Observation of the isomeric E4 transition in the ^{95m}Pd decay

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The $21/2^+$ isomer in ^{95}Pd is known [1-3] to emit β-delayed protons to states in ^{94}Ru and β-delayed γ rays to states in ^{95}Rh. The ^{95m}Pd state, with an estimated excitation of about 2 MeV, has been interpreted as an E4 spin-gap isomer through shell-model considerations [4]. The E4 γ-ray decay to the then unknown $13/2^+$ state in ^{95}Pd was searched for but not found. In the βγ decay to ^{95}Rh, γ rays at 381.8, 716.6 and 1351.1 keV were identified as the dominating $21/2^+ \rightarrow 17/2^+ \rightarrow 13/2^+ \rightarrow 9/2^+$ decay sequence. Recently, the 1351 keV γ ray was identified to be a doublet, consisting of the known 1351.1 keV transition depopulating the $13/2^+$ level in ^{95}Rh [1], and a 1351.3 keV γ-ray assigned by in-beam work to depopulate the $13/2^+$ state in ^{95}Pd [5]. The in-beam observation of new states in ^{95}Pd allowed one to deduce the energy of the isomer to be 1876 keV, resulting in an estimated energy of 525 keV for the isomeric E4 decay. We performed a search for this isomeric γ transition by analysing the data set obtained in the study of the ^{95}Ag β decay [6].

The ^{95}Pd nuclei were produced via the ^{58}Ni(^{40}Ca,2pn) reaction using a 3.94 MeV/u, 80 particle-nA ^{40}Ca beam provided by the GSI UNILAC accelerator. The reaction products were stopped in a hot carbon catcher inside a FEBIAD-B2C ion source. Although the ion source was optimised for the release of silver isotopes, the release of palladium ions was not completely suppressed. The A=95 ions were separated from other reaction products by the GSI on-line mass separator. For the detection of γ rays, an array of 13 Ge crystals was used in close geometry around the point where the mass-separated beam was deposited on a transport tape. Positrons were measured with a plastic scintillator having a detection efficiency of about 85%.

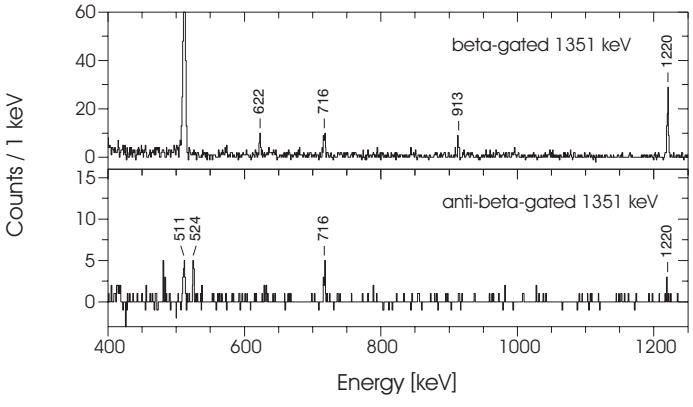

Figure 1: Background-corrected, 1351-keV-gated γ-ray spectra measured in coincidence (top panel) and in anticoincidence (bottom panel) with positrons. The weak 511, 716 and 1220 keV lines in the bottom spectrum are interpreted as being due to the limited positron efficiency and/or incomplete background subtraction.

The grow-in of the A=95 activity was measured with a tape-cycle time of 4.8 s for about 7.5 h. We observed the known β-delayed γ rays from the ^{95}Pd → ^{95}Rh decay [3], such as the 382, 716 and 1351 keV lines, and from the ^{95}Ag →^{95}Pd decay [7], the latter data yielding a considerably extended decay scheme [8]. In particular, a recently reported 622.1 keV transition was observed in βγ coincidence with the 1351 keV line (see Fig. 1), supporting the ^{95}Pd level at 1973 keV [5] and thus confirming the doublet nature of the 1351 keV line. The high β-detection efficiency allowed us also to inspect γγ coincidence events in anti-coincidence with positrons with little distortion by leakage of βγγ events. Besides the three distinct γ-decay sequences assigned to the decay of three isomers in ^{95}Ag [6], a 524-1351 keV coincidence pair was identified (see Fig. 1). Such a pair was reported previously [3], however, placed into the ^{95}Rh level scheme. The observation of the weak 524.0(4) keV line in anti-coincidence with positrons, i.e. as isomeric γ decay (see Fig. 2), represents the first unambiguous observation of an E4 transition in this mass region. Using the half-life of $T_{1/2}$=13.3 s [3] and the branching ratio as deduced from the intensities of the 524 and 1351 keV transitions observed (and misassigned) in Ref. [3], an E4 transition strength of about 0.8 W.u. was preliminarily inferred. Shell-model predictions of the E4 transition strength depend sensitively on the model space, the interaction and the effective E4 polarization charge. An empirical shell-model approach (see Ref. [6] and Refs. therein) yields a value of 3.9 W.u.

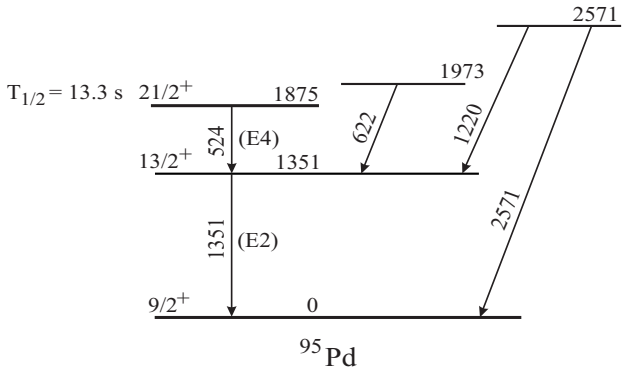

Figure 2: Gamma-decay of the isomer and selected low-lying states in ^{95}Pd.

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