COULOMB EXCITATION OF ^{231}Pa*

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The nucleus ^{231}Pa was studied by Coulomb-excitation. New states were identified by particle-$\gamma\gamma$ coincidences using the NORDBALL array in coincidence with two different particle detector systems. A regular band-structure is observed in the 3/2[651] band for levels above 9/2+ fed by strong E1 transitions from the ground-state band.

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1. Introduction

The nucleus ^{231}Pa is located near the boundary of octupole correlations manifesting themselves by the structure of the ground-state band 1/2[530] and the side band 1/2[400] [1]. The investigation of side-bands is possible because strong K-mixing of the bands enables their excitation. The nuclei

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^{231}Pa, ^{229}Pa and ^{233}Pa are good probes for the influence of octupole correlations on the nuclear structure. Extracted electromagnetic moments can be compared to calculations of the quasiparticle-plus-phonon model.

2. Experiments

A $105\,\mu g/cm^2$ ^{231}Pa oxide target on a $15\,\mu g/cm^2$ carbon backing was Coulomb-excited and particle-$\gamma\gamma$ coincidences were collected using 20 Compton-suppressed germanium detectors of NORDBALL in coincidence with either a PSD-silicon detector [2] or a multi-PIN-diode detector array [3] for the backscattered 32S(148 MeV) and 58 Ni(255,260,261 MeV) projectiles.

The Doppler-shift corrected data were energy and efficiency calibrated using the GASPAN [4] computer code, based on more than 1000 calibration points for each beam energy, not only at the beginning but also at end of each run. More than 400K-events of the p-$\gamma\gamma$ coincidences were used to pin down the level scheme with the help of the Radware97 computer code [5]. New calculations of the depopulation process following Coulomb excitation with the quasiparticle-phonon-model [1] are under way. They are used for comparison with the results of a simultaneous fit by the GOSIA computer code [6] of the matrix elements for all transitions to all experimentally measured intensities.

3. Level scheme

A continuation of the known part of the 5/2+ 3/2[651] band was followed up to 37/2+ (see Fig. 1) in addition to the 3/2− 1/2[530] g.s. rotational band seen up to 39/2− (see Fig. 2).

Strong connecting transitions from the 1/2[530] g.s. band to the 3/2[651] band at spins above 9/2+ were identified. Their angular distributions are consistent with E1. The part below 9/2+ level is known from conversion-electron measurements [1]. The E1 inter-band and E2 in-band transitions in coincidence allow the assignment to the individual bands. An E1 depopulation of the 3/2[651] band is possible from 13/2+ state and is observed indirectly by gating on the low-spin part of the ground-state band. The low energy of these transitions prevents direct observation. Nevertheless they depopulate the 3/2[651] band strongly so that the 11/2+ to 9/2+ in-band transition is very weak in the coincidence spectra. Although the structure of the low part is strongly determined by Coriolis coupling [7] leading to squeezed levels, the $E(I+1) - E(I-1)$ differences are roughly proportional to the spin for the two signatures. This feature is reproduced in quasiparticle-phonon model calculations [1, 8].

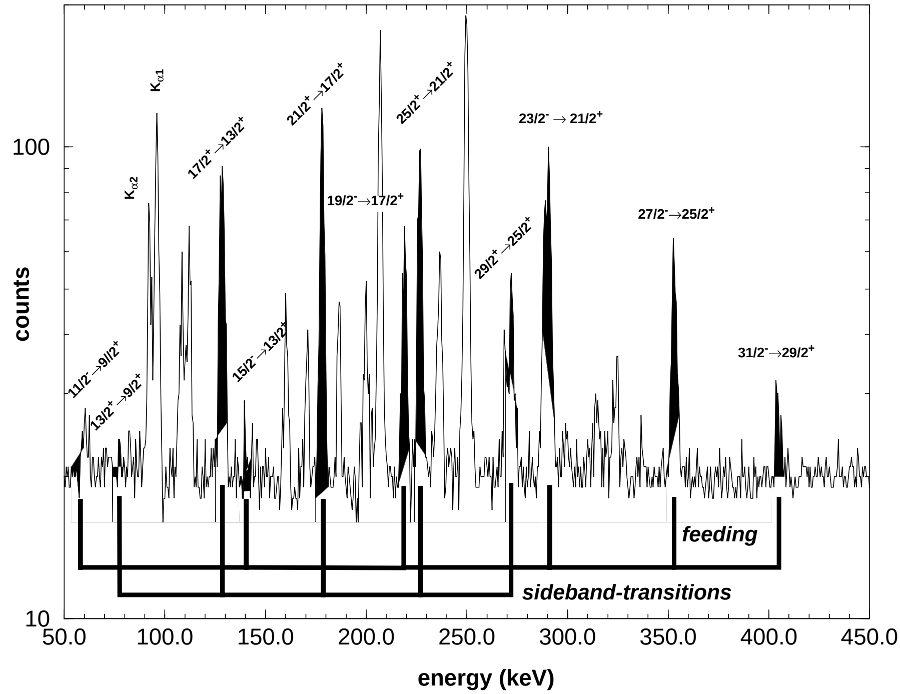

Fig. 1. Spectrum of ^{231}Pa(260 MeV)^{58}Ni particle-$\gamma\gamma$ coincidences, gated on sideband B transitions (Fig. 2); background subtracted.

4. Conclusion and Outlook

New insight into the structure of the 3/2[651] band and the associated γ-intensity flows could be obtained. A detailed fit of about 2400 experimental yields to the about 500 electromagnetic matrix elements including the 1/2[530], 3/2[651] and 1/2[660] bands is in progress. First results reproduce the theoretically proposed structure-change [1,8] at the spins 21/2−, 25/2− in the 1/2[530] g.s. band. A comparison to independent calculations of the matrix elements in the quasiparticle-plus-phonon model is on the way. A problem of the fit are the unobserved low-energy transitions in the region of edges of conversion coefficients and the verification of a global minimum.

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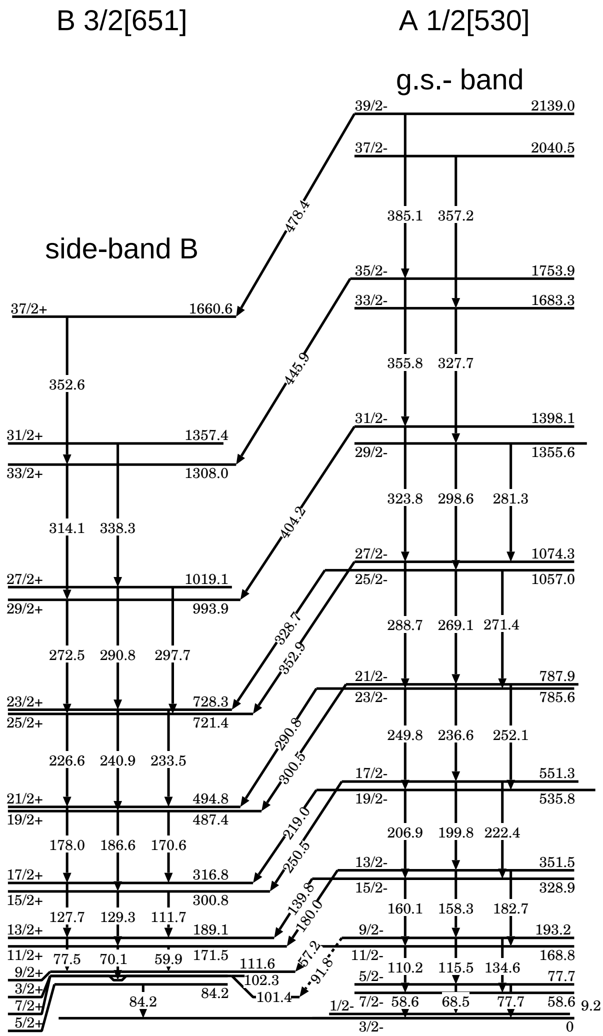

Fig. 2. Proposed levels and their assignment to the known bands in ^{231}Pa according to observed particle-$\gamma\gamma$-coincidences.

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