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HIGH-SPIN SPECTROSCOPY OF ^{124,125,126}Xe*

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High-spin states in ^{124,125,126}Xe have been populated in the reaction ^{82}Se$\,(^{48}$Ca$, xn)^{130-x}$Xe and γ-ray coincidences were measured with the GAMMASPHERE spectrometer. Twelve new bands extending into the spin 50–60 $\hbar$ region are identified in ^{125}Xe and ^{126}Xe and previously known rotational bands at low spins are confirmed and extended. Earlier known structures in ^{124}Xe are confirmed and a new band is observed. Irregular structures are identified at the top of the yrast and a side band in this nucleus. Configuration assignments for the different structures are suggested.

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1. Introduction

The main aim of the investigation of ^{124,125,126}Xe was to search for hyperdeformed structures at very high spin. Up to date no statistically significant discrete-line hyperdeformed bands have been discovered, but the analysis of the γ-ray continuum shows ridge structures with small energy spacings which may result from rotational bands with very large moments of inertia [1–3]. In the present paper, we report on an analysis of the normal-deformed level structure of these isotopes. Results on ^{126}Xe have been reported at a previous conference [2].

2. Experimental details

High-spin states in ^{124,125,126}Xe were populated in the ^{82}Se(^{48}Ca, xn) reaction. The ^{48}Ca beam of 205 MeV was provided by the ATLAS accelerator at ANL. The target consisted of a 0.5 mg/cm^2 foil of ^{82}Se evaporated on a 0.5 mg/cm^2 Au backing, and the Se was protected by a thin Au layer. Since the Au backing faced the beam, the beam energy at mid-target was about 199 MeV. For heat dissipation, the target was mounted on a rotating wheel and the beam was wobbled horizontally by about 5 mm. With these precautions, a beam current of about 4 pnA could be used. Gamma-ray coincidences were measured with the GAMMASPHERE spectrometer. With a Ge-detector fold selection of ≥ 5, a total of 2.8×10^9 events were recorded in a beam time of 7 days.

The γ-ray coincidence events were sorted into three- and four-dimensional arrays and were analysed using the RADWARE program package [4]. Matrices and γ-ray-gated matrices were created for an analysis of angular correlation ratios. This work and a complete determination of γ-ray intensities are in progress.

3. Results and discussion

The level structures of ^{124,125,126}Xe were previously studied up to a spin of about 20 $\hbar$ [5–8]. The present work extends the level schemes of ^{125,126}Xe into the region of 50–60 $\hbar$. As ^{124}Xe is populated in the $6n$ reaction channel, its level scheme can only be moderately extended. The level schemes of ^{124}Xe and ^{125}Xe are presented in Figs. 1 and 2, respectively. The level scheme of ^{126}Xe was given in a previous publication [2]. The most prominent features of the level schemes of ^{125,126}Xe are the long regular cascades extending to high angular momenta. An example of the spectra of one of these bands in ^{125}Xe is shown in Fig. 3, together with the spectrum of a new band found in ^{124}Xe.

Due to the short lifetimes of the transitions within the high-spin bands in ^{125,126}Xe, Doppler shifts could be observed even with the thin target used in the experiment. Following the method suggested by Cederwall [9], spectra

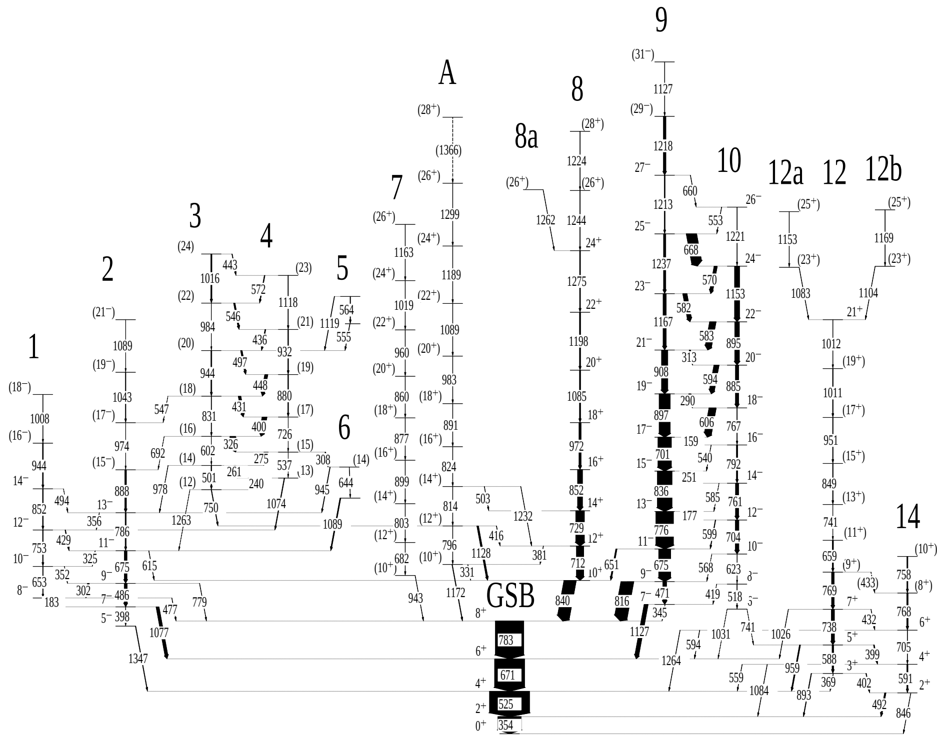

Fig. 1. Level scheme of ^{124}Xe based on present work and previous results [6].

were sorted for the strongest band in ^{126}Xe, band **a** [2], for different recoil velocities v/c, and the widths of the γ-ray peaks were determined in each of these spectra. An $F(\tau)$ curve was obtained adopting the v/c values for which the width of a given peak was a minimum. For band L4 in ^{125}Xe, see Fig. 2, spectra were sorted for different Ge-detector angles relative to the beam direction, from which v/c and $F(\tau)$ values were determined. Due to the thin target, Doppler shifts could be determined for 12 transitions in each band and the change in $F(\tau)$ is about 6%. Therefore, only estimates of the transition quadrupole moments are obtained from fits to the $F(\tau)$ curves, resulting in $Q_{\rm t} \simeq 5.0$–5.5 b for both bands. These quadrupole moments are significantly larger than those for low-spin states in these nuclei [10] and probably correspond to highly deformed prolate minima ($\varepsilon \approx 0.35, \gamma \approx 5°$) in the potential energy calculations using the Ultimate Cranker (UC) code.

To assign configurations to the bands, we compare excitation energies, moments of inertia, quadrupole moments, aligned angular momenta and band-crossing frequencies to UC calculations [11]. In the lower-spin region, where the deformation is small and the shape is fluctuating, the configurations are dominated by $h_{11/2}$ and $g_{7/2}$ neutrons and $h_{11/2}$ and $g_{7/2}$ protons.

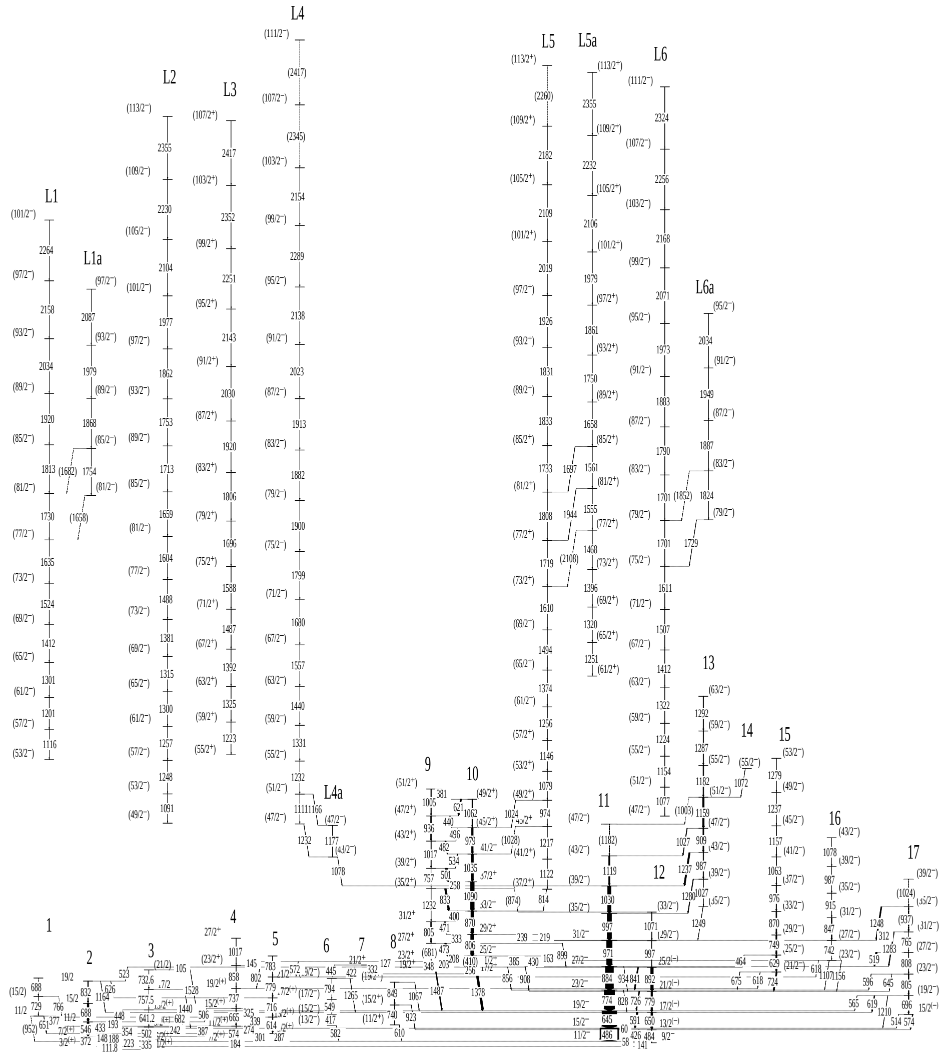

Fig. 2. Partial level scheme of ^{125}Xe deduced from this work. The low-spin part is taken from [5].

According to the calculations, strongly prolate-driving intruder configurations are responsible for the observed properties of the new high-spin bands. They are of neutron-$i_{13/2}$ origin, but also further $h_{11/2}$ and $g_{7/2}$ proton orbitals play a role.

A sharp crossing and strong alignment gain is observed at a frequency of 1.15 MeV in several of the high-spin bands in ^{125,126}Xe. The calculations suggest that it is caused by the strongly shape-driving $j_{15/2}$ neutron orbital. As pairing is probably quenched for multi-particle excitations at such high

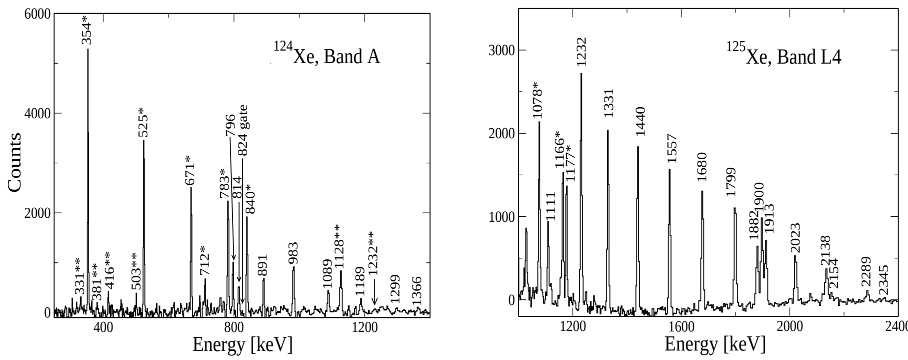

Fig. 3. Examples of γ-ray coincidence spectra in ^{124}Xe and ^{125}Xe. The peaks marked by a single asterisk belong to the ground and yrast bands and those marked by two asterisks are decay-out transitions.

frequencies, crossings with unpaired bands may also occur. It should be pointed out, however, that several of the high-spin bands are still not linked to low-spin states and final configuration assignments have to await firm spin determinations. This work is in progress.

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