Octupole Correlation in ^{106}Cd

D.Choudhury[1], R.Goswami[1],S.S.Ghugre[2], R.Raut[2],A.Y. Deo[3] and A.K.Sinha[4]
[1]*B.P.Poddar Institute of Management and Technology,137,VIP Road, Kolkata-700052, INDIA*
[2]*UGC-DAE-CSR-Kolkata ,Sector III, LB-8, Bidhan Nagar, Kolkata 700098, INDIA*
[3]*Department of Physics, Indian Institute of Technology Roorkee, Roorkee - 247667, INDIA*
[4]*UGC-DAE-CSR, Indore, University Campus, Khandwa Road, Indore 452017 INDIA*
* *email: hodbasicsc1@gmail.com*

Introduction

The Cadmium isotopes with Z close to 50 and A~110 are known to be spherical at low spins [1] . However prolate deformation driving orbitals 1/2[550] of the neutrons originating from the $h_{11/2}$ subshell, can give rise to deformed band structures at medium to high spins [2,3]. Recent studies of even-even Cd isotopes [3,4] show decoupled bands arising from $\nu(h_{11/2})^2$ configuration and low-lying yrast states showing quadrupole-octupole correlations in ^{108}Cd. In the present work we have studied ^{106}Cd nucleus using heavy- ion induced reactions focussing mainly on the low-lying states with octupole correlations .

Experiment

It is well known that octupole correlations in atomic nuclei occur due to interaction of orbital close to Fermi surface with opposite parity whose angular momentum differ by 3 hbar (units of angular momentum). Some experimental fingerprints of octupole correlation are alternate parity bands linked by enhanced E1 transitions and very collective E3 transitions, parity doublets in odd nuclei etc.

The present experimental work was done using ^{20}Ne beam on ^{93}Nb target at beam energy of E=150MeV using the heavy-ion beam of Variable Energy Cyclotron Centre Kolkata. The experiment yielded two and higher fold coincident events using the Indian National Gamma Array (INGA) comprising of eight Compton suppressed clover detectors . In our experiment four detectors were placed at 90^0 two detectors at 125^0 and two each at 40^0 to the beam direction. Gated spectra with a dispersion of 0.5 keV per channel were generated from 4096×4096 matrices obtained from the sorting of the gain matched raw data. The symmetric E_γ-E_γ matrix was used to establish and extend the level scheme based on the observed γ-ray coincidence relationships and intensity arguments. The DCO ratio measurements and assignment of multipolarity of the γ-rays were also determined by sorting the asymmetric matrix with four detectors placed at 90^0 at one axis and all the other detectors placed in another axis.

The present work shows E1 transitions between two sequence of low-lying positive and negative parity levels. Transitions of 524.5 keV, 423 keV, and 311 keV have been reported previously [1] as E1 transitions between two sequence of levels of alternating parity. The present work shows three new E1 transitions 110 keV , 443 keV and 1135 keV between low-lying yrast alternate parity states. The previous work [1] shows a 335 keV (M2+E3) transition depopulating a 12^+ level of positive parity shown in Fig.1. The present work shows an indication of 415 keV E3 transition depopulating the low-lying yrast 8^+ level. The partial level scheme shows the three sequence of levels of opposite parity with new transitions shown in dotted lines. Calculation of single particle reduced transition probability B(E3) is 674.16 e^2fm^6 whereas the same calculated using the E3 transition is 658.34 e^2fm^6 which corroborates the enhancement in B(E3) values which is an important signature of octupole correlation. The strength of the octupole correlation is also inferred from the relative excitation energies of the positive and negative parity states. Hence the I^- states would be lower in energy than the $(I+1)^+$ states of the alternating sequence of levels. In the present work though the lowest negative parity spin member are higher in energy than the corresponding positive spin upto 7^- state, the higher negative parity spins are lower in energy than their corresponding positive parity members. The single particle reduced transition

probability for B(E1) in this mass region is 1.96 e^2fm^2 and the same calculated using the new E_γ of 443 keV which is an E1 transition obtained from the present work is 70 e^2fm^2. Hence our preliminary studies show octupole correlation in the yrast states of ^{106}Cd.

Conclusion

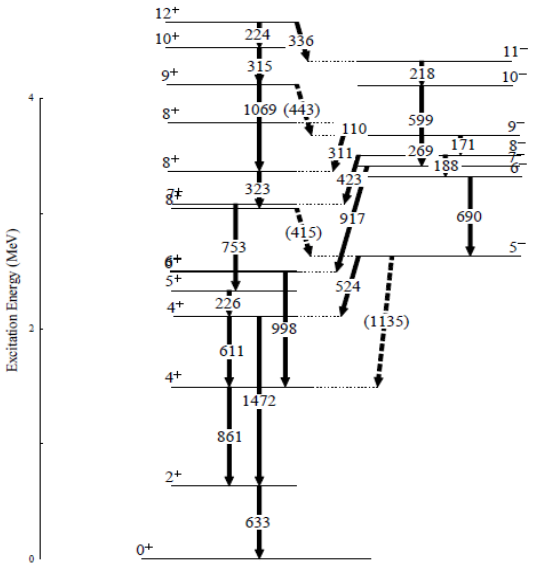
A survey of the experimental findings of the nuclear structure study of ^{106}Cd nucleus show indications of octupole correlations. The evidence for the existence of such states is corroborated by the existence of E1 and E3 transitions of enhanced strengths. Such observations were also reported in the Xe-Cs-Ba region. However apart from quadrupole-octupole correlations in the low-lying yrast states of ^{108}Cd no work has been done in this mass region.

Acknowledgement

The help and support received from the INGA collaboration in setting up the array at VECC, and support from the Cyclotron staff is gratefully acknowledged. D.C and R.G wishes to acknowledge the grant received from UGC-DAE-CSR-KC under the CRS : UGC-DAE-CSR-KC/CRS/13/NP07.

References

[1] P.H.Regan, A.E.Stuchbery, G.D.Dracoulis et al. Nucl.Phys.A586,351-376.(1995) .
[2] I.Thorslund, C. Fahlander, J.Nyberg et al, Nucl.Phys.A 564 ,285(1993).
[3] M.Piiparinen, R.Julin, S.Juutinen et al , Nucl. Phys. A 565, 285 (1993).
[4] A.Gade, D.Belie, P.Von Brentano et al, PRC 67, 034304 (2003).



Partial Level Scheme of ^{106}Cd