONTANER PIZA, Ana (Universidad de Valencia (ES))

Session Classification: MINIBALL experiments at MLL, Munich Part II

Contribution ID: 21

Type: **not specified**

Multiplicities of X-rays after fusion evaporation using MINIBALL

Friday, 25 October 2013 14:15 (15 minutes)

Presenter: REICHERT, Sebastian (TU Munich)

Session Classification: MINIBALL experiments at MLL, Munich Part II

Contribution ID: 22

Type: **not specified**

X-ray spectroscopy of $^{132,133}\text{Ce}$

Friday, 25 October 2013 14:30 (15 minutes)

Presenter: BERNER, Christian (TU Munich)

Session Classification: MINIBALL experiments at MLL, Munich Part II

Contribution ID: 23

Type: **not specified**

Study of two-neutron transfer with Lithium and Oxygen targets using MINIBALL in Munich

Friday, 25 October 2013 14:45 (15 minutes)

Presenter: PLEINTINGER, Moritz (TU Munich)

Session Classification: MINIBALL experiments at MLL, Munich Part II

Contribution ID: 24

Type: **not specified**

Determination of the 2+1 level lifetimes in $^{58,60,62}\text{Ni}$ using the DSA method

Friday, 25 October 2013 15:00 (15 minutes)

Presenter: STEGMANN, Robert (Technische Universität Darmstadt (DE))

Session Classification: MINIBALL experiments at MLL, Munich Part II

Contribution ID: 25

Type: **not specified**

Concluding remarks and discussion

Friday, 25 October 2013 15:15 (30 minutes)

Session Classification: MINIBALL experiments at MLL, Munich Part II