UNIVERSITY OF STOCKHOLM

INSTITUTE OF PHYSICS

REPORT

COINCIDENCE MEASUREMENTS IN ^{175}TA

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INTRODUCTION

A newly performed work (1) has established the existence of more than forty gamma transitions in the decay $^{175}W \rightarrow {}^{175}Ta$. Among these, the three low-energy transitions of 15.3 keV (detected with a proportional counter), 36.5 keV M1+E2 and 51.5 keV E1 (characterised by their LI, LII and LIII lines in a 180^0 spectrograph) seem, because of their intensities, to fit in the bottom of the level scheme. However, the exact location of these transitions is not known. Moreover, a study of the reaction $^{175}Lu(\alpha,4n)^{175}Ta$ (2) has shown the existence of four rotational bands among which two most probably deexcite to the ground state through the 36.5 and 51.5 keV transitions.

We have, at the Institut de Physique Nucléaire in Orsay, continued the measurements on the decay of ^{175}W with high resolution Si(Li) detectors. For obtaining the singles spectra we used mass-separated sources and for the coincidence measurements chemically separated sources.

ENERGY MEASUREMENTS

We used a Si(Li) detector with an energy resolution of 330 eV at 14 keV and of 440 eV at 59 keV. The calibration was performed using the X_L-ray and γ-ray spectrum from ^{237}Np and the $K_{\alpha_1\alpha_2\beta_1\beta_2}$ lines from ^{152}Sm. These data were analysed with the computer at the Research Institute for Physics in Stockholm. We now obtained the transition energies with a very good precision:

14.97 $\pm$ 0.02 keV, 36.40 $\pm$ 0.02 keV and 51.38 $\pm$ 0.02 keV.

The sum of the first two transitions gives the third one within the experimental errors (here less than 40 eV). One could, then, think that the 51.38 keV transition is the E1 cross-over in the cascade of the 14.97 keV and 36.40 keV transitions (fig. 1). Furthermore, it seems very probable that the 14.97 keV transition has the multipolarity E1, which is the only alternative that is compatible with the relative intensities of the X_L-rays observed in coincidence as well as with the total conversion coefficient in the L shell. The detector we used for taking the coincidence spectra had unfortunately a non negligible entrance window, which caused a change of the absorption as large as a factor three between the 15 keV and 8.1 keV ($X_{L\alpha_1+\alpha_2}$ of tantalum). This makes it difficult to quantitatively evaluate the intensities of the different X_L-rays relative to the gamma-rays.

COINCIDENCE MEASUREMENTS

For these measurements we used two Si(Li) detectors, one with a surface area of 10 mm^2 and one with 25 mm^2. With the experimental set-up shown in figure 2 we got a 8 × 512 channels coincidence matrix. The 8 gates were choosen in the spectrum from the 25 mm^2 detector. The resolution of the set-up, 1 µs, is given by a coincidence circuit (MC2V).

In figure 3 one finds the singles spectrum in a, whereas b, c and d show the coincidence spectra with the gates set on the 14.97 keV peak, the 51.38 keV peak and the 36.40 keV peak respectively.

In a one can distinguish four X_L groups corresponding to the $\alpha_1+\alpha_2$ transition at 8.1 keV, the $\beta_1+\beta_2+\beta_3$ transitions between 9.2 keV and 9.5 keV, the $\gamma_1$transition at 10.9 keV and the $\gamma_2+\gamma_3$ transition at 11.2 keV, all occuring in ^{175}Ta. Then there is the ^{175}Ta nuclear transitions at 14.97, 36.40 and 51.38 keV. At 30.5 keV there is a transition belonging to ^{177}Ta. At last, at 56.28 and 57.54 keV one finds the K_{α_2} and K_{α_1} transitions in tantalum. The two parasite transitions, K_α and K_β of In are coming from the joint between the detector and the liquid nitrogen cooled "finger".

In b one can distinctly see the 36.40 keV peak but also a peak at 14.97 keV, which is probably due to background coincidences.

In c one notes the total absence of coincidences at the energies of the two other transitions.

And finally in d the 14.97 keV transition line shows up very distinctly. In this last spectrum one observes that using a detector with a very well known efficiency one could obtain – by comparing the intensities of the X_L lines with the intensity of the gamma line – informations either on the conversion coefficients in the different L shells or, if these coefficients are already known, on the fluorescence yield, ω, and the Coster-Kronig yield, f. The 8.1 keV transition, which corresponds to the line $\alpha_1(L_{III}M_V)$ and $\alpha_2(L_{III}M_{IV})$ could, for instance, give ω_3 and f_{13} (Coster-Kronig yield from L_I to L_{III}).

REFERENCES

(1) B. Ader, Thesis, Orsay 1969

(2) C. Foin, T. Lindblad, B. Skånberg, H. Ryde and J. Valentin, Research Institute for Physics, Stockholm, Ann.Rep. 1970 p. 61 Institut des Sciences Nucléaires, Grenoble, Ann.Rep. 1971 p. 70 and to be published

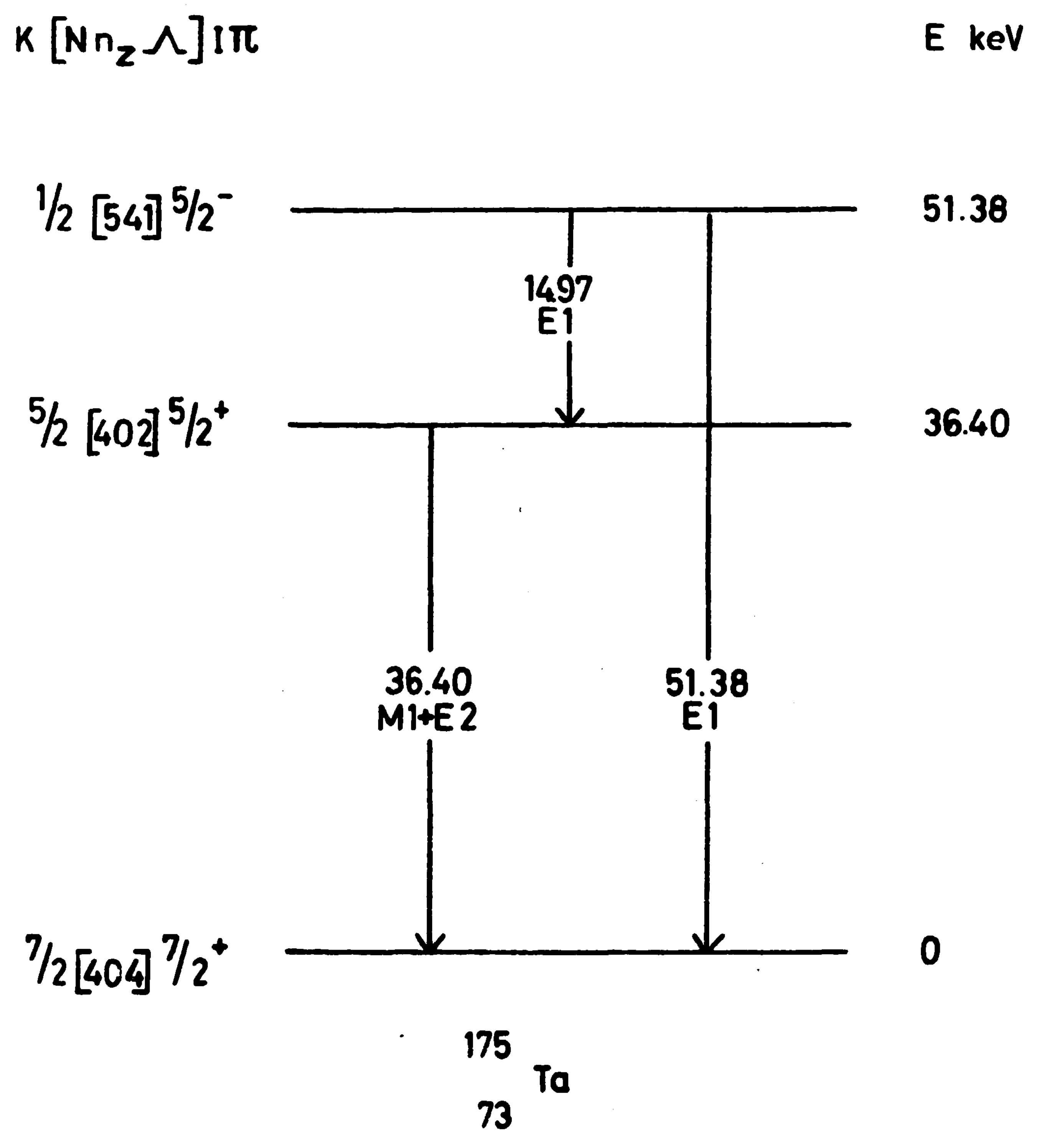

Fig. 1 Partial level scheme

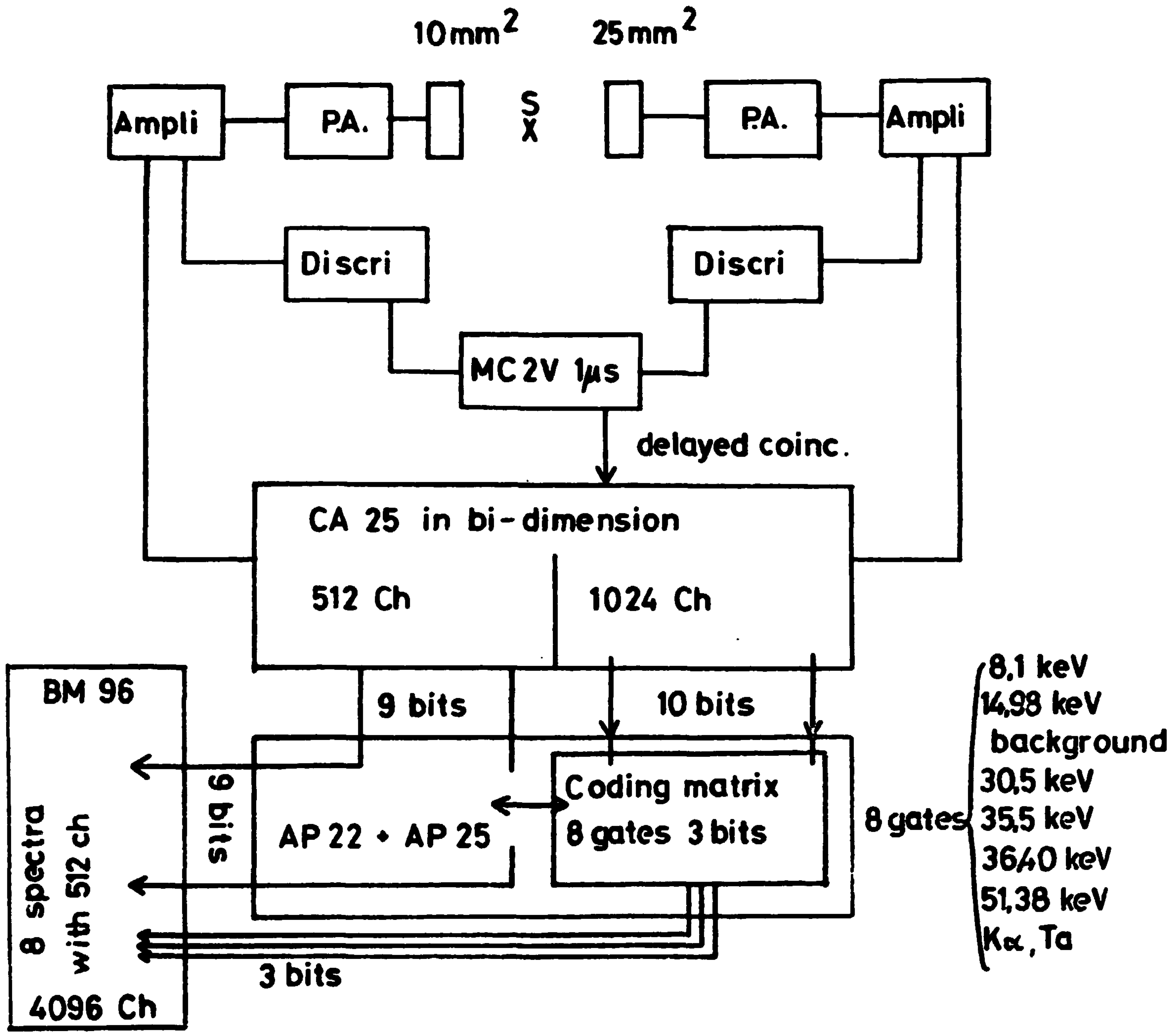

Fig. 2 Experimental set-up

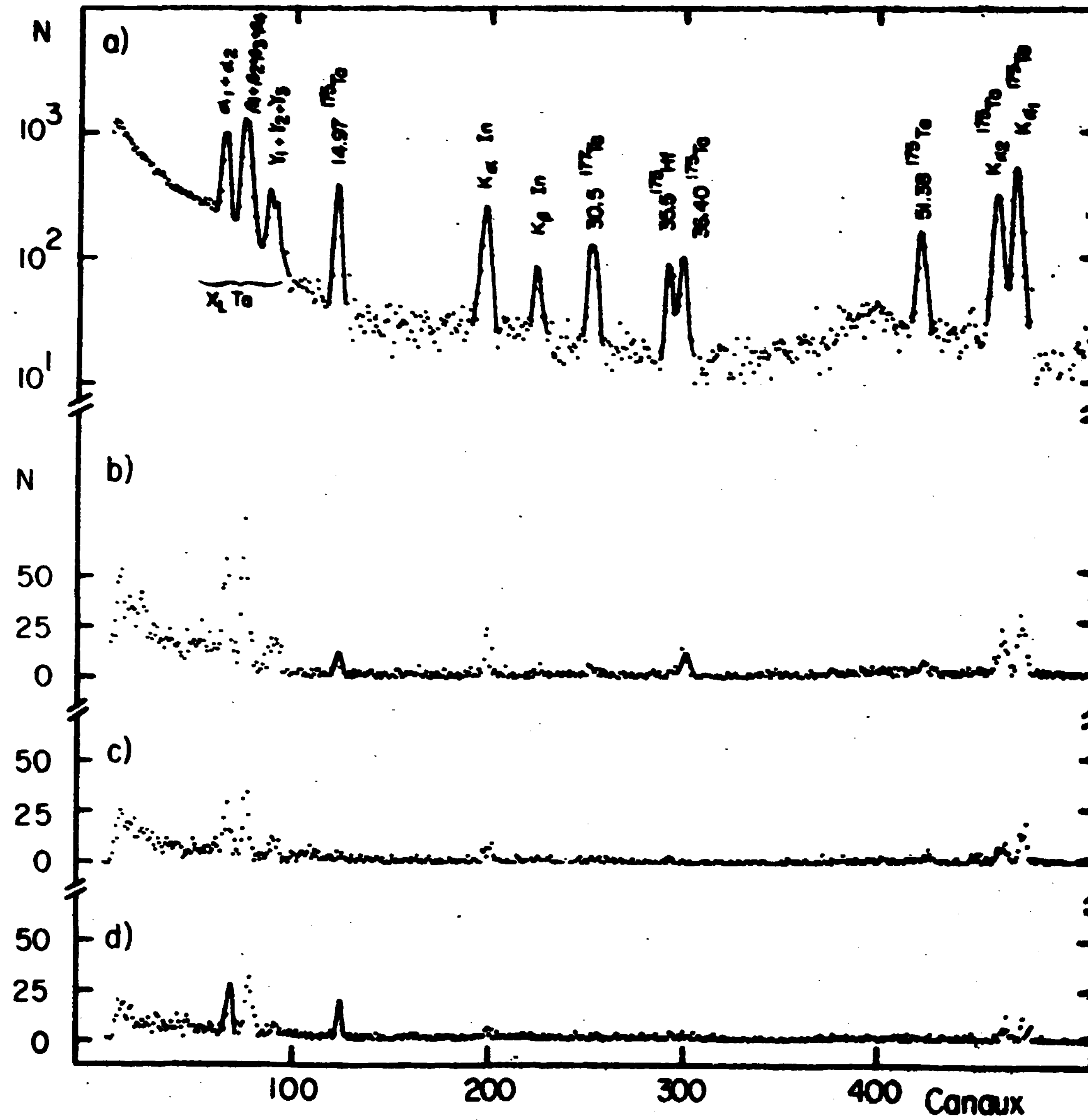

Fig. 3 a) singles spectrum
b) coincidence spectrum with the gate set on the 14.97 keV peak
c) coincidence spectrum with the gate set on the 51.38 keV peak
d) coincidence spectrum with the gate set on the 36.40 keV peak