0^+- STATES IN ^{102}Pd AND ^{108}Cd.

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Abstract

A presentation is made of an angular correlation experiment by wich we could identify the two fonon 0^+- states in ^{102}Pd and ^{108}Cd. In the case of Pd a comparison is shown with IBA calculations and a levelstructure calculated with a asymmetric rotor vibratormodel.

1. Introduction

The even-even Pd and Cd-nuclei have for many years been interpreted as having an anharmonic vibrational structure. A two fonon multiplet can be seen from N=60 for Cd-nuclei and from N=58 for Pd-nuclei (fig. 3.4.). In order to extend the systematics in the behaviour on those multiplet states we looked for the 0^+- states in ^{102}Pd and ^{108}Cd.

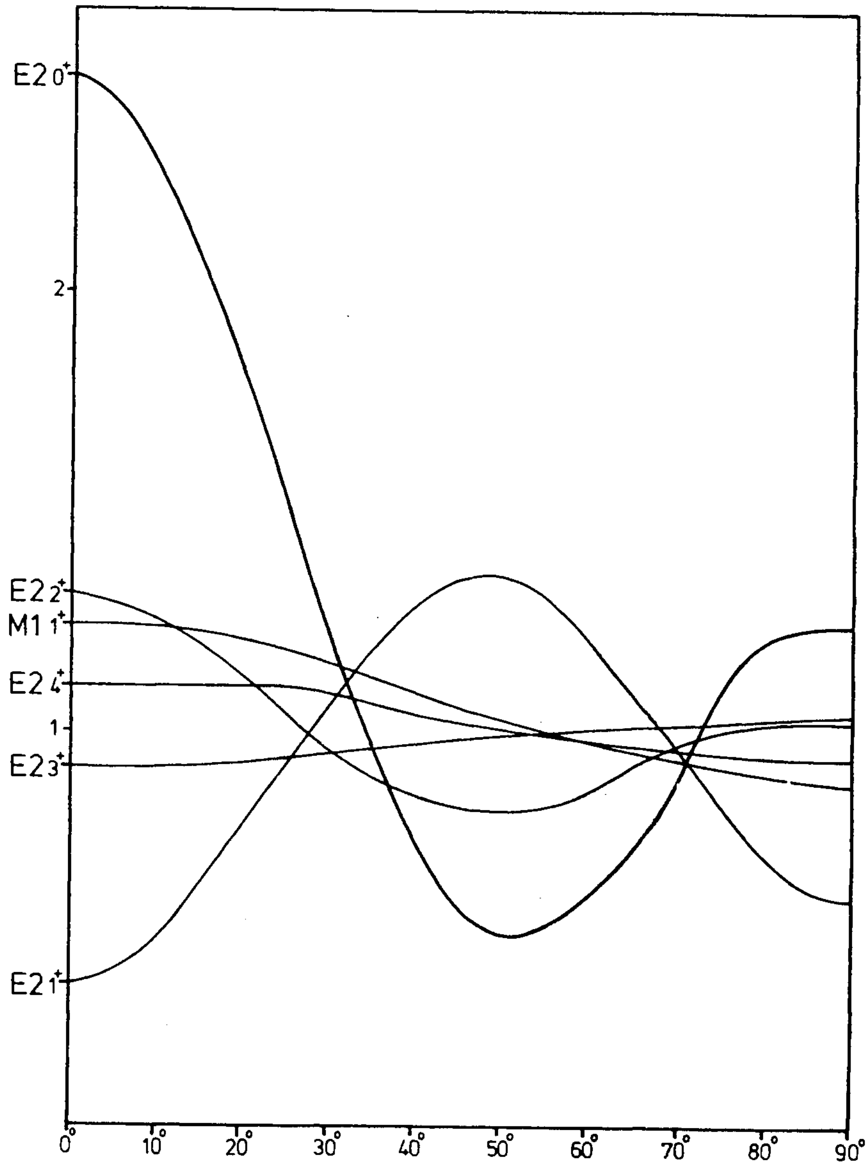

fig.1. Angular correlation patern of some $x^{\pi}\rightarrow 2^+\rightarrow 0^+$ cascades.

Therefor we performed a γ-γ angular correlation experiment on the (β^++ EC)- decays of ^{102m}Ag- and ^{108m}In nuclei. In ^{102} Pd we found a 0^+ state very close to the long living anomalous 0^+ on wich we reported earlier [1]. The electromagnetic features of the new 0^+-state are more in agreement with a two fonon description whereas the other 0^+- state seems to be some kind of intruder which can not be acounted for in a normal collective (IBA, triaxial rotor vibrator etc.) model. The 0^+-state in ^{108}Cd is lower in energy than the expected trend, but seems to have normal electromagnetic properties.

2. The angular correlation experiment.

The produced radio activity and the available measuring time for a ISOL setup at a cyclotron are normally not sufficient to perform a decent γ-γ angular correlation experiment. However, the huge anisotropy of a $0^+\to2^+\to0^+$ cascade makes it possible to distinguish it from other $x^\pi\to2^+\to 0^+$ cascades, even with poor statistics as can be seen in fig.1. This means that the angular correlation technique can still be a usefull tool when looking for 0^+- states in low activity- and short living sources.

In our experiment we only measured the correlation at the three crusial angles 0° (180°), 50° and 90°. The ^{102m}Ag and ^{108M}In sources were produced with a ^{nat}Mo(^{14}N(90Mev), xpyn) reaction and mass-separated using the LISOL facility at Louvain-la-Neuve [2]. An example of the resulting spectra gated on the $2^+\to0^+_g$ transition is shown in fig.2. The spectrum at 180° shows the (1101.7 ± 0.5)keV gamma which proved to have the good anisotropy for a $0^+\to2^+\to 0^+$ cascade. From the coincidences we could also deduce that the 0^+ level at 1658 keV is almost completely fed by a 729 keV gamma coming from a known level at 2390 keV (J^π 1,2$^\pm$)

In the same way we observed a 0^+ state at (1375.0 ± 0.9) keV which is mainly fed by 1244, 1306 and 827- keV transitions depopulating known levels in ^{108}Cd [3]. Also mini-orange spectra were taken from both sources in order to measure the $E0(0^+ \to 0^+_g)$ transition strength. From these spectra only an upper limit could be deduced for the parameter.

$$X = \frac{B(E0,\ 0^+ \to 0^+_g)}{B(E2,\ 0^+ \to 2^+_1)}$$

For ^{102}Pd we have $X \leqslant 2.7.10^{-1}$ and for ^{108}Cd $X \leqslant 4$.

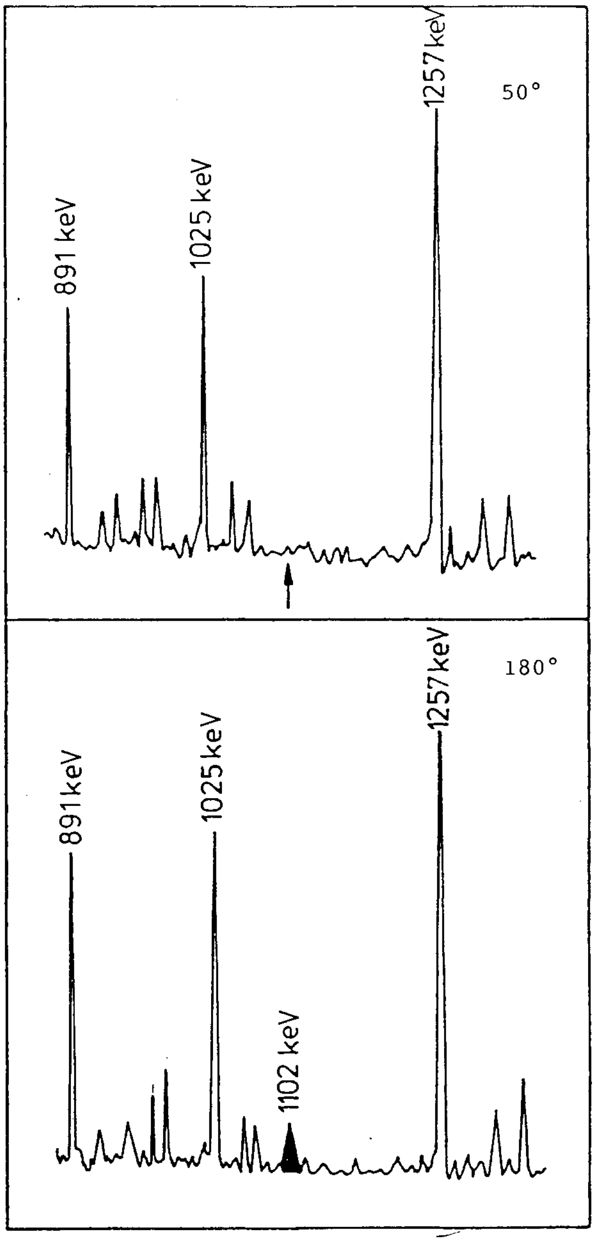

fig 2. Spectra at 50° and 180° gated on the $2^+ \to 0^+_g$ transition

3. Discussion.

In fig. 3 we can see that the 0^+- state in ^{102}Pd is following the systematical trend of rising when going to lesser neutrons. The 2_2^+ and 4_1^+ do not go up as fast and in ^{102}Pd the two fonon triplet is completely broken. The same systematical behaviour can be reproduced by IBA-2 calculations [4] as shown in fig. 4.

In table 1 a comparison is shown of the low energy levels in ^{102}Pd and a theoretical calculation with an anharmonic vibrator model [5].

Table 1.

I^π	Exp. (keV)	Theory: E_{INn}	INn
0^+	0	0	011
2^+	556	552	211
4^+	1275	1333	411
2^+	1534	1492	211
0^+	1658	1658	012
6^+	2111	2119	611
4^+	2138	2177	421

In this calculation the experimental energy of the 0^+- state was not used in fitting the model parameters, however, the agreement with experiment is excellent.

The first excited 0^+-state in ^{108}Cd (fig. 5) does not seem to follow this systematical trend of rising when going more neutrondeficient. In this case it would be interesting to find the second excited 0^+-state which appears to be low in the heavier Cd isotopes. These 0^+- states can propably be explained in terms of 2-proton particle - 2 hole excitations through the Z=50 shell closure as in the case of the even Sn isotopes [6].

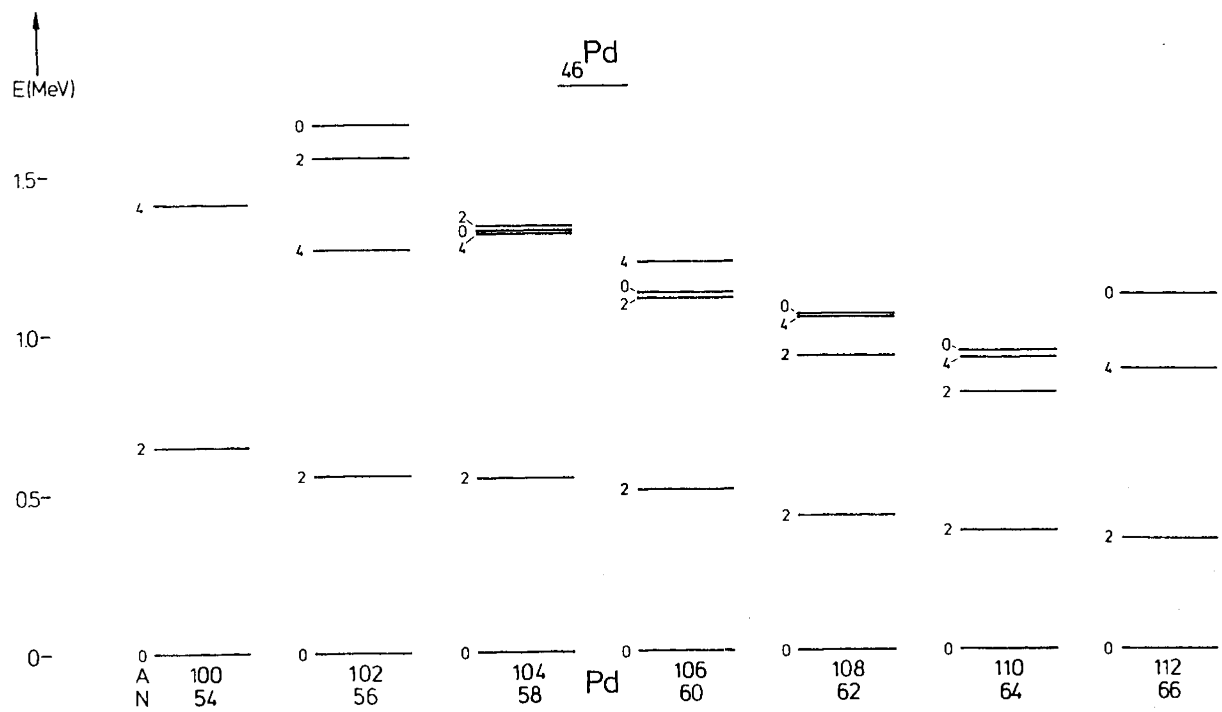

fig. 3 Positive parity states in even Pd nuclei.

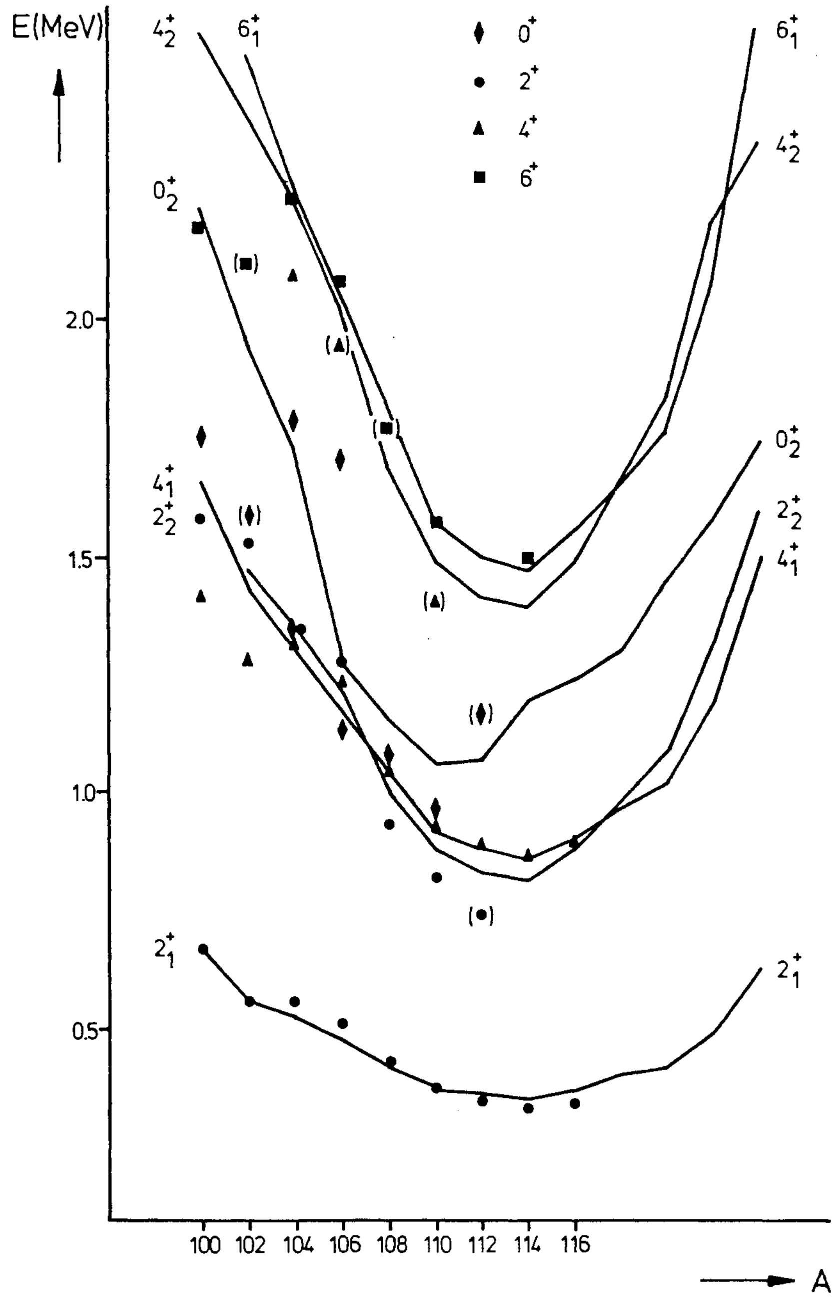

fig. 4 IBA-2 calculation of the Pd isotopes.

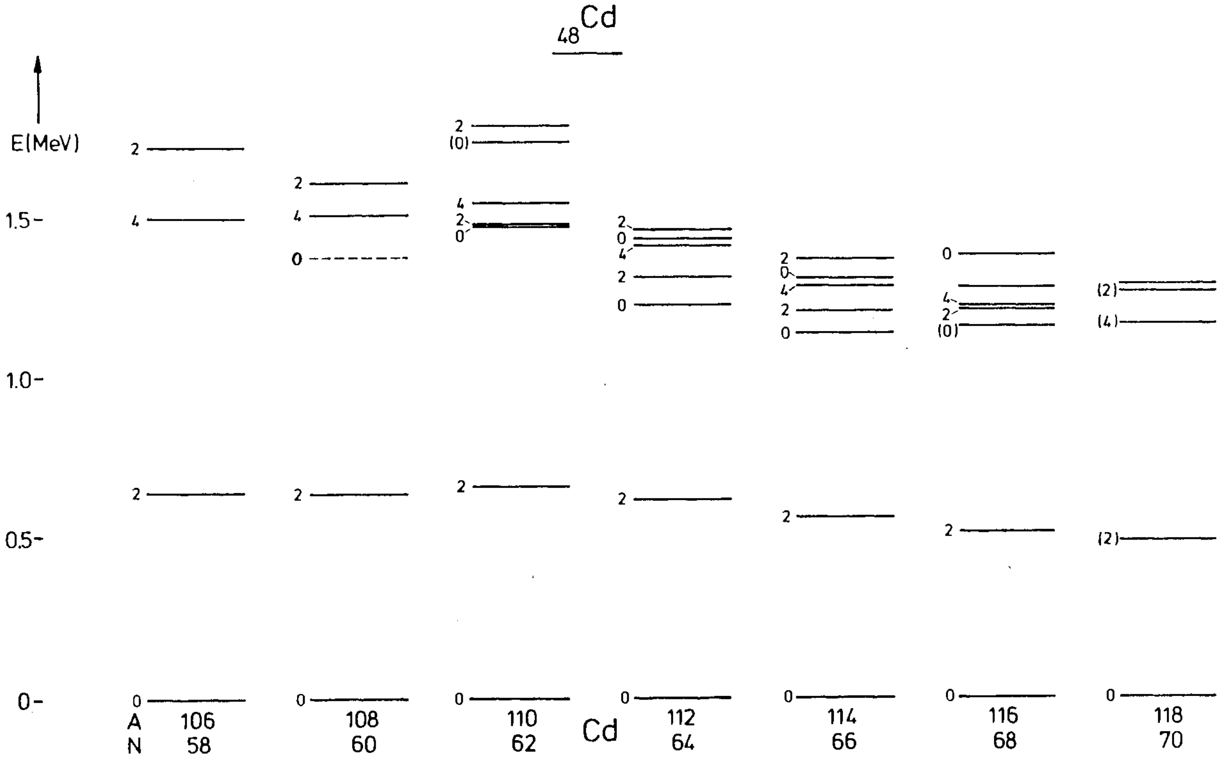

fig. 5 Positive parity states in even Cd nuclei .

References

1) K.Cornelis, et al., Z. Physik A 292 (1979) 403
2) G. Dumont, et al., Nucl. Inst. and Meth. 153 (1978), 81
3) I.N. Wischnewski, et al., Z. Physik A 298 (1980), 21
4) P. Van Isacker, et al., Nucl. Phys. A 348 (1980), 125
5) H. H. Hsu, et al., Phys. Rev. C 16 (1977), 1625
6) G. Wenes, et al. Phys. Rev. C 23 (1981), 2291

DISCUSSION

J. Kantele: I have some complementary information to give: within the Jyväskylä-Uppsala collaboration, we have studied ^{102}Pd low-spin states using (pp′) and double Coulomb excitation. The 1648 keV state is seen in the latter reaction which indicates a collective character for this state; it probably contains some two-phonon strength. The 1592 keV level does not seem to be connected to the 2_1^+ state, which yields the largest known X-value, over 400. Thus the 1592 keV 0_2^+ state has a structure completely different from that of the 0_3^+ one at 1648 keV; the wave function is probably dominated by some two-quasiparticle component.

V. Paar: How many parameters do you have in fitting spectra in your figure? Do you fit to each nucleus parameters separately?

K. Cornelis: The parameters in this fit were allowed to vary in the fit.

J. Stachel: In principle the full IBA-2 Hamiltonian has ≈ 12 free parameters. The calculations referred to here (P. Van Isacker, G. Puddu, Nucl. Phys. 1980) are a simultaneous fit to all neutron-rich (N = 50-66) Pd- and Ru-isotopes. Some of the parameters were set = 0 in this fit, all parameters involving only protons were kept constant over the whole isotope chain, some were taken equal for Ru- and Pd-isotopes. So it is essentially the change in three parameters describing the change in excitation energies and decay properties along each isotope chain.

D.S. Brenner: In your IBA-2 calculations which parameters did you vary to obtain your fits to the Pd and Cd isotopes? What criteria were used to determine the "best" fit to these data?

K. Cornelis: For this question I refer to P. Van Isacker, for he has been doing the calculations. He certainly can tell you more about the details.