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1. Introduction

The two proton multiplet $(h_{9/2})^2$ with the spin sequence 2^+, 4^+, 6^+, 8^+ appears with surprising regularity in the even-even polonium isotopes ^{210,208,206,204}Po /1/ and performs isomeric states with nanosecond half-lives. These states were observed when targets of enriched lead isotopes were bomarded with α -particles. A recent study of the K -capture of the neutron-deficient astatine isotopes ^{206,204,202}At shows, that the $(h_{9/2})^2$ band in the polonium daughter nuclei is strongly populated /2/. Furthermore these studies suggest the possible existence of an isomeric state in ^{202}Po in analogy to the other isomers in the even-even polonium isotopes.

2. Experimental Method

In order to study the neutron-deficient nucleus ^{202}Po a nanosecond equipment was arranged at the U-300 Heavy Ion Cyclotron of the Laboratory for Nuclear Reactions, JINR Dubna. The extracted 82 MeV ^{12}C -beam was collimated by a vertical slit in front of the last bending magnet and a graphit collimator of 10mm

diameter, placed in a distance of 4 m from the target position. The used target was a metallic foil of natural platinum (10.8 $mgcm^{-2}$), which gave the interesting reactions $^{195}Pt(^{12}C, 5n)^{202}Po$ and $^{194}Pt(^{12}C, 4n)^{202}Po$.

The γ-spectra were measured with a 2.8 cm^2 x 11 mm thin-window planar Ge(Li) detector. The fast output signal of the Ge(Li) detector was used to operate the start input of a time-to-pulse height converter and the r.f. signal induced by the cyclotron dees was used to generate the stop signal. The energy and the time signal were analysed by a two-dimensional pulse height analyzer. The 2048 channel memory was split into 256 channels for energy analysis times 8 channels for time analysis. The low frequency of the U-300 cyclotron allows time measurements up to several hundred nanoseconds. For ^{12}C the time interval between two beam bursts amounts to $\tau = 237$ ns, and the beam bunch has a width of about 8 ns FWHM. Details of the experimental arrangement will be discussed in a forthcoming paper.

3. Results and Discussion

Fig.1 shows a part of the two-dimensional γ-ray spectrum. Three strong γ-ray transitions with energies 443, 571 and 677 keV and of nearly equal intensities were observed. Just these energies coincide with the strongest transitions in the $^{202}At \rightarrow {}^{202}Po$ decay[2]. Each of these γ-transitions follows a half-life of $T_{1/2} = 165 \pm 20$ ns (Fig.2). The weak 526 keV γ-transition decays with $T_{1/2} = 25 \pm 10$ ns. From the level systematics[1], the γ-intensities of the prompt spectrum and results of the investigation of the radioactive decay[2] we propose the level scheme shown in fig. 3. The transition energy is unknown, for the $8^+ \rightarrow 6^+$ isomeric

transition is missing in our spectrum. At first sight it seems impossible to deduce B(E2) values from the measured half-lives. It can, however, be shown that for a given half-life and the energy region between the L_2 and K electron binding energies (region I) and between the M_2 and L_3 binding energies (region II) the B(E2) value is energy independent[1]. Thus we obtain the following B(E2) values (table 1).

With the method of delayed coincidences we also measured the half-life of the $I = 8^+$ state in ^{204}Po. A gold target was bombarded with ^{12}C ions in order to produce ^{204}At. The X-rays from the K-capture decay were detected with a NaJ(Tl) scintillator cemented to a FEU-36 photomultiplier tube. The fast pulses from the photomultiplier anode started the time-to-pulse-height converter. One of the prominent γ-transitions[2] was selected in the stop-branch. A time spectrum obtained in this way is shown in fig.4. It was found that the 427, 517 and 686 keV cascade γ-transitions have a delayed component with a half-life of $T_{1/2} = 140 \pm 5$ ns.

The B(E2) values and the level spacings of the three nuclei $^{206, 204, 202}Po$ are very similar. Contrary to the pure two-quasiparticle spectrum in ^{210}Po in the neutron-deficient nuclei $^{206, 204, 202}Po$ the increased coupling of the two protons to the vibrating core causes a downward shift of the lower lying levels of the multiplet, and the spectrum gets a more vibrational like character. The upper high spin levels, however, remain nearly unchanged relative to the ^{210}Po levels. This indicates that the highly excited levels with high spin and seniority quantum members are predominantly pure configurations.

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References

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2. T. Morek et al. JINR preprint, P6-4868, Dubna (1969).

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Table 1

Half-lives and B(E2) values for the $(h_{9/2})^2$ isomeric states in even-even polonium nuclei.

Nucleus	$T_{1/2}$ (8+ → 6+) ns	B(E2) [e^2 fm^4] Region I	Region II	Ref.
^{210}Po	110 ± 10	90		1.
^{208}Po	380 ± 10	25	100	1.
^{206}Po	160 ± 40	63	250	1.
^{204}Po	140 ± 5	72	286	present work
^{202}Po	165 ± 20	61	242	present work

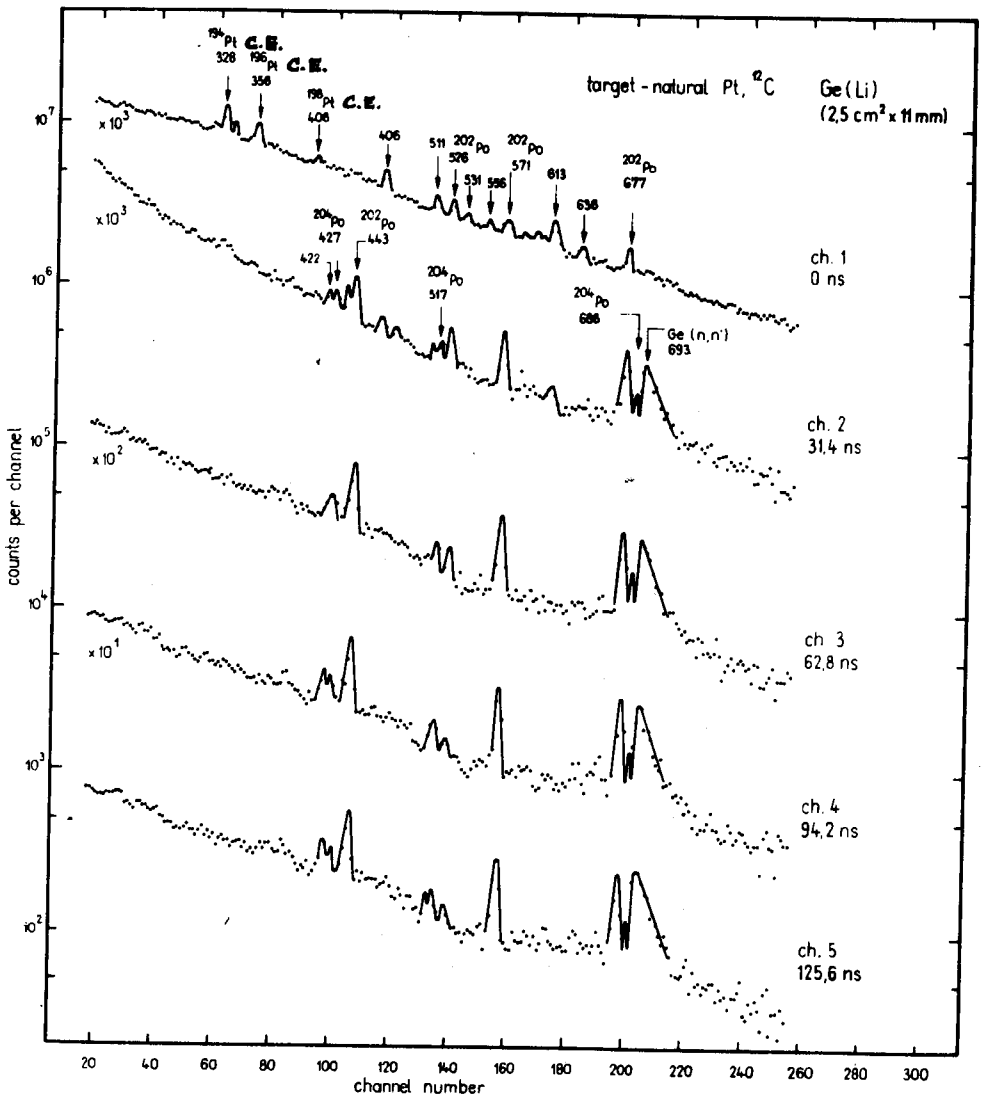

Fig.1. Part of the two-dimensional γ-ray spectrum of a Pt + ^{12}C bombardment.

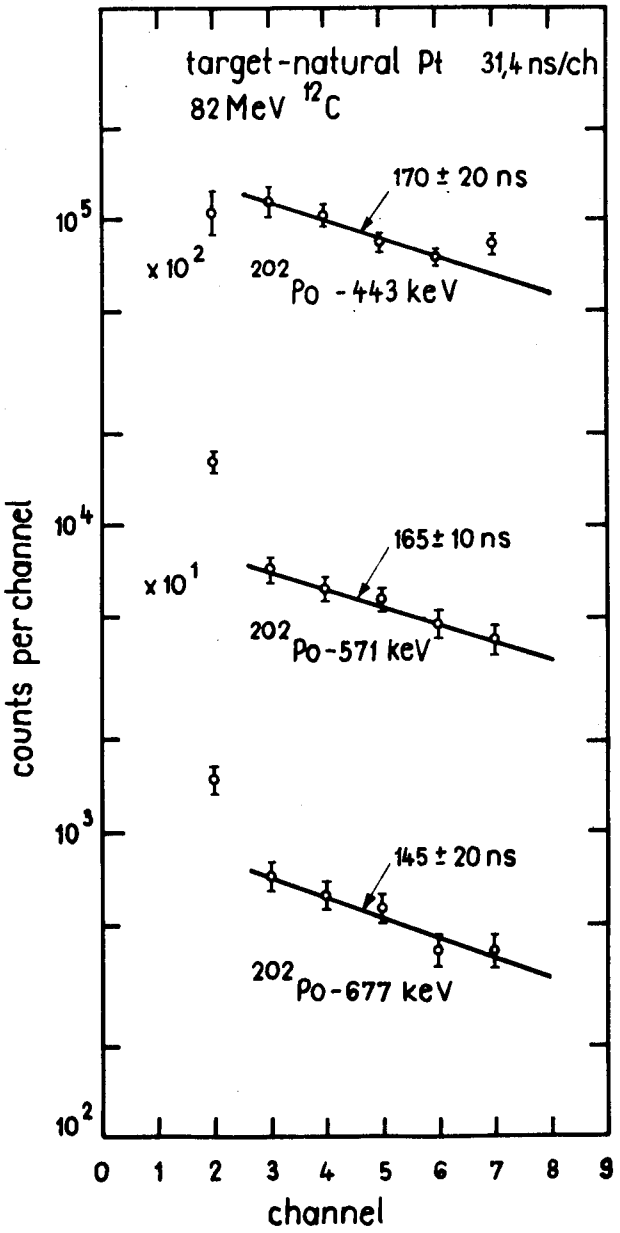

Fig.2. Time spectra of some γ-transitions in ^{202}Po.

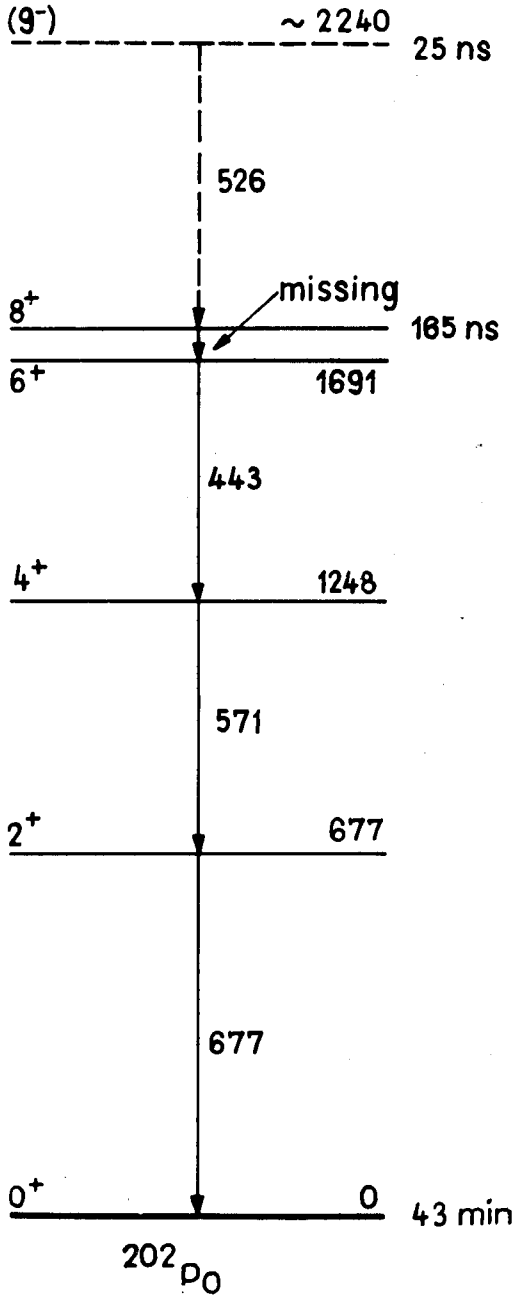

Fig.3. Proposed decay scheme of ^{202}Po.

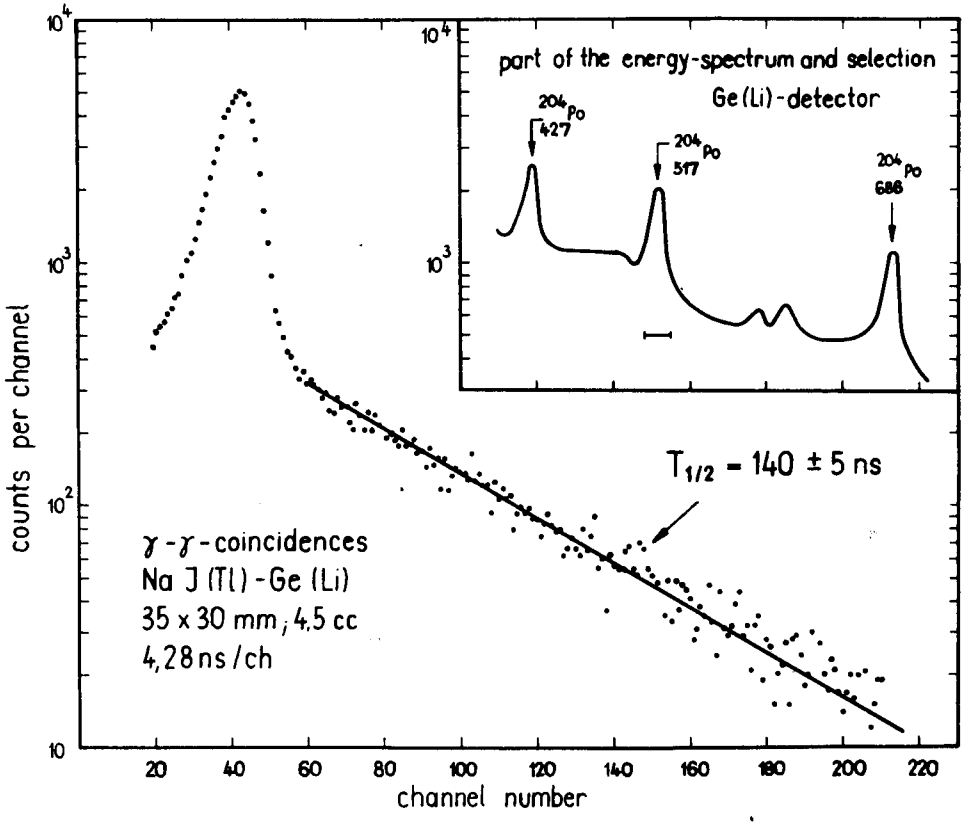

Fig.4. Time spectrum of the 517 keV γ-transition in ^{204}Po obtained with delayed KX – γ-coincidences of the ^{204}At decay.