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BAND STRUCTURE IN NEUTRON-DEFICIENT ^{103}Cd

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1. INTRODUCTION

A considerable amount of experimental works has been recently done on the light Cadmium isotopes. The main purpose of these studies was to search for Coriolis decoupling mechanism in a transitional region.

Decoupled bands ($\Delta I = 2$) based on the unique parity $\nu h_{11/2}$ neutron orbital were identified first in ^{107}Cd [1] and ^{109}Cd [2]. This band strongly fed via Pd(α, xnγ)Cd reactions was then observed in ^{105}Cd [3] and ^{111}Cd [4]. A positive parity band ($7/2^+$, $11/2^+$, $15/2^+$ ...) is simultaneously excited with increasing intensity when A decreases. We note that the energy spacings are quite comparable to that of the 0^+, 2^+, 4^+, 6^+, ... states of the adjacent even Cd isotopes. A second positive parity band based on the $2d_{5/2}$ orbital, is well-fed in ^{105}Cd and seemed to be perturbed by Coriolis effects since $\Delta I = 1$ and $\Delta I = 2$ transitions both occur.

Negative and positive parity bands occuring in ^{105,107,109,111}Cd have been correctly reproduced within the rotor-plus-particle model using self-consistent prolate core single-particle states [5].

The aim of the present work is, using HI reactions, to search for the high spin states in ^{103}Cd where only two low-lying levels are known so far, from on-line radioactivity studies [6], and to check whether our theoretical description remains still satisfactory.

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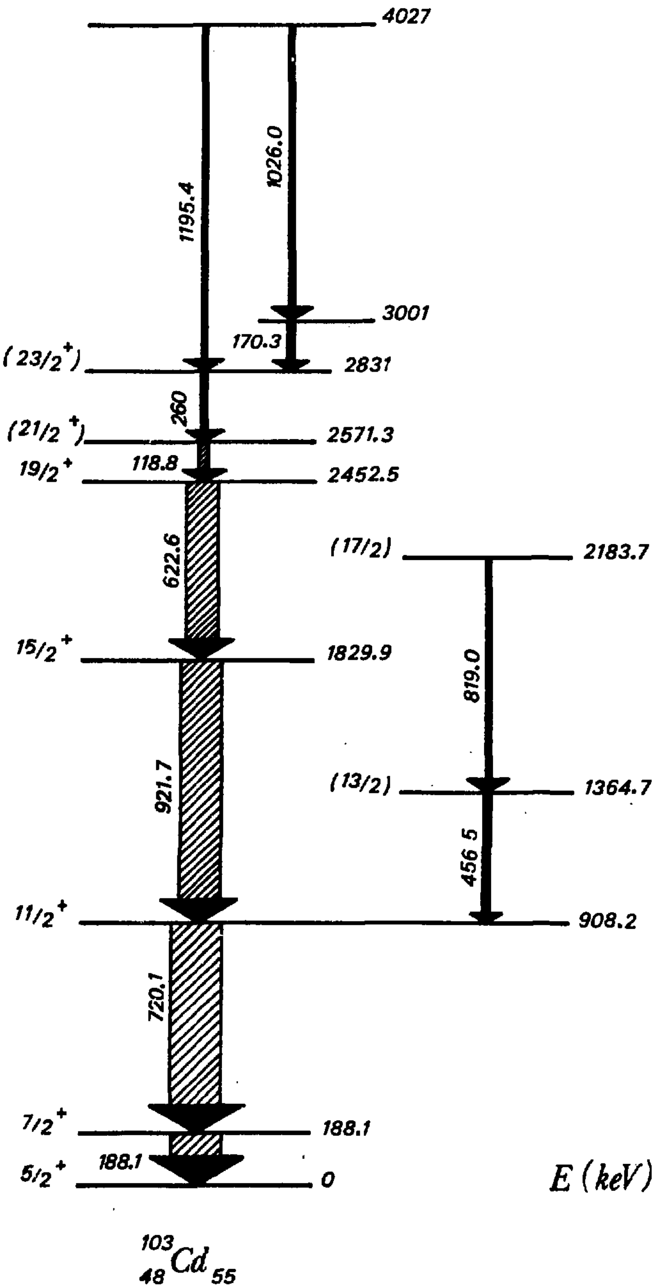
2. EXPERIMENTAL RESULTS

The excited levels of ^{103}Cd were populated using the $^{94}Mo(^{12}C, 3n)^{103}Cd$ reaction at 54 MeV. A 4 mg/cm^2 metallic target of isotopically-enriched ^{94}Mo (94.6 %) has been used in these experiments. Excitation functions were measured at bombarding energies ranging from 44 MeV to 65 MeV.

To search for long-lived isomers (10-100 ns), γ singles were measured between the beam bursts and compared to direct spectra in coincidence with the high-frequency signal of the Grenoble Cyclotron. There was no evidence for such lifetimes in the ^{103}Cd nucleus.

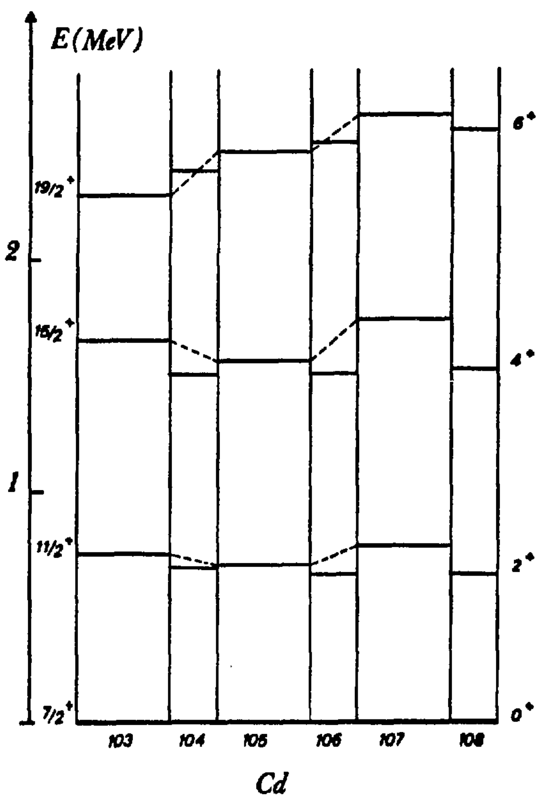
γ-γ coincidence experiments, using two coaxial Ge(Li) detectors, were performed to establish a level scheme. The γ-γ data were stored on magtape via a PDP 9 computer and a 2048 x 2048 channels matrix was then constructed off-line. The g. s. ($5/2^+$) and first excited level (188.1 keV, $7/2^+$) have been used as a starting point to establish the level scheme presented in Figure 1. γ-rays have been assigned to ^{103}Cd on the basis of coincidences with the 188 keV γ-line and excitation functions. γ-ray intensities are proportional to the width of arrows in Figure 1. A ^{94}Mo target deposited on a 130 mg/cm^2 lead backing was used for the angular distributions. γ-singles were measured at 5 position angles from 0° to 90°. The beam monitoring was performed using an extra Ge-Li γ-counter placed at a fixed angle. The angular distribution data have been analyzed according to Yamazacki's prescription [7] assuming gaussian distributions of the substates centered on m = 0. The spin changes then deduced led us to assign spin and parity to the four first excited levels and propose spin for the upper levels. From internal conversion coefficients measurements G. Lhersonneau et al. [4] attributed pure M1 character to the 188 keV transition ($7/2^+ \rightarrow 5/2^+$). This result is corroborated by our angular distribution data ($A_2 = 0.27 \pm 0.04$, $A_4 = -0.03 \pm 0.04$).


4027
1195.4
1026.0
3001
170.3
(23/2+)
2831
260
(21/2+)
2571.3
118.8
19/2+
2452.5
622.6
(17/2)
2183.7
15/2+
1829.9
819.0
921.7
(13/2)
1364.7
456.5
11/2+
908.2
720.1
7/2+
188.1
188.1
5/2+
0
E (keV)
103 48 Cd 55

3. DISCUSSION

The dominant feature of our level scheme is the occurence of a cascade of strong stretched E2 transitions based on the $7/2^+$ first excited level. It is characterized by level spacings quite similar to those of the g. s. band in ^{104}Cd. Figure 2 shows the smooth trend versus mass number of the energy spacings of the g. s. band in the even Cd isotopes and of the $7/2^+$ band in the odd isotopes. When A is decreasing the alignment of the odd $\nu(g_{7/2}+)$ particle seems to become more complete.

In order to account for these experimental data we used the quasi-particle + rotor model [5] in the case of prolate or oblate deformations. The calculations have been performed with a variable moment of inertia $\mathfrak{I}(R)$ deduced from experimental level schemes of adjacent even Cd cores.



The success of this description has been already reported for the negative parity $11/2^-$ decoupled band [3] associated with prolate deformation. The absolute energy of the $11/2^-$ bandhead is also well reproduced. In ^{103}Cd it is predicted around 2 MeV, this could explain its non-observation in this work.

The experimental $7/2^+$, $11/2^+$, $15/2^+$, $19/2^+$ sequence is well reproduced by the calculated spectrum of ^{102}Cd + 1 QP $\nu g_{7/2}$) system. The favoured states have large components on $I = R + 7/2$ states, indicating thus their rotation aligned character. The prolate intrinsic solutions reproduce better the experimental spectrum than the oblate ones even in the case of positive parity levels. The problem of unfavoured states $I = (R-1) + 7/2$, not clearly identified here need additional experimental investigations.

This band picture should be more firmly established by transition probability calculations. The corresponding theoretical work is underway.

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