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HIGH-SPIN STATES IN ^{124}Ba*

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High-spin states in ^{124}Ba were populated using the ^{64}Ni(^{64}Ni,4n)^{124}Ba reaction at beam energies of 255 and 261 MeV. Gamma-ray coincidences were measured using the EUROBALL detector array.The charged-particle detector array DIAMANT provided channel selection. The previously known rotational bands are extended to higher spins. Five new bands are observed, one of them extends up to the spin $40\hbar$ region.

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1. Introduction

The nuclei around mass number $A \simeq 130$ are very well suited to study the interplay between single-particle and collective excitation modes. The transitional nuclei with a few nucleons outside a closed-shell core are soft with respect to γ-deformation [1–3] and shape driving effects of nucleons in different orbitals can be investigated. In particular, protons and neutrons in $h_{11/2}$ intruder orbitals compete in polarising the nuclear core which leads to a co-existence of different shapes [4, 5]. Recent investigations have also revealed terminating bands, *e.g.* in ^{122}Xe [6] and ^{123}Cs [7]. The aim of this work is to search for these phenomena as well as to test the cranked shell model (CSM) at high spins.

2. Experimental methods and results

The reaction ^{64}Ni(^{64}Ni,4n)^{124}Ba was used to populate high-spin states in ^{124}Ba. The beam with energies of 255 and 261 MeV was provided by the Vivitron Tandem accelerator at IReS, Strasbourg. The target consisted of a self supporting foil of $\simeq 500$ μg/cm^2 thickness. The γ-ray coincidences were detected by the EUROBALL-IV spectrometer array [8]. A total of 12×10^9 Compton suppressed coincidence events was recorded. In addition, the charged-particle detector array DIAMANT [9] was mounted inside the target chamber. For the present analysis it was used to suppress the charged-particle reaction channels.

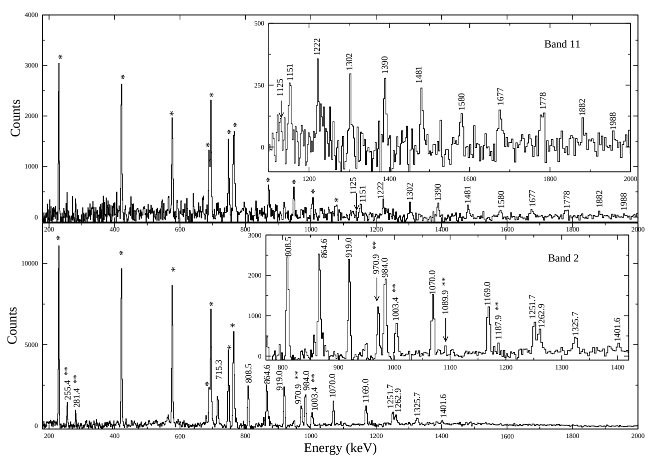

Fig. 1. Summed triple gated γ-ray coincidence spectra of band 11 (upper panel) and of band 2 (lower panel) in ^{124}Ba. The peaks marked by a single asterisk belong to band 1 (yrast band) and those marked by two asterisks (lower panel) are decay-out transitions from band 2 to band 1.

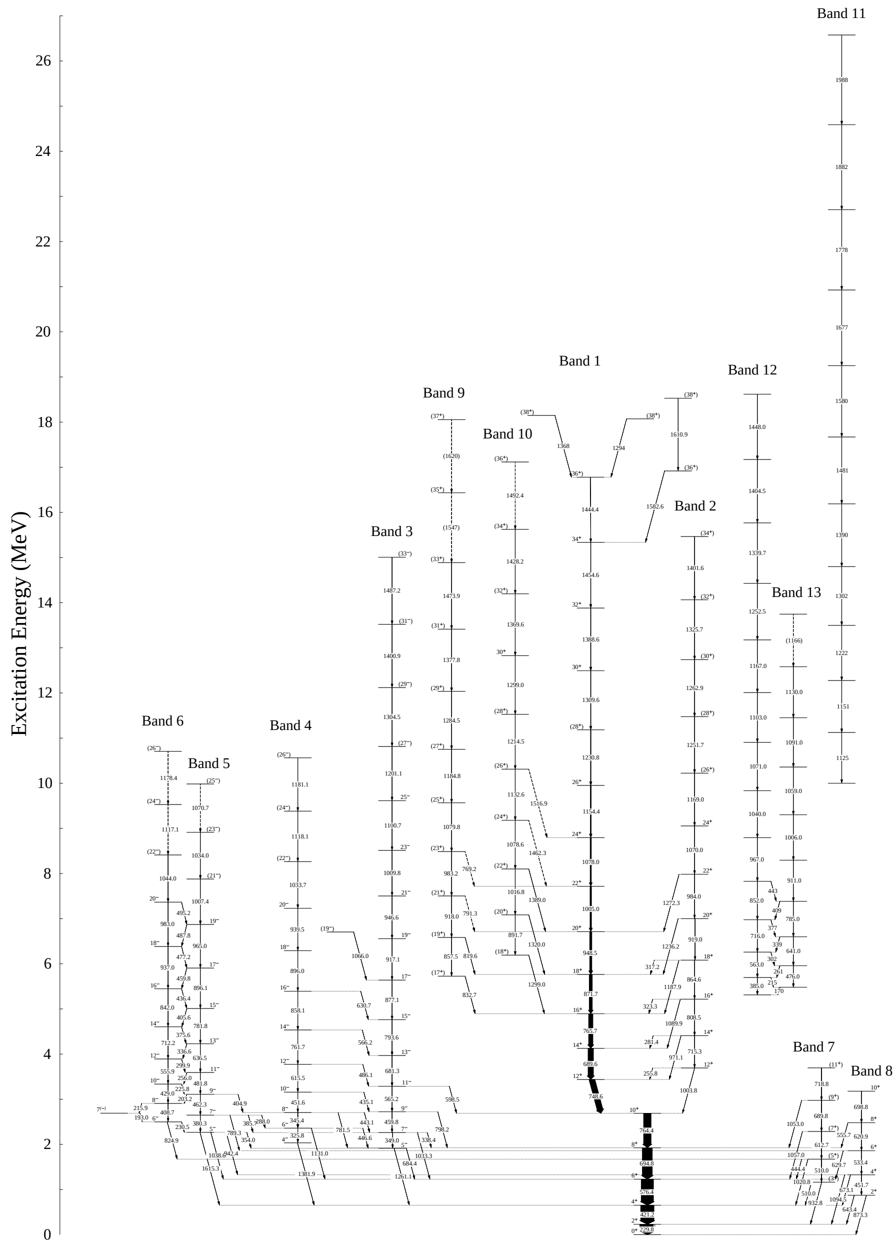

Fig. 2. Partial level scheme of ^{124}Ba deduced from this work. The low-spin part of bands 1-8 is taken from [11]. Transition intensities are not completely determined.

The γ-ray coincidence events were sorted into three- and four-dimensional arrays, cubes and hypercubes, respectively and were analysed using the RADWARE program package [10]. The previously observed structures [11] were extended to higher spins. Five new rotational bands (bands 9–13) were observed for the first time in this work, two of them (bands 9 and 10) could be connected to the yrast band. Fig. 1 shows examples of the coincidence spectra and in Fig. 2 the partial level scheme for ^{124}Ba deduced from this work is presented. The unconnected band 11 feeds into the yrast band around spin $22\hbar$ and is therefore expected to extend up to about spin $48\hbar$. The yrast band shows an irregular structure above spin $34\hbar$, which is a typical fingerprint of band termination. However, theoretical calculations are needed for a detailed interpretation of the observed structures.

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REFERENCES

[1] J. Gizon, A. Gizon, J. Meyer-ter-Vehn, *Nucl. Phys.* **A277**, 464 (1977).
[2] R.F. Casten, P. von Brentano, *Phys. Lett.* **B152**, 22 (1985).
[3] S. Frauendorf, F.R. May, *Phys. Lett.* **B125**, 245 (1983).
[4] A. Granderath *et al.*, *Nucl. Phys.* **A597**, 427 (1996).
[5] R. Wyss *et al.*, *Nucl. Phys.* **A505**, 337 (1989).
[6] H. Timmers *et al.*, *J. Phys. G: Nucl. Part. Phys.* **20**, 287 (1994).
[7] A.K. Singh *et al.*, *Phys. Rev.* **C70**, 034315 (2004).
[8] J. Simpson, *Z. Phys.* **A358**, 139 (1997).
[9] J.N. Scheurer *et al.*, *Nucl. Instrum. Methods* **A385**, 501 (1997).
[10] D.C. Radford, *Nucl. Instrum. Methods* **A361**, 297 (1995).
[11] S. Pilotte *et al.*, *Nucl. Phys.* **A514**, 545 (1990).