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Short note

A dipole band in ^{124}Xe

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Abstract. High-spin states in ^{124}Xe were populated by means of the ^{110}Pd(^{18}O,4n) reaction. In-beam γ rays were measured using the GASP spectrometer. A dipole band, similar to those previously found in other nuclei of this mass region, was identified in ^{124}Xe.

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Sequences of levels joined by strong M1 γ rays and by comparatively weak cross-over quadrupole transitions have been identified in a number of nuclei in the A≈120-130 mass region (^{122,126,128}Ba [1-3] and ^{126}Xe [4]).Recently such bands were described by Dönau et al. [5] in the framework of the tilted-axis cranking (TAC) model and were interpreted as "t-bands", corresponding to states in which the quasiparticle angular momentum is aligned in a tilted direction with respect to the principal axes of the nuclear density distribution, as in the case of the "shear bands" of the light lead isotopes.

In this short note we are reporting on a similar band in ^{124}Xe, that we observed in the course of an experiment whose main objective was the study of ^{124}I. The nucleus ^{124}Xe has previously been studied by Gast et al. [6] and by Hattula et al. [7]. A compilation of the data on ^{124}Xe has recently been published by Imura et al. [8] .

High-spin states in ^{124}Xe were populated in the ^{110}Pd(^{18}O,4n) reaction on a thick (10 mg/cm^2) target. The 75 MeV beam was provided by the XTU Tandem accelerator of the Laboratori Nazionali di Legnaro. γ rays following the reaction were detected by the GASP spectrometer [9]. The ISIS array of silicon particle detectors [10] was included in the experimental setup in order to select the weaker particle-emitting channels.

Coincidence data were recorded on magnetic tape on the condition that at least three HPGe and three BGO detectors fired and were later unfolded to give a total of 5 $\times 10^9$ $\gamma\gamma$ events. The ^{124}Xe level scheme was deduced from the analysis of $\gamma\gamma$ and $\gamma\gamma\gamma$ matrices. In the latter case a gate on the $2_1^+ \rightarrow 0_1^+$, 354 keV transition in ^{124}Xe was used to select the reaction channel. Information on transition multipolarities was obtained by measuring directional correlation (DCO) ratios from oriented states [11].

In the present note we will only discuss the dipole band. New information, that will be reported elsewhere, was also obtained on the other bands of ^{124}Xe, that were all extended by several transitions.

The proposed new band is shown in Fig. 1. The order of the levels is unambiguously fixed by the weak cross-over transitions. Whenever they could be reliably determined, the DCO ratios were found to be consistent with M1 multipolarity

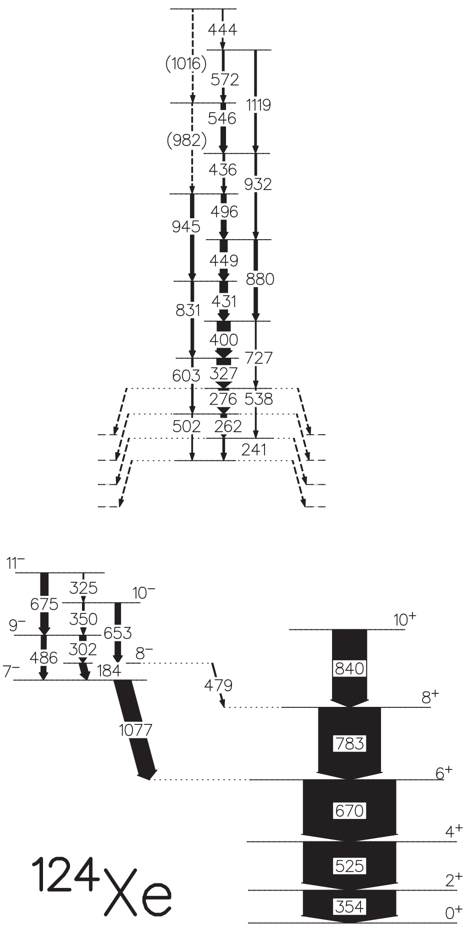

Fig. 1. Partial level scheme of ^{124}Xe obtained in the present experiment, showing the proposed dipole band and the states to which it decays

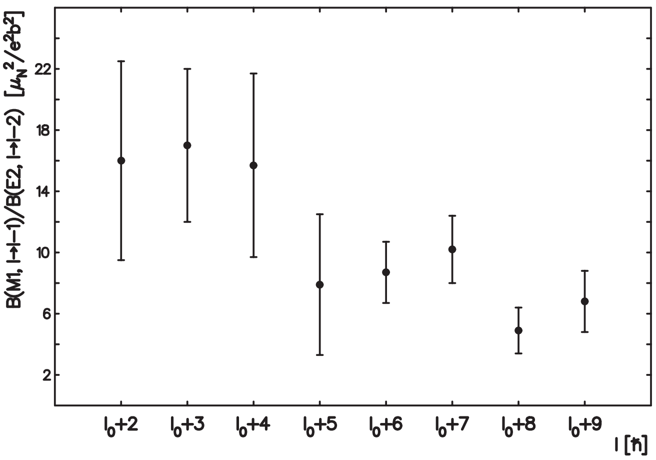

Fig. 2. Experimental transition probability ratios for the dipole band as a function of the spin of the decaying level. I_0 denotes the unknown spin of the lowest observed state

for the cascade transitions and with E2 multipolarity for the cross-over ones.

The intensities of the dipole transitions regularly increase with decreasing excitation energy of the initial level, reaching a maximum value for the 327 keV γ ray (15% with respect to the 354 keV, $2^+ \rightarrow 0^+$ transition), then drop again for the lowest three transitions of the cascade, indicating the onset of decay out of the band. The dipole band decays with comparable probabilities to the ground-state band and to the negative-parity band based on the 2626 keV , I=7 state. The coincidence spectrum gated by the 241 keV transition, however, shows that, in the case of the lowest observed level, decay to the ground-state band is favoured. The states that are fed by the decay of the dipole band have spin I $\leq$ 10 in the case of the ground-state band and I $\leq$ 11 in the case of the negative-parity band.

A connection between the dipole band and the rest of the level scheme could not be established; the excitation energy, spin and parity of the lowest observed state remain, therefore, unknown. Given the similarity with the bands discussed in [5], however, it seems reasonable to assume that also the dipole band in ^{124}Xe is based on the $\nu h^2_{11/2} \otimes \pi(h_{11/2},d_{5/2})$ configuration.

Support for such an interpretation comes from an analysis of the reduced electromagnetic transition probabilities. $\frac{B(M1; I \rightarrow I-1)}{B(E2; I \rightarrow I-2)}$ ratios were computed from the experimental branching ratios, assuming pure dipole character for the cascade γ rays. The resulting values (Fig. 2) range from $\sim 5\ \mu_n^2/e^2b^2$ to $\sim 17\ \mu_n^2/e^2b^2$ and decrease as the spin of the decaying level increases from I_0+2 to I_0+9, where I_0 is the spin of the lowest observed state. The obtained ratios and their dependence on spin are consistent with the results of the TAC calculations for the dipole band of ^{128}Ba [5].

The extremely low intensity of the $I_0+10 \rightarrow I_0+8$ transition and the loss of regularity in the sequence of the energy spacings may indicate a change in the structure of the dipole band at spin I_0+9.

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