α decay of ^{180,181}Pb

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A detailed α-decay study of the neutron-deficient isotope ^{181}Pb has been performed in the complete fusion reaction ^{40}Ca + ^{144}Sm → ^{184}Pb* at the velocity filter SHIP (GSI, Darmstadt). In comparison with the literature, more precise data have been deduced for the $I^{\pi} = (9/2^{-})$ ground state in this nucleus, which is presumably based on the neutron $\nu h_{9/2}$ spherical orbital. Improved α-decay data were also measured for ^{180}Pb.

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I. INTRODUCTION

The odd-A neutron-deficient isotopes $^{183-189}$Pb are well known for the systematic appearance of two α and/or β-decaying states with spin and parity assignments of $I^{\pi} = 3/2^{-}$ for the ground state and of $13/2^{+}$ for the isomeric state [1,2]. These states are produced when an odd valence neutron occupies either the $3p_{3/2}$ or the $1i_{13/2}$ spherical orbital, respectively. Recent laser-spectroscopic studies at the mass separator ISOLDE confirmed these conclusions by measuring the magnetic moments and charge radii of both the $3/2^{-}$ ground state and the $13/2^{+}$ isomer in the isotopes $^{183-189}$Pb [2–4]. A surprising observation for all these isotopes was the persistence of the $3/2^{-}$ ground state even down to the neutron number $N = 101$ (^{183}Pb), despite the fact that in the simple spherical shell model, the $3p_{3/2}$ orbital should already become empty by $N = 114$ (^{196}Pb). Thus it can be expected that below the neutron mid-shell at $N = 104$, the $1h_{9/2}$ or $2f_{7/2}$ neutron orbitals become important in the lead isotopes, as is observed in the light mercury and platinum nuclides, for example, in ^{175,177,179}Hg ($N = 95, 97, 99$) [5–9] or in ^{177}Pt ($N = 99$) [1,9,10].

The present work reports on a dedicated α-decay study of ^{181}Pb, for which more detailed information is now obtained in comparison to the previously known data. This isotope was previously studied in three experiments [11–13]. The studies [11,12] provided first, though relatively imprecise, α-decay data (see Table I), with no spin-parity assignment proposed. The latest work on this nucleus was published in a conference contribution [13], which suggested for the first time that, indeed, the ground state of ^{181}Pb should have a spin-parity assignment of $(9/2^{-})$. However, no spectra, α-decay energy, or half-life information for ^{181}Pb was presented in Ref. [13].

II. EXPERIMENTAL SETUP

The isotopes ^{181}Pb and ^{180}Pb were produced in the $3n$ and $4n$ evaporation channels, respectively, of the complete fusion reaction ^{40}Ca + ^{144}Sm → ^{184}Pb*. Eight ^{144}Sm targets, each of 96.4% enrichment and 350 μg/cm^2 thickness, were mounted on a wheel, rotating synchronously with the UNILAC macropulsing of 5 ms ("beam on") and 15 ms ("beam off"). The targets were produced by evaporating the ^{144}SmF$_3$ material onto a carbon backing of 40 μg/cm^2 thickness and covered with a 10 μg/cm^2 carbon layer to increase the radiative cooling and reduce the sputtering of the target material. Data were taken at several beam energies, covering the energy range of the $3n$-$4n$ evaporation channels.

After separation by the velocity filter SHIP [14], the evaporation residues (ERs) were implanted into a 300-μm-thick, 35 × 80 mm^2, 16-strip position-sensitive silicon detector (PSSD), where their subsequent particle decays were measured using standard implantation techniques [15].

The α-decay energy calibration of the PSSD was performed using known α lines of the isotopes $^{176-182}$Hg (and their daughters), produced via the α, xn channels of the studied reaction. The broad energy range of ∼5300–6800 keV and a small energy uncertainty for most of the α lines used for calibration allowed us to make a reliable extrapolation to the α-energy region of 6900–7300 keV, relevant for ^{180,181}Pb. A typical PSSD energy resolution of ∼25 keV (FWHM) was achieved in the energy interval of 6000–7300 keV. Since α-particle emission is a dominant decay mode of most of the nuclei produced in this reaction, the identification of nuclides was based on the observation of genetically correlated α-decay chains complemented with excitation function measurements.

A large-volume, fourfold segmented clover germanium detector was installed behind the PSSD to measure the energies of γ rays occurring within 5 μs of the detection of any particle decay in the PSSD. The energy threshold for the γ-ray registration was at ∼15 keV; therefore we could not observe Hg L x rays ($E_{\gamma} \sim$ 9–12 keV) in this experiment.

Three time-of-flight (TOF) detectors [16] were installed in front of the PSSD system, allowing us to distinguish the reaction products from the scattered beam particles. More

TABLE I. A comparison of α-decay energies E_α, half-life values $T_{1/2}$, and reduced α-decay widths δ^2_α for ^{180,181}Pb from our measurement and from the earlier data. Note that no α-decay energy or half-life values were given for ^{181}Pb in Ref. [13].

Isotope	E_α (keV)	$T_{1/2}$ (ms)	δ^2_α (keV)	Reference
^{181}Pb	7016(15)	36(2)	37(4)	Present work
	7044(15)	50^{+40}_{-30}	21^{+17}_{-13}	[11]
	7065(20)	45(20)	20(10)	[12]
^{180}Pb	7254 (10)	4.2 (5)	54 (8)	Present work
	7230(40)	4^{+4}_{-2}	68^{+70}_{-40}	[23]
	7250(15)	4.5(11)	52(14)	[24]

important, decay events in the PSSD could be distinguished from the implantation events by requiring an anticoincidence condition between the signals from the PSSD and from at least one of the TOF detectors.

III. EXPERIMENTAL RESULTS

A. Decay of ^{181}Pb

Figure 1(a) shows a part of the energy spectrum of α decays correlated with the ER implantation within the time interval $\Delta T(\text{ER-}\alpha_1) \leqslant 200$ ms. The shown data were collected during the "beam off" interval at the beam energy of 196(1) MeV in front of the target, at which most of the data for ^{181}Pb have been measured. Figure 1(b) shows the two-dimensional plot of α_1-α_2 correlations for α_1 decays from Fig. 1(a) for the time interval $\Delta T(\alpha_1\text{-}\alpha_2) \leqslant 2$ s, while Fig. 1(c) shows the projection of Fig. 1(b) on the $E_{\alpha 1}$ axis.

Three main groups of α decays can be seen in Fig. 1(a): at 6911(15) keV, the broad group at ~6990–7060 keV and a peak at 7083(15) keV. The α-line at 6911(15) keV is due to well-known decay of ^{182}Pb, see e.g. [17], which is also confirmed by the α_1(6911 keV)-α_2(6430(15) keV) correlations with its daughter nuclide ^{178}Hg, see Fig. 1(b).

We assign both the broad group at 6990–7060 keV and a peak at 7083(15) keV, seen in Figs. 1(a)–1(c), is due to α decay of ^{181}Pb. This is based on α-α correlations of these α decays with the known α decays of the daughter ^{177}Hg [$E_\alpha = 6582(15)$ keV, $T_{1/2} = 118(8)$ ms] and granddaughter ^{173}Pt [$E_\alpha = 6240(15)$ keV, $T_{1/2} = 430(40)$ ms] nuclides [see Fig. 1(b)]. Indeed, our measured data compare well with the tabulated values both for ^{177}Hg [$E_\alpha = 6580(8)$ keV, $T_{1/2} = 127.3(18)$ ms [9]] and for ^{173}Pt [$E_\alpha = 6225(9)$ keV, $T_{1/2} = 376(11)$ ms] (see, e.g., Refs. [1,18]). In total, ~700 ER-α correlated events have been attributed to ^{181}Pb.

Figure 1(d) shows the two-dimensional α_1-γ spectrum for α_1 events from Fig. 1(b) observed within the time interval $\Delta T(\alpha\text{-}\gamma) \leqslant 5$ μs. The group of four α(7016(15) keV)-γ(77.2(5) keV) coincident events must therefore originate from ^{181}Pb. We interpret the 7016-keV α decay is due to the fine structure α decay of ^{181}Pb feeding the known excited state at 77 keV in ^{177}Hg [6]. As shown in Ref. [6], this state deexcites directly to the $7/2^-$ ground state of ^{177}Hg by a 77-keV transition. Unfortunately, as stated in Ref. [6], the multipolarity of the 77-keV transition could not be

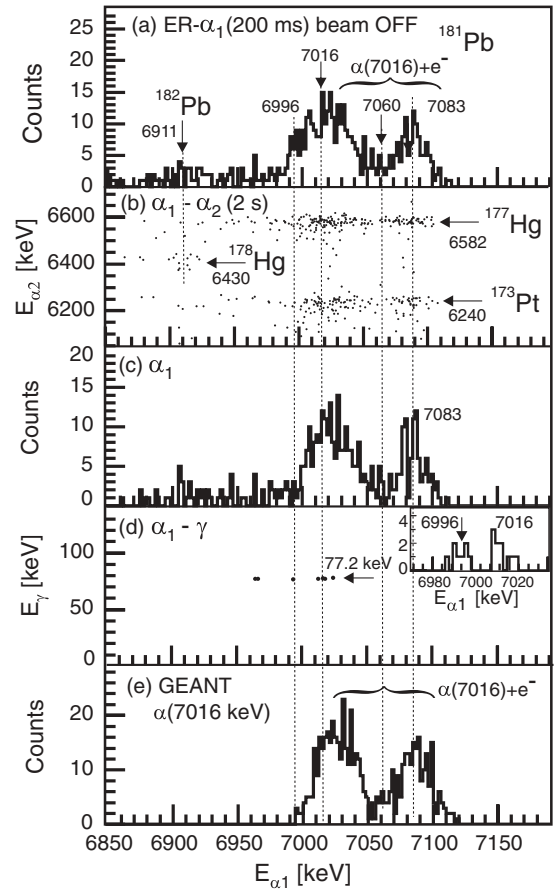

FIG. 1. (a) Part of the energy spectrum of α decays correlated with the ER implantation within the time interval of $\Delta T(\text{ER-}\alpha_1) \leqslant$ 200 ms. The data were collected during the "beam off" interval. α-decay energies are given in keV. (b) The α-α correlation plot for the α_1 decays from (a), measured within the time interval of $\Delta T(\alpha\text{-}\alpha) \leqslant$ 2 s. (c) Projection from (b) on the $E_{\alpha 1}$ axis. (d) E_{α_1}-E_γ spectrum for α_1 decays from (b) in coincidence with γ rays within 5 μs. The inset shows the spectrum of α decays observed in coincidence with the 77.2 keV γ decays without any further conditions, except for the coincidence time interval of 5 μs. (e) The result of the GEANT Monte Carlo simulation for the 7016-keV decay (see text for details).

unambiguously determined from their data, and based on a number of arguments, a tentative $M1$ multipolarity was suggested for this decay. In the following discussion, based on our data, we will confirm this inference experimentally.

We note in passing that our measured energy of 7016(15) keV differs from the energies of 7044(15) keV and 7065(20) keV reported for ^{181}Pb in the earlier studies of Ref. [11] and Ref. [12], respectively (see Table I).

The theoretical total conversion coefficient of the 77.2-keV transition is $\alpha_{\text{tot}}(M1) = 3.04$ [19]. As the energy of 77.2 keV is below the K-electron binding energy in Hg (83.1 keV [10]), the internal conversion from, predominantly, the L shell must be considered (L/M ratio is 4.3 [19]). This internal conversion results in conversion electrons with the energy of ~62.5 keV (L conversion) or ~73.7 keV for the weaker M conversion. Therefore the well-known effect of energy summing in a

silicon detector of the α-decay energy with the energy of the coincident conversion electron (and corresponding x rays) must be considered (see the detailed discussion in Refs. [20,21]). For example, if 62.5-keV conversion electrons are fully stopped in the PSSD, the full-energy peak at $\alpha(7016\ \text{keV}) + e^-(62.5\ \text{keV}) = 7079(15)$ keV is produced, which is close to the α line at 7083(15) keV seen in Fig. 1(a). The weaker full-energy summing with the M electrons of 73.7 keV explains the broadening of this peak up to the energy of ∼7100 keV [see Fig. 1(a)].

On the other hand, if such conversion electrons escape from the PSSD in the backward hemisphere, the partial $\alpha + e^-$ summing in the PSSD results in a higher energy tail of the 7016-keV α decay, also seen in our spectra. Collectively, both this tail and the full-energy summing peak at 7083 keV are denoted as $\alpha + e^-$ in Fig. 1. We also mention here explicitly that the energy summing with the Hg L x rays of ∼10–15 keV also contributes to the observed spectra as x rays with such a low energy have a sizable probability of being fully or partially registered in the 300-μm-thick PSSD. These effects will be discussed further in the text.

By using the ER-α correlation analysis, half-life values of 37(4) ms and 35(3) ms have been deduced for the 7010–7060 and 7083-keV groups, respectively, which is consistent with both originating from the decay of the same state in ^{181}Pb. Based on all data in the 7010–7100 keV interval, the half-life value of 36(2) ms was deduced for the 7016-keV α decay of ^{181}Pb.

We note that if it exists, the full-energy "cross-over" $\alpha(7016(15)\ \text{keV}) + \gamma(77.2\ \text{keV}) \sim 7093(15)$ keV α decay of the 36(2)-ms state in ^{181}Pb would have an energy close to the energy of the full-energy $\alpha + e^-(M)+$ x ray summing peak, seen in Fig. 1(a). Therefore, for the (yet unobserved) 7093(15)-keV decay, we provide only an upper intensity limit of 5% relative to the main 7016-keV α decay.

To confirm this scenario, we performed GEANT simulations with a dedicated code, developed for the SHIP detection system [20]. In the simulations, a single 7016-keV decay of ^{181}Pb was considered, being in coincidence with the 77.2-keV $M1$ decay. For the sake of simplicity, in our simulations, we included only the L conversion of the 77.2-keV decay; however, the inclusion of a weaker M conversion will not change our conclusions. Also, the effect of the Hg L x rays at ∼10–15 keV was considered in the simulations.

The result of such simulations for the 7016-keV α decay and related $\alpha(7016\ \text{keV}) + e^-(62.5\ \text{keV})$ summing effect is shown in Fig. 1(e). One can clearly see that the simulated spectrum is very similar in shape to the experimental spectrum in Fig. 1(c), which strengthens the proposed decay scheme.

However, we want also to point out two experimental facts. First of all, the comparison of Fig. 1(a) and Figs. 1(b) and 1(c) clearly shows that there is a weak "extra" peak at ∼6996 keV in Fig. 1(a), which practically disappears (or becomes very weak) in Fig. 1(b) and Fig. 1(c). As mentioned earlier, Fig. 1(a) shows the result of ER-α correlations, in which no requirement of a subsequent correlation with the α decays of the daughter nuclides ^{177}Hg and ^{173}Pt was applied. Therefore the tentative 6996-keV decay in Fig. 1(a) can actually originate from some other nucleus, rather than from ^{181}Pb.

On the other hand, one $\alpha(6996\ \text{keV})$-$\gamma(77.2\ \text{keV})$ coincident event is seen in Fig. 1(d), similar to the 7016-keV decay of ^{181}Pb. This might indicate that the 6996-keV decay also belongs to ^{181}Pb, but it could also be that this particular coincident event is due to the lower energy tail from the 7016-keV decay. In this respect, we remind the reader here that Fig. 1(d) was produced from the ER-[α_1-γ]-α_2 correlation analysis, which reduces the number of such correlated events by at least a factor of 2, relative to the ER-[α_1-γ] analysis. The latter is due to ∼50% PSSD detection efficiency for α decays. Therefore, to provide the full available statistics, the inset to Fig. 1(d) shows the α_1 spectrum, collected in coincidence with the 77.2-keV γ decays within the time interval of 5 μs without any extra conditions or correlations. Two peaks are clearly seen in the inset. One of them, with 10 counts, is the 7016-keV decay of ^{181}Pb, discussed earlier. The second decay, with eight counts, is at 6996(15) keV, which matches well to the position of the 6996-keV peak in Fig. 1(a). The half-life value of 30(10) ms for the latter events was deduced. However, as a word of caution, we reiterate here that only one out of these eight $\alpha(6996\ \text{keV})$-$\gamma(77\ \text{keV})$ coincident events in the inset remains in the ER-[α_1-γ]-α_2 correlation analysis in Fig. 1(d), instead of the expected four or five counts, as in the case of the 7016-keV decay. The 6996-keV decay will be discussed further in Sec. IV B.

By comparing the number of the α decays in the 6990–7060 keV group in Fig. 1(a) with the number of these decays in coincidence with the 77.2-keV γ ray in the inset to Fig. 1(d), after correction for the γ-registration efficiency, a total conversion coefficient of $\alpha_{\text{tot}}(77.2\ \text{keV}) = 2.7(9)$ was deduced. This confirms experimentally an $M1$ multipolarity, tentatively proposed in Ref. [6] for this transition, as the calculated total conversion coefficients are $\alpha_{\text{tot}}(E1) = 0.17$, $\alpha_{\text{tot}}(M1) = 3.04$, and $\alpha_{\text{tot}}(E2) = 16.7$ [19].

From the comparison of the number of α_1(6990–7100 keV) decays of ^{181}Pb in Fig. 1(a) and the number of α_1(6990–7100 keV)-α_2(^{177}Hg, 6582 keV) correlated decays in Fig. 1(b), an α-branching ratio of $b_\alpha = 100\%$ was deduced for ^{177}Hg with a precision of 5%, which is determined by the statistical uncertainty. This value is larger and more precise than the previously reported estimate of $b_\alpha \sim 85\%$ (see Refs. [9,22]).

B. α decay of ^{180}Pb

The first identification of ^{180}Pb was performed by using a rapidly rotating wheel system [23]. An α-decay energy of 7230(40) keV and a half-life value of 4^{+4}_{-2} ms were deduced based on a few registered events (see Table I). The subsequent work [24] at the fragment mass analyser collected approximately 10 decay events of ^{180}Pb (see Fig. 1 of Ref. [24]). Improved values of $E_\alpha = 7250(15)$ keV and $T_{1/2} = 4.5(11)$ ms were deduced.

In our experiment, we collected approximately 100 α-decay events of ^{180}Pb, which could reliably be identified based on their correlations with well-known α decays of daughter ^{176}Hg and granddaughter ^{172}Pt nuclides. Our measured values for ^{176}Hg are $E_\alpha = 6760(15)$ keV, $T_{1/2} = 20(3)$ ms; those for ^{172}Pt are $E_\alpha = 6324(15)$ keV, $T_{1/2} = 100(20)$ ms. These values

are in good agreement with the literature values of $E_\alpha = 6761(9)$ keV, $T_{1/2} = 20.3(14)$ ms for ^{176}Hg [18,25,26], and with the recent measurements for ^{172}Pt: $E_\alpha = 6316(5)$ keV, $T_{1/2} = 97.6(13)$ ms [27].

This allowed us to deduce more precise values of $E_\alpha = 7254(10)$ keV and $T_{1/2} = 4.2(5)$ ms for this nucleus (see the comparison of all known data in Table I). Based on this, a more precise reduced-width value of 54(8) keV was calculated for the 7254-keV decay. This value is in the range of $\delta_\alpha^2 =$ 40–70 keV for typical unhindered $0^+ \rightarrow 0^+$ α decays of even-even nuclei in this region of the nuclear chart.

IV. DISCUSSION

A. α decay of the $(9/2^-)$ state in ^{181}Pb

As mentioned in Sec. I, the odd-A isotopes $^{183-189}$Pb are well known for the systematic appearance of two α- and/or β-decaying states with spin and parity assignments of $I^\pi = 3/2^-$ for the ground state and $13/2^+$ for the isomeric state [2]. These states are due to the occupation of either the $3p_{3/2}$ or the $1i_{13/2}$ spherical neutron orbital, respectively. For example, in ^{183}Pb, the $13/2^+$ α-decaying isomeric state was found at only 79(6) keV above the $3/2^-$ ground state [7]. Furthermore, it is expected that in the lighter odd-A Pb isotopes, the $3/2^-$ state should become excited, while either the $9/2^-$ state originating from the $\nu h_{9/2}$ orbital or the above mentioned $13/2^+$ state could become the ground state.

Our data confirm the spin-parity assignment of $(9/2^-)$ for the ground state of ^{181}Pb, proposed in Ref. [13]. Indeed, as discussed in Ref. [6] and references therein, the $(7/2^-)$ ground state of ^{177}Hg can be understood as being due to an odd neutron occupying a somewhat mixed $7/2^-$ state from $f_{7/2}$ or $h_{9/2}$ orbitals at a weak deformation of $\beta_2 \sim 0.1$. The excited $(9/2^-)$ level at 77.2 keV in ^{177}Hg is then understood as due to the occupation of the spherical $h_{9/2}$ orbital.

The reduced α-decay width, $\delta_\alpha^2(7016 \text{ keV}) = 37(4)$ keV, was calculated for this decay with the Rasmussen prescription [28] and an assumption of $\Delta L = 0$. This value is similar to the reduced α-decay width of 54(8) keV for the neighboring even-even isotope ^{180}Pb (Table I), which suggests that the 7016-keV decay of ^{181}Pb is unhindered. Therefore, based on the presumed assignment of $I^\pi = (9/2^-)$ for the excited state at 77.2 keV and unhindered 7016-keV decay, we assign $I^\pi = (9/2^-)$ to ^{181}Pb.

Our detailed data along with the results of study [13] confirm that for the first time in the odd-A Pb isotopes, a low-lying particle-decaying state is based on the neutron $h_{9/2}$ orbital. The change in the ground state spin in ^{181}Pb relative to the heavier odd-A Pb isotopes is due to the complete depletion of the $i_{13/2}$ and $p_{3/2}$ orbitals lying above the $N = 100$ spherical subshell closure and a creation of a hole in the $h_{9/2}$ spherical orbital lying below this gap. Important for this inference is that the sphericity of the neutron-deficient Pb isotopes up to at least ^{182}Pb has recently been proven by the laser spectroscopic studies at ISOLDE [2,3], and presently, we have no reason to believe that this should change by moving toward lighter Pb isotopes.

Related to the preceding discussion, we note that the direct (yet unobserved) 7093(15)-keV α decay to the $7/2^-$ ground state of ^{177}Hg is strongly hindered by $\text{HF}_\alpha \geqslant 37$ (see Fig. 2). This is indeed expected as it involves different parent and daughter configurations.

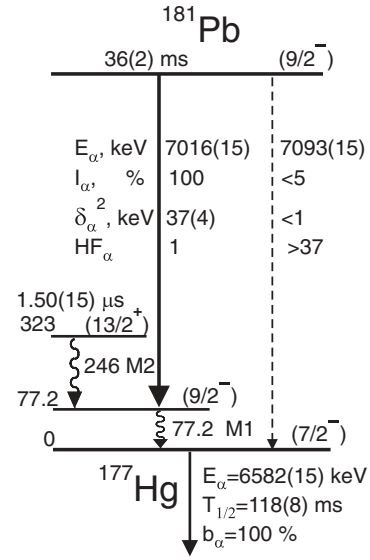

FIG. 2. Decay scheme of ^{181}Pb and ^{177}Hg deduced in our work (see text for details). Shown are α-decay energies E_α, relative intensities I_α, reduced α widths δ_α^2, and hindrance factors HF_α. The tentative 7093(15)-keV α decay is shown by a dashed line. The 1.50-μs $I^\pi = 13/2^+$ state at 323 keV in ^{177}Hg, identified in an in-beam study [6], is shown for completeness. The reduced α widths were calculated with the Rasmussen prescription [28] by assuming $\Delta L = 0$ decays. The HF_α value for the 7093-keV decay was calculated relative to the 7016-keV decay, for which $\text{HF}_\alpha = 1$ was assumed. All spin-parity assignments are tentative and are shown in parentheses.

Furthermore, we remind the reader that Ref. [13] briefly mentioned that "a γ transition with a lifetime of $\sim$10 μs was observed to feed the ^{181}Pb ground state. This level has been given a tentative assignment of $(13/2^+)$ and could represent an excitation into the $i_{13/2}$ orbital." Unfortunately, no spectra or γ-ray energy or any further discussion to support this claim were presented in Ref. [13]. In our work, no such transition has been observed. However, this could possibly be explained by a relatively short coincidence time interval of $\Delta T(\text{ER-}\gamma) \leqslant 5$ μs used in our study.

Nevertheless, such a γ decay, if it indeed exists, should, most probably, represent the $13/2^+ \rightarrow 9/2^-$ internal transition decay of an $M2$ multipolarity. Indeed, according to the Weisskopf single-particle estimate [10], the expected half-life for such an $M2$ transition with an energy up to a few hundred keV would be $\sim$0.5–10 μs, which would be in agreement with the value reported in Ref. [13].

It is also important to stress that in any case, it is highly improbable that the $13/2^+$ state in ^{181}Pb would be lying below the $9/2^-$ state, as the corresponding $M2$ $9/2^- \rightarrow 13/2^+$ internal transition decay should be much faster than the observed 36-ms α decay of the $9/2^-$ state, unless a very strong hindrance of the order of $>10^3$ for this $M2$ decay is involved. However, we are not aware of a possible mechanism that could provide such a strong retardation for this decay.

B. Tentative 6996-keV α decay

Finally, as far as the tentative 6996-keV α decay is concerned, we also mention a possible scenario in which the 6996-keV α decay actually originates from another α-decaying state in ^{181}Pb with a half-life similar to that of the $9/2^-$ state decaying by the 7016-keV decay. Such a state could then have a spin-parity assignment of either $13/2^+$ or $3/2^-$ as such α-decaying states are well known in the heavier odd-A isotopes. For example, in ^{183}Pb, the $13/2^+$ and $3/2^-$ α-decaying states have comparable half-life values of 415(20) ms and 535(30) ms, respectively [7], with the $13/2^+$ state lying only 79(6) keV above the $3/2^-$ ground state. However, as mentioned earlier, the $13/2^+$ assignment for this state is highly unlikely because of the half-life considerations, and thus we rule out this possibility and discuss subsequently the possible $3/2^-$ assignment for this state.

The observed 6996–77.2 keV α-γ coincidences might indicate that the 6996-keV decay actually proceeds from the state $\sim$20 keV below the 36(2)-ms α-decaying state; thus the former state would then become the ground state in ^{181}Pb. In this case, the 6996-keV decay would be a $\Delta L = 4$, $3/2^- \rightarrow 9/2^-$ α decay, which would need to compete with a direct, $\Delta L = 2$, 7071(15)-keV α decay to the $7/2^-$ ground state of ^{177}Hg. Clearly the latter decay should be more favorable, both because of its larger energy and lower ΔL value. Unfortunately, such a decay would be hidden by the summing peak at 7083 keV (see Fig. 1), and thus we cannot quantify this scenario.

To summarize this tentative discussion, given the scarce data for the 6996-keV α decay, it is presently impossible to discuss this decay unambiguously. Much higher statistics would be required to clarify if the 6996-keV decay belongs to ^{181}Pb and from which state it originates.

V. CONCLUSIONS

A detailed α-decay study of isotope ^{181}Pb was performed in the complete fusion reaction of ^{40}Ca ions with the ^{144}Sm target. The relatively large number of decays collected in our experiment, along with the efficient and versatile detection system, allowed us to identify the fine-structure 7016-keV α decay of this nucleus. Based on the much more detailed decay pattern of ^{181}Pb (in comparison with previous Refs. [11,12]) and on the properties of the states in the daughter nucleus ^{177}Hg, it is shown that an α-decaying state with a spin-parity assignment of $I^\pi = 9/2^-$ is present. The state is based presumably on the spherical $\nu h_{9/2}$ orbital. No unambiguous evidence for the $3/2^-$ or $13/2^+$ states, which are typically seen in the heavier odd-A Pb isotopes, was found in our data.

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