E0-DECAY OF THE 1592 keV LEVEL IN ^{102}Pd

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ABSTRACT — By means of a (p, p'e$^-$) coincidence experiment a previously reported E0 decay can be assigned to a level at 1592 keV in ^{102}Pd. The lifetime of this state is determined as 21 (1) ns.

INTRODUCTION

van Klinken et al. [1] have reported on the observation of an E0 transition in ^{102}Pd which they attribute to the ground state decay of a 1592 keV 0^+ level in this nucleus. In our (p, p'γ) experiment [2] we found no evidence for a γ-decay of a state at this excitation energy. Instead, we observed a level at 1658 keV to which, according to the isotropy of the pγ-angular correlations involving this level and the non-observation of this state in the radioactive decay, we have tentatively assigned an angular momentum of 0^+.

These findings give rise to the puzzling situation of the possible existence of two close lying 0^+ levels in this nucleus. In order to establish the assignment of the reported [1] E0 transition in the level scheme of ^{102}Pd and possibly to determine the lifetime of that state we have performed the experiment presented here [3].

EXPERIMENTAL DETAILS AND RESULTS

A schematic view of the experimental arrangement for the measurement of (p, p'e$^-$) coicidences is given in fig. 1. The target consisted of a metalic foil of isotopically enriched ^{102}Pd (76%)

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and had an aereal thickness of about 1 mg/cm^2. The scattered protons were registered by an annular surface barrier detector positioned at 180 degrees with respect to the beam direction. The incident beam energy was 6.9 MeV in order to separate the proton line originating from the excitation of the 1592 keV level in ^{102}Pd from the elastic peaks of the target contaminants ^{12}C and ^{16}O.

The electrons were detected at 135 degrees by a mini-orange device [1] which consists of a set of $SmCo_5$ permanent magnets, arranged to form a low dispersion spectrometer, and a cooled Si(Li)-diode. A central Au-absorber serves to prevent δ-electrons,

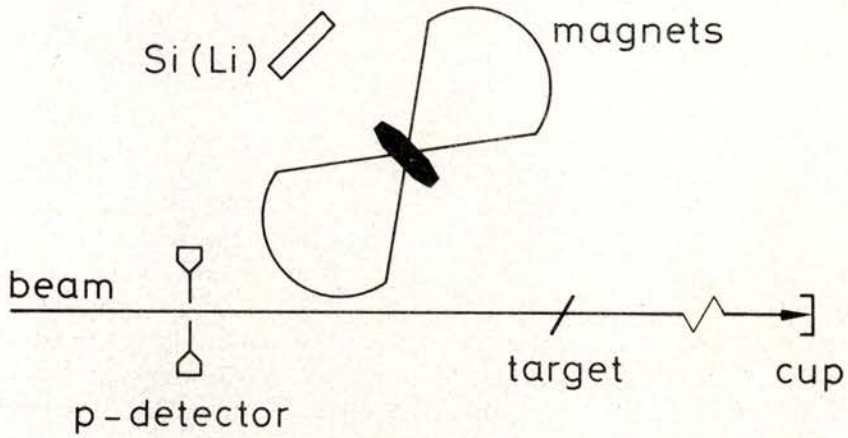

Fig. 1 — Schematic view of the experimental arrangement for (p,p'e$^-$) measurements

X- and γ-rays and also scattered particles from entering the detector, while the electrons of interest are deflected around this absorber in the appropriately dimensioned magnetic fields. The magnets are wedge-shaped and arranged such as to produce a toroidal field with focusing properties. Hence the effective solid angle for electron detection can be increased, in this case by a factor of 17, as compared to the diode alone. The magnetic field was chosen such that the transmission curve is centered at the energy of interest (see fig. 2). The energy calibration was carried out with ^{207}Bi and ^{60}Co radioactive sources. The energy resolution of the Si(Li)-detector amounts to 2.2 keV at 1 MeV. The coincidence data were taken in list-mode as triple information on the energy of proton and electron and the time

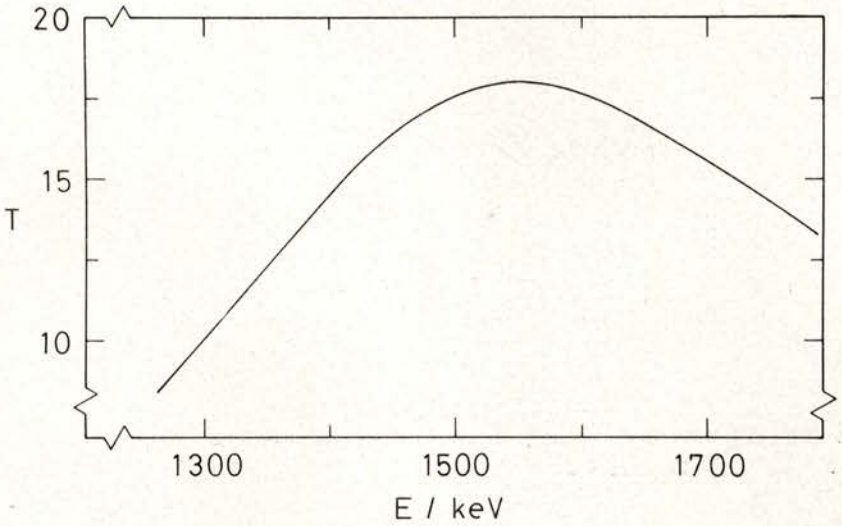

Fig. 2 — Relative transmission of the mini-orange device as obtained from the ratio of count rates with and without magnets.

difference between both events. Using constant fraction discriminators the time resolution was about 4 ns FWHM. Fig. 3 shows a chance and background corrected [4] electron spectrum in coinci dence with the proton line corresponding to the excitation of the 1593 (5) keV state. The energy of the K-conversion line was determined to be 1568.0 (5) keV which results in a level energy of 1592.4 keV. Our result verifies the assumption made in ref. [1] concerning the position of this E0 decay in the level scheme of ^{102}Pd. After correction for the energy dependence of the detection efficiency we find, from the intensities of K- and L-lines, a K/L ratio of 8.2(6) which is compatible with E0-conversion. The background corrected time spectrum of the (p, e^-) coincidence is shown in fig. 4. A fit to the data using an exponential function plus a constant (allowing for the chance events) yields a lifetime of 21 (1) ns. The same result has recently been obtained in a (p, 2n) experiment [5].

The long lifetime of the 1592 keV level indicates a strong hindrance of its γ-decay to the 2^+ first excited state. If the branching ratio I(E2, 1592-556 keV) / I(E0, 1592-0 keV) $\simeq$ 6 as estimated by van Klinken et al. [1] is used, an E0 transition matrix element ρ (E0) $\simeq$ 0.03 is obtained, a value about ten times smaller than the

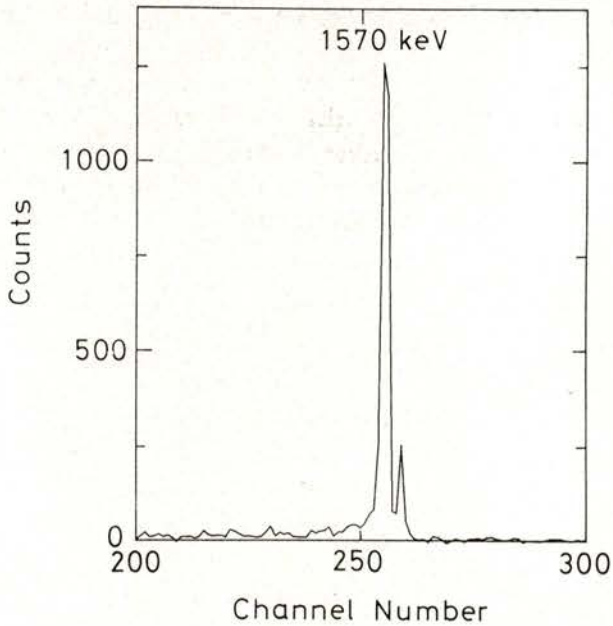

Fig. 3 — Part of the chance and background corrected electron spectrum in coincidence with the proton line populating the 1592 keV level.

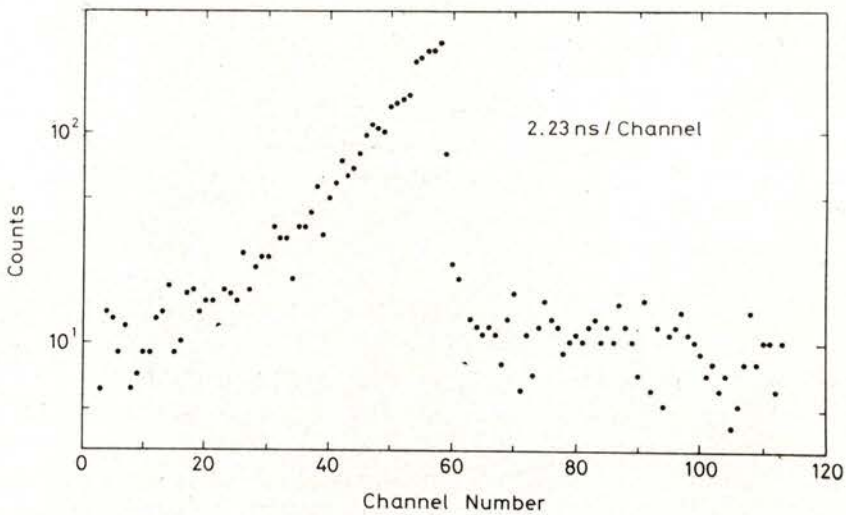

Fig. 4 — Time spectrum of the (p,e⁻) coincidences involving the 1592 keV state.

vibrational estimate. The γ-hindrance then turns out to be 4 orders of magnitude.

In order to reveal the nature of the 1592 keV level, experiments are in progress to secure the I(E2)/I(E0) estimate of ref. [1] and to establish relationships to other states in ^{102}Pd. Furthermore, a γγ-angular correlation measurement on the 1658 keV level is planned to ascertain the tentative spin assignment [2] for that state.

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