Angular distributions in ^{109}Cd

K. P. Singh
D.A.V. College, Chandigarh 160011, India

D. K. Avasthi* and I. M. Govil
Physics Department, Panjab University, Chandigarh, India

(Received 20 September 1991)

The low-lying levels in ^{109}Cd were excited via the $(p,n\gamma)$ reaction. Angular distributions of deexcitated gamma rays were studied at 4.2 MeV proton energy to resolve the ambiguity in the spin values for the levels at 721.3, 891.1, 997.3, and 1133.6 keV excitation energies.

PACS number(s): 23.20.En, 25.40.−h, 27.60.+j

The experimental investigations of ^{109}Cd have been carried out by several workers [1–9] through various nuclear reactions and beta decay. The experimental information prior to 1984 has been summarized by Blachot [10]. The theoretical calculations and experimental studies have not been completely successful for assigning the spin values of many low-lying levels of ^{109}Cd. We have, therefore, conducted the present experiment to resolve the ambiguity in the spin values of some low-lying levels.

In the present investigations, the levels of ^{109}Cd were excited through the $(p,n\gamma)$ reaction with 4.2 MeV proton beam from the Variable Energy Cyclotron, Chandigarh, India. A thick self-supporting target of natural silver (99.9% pure) was positioned at 45° to the beam axis; the gamma rays were detected by a shielded 50 cm^3 Ge(Li) detector having energy resolution of 2.0 keV for the 1.332 MeV line of ^{60}Co. The singles gamma-ray spectra were recorded at 0°, 30°, 45°, 60°, and 90° with respect to the beam line. The efficiency of the detector and the other details of the experiment are described elsewhere [11,12]. To find the gamma-ray intensities at each angle, spectra were analyzed using computer code SAMPO [13]. The angular distributions of the 571 (977→426), 721 (721→0), 832 (891→59), and 931 (1134→203) keV gamma-ray transitions were studied using the yields at each angle. Theoretical angular distributions were calculated using the code CINDY [14] based on Hauser-Feshbach theory of compound nucleus. The theoretical angular distributions were compared with experimental data using the χ^2-fits method [11,12]. The criterion of a 0.1% confidence limit was used to exclude the unacceptable spins.

The summary of the results from the present measurements is shown in Table I. Our analysis resolves the ambiguity in the spin values for the levels at 721.3, 891.1, 997.3, and 1133.6 keV excitation energies. The spin values for the levels at 203.6 and 347.5 keV have been found to be in agreement with those reported earlier [9]. The typical χ^2 plots for four transitions are displayed in Fig. 1.

The authors wish to thank the cyclotron crew for smooth operation of the machine.

TABLE I. The angular distribution results of the levels of ^{109}Cd.

Level energy (keV)	Gamma-ray transition	J^π values Literature (Ref. [9])	Present work
203.6	203.6→0	$\frac{7}{2}^+$	$\frac{7}{2}^+$
347.5	347.5→0	$\frac{5}{2}^+$	$\frac{5}{2}^+$
721.3	721.3→0	$\frac{3}{2}^+, \frac{5}{2}^+$	$\frac{5}{2}^+$
891.1	891.1→59.6	$\frac{3}{2}^+, \frac{5}{2}^+$	$\frac{5}{2}^+$
997.3	997.3→426.3	$(\frac{9}{2}^+)$	$\frac{9}{2}^+$
1133.6	1133.6→203.3	$\frac{7}{2}^+, \frac{9}{2}^+$	$\frac{7}{2}^+$

*Permanent address: Nuclear Science Centre, P.O. Box 10502, J.N.U. Campus, New Delhi-110067, India.

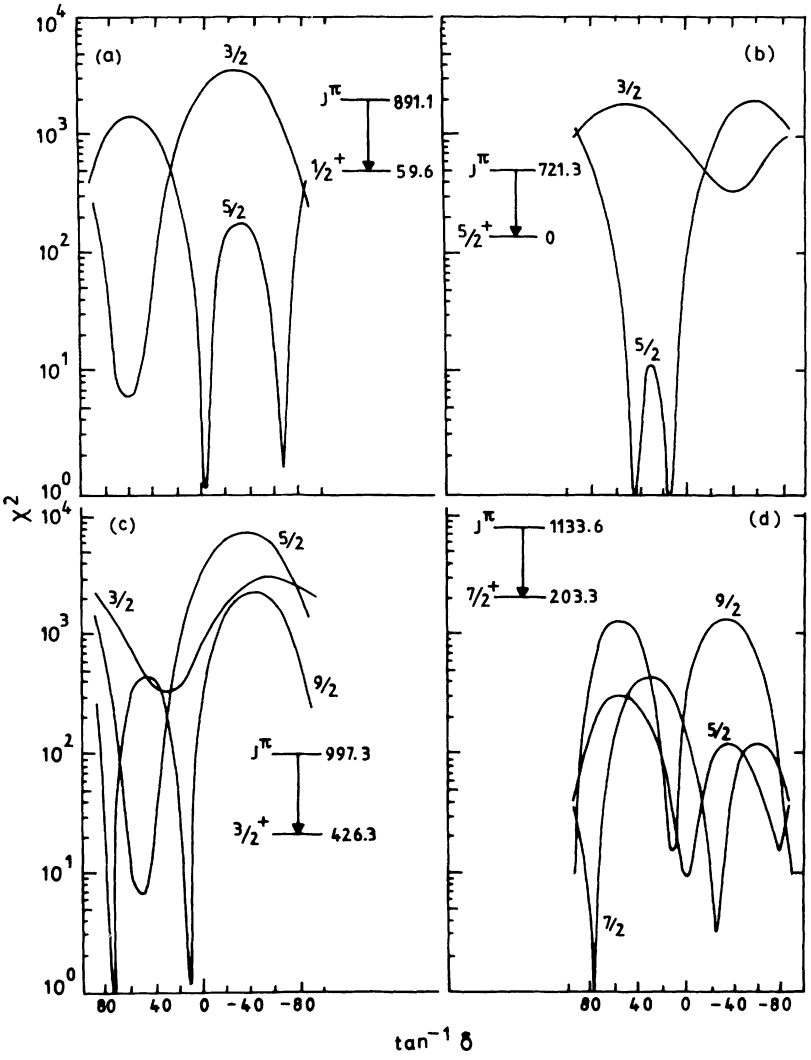

FIG. 1. Values of χ^2 as a function of mixing ratio for the transitions (a) 891.1→59.6, (b) 721.3→0, (c) 997.3→426.3, and (d) 1133.6→203.3.

[1] B. Rosner, Phys. Rev. **136**, B664 (1964).

[2] J. Rivier and R. Moret, Nucl. Phys. **A149**, 337 (1970).

[3] H. Bhakru, I. M. Ladenbauer-Bellis, and I. Rezanka, Phys. Rev. C **3**, 937 (1971).

[4] K. C. Chan, B. L. Cohen, and L. Shabason, Phys. Rev. C **11**, 1064 (1975).

[5] M. Meyer, R. Beraud, J. Daniere, R. Rougny, J. Treherne, and D. Barneoud, Phys. Rev. C **12**, 1858 (1975).

[6] S. Ohya, Y. Shida, O. Hashimoto, N. Yoshikawa, and M. Ishi, Nucl. Phys. **A325**, 408 (1975).

[7] D. K. Avasthi, V. K. Mittal, and I. M. Govil, Phys. Rev. C **26**, 1310 (1982).

[8] M. B. Chatterjee, B. B. Baliga, and R. Bhattacharya, Czech. J. Phys. **B33**, 990 (1983).

[9] M. B. Chatterjee, R. Bhattacharya, and B. B. Baliga, Il. Nuovo Cimento **100A**, 239 (1988).

[10] Jean Blachot, Nucl. Data Sheets **31**, 111 (1984).

[11] D. C. Tayal, K. P. Singh, Gulzar Singh, V. K. Mittal, and H. S. Hans, Phys. Rev. C **32**, 1882 (1985).

[12] V. K. Mittal, D. K. Avasthi, and I. M. Govil, J. Phys. G **9**, 91 (1983).

[13] J. T. Routti and S. G. Prussian, Nucl. Instrum. Methods **72**, 125 (1969).

[14] E. Sheldon and V. C. Rogers, Comput. Phys. Commun. **6**, 99 (1973).