Absolute E3 and M2 transition probabilities for electromagnetic decay $K^{\pi}=8^{-}$ isomeric state in ^{132}Ce

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The problem of the K selection rule violation for electromagnetic transitions in nuclei, in spite of being a subject of extensive investigations, is not yet well understood. One of possible reasons of the phenomenon is the Coriolis interaction, which is responsible for a substantial admixture of wave function components characterized by K values higher than the main one [1-3]. However, the non-axial deformation may cause the same experimental effects. Measurement of absolute values of the transition probability can help clarifying the underlying mechanism. The nuclei from the mass area around A=130, exhibiting large triaxiality (γ around 20° ÷ 30°), constitute an excellent testing ground to study this phenomenon.

The main goal of the measurement was to determine multipolarities of the gamma transitions de-exciting the $K^{\pi} = 8^{-}$ isomeric state ($T_{1/2} = 9.4$ ms) in ^{132}Ce. The gamma and internal conversion electron spectroscopy were carried out using the ^{16}O beam from the U-200P cyclotron of the Heavy Ion Laboratory, University of Warsaw. The OSIRIS-II, array of 11 HPGe ACS detectors was coupled to the electron spectrometer [4] for γ-γ and γ-e measurements. The main goal of this experiment was to determine multipolarities for the 526 and 798 keV transitions. The multipolarities of these transitions were determined by comparison experimentally obtained coefficients with theoretical ones. The electron spectrum gated by the 683 keV γ line, together with the decay level scheme below the isomeric state, are shown in Fig 1. Multipolarities, reduced transition probabilities, hindrance factor and reduced hindrance factor for the 526 and 798 keV transitions will be presented. Recently, the electron spectrometer was equipped in the new 12 segmented Si(Li) detector and together with the EAGLE array [5] is powerful tool for successive studies of the $K^{\pi} = 8^{-}$ isomers for N=74.

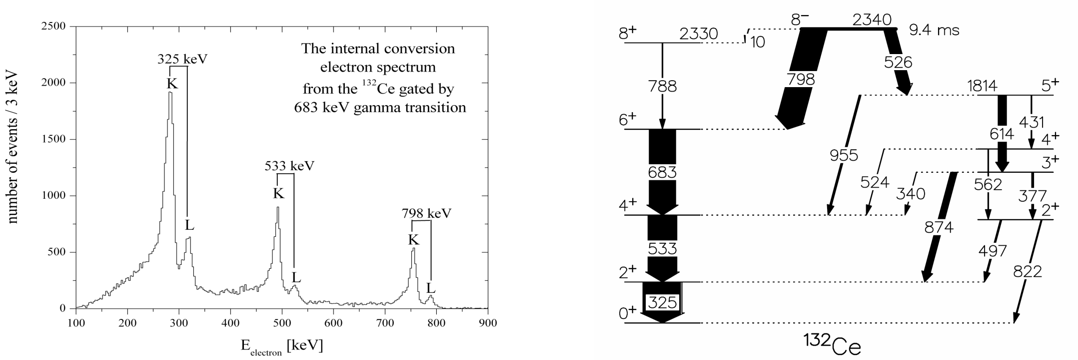

Fig. 1 The internal conversion electron spectrum showing the K and L peaks from the decay of the K-isomeric state $I^{\pi} = 8^{-}$ in ^{132}Ce populated in the ^{120}Sn(^{16}O, 4n) ^{132}Ce reaction.

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Mechanism of weakening of the K-forbidness in 132Ce: triaxiality or S-band – yrast band interaction ?

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The unexpected population of high-K isomers by COULEX has brought into question the validity or "goodness" of the K quantum number (see [1]). Experimental data for ^{178}Hf have shown that K-isomer electromagnetic population in this nucleus was due to high–K component admixture to low K bands [1]. The same mechanism was observed in E1 decay of $K^{\pi} = 8^{-}$ isomer in ^{132}Ce [2].

However, new decay branch to quasi γ –band observed in [2] could be interpreted in the frame of triaxial rotor Davydov-Fillipov model. I will present the isomer decay pattern interpretation based on K-component distribution[4] of wave functions of individual states. In Fig.1 K=4 component probability for 6+ state of the ground-band and 5+ state of the quasi γ-band is shown.

The results of γ - γ and γ – e measurements [3] on beam of the U200P cyclotron at HIL Warsaw were used to determine the B(E3; 8 → 5+) / B(E3; 8 → 6+) ratio. Assuming that E3 transition proceeds from K=7 to K=4 , the ratio happened to be a function of K=4 components in both final states and a sensitive probe of gamma deformation for 5+ and 6+ states. This way it was deduced that difference in the γ deformation parameter of 5+ and 6+ states is $\Delta\gamma = 3.5 \pm 1.0°$.

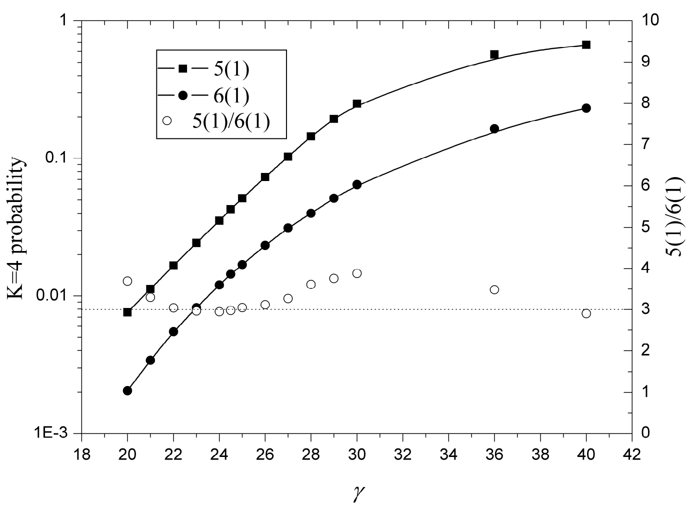

Fig. 1 Results of the D-F model calculation[4]. Full dots and squares show K=4 component probability (left axis) for 5+ and 6+ states, respectively, as a function of γ deformation. Open dots show ratio of K=4 component in 5+ and 6+ states(right axis). The ratio is very close to 3 independently of the value of γ deformation.

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[3] J. Perkowski et al. **contribution to this Workshop**
[4] P.Napiorkowski **http://www.slcj.uw.edu.pl/~pjn/DF/DF.htm**

Analysis of states above the K^{π}=8^{-} isomer in ^{138}Gd

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Abstract

States above the known K^{π}=8^{-} isomer in ^{138}Gd were populated with the ^{106}Cd(^{36}Ar^{8+},2p2n) interaction, at a beam energy of 180 MeV, using the K130 cyclotron accelerator at the University of Jyväskylä, Finland. The recoil isomer tagging technique was utilised to correlate delayed γ ray decays detected in the GREAT focal plane spectrometer, with prompt decays measured in the JUROGAM spectrometer at the target position. Current analysis has managed to measure more accurately the lifetime of the isomeric state, with a value of 6.2(2) μs. Angular distributions have been performed for the known states above the isomer and confirm their placements as either E2 or M1 transitions. The band above the isomer has also been extended with the addition of both an E2 and M1 transition, and the measurement of g_k values for all the states in this band further confirm its assignment to the two-quasineutron [514]9/2⊗[404]7/2 configuration. Several other bands above the isomer have been observed and work is currently undergoing to determine whether these belong to rotational structures at higher spin, which are seen in the lower-mass even-even nuclei ^{136}Sm [1] and ^{134}Nd [2].

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Decay of the $K^{\pi}=23/2^-$ Isomer ($T_{1/2}$=160.44 d) in ^{177}Lu: Revisited

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Gamma-ray spectroscopy studies of K isomers play an important role in understanding properties of deformed, axially symmetric nuclei. While considerable progress has been made in the past 30 years to describe the excitation energy and quantum numbers of many isomers located in different areas of the nuclear chart, prediction of their lifetimes still remains a challenge for theory. The lifetimes can be particularly long, especially when the isomer is classified as being both a K-trap (large difference in K quantum numbers between the isomeric and final states) and an yrast-trap (lower excitation energy of the isomer, which enables the decay to proceed only via high-multipolarity transitions). The most notable examples are the $K^{\pi}=16^+$ isomer ($T_{1/2}$=32 y) in ^{178}Hf and the $K^{\pi}=23/2^-$ isomer ($T_{1/2}$=160.44 d) in ^{177}Lu; these are also of interest for various applications, owing to their very long lifetimes.

At ANL, we have recently studied decays of the $K^{\pi}=23/2^-$ isomer ($T_{1/2}$=160.44 d) in ^{177}Lu by means of various Ge and scintillation detectors. The isomer was produced following neutron capture on ^{176}Lu (using natural lutetium material as a target) at the University of Massachusetts Lowell research reactor facility. The radioactive source was prepared at ANL following radiochemical separation of ^{177}Lu and ^{182}Ta radionuclide, the latter being produced from small tantalum impurities in the natural lutetium material. Singles measurements were carried out using high-purity Ge and LEPS detectors, as well as gamma-ray coincidence studies with Gammasphere. In addition, two $LaBr_3$(Ce) scintillation detectors were incorporated in the Gammasphere array. These allowed gamma-ray coincidences and fast-timing measurements to be performed. The previously known decays of the $K^{\pi}=23/2^-$ isomer, via the 115-keV E3 transition to the $17/2^+$ member of the ground state band of ^{177}Lu and via a first forbidden β^- decay to a similar $K^{\pi}=23/2^+$ isomer in ^{177}Hf, were confirmed, with the corresponding gamma-ray intensities determined with better precision in the present work. Importantly, new high-multipolarity (M3, E4 and tentatively E5) decay branches were discovered, which allowed the transition strengths for such rare decay modes to be determined and compared with the limited data available in neighbouring nuclei.

Results from these studies will be presented. Applicability of $LaBr_3$(Ce) detectors, coupled to a large multi-detector Ge array, for studying short-lived isomeric states in transitional and well-deformed nuclei will be also discussed.

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Shell evolution in the newly-explored neutron-rich region around Z=82 and far beyond N=126: experimental details

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The study of exotic nuclei has shown that significant changes of the well known shell structure along the stability valley occur, especially for very neutron-rich nuclei with mass numbers below 100. Little is known on the evolution of Z=82 shell closure beyond N=126 and on the neutron-rich nuclei around ^{208}Pb, because of the experimental difficulties to reach such nuclei [1]. Their study is relevant also for nuclear astrophysics, since the measurement of their β-decay half lives will improve the understanding of the r-process stellar nucleosynthesis in heavy nuclei [2].

In this talk results from an experiment aiming at the population of exotic neutron-rich isotopes around ^{208}Pb will be presented.

Many neutron-rich isotopes were identified for the first time and a significant number of new isomers were discovered.

Preliminary experimental results will be presented.

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Shell evolution in the newly-explored neutron-rich region around Z=82 and far beyond N=126: interpretation

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Neutron-rich nuclei above ^{208}Pb were populated by using a 1 GeV*A ^{238}U beam at GSI and their study was made possible by the presence of long-lived isomeric states that were indeed expected by shell-model calculations. The resulting fragments were separated and analyzed with the FRS-Rising setup together with a Si array to detect the beta decay [3,4,5].
Several new exotic isotopes have been observed, up to ^{218}Pb along the Z=82 shell closure and up to N=138 and N=135 for the proton-hole and proton-particle Tl and Bi nuclei, respectively. Several isomers were observed for the first time. Their structure involves the neutron $1\nu i_{11/2}$,$1\nu i_{13/2}$ $1\nu j_{15/2}$ and $2\nu g_{9/2}$ shells and proton $1\pi h_{11/2}$ and $1\pi h_{9/2}$ orbitals.
In this presentation we will discuss the results for neutron-rich Z=82 Lead in terms of state-of-the-art shell-model calculations.
The evaluation of the resulting isomers will give clues about the evolution of the nuclear structure into this newly-explored region of the nuclide chart.

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Structure Assignment Methods For K-Isomers in N=150 nuclei

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Abstract

K-isomer states of nuclei around the deformed shell gaps at Z = 102 and N = 152 provide us with an opportunity to study single particle energy levels in this region. Some of these energy levels are also present around the next predicted spherical shell gaps. Experimental results for the energy and ordering of these levels therefore provide us with crucial information in helping predict the position of the so called 'Island of stability'.

K-isomeric states were studied in both ^{252}No and ^{250}Fm [1] at the University of Jyväskylä in Finland. In-beam data was taken using the JUROGAM array and nuclei produced in an isomeric state were identified using recoil-decay tagging methods [2] from decays in the GREAT focal plane detector. Rotational band spectra built upon the isomeric states are used to determine their single particle structural assignment, however low statistics meant conventional methods were inconclusive.

A new approach was therefore used and will be presented here for the assignment of two 8^- K-isomeric states in ^{252}No and ^{250}Fm.

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Isomeric states in ^{197,199}At and ^{203,205}Fr

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Recently a rotational band has been observed to feed the 13/2$^+$ isomer in both ^{197}At and ^{199}At [1]. The evolution of the isomeric state itself when approaching the neutron mid-shell, from becoming yrast in ^{199}At and α-particle decaying in ^{193}At [2], has earlier been studied. Moreover, a spherical 29/2$^+$ isomer has been identified to feed the $i_{13/2}$ band in ^{199}At. This high-spin isomer has been observed sporadically throughout the neutron-deficient odd-mass astatine isotopes.

Preliminary results from a recent recoil-decay tagging [7] study reveal decays from isomeric states detected in ^{203}Fr and ^{205}Fr for the first time. These could present a single-step decay of the intruding 13/2$^+$ isomer to the ground state.

The experiments were performed at JYFL using the gas-filled recoil separator RITU [3] together with the Ge-detector array JUROGAM [4, 5] and the focal plane spectrometer GREAT [6].

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Recoil-isomer tagging studies in the vicinity of $Z = 82$ and $N = 82$ shell closures

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Abstract

The recoil-isomer technique has been used to study excited states of the extremely neutron-deficient nucleus ^{175}Hg for the first time. The decay path of a $J^{\pi} = 13/2^{+}$ isomeric state to the ground state has been observed and has permitted the identification of a band exhibiting characteristics consistent with a mildly oblate shape. The observations are interpreted in terms of single-particle configurations and are discussed in the context of the shape-coexistence reported in neighbouring Hg isotopes.

$\frac{13}{2}^{+}$ isomeric states in neutron deficient ^{173,175}Pt nuclei

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Two platinum nuclei, A = 173, 175, lying in between the N = 104 mid-shell and the proton drip-line have been studied. Studying odd-mass nuclei in this region sheds light on the single-quasiparticle orbitals present near the Fermi surface. The low-lying $i_{13/2}$ shell model intruder state gives a reason to expect low-lying isomeric states in these platinum nuclei.

Recoil decay tagging (RDT) method has been used in the experiments performed at JYFL to achieve good selectivity despite many possible particle evaporation channels and relatively long alpha-decay half-lives in the region of this study.

The $13/2^{+}$ band head of ^{173}Pt was found to be isomeric but no isomeric transitions from the assumed $13/2^{+}$ state have been observed for the ^{175}Pt. The results of these studies will be discussed.

Three-quasiparticle-plus-rotor Coriolis coupling calculations

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In this paper, we present three-quasiparticle-plus-rotor Coriolis coupling calculations for explanation of signature effects exhibited by the three-quasiparticle (3qp) rotational bands. We also discuss various special issues involved in these Coriolis mixing calculations.

The Coriolis mixing is generally responsible for a host of phenomena in rotational bands [1, 2]. Therefore, in order to reproduce the experimentally observed staggering behavior in the 3qp rotational bands, we have undertaken a Coriolis mixing of the 3qp bands with higher order mixing taken into account. Some of the major issues involved in these calculations are:

1. For a given 3qp configuration, we have four band-heads and hence four different rotational bands, which leads to the complexity of Coriolis mixing calculations. In order to overcome this problem and to test the validity of our calculations, we have considered only those 3qp configurations which involve relatively low-Ω orbitals, so that we get a small basis and hence a relatively small number of interacting bands.
2. Since the experimental data for 3qp bands is still scarce, most of the important bands taking part in the Coriolis mixing are not known. In order to handle this problem we calculate the band-head energies for all the interacting bands.
3. The exact estimation of the band-head energies, which is one of the main input parameters in these calculations, is still a problem due to non-availability of the experimental data/accurate estimates for the Gallagher-Moszkowski (GM) splitting as well as the Newby shift energies of all the two-quasiparticle (2qp) doublets comprising the 3qp configurations. In order to handle these situations, we obtain the energies for all the three-quasiparticles in a given 3qp configuration by using the known properties of the involved one-quasiparticle (1qp) configuration from the neighboring odd-A nuclei [3] and estimated values GM splitting energies [3].

With the existing experimental data and the above choice of parameters, we are able to reproduce the phase of staggering in the 3qp rotational bands observed in ^{155}Dy, ^{165}W [4] and ^{167}W. On the basis of these Coriolis mixing calculations, we suggest that the rotor-particle (Coriolis) terms play a major role for the observed signature effects in the 3qp rotational bands. The phase as well as the magnitude of the staggering do not remain same for all the members of a given 3qp quadruplet. Since a complete and confirmed quadruplet is yet to be observed in any nucleus, it remains an open challenge for experimentalists to reliably identify a given 3qp quadruplet and rotational bands for each member of a quadruplet, and hence to see the variation in the phase of the staggering in all the members of a given 3qp quadruplet.

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High-spin isomers in nuclei around the N=82 shell closure

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The recent observation of high-spin isomers in Neodymium nuclei around the N=82 shell closure triggered new experimental investigations aiming to the identification of other similar isomers in the neighboring nuclei. The results of a lifetime measurement of the 6-quasiparticle 20^+ isomer in ^{140}Nd and of the 3-qp isomer above the $19/2^+$ state in ^{139}Nd represent a strong support to the cranked Nilsson-Strutinsky calculation. New experiments for the search for isomeric states with even higher spins and excitation energies in ^{140}Nd and high-spin isomers in ^{136}Ba will be discussed.

Recoil-Isomer Tagging of Extremely Neutron-Deficient Nuclei, ^{142}Tb and ^{144}Ho

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Excited states in the neutron-deficient odd-odd nuclei ^{142}Tb and ^{144}Ho have been populated using the ^{92}Mo(^{54}Fe,3pn)^{142}Tb and ^{92}Mo(^{54}Fe,pn)^{144}Ho reactions and studied using the recoil-isomer tagging technique. The beam was supplied at energies between 226 and 265 MeV by the K130 cyclotron at the University of Jyväskylä, Finland. The JUROGAM and GREAT detector arrays were employed with the RITU gas-filled recoil separator to study these nuclei using γ-ray spectroscopy. Recoil distance Doppler-shift (RDDS) lifetime measurements have been performed on the states above the ^{144m}Ho isomer using the Köln differential plunger. This measurement represents the first differential-plunger lifetime measurement to utilize recoil-isomer tagging to isolate the nucleus of interest.

Potential energy surface calculations predict these nuclei to have axially asymmetric and γ-soft shapes and the data have been interpreted within the framework of the cranked-shell model. The properties of the rotational bands above the $I^\pi = 8^+$ isomers in ^{142}Tb and ^{144}Ho indicate that these states are based on $\pi h_{11/2} \otimes \nu h_{11/2}$ two-quasiparticle configurations. The data show good agreement with the predicted axial asymmetry for these nuclei.

A lifetime of 6(1) ps was determined from the RDDS measurements for the $I^\pi = 10^+$ state above the ^{144m}Ho isomer. The lifetime of this state can be understood from these calculations if a degree of rotational alignment is invoked for this band, with the K value being lower than the bandhead spin. However, the validity of the K quantum number with large predicted triaxiality and softness requires further theoretical study.

Deformation in the mid fp-shell region: isomer tagging in ^{59}Cr

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The structure above the 96-μs isomer in the isotope ^{59}Cr has been investigated to shed light on the nature of the developing nuclear shapes in the neutron-rich fp shell. The current understanding in this region is somewhat muddled, with evidence having been previously interpreted in different cases as indicating strong prolate, mildly oblate, oblate and rather soft deformations in closely-lying isotopes. Neutron shell gaps appear at both prolate and oblate shapes near mass-60 that might help drive rapid shape changes. It has been suggested that the ^{59}Cr isomer is associated with an oblate shape [1], but the experimental situation is rather uncertain, and other interpretations are possible [2]. This study was motivated by the need to establish the level structure built on the isomer in order to gain further insight.

The ^{13}C(^{48}Ca,2p)^{59}Cr reaction was used at Gammasphere to populate states above the isomer. Isomer-decay tagging was used in two different ways. Firstly, a Pb catcher placed after the target, along with beam pulsing, provided high-statistics, but complex, prompt-delayed correlations. Secondly, following recoil separation through the Fragment Mass Analyzer (FMA) and a transmission ion chamber, delayed transitions detected in a clover array behind the focal plane were correlated to prompt γ rays in Gammasphere.

Presented here are the first results from this experiment and a discussion of the viability of combining these two methods of isomer tagging.

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A RECOIL-BETA TAGGING STUDY OF THE N=Z NUCLEUS ^{66}As

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A Recoil-Beta Tagging (RBT) experiment was recently performed at the University of Jyväskylä Accelerator Laboratory in order to study excited states in the medium-heavy N=Z=33 nucleus ^{66}As. To date, there are two experimentally observed isomeric states ($I^{\pi} = (5^{+})$ and $I^{\pi} = (9^{+})$) in ^{66}As, first discovered by Grzywacz et al. [2]. The existence of two states was confirmed in the recent experiment. In addition, the ordering of the isomeric states was established by comparing the time stamps of the decay events. This comparison indicates the (9^{+}) isomer to be higher lying in excitation energy. A spherical shell model study by Hasegawa et al. [3] predicted a third low-lying 3^{+} isomeric state arising from shape co-existence. However, the experimental confirmation of this shape isomer has been unsuccessful. This might indicate that the isomer is extremely short lived, if it exists.

The experiment was performed utilising the JUROGAM II γ-ray spectrometer in conjunction with the gas-filled recoil separator RITU and the GREAT focal plane spectrometer system. The ^{66}As nuclei were produced via a ^{40}Ca(^{28}Si,pn)^{66}As reaction at a beam energy of 75 MeV. This experiment was successful due to the technical developments in the measurement set-up. New 50 μm thick Mylar windows were installed in the multi-wire proportional counter at the focal plane, which allowed a higher gas pressure to be used in RITU, thereby improving the separation between the recoils of interest and beam like projectiles. The planar Ge detector of GREAT was used to detect the beta particles as well as γ-rays.
This presentation will discuss the structures of the isomeric states, along with the most recent results regarding ^{66}As, the lightest nucleus ever studied at RITU.

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High-spin Isomers in ^{94}Pd

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The region of neutron-deficient nuclei just below ^{100}Sn is remarkable for an abundance of high-spin isomeric states. The 14^+ isomer in ^{94}Pd is one example that has been well studied via-fusion evaporation [1, 2] and fragmentation [3, 4] reactions and via the β decay of the (21^+) isomer in ^{94}Ag [5, 6]. This talk will report the discovery of a second γ-decaying high-spin isomeric state in ^{94}Pd, populated via fragmentation of an 850 MeV/u ^{124}Xe beam from the SIS synchrotron at GSI. The FRagment Separator (FRS) and its ancillary detectors [7] provided a clean identification of each fragment implanted in an active stopper at the separator's final focus. Combined with the high efficiency of the RISING array surrounding the stopper, this allowed for the lifetime measurement of both isomeric states in an almost background-free environment through γ-γ coincidences. These measurements will be discussed along with the possible spin and parity assignments of the new state. Results will also be compared to shell model calculations.

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Differential isomeric ratios following two-proton knockout from ^{208}Pb

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We consider direct two-nucleon knockout reactions using light nuclear targets as a means of populating isomeric states in exotic nuclei, taking the example of two-proton removal from ^{208}Pb. Two isomeric states in ^{206}Hg are observed [1], the isomeric population ratios of which are reasonably described by two-proton knockout calculations once the observed feeding is taken into account [2].

Recent theoretical developments indicate that residue momentum distributions depend strongly on the final-state spin [3], such that the population ratio of high-spin states increases for large residue momentum. This tendency was observed in isomer studies using fragmentation reactions, which show a strong sensitivity of the isomeric ratio to the residue momentum [4,5].

The previous theoretical analysis for ^{208}Pb(-2p) is extended to consider isomeric ratios as a function of residue longitudinal momentum. Despite strong broadening due to the thick reaction target of the present experiment, the isomeric ratio retains significant sensitivity to the residue momentum, well reproduced by the direct two-proton removal calculations. The theoretical underestimation of the isomeric ratio near the residue central momentum suggests a degree of additional, unobserved feeding from low-spin states.

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Isomeric ratios for nuclei produced

in the fragmentation of ^{208}Pb At 1 AGeV

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Isomeric ratios for a number of nuclei with Z=62-67 and A=142-152 were extracted. Production mechanism of these nuclei was fragmentation of the relativistic (1 GeV/u) ^{208}Pb beam from the SIS-18 synchrotron of the GSI facility on a ^{9}Be target. The nuclei of interest were selected using the FRagment Separator (FRS) and implanted into the 7mm thick plastic stopper. The gamma-rays from the decay of isomeric states in the implanted nuclei were measured by the RISING array [1]. Details of the experiment are described in Ref. [2]. In total 22 nuclides were detected, isomeric states were observed in 9 of them: $I^{\pi}=19^{-}$ in ^{152}Ho (τ= 8.4μs), $I^{\pi}=31/2^{+}$ in ^{153}Ho (τ= 229ns), $I^{\pi}=27^{+}$ in ^{148}Tb (τ=1.3μs), $I^{\pi}=10^{+}$ in ^{144}Gd (τ=145ns), $I^{\pi}=49/2^{+}$ in ^{147}Gd (τ=510ns), $I^{\pi}=11/2^{-}$ in ^{143}Eu (τ= 50μs), $I^{\pi}=8^{-}$ in ^{144}Eu (τ=1μs), $I^{\pi}=11/2^{-}$ in ^{145}Eu (τ=490ns), $I^{\pi}=10^{+}$ in ^{142}Sm (τ=480ns) and $I^{\pi}=7^{-}$ in ^{142}Sm (τ=170ns). Resulting data on isomeric ratios were compared with theoretical predictions, calculated using an abrasion-ablation approach [3]. Significant differences between experimental and theoretical results were observed, similarly as in Ref. [4,5]. Possible reasons for such behaviour, as for example the temperature of the fragments, were investigated.

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Fragmentation reaction studies of high-spin isomeric states

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Abstract

The population of high-spin isomeric states in neutron-deficient N$\sim$126 nuclei has been studied in order to further understand the reaction mechanism of projectile fragmentation. The nuclei of interest were produced in the fragmentation of a 1 GeV/u ^{238}U beam impinging on a ^{9}Be target. The reaction products were selected and separated in the FRagment Separator [1] and brought to rest in a passive stopper placed at the focus of the RISING gamma-ray detector array. The intensities of the gamma-rays emitted in the decay of the isomeric states were measured and used to obtain the corresponding isomeric ratios. Such ratios provide information on the probability of nuclei produced in a reaction in a given state, and will be of great interest for the production of radioactive beams in an isomeric state in present and future nuclear physics facilities.

These data will be used to test the predictions of theories of peripheral fragmentation, such as the abrasion-ablation model. The experimental isomeric ratios will be compared with those predicted by the ABRABLA code [2,3], which assumes that only the abrasion stage contributes to the angular momentum population. There also exists the possibility of testing a more recent model [4], in which both the abrasion and ablation stages of the reaction are considered to contribute to the angular momentum.

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