

Observation of a core-excited $E4$ isomer in ^{98}Cd

A. Blazhev^{1,2}, M. Górska^{1,3}, H. Grawe¹, J. Nyberg⁴, M. Palacz⁵, E. Caurier⁶, O. Dorvaux⁶, A. Gadea⁷, F. Nowacki⁶, C. Andreoiu⁸, G. de Angelis⁷, D. Balabanski², Ch. Beck⁶, B. Cederwall⁹, D. Curien⁶, J. Döring¹, J. Ekman⁸, C. Fahlander⁸, K. Lagergren⁹, J. Ljungvall⁴, M. Moszyński¹⁰, L.-O. Norlin⁹, C. Plettner¹, D. Rudolph⁸, D. Sohler¹¹, K. M. Spohr¹², O. Thelen¹³, M. Weiszflog¹⁴, M. Wisell¹⁴, M. Wolińska⁵, and D. Wolski¹⁰

¹GSI, Darmstadt, Germany; ²University of Sofia, Bulgaria; ³Katholieke Universiteit Leuven, Belgium; ⁴Department of Radiation Sciences, Uppsala University, Sweden; ⁵University of Warsaw, Poland; ⁶IREs, Strasbourg, France; ⁷INFN Legnaro, Italy; ⁸Lund University, Sweden; ⁹RIT, Stockholm, Sweden; ¹⁰Soltan Institute for Nuclear Studies, Świerk, Poland; ¹¹INR, Hungarian Academy of Science, Debrecen, Hungary; ¹²University of Paisley, Scotland; ¹³IKP, Universität zu Köln, Germany; ¹⁴Department of Neutron Research, Uppsala University, Sweden

The first observation of excited states in ^{98}Cd via population of an $I^\pi = (8^+)$ isomer [1] in a fusion-evaporation reaction reported an extremely small proton polarisation charge $\delta e_\pi < 0.1 e$ which was derived from the measured half life by assuming a pure proton hole valence configuration. A follow-up experiment employing fragmentation and in-flight separation [2] yielded a much shorter half life and $\delta e_\pi = 0.3 e$. A solution to this puzzle was proposed by invoking the existence of a second, core-excited $I^\pi = 12^+$ isomer, which in fusion-evaporation reactions is populated with much larger cross section (isomeric ratio) than in fragmentation [3]. The identification of core-excited states in ^{98}Cd combined with a shell model estimate of residual interactions provides a very direct measure for the ^{100}Sn shell gap [3].

A pulsed beam of ^{58}Ni of $\Delta t = 330$ ns repetition time was used for the $^{46}\text{Ti}(^{58}\text{Ni}, \alpha 2n)^{98}\text{Cd}$ reaction. The ^{46}Ti target of 1 mg/cm^2 thickness was enriched to 86%. To study the excited states the EUROBALL [4] γ -ray spectrometer was used in combination with the EUCLIDES [5] Si-ball and the Neutron Wall [6]. In coincidence with γ rays emitted from recoiling residues stopped in a catcher foil at 1.19 m downstream from the target this enabled reaction channel identification.

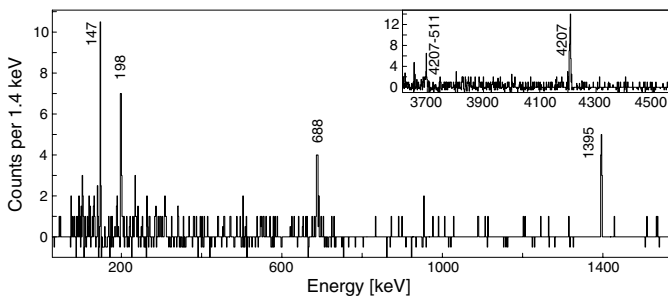


Figure 1: Spectrum gated on the 4207 keV line. The inset shows the high-energy part of the cross-coincidence spectrum created by the sum of gates on the 147, 198, 688 and 1395 keV lines.

The four known γ -ray transitions [1] were observed in the delayed spectra (Fig. 1) and their origin from ^{98}Cd was again confirmed. In the higher energy part of the cross-coincidence spectrum a new line at 4207 keV was observed (inset of Fig. 1). Based on the coincidence relations, the γ -ray intensities and the half lives the decay scheme shown in Fig. 2 is proposed.

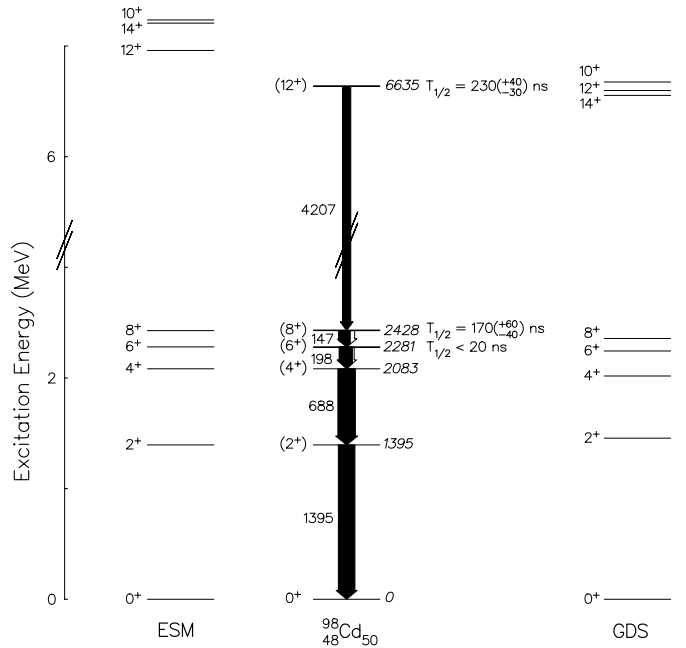


Figure 2: Experimental level scheme of ^{98}Cd in comparison to empirical shell model results in the pure configuration $\pi g_{9/2}^{-2} \nu g_{9/2}^{-1} d_{5/2}$ (ESM) and in the full $\pi \nu(gds)$ model space at truncation level $t = 4$ (GDS). Note the broken energy scale between 2 and 6 MeV.

Empirical (ESM) and realistic (GDS) shell-model calculations were performed (Fig. 2). The GDS results including up to $4p4h$ excitations of the ^{100}Sn core are found to excellently account for the experimental observations. From a comparison to the experimental core-excitation energy as documented in the $12^+ \rightarrow 8^+$ transition a value of 6.46 (15) MeV is inferred for the ^{100}Sn shell gap.

References

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