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The present paper reports the results of an attempt aimed at the synthesis of element 118 in the reaction ^{249}Cf(^{48}Ca,3n)^{294}118. The experiment was performed employing the Dubna Gas-filled Recoil Separator and the U400 heavy-ion cyclotron at FLNR, JINR, Dubna. In the course of a 2300-hour irradiation of an enriched ^{249}Cf target (0.23 mg/cm^2) with a beam of 245-MeV ^{48}Ca ions, we accumulated a total beam dose of 2.5×10^{19} ions. We detected two events that may be attributed to the formation and decay of nuclei with Z=118. For one event, we observed a decay chain of two correlated α-decays with corresponding energies and correlation times of $E_{\alpha1}$=11.65±0.06 MeV, $t_{\alpha1}$=2.55 ms and $E_{\alpha2}$=10.71±0.17 MeV, $t_{\alpha2}$=42.1 ms and, finally, a spontaneous fission with the sum of the kinetic energies of the fission fragments E_{tot}=207 MeV (TKE~230 MeV) and t_{SF}=0.52 s. In the second event chain, the recoil nucleus decayed into two fission fragments with E_{tot}=223 MeV (TKE~245 MeV) 3.16 ms later, without intervening α decays. The probabilities that these events were caused by the chance correlations of unrelated signals are negligible. Both events were observed at an excitation energy of the compound nucleus ^{297}118 of E^*=30.0±2.4 MeV, close to the expected maximum of the 3n-evaporation channel. The relationship between the decay energy Q_α and decay period T_α shows that sequential α-transitions in the first event correspond to the decay chain with Z=118_116_114. Decay characteristics of the newly observed nuclides are compared with radioactive decay properties of the even-even isotopes with Z=116, 114 and 112 previously produced in the reactions ^{244}Pu, ^{248}Cm+^{48}Ca and calculations made in various nuclear models.

I. INTRODUCTION

One of the fundamental outcomes of the nuclear shell model is the prediction of the existence of the "Island of Stability" in the domain of the hypothetical superheavy elements. This hypothesis has been under development for more than 30 years in various nuclear models, and again finds support in the most recent experiments on the synthesis of superheavy elements. Among the accessible superheavy nuclides, even-even isotopes are of the most interest as their decay properties can be most accurately calculated by theory without interference from single-particle effects.

Four even-even nuclides involved in the decay chains $^{292}116 \xrightarrow{\alpha} {}^{288}114 \xrightarrow{\alpha} {}^{284}112 \xrightarrow{\alpha} {}^{280}110 \xrightarrow{SF}$ were recently produced in the reactions ^{244}Pu+^{48}Ca and ^{248}Cm+^{48}Ca [1,2]. The predominance of α-decay as observed in the new nuclei with Z=112-116 and N=172-176 demonstrates their high stability against spontaneous fission (SF). Their decay energies and lifetimes point to a considerable increase in the stability of nuclei with $Z\geq110$ as the neutron number increases. In general, these findings support theoretical predictions of the influence of closed nuclear shells in the large domain of nuclides close to Z=114 or higher and N=184.

At the same time, the position of the peak of stability of superheavy nuclei as well as the limits of the "Island of Stability" are quite sensitive to nuclear model parameters, in particular, to the Z value of the magic nucleus with N=184 that shows the maximum shell stabilization. Further investigation of the domain of superheavy nuclei would be the search for isotopes with Z>116; a logical next step is an experiment aimed at the synthesis of Z=118 nuclides, which can be produced in the reaction ^{249}Cf+^{48}Ca.

II. SYNTHESIS REACTION

The choice of the reaction to produce element 118 depends on the following factors. Of the californium isotopes produced in high-flux reactors, 350-y ^{249}Cf is available in amounts sufficient for making a target (~10 mg), and is also available in high enrichment as the β-decay daughter of chemically purified ^{249}Bk (T_{β}=320 d).

The excitation energy of the compound nucleus ^{297}118 at the Coulomb barrier of the reaction ^{249}Cf+^{48}Ca is expected to be E^{*}_{min}=26.6 MeV, i.e., 4 MeV less than that of ^{296}116 produced in the reaction ^{248}Cm+^{48}Ca. This should result in an increased survival probability of the evaporation residues (EVRs) in the process of neutron emission and, thus, compensate for the probable reduction of the EVR production due to the lower expected cross section for complete fusion. Using experimental cross sections of the reactions $^{204\text{-}208}$Pb(^{48}Ca,xn)$^{(252\text{-}256)\text{-}x}$No ($x$=1-4) [4] measured in a wide energy range and cross sections of the reactions ^{244}Pu(^{48}Ca,4n)^{288}114 [1] and ^{248}Cm(^{48}Ca,4n)^{292}116 [2] we can estimate the cross sections of the production of isotopes of element 118 in the reaction ^{249}Cf+^{48}Ca. Calculated values of the xn-evaporation cross sections vs. excitation energy of the ^{297}118 compound nucleus are shown in Fig. 1. For the reaction ^{249}Cf+^{48}Ca, the maximum yield of EVRs is expected in the 3n-evaporation channel that leads to the formation of the even-even nuclide ^{294}118 in the ground state [3].

Using neutron-rich ^{48}Ca as a projectile allows the production of the isotope of element 118 with N=176. A comparison of the radioactive properties of ^{294}118 with the previously measured data for ^{292}116, would suggest the strength of the stabilizing effect of the proton shell at N=176. Provided ^{294}118 undergoes sequential α-decays, a similar comparison could be made for its descendants, i.e., nuclides with Z=116, 114, and probably 112 with neutron numbers N=174, 172 and 170, respectively.

The radioactive decay properties of ^{294}118 can be calculated with various nuclear models. However, the calculated data strongly differ since different models predict different proton shell closures for the superheavy nuclides. According to the macroscopic-microscopic model [5], ^{294}118 should undergo α-decay with energy Q_{α}=12.11 MeV and half-life _$_{\alpha}$=58 µs; Hartree-Fock-Bogoliubov calculations [6] give Q_{α}=11.3 MeV, _$_{\alpha}$~7 ms; relativistic mean-field calculations [7] predict Q_{α}=11.03 MeV, _$_{\alpha}$~0.04 s. With the uncertainty in the alpha-decay energy spanning more than 1 MeV, the corresponding partial half-lives vary by three orders of magnitude.

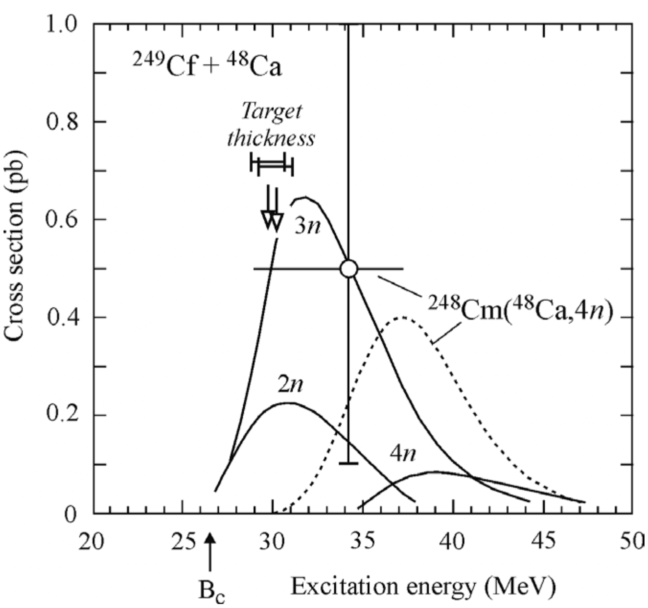

Fig. 1. Calculated excitation functions for xn-evaporation channels in the reaction ^{249}Cf+^{48}Ca [3]. Arrows show excitation energies corresponding to the events observed in the present work and to the Bass barrier B_c. The dashed line and an experimental point refer to the reaction ^{248}Cm(^{48}__,4n)^{292}116.

Nevertheless, this uncertainty does not prevent us from performing the experiment; we employ an experimental setup and a detection system characterized by a short dead time (t_{min}~6 µs) and narrow energy resolution (~0.06 MeV) when detecting α-particles over a wide range of energies. To determine the decay scenario of ^{294}118, more realistic estimates can be obtained by extrapolating radioactive properties of the neighboring even-even nuclides ^{292}116, ^{288}114, ^{284}112, and ^{280}110 produced in the reactions ^{244}Pu+^{48}Ca and ^{248}Cm+^{48}Ca. Such a simple extrapolation gives the following decay chain (Q_{α} and _$_{\alpha}$ given in brackets): ^{294}118 (~11.8 MeV, ~0.5 ms) $\xrightarrow{\alpha}$ ^{290}116 (~10.8 MeV, ~50 ms) $\xrightarrow{\alpha}$ ^{286}114 (10.4 MeV, ~0.1 s) $\xrightarrow{\alpha}$ ^{282}112 (_$_{SF}$~0.1 s). The granddaughter nuclide ^{286}114 can also undergo spontaneous fission with a significant probability.

Therefore, the decay chain of ^{294}118 can be expected to last for less than one second, include two or three sequential α-decays, and end in a spontaneous fission. With the given estimates of the production cross section and radioactive properties in mind, we performed an experiment in search of element 118 in the complete-fusion reaction $^{249}Cf+^{48}Ca$.

III. EXPERIMENT

The experimental set up used in the current attempt to synthesize nuclei with *Z*=118 is fully analogous to that used in our previous works on elements 114 and 116 [1,2]. The following is information specific to this experiment.

We used a rotating target with 6 separate target sectors, each being 5.3 cm^2 in area. The ^{249}Cf (97.3%) used for preparing the target was produced at the reactor facility of RIAR (Dimitrovgrad). The target material is deposited onto 1.5-μm Ti foils as CfO_2 (0.23 mg/cm^2). The target sectors were mounted on a disk that rotated at 2000 rpm in the hydrogen atmosphere (1 Torr) of the gas-filled separator. A total of 7.25 mg of ^{249}Cf was used, with a corresponding activity of ~30 mCi. To prevent α-radioactivity contamination of the laboratory due to possible target damage, we employed double containment of the target assembly and a special system to measure any α-radioactivity in the hydrogen flowing through the separator. The integrity of the californium layer was checked periodically by measuring the ^{249}Cf α-particle counting rate with the focal-plane detector, with the separator operated at a lower magnetic rigidity that transmitted the 5.8-MeV α-particles to the detector array.

In our experiments, we used a ^{48}Ca beam from the FLNR, JINR U400 cyclotron, delivered to the target system with an energy of 265 MeV. The beam energy was determined and controlled by employing a time-of-flight measuring system and by a Si(Au) surface-barrier detector that registered ions scattered from a thin Au target. After traversing an entrance window that separated the beam line and the separator (1.5 μm of Ti), and also the 1.5-μm Ti target backing, the ions had an energy in the middle of the CfO_2 layer of E_L=245 MeV. Taking into account the energy loss in the target (~2.1 MeV), a small variation of individual target sector thickness, the beam energy resolution (~2.8 MeV), and the normal variation of primary beam energy in a 2300-hour run, we determined that the excitation energy of a $^{297}118$ compound nucleus could vary within E^*=26.6-31.7 MeV. The ion beam was spread over the target area and the ion flux did not exceed 3×10^{11} s^{-1} cm^{-2}, which allowed us to perform long-term irradiations and accumulate an integral dose of 2.5×10^{19} ions. The time of flight of a recoil nucleus traversing the separator from the target to the focal-plane detector (a distance of 4 meters) was about 1 μs.

The measurement system provided for the determination of the position on the target wheel that gave rise to the recoil and the corresponding instantaneous value of the beam energy. This allowed us to determine the excitation energy of the compound nucleus associated with a potential element 118 event to an accuracy of $\Delta E^*\approx4.3$ MeV in the subsequent data analysis.

The complete-fusion reaction products emerging from the target were separated in flight from the primary beam, scattered target and beam particles, and various transfer-reaction products by the Dubna Gas-filled Recoil Separator [8], shown schematically in Fig. 2. The separator's magnetic rigidity was set to transport *Z*=118 EVRs. We extracted this parameter from our experimental data on the average equilibrium charge states of nuclei with *Z*=89-116 [9]. The average charge state of the *Z*=118 recoils in the hydrogen gas filling the separator was estimated to be $q\approx5.7$.

Reaction products that traversed the separator entered a detector module that was separated by a 1-μm Mylar window and filled with 1.5 Torr of pentane. The EVRs were finally implanted into a 48-cm^2 detector array in the focal plane of the separator. The focal-plane detector was composed of 12 strips, each 1-cm wide and 4-cm high, and each with vertical position sensitivity. A time-of-flight (TOF) detector with a 65-mm flight base was mounted ahead of the focal-plane detector. It measured the velocity of the recoils and permitted the discrimination of the signals of particles that passed through the separator from those of α-particles and fission fragments from decays of implanted EVRs (no TOF signal).

For the heavy recoils and decay events (α-particles or SF), we determined the relative position on the detector's sensitive area as the strip number (*x*) and vertical position (*y*). This position correspondence gave the genetic correlation between the implanted recoil and its subsequent decay.

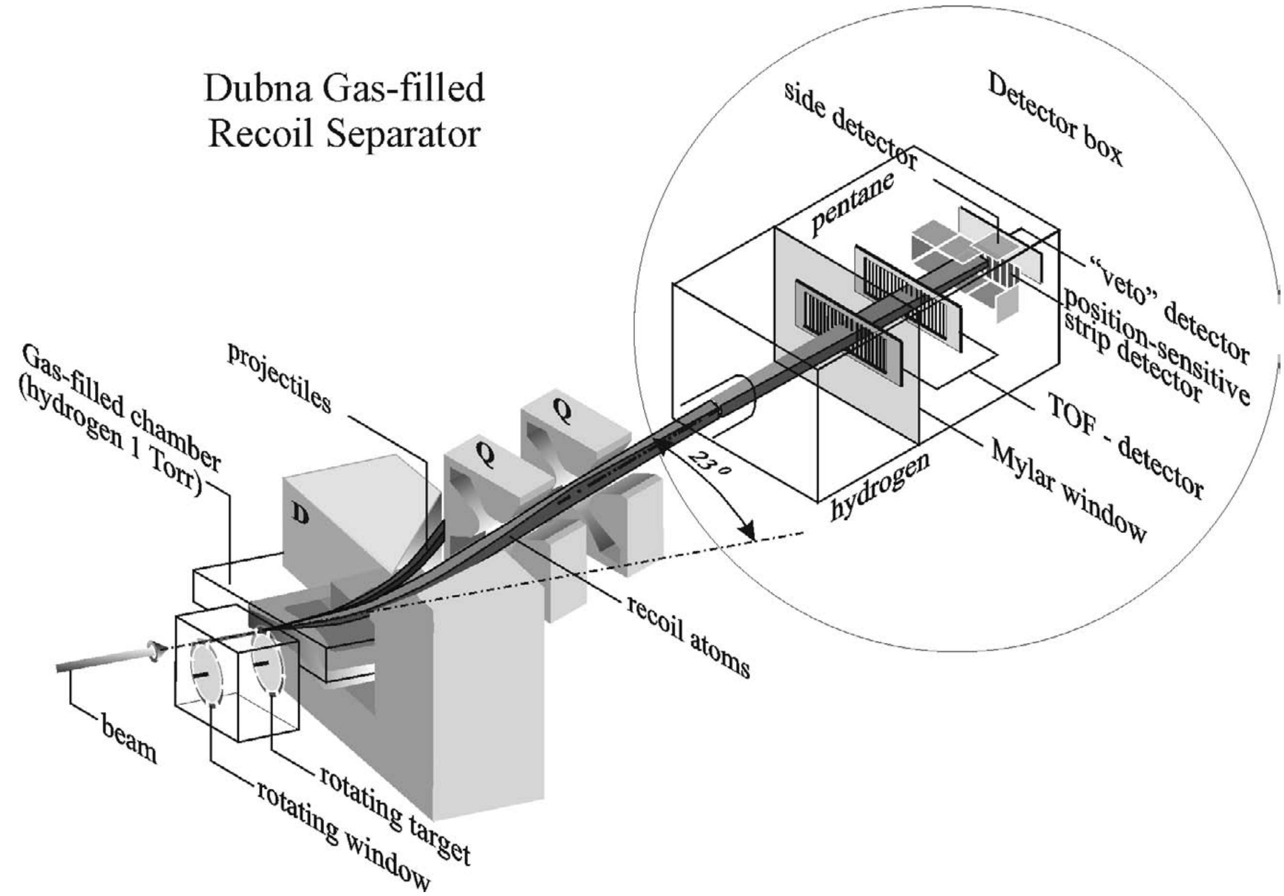

Fig. 2. Schematic diagram of the Dubna Gas-filled Recoil Separator used in the experiments with the reaction ^{249}Cf+^{48}Ca. D is the dipole magnet and Q is the quadrupole doublet.

To detect α-particles escaping into the back hemisphere, side detectors (without position sensitivity) surrounded the focal-plane detector, so that the entire detector array looked like a box with an open front. This enhanced the efficiency of detecting full energy α-particles to 87% of 4π. A "veto" detector was mounted behind the focal-plane detector to suppress the signals of particles with low ionization (protons, deuterons, α-particles) that could pass from the target, through the separator, and through the 300-μm thick focal-plane detector without being detected by TOF system.

With a ^{48}Ca beam intensity of 5×10^{12} s^{-1}, the average counting rate of the TOF detector was about 8 s^{-1}, while the signals within the energy interval expected for Z=118 EVRs came with an intensity of 2 s^{-1}. Signals without a TOF signal and with energies ranging from E_{α}=9-13 MeV were detected over the entire area of focal-plane and side detectors with a counting rate of about 0.5 s^{-1}. Counting-rate distributions across the detector array as a function of strip number in the energy range expected for EVRs (E_{R}=5-18 MeV) and individually detected fission fragments are shown in Fig. 3.

From our previous experiments and calculations of the separator's collection efficiency [10] we estimated that about 35% of recoils with Z=118 emerging from the ^{249}Cf target should reach the focal-plane detector.

An α-energy calibration was performed periodically, using α-peaks arising in the decays of isotopes of No and Th and their decay products, isotopes of Fm, Cf and Ra, Rn, that were produced in the reactions ^{206}Pb+^{48}Ca and ^{nat}Yb+^{48}Ca, respectively. The energy resolution for α-particles registered by the focal-plane detector with full energy was about 0.06 MeV; for escaping α-particles registered in side detectors the resolution was 0.17 MeV.

The fission-fragment energy calibration was performed using SF fragments from the decay of ^{252}No produced in the reaction ^{206}Pb(^{48}Ca,2n). In our experiments, 43% of the SF events of ^{252}No were detected as two coincident fragments in the focal-plane and side detectors, with an average total detected energy

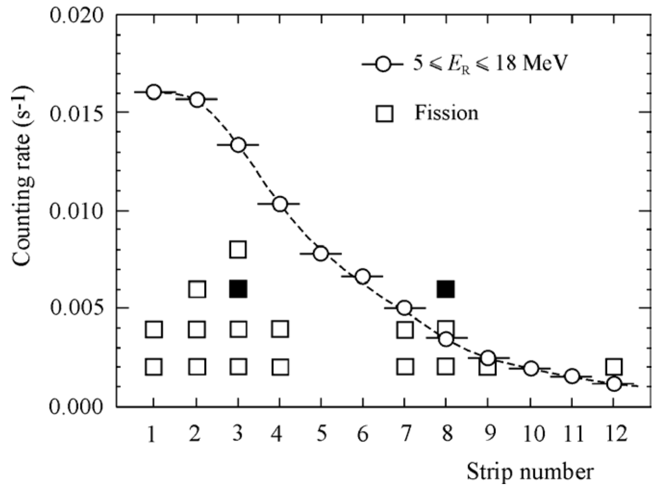

Fig. 3. The distribution of signals over the strips of the focal-plane detector. Open circles show the counting rate of recoils with E_R=5-18 MeV, normalized for the ^{48}Ca beam intensity of 5×10^{12} s^{-1} and given per vertical position window of 1.5 mm. Open squares - the 16 observed SF events with E_{tot}<200 MeV. Full squares - fission events with E_{tot}>200 MeV.

release of $\overline{E}_{tot}$=176 MeV. In the SF of an implanted nucleus, a fragment escaping from the focal plane in the backward direction deposits part of its energy in the focal-plane detector. This part is summed with the energy deposited by the other fragment. However, the emitted fragment loses energy in the dead layers of both the focal-plane and side detectors, and in the pentane filling the detector module before impacting the side detectors. For ^{252}No, these losses amount to about 20 MeV. These losses should be taken into account in calculating total kinetic energy value $\overline{TKE} \approx \overline{E}_{tot}$+20 MeV.

In calibration experiments we also determined the vertical position resolution values for the detection of correlated decays of implants. For detecting an EVR-α-decay sequence in the focal-plane detector, we obtained a position resolution (FWHM) of 1.1±0.2 mm. If an alpha event were detected by both the focal-plane and side detectors, the position resolution depended on the amplitude of the signal in the focal-plane detector, see Fig. 4. For detecting the EVR-SF correlations, the position resolution was 0.7±0.1 mm.

The experimental sensitivity corresponded to a cross section of about 0.3 pb, calculated for one detected decay event of element 118.

IV. EXPERIMENTAL RESULTS

The experiment was performed from February through June, 2002, inclusive. In a 2300-hour irradiation we accumulated a total beam dose of 2.5×10^{19} ^{48}Ca ions.

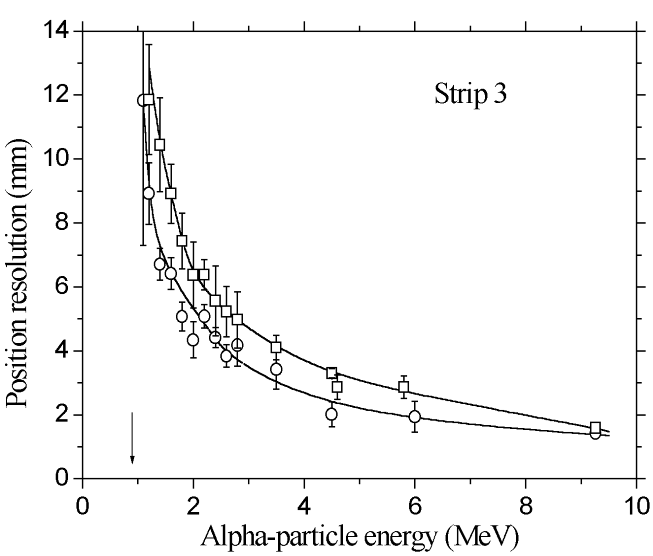

Fig. 4. Dependence of EVR-α position resolution (FWHM) on the amplitude of α-particle signal in strip 3 of the focal-plane detector at the start (○) and at the end of the experiment (□) when a beam dose of 2.5×10^{19} was accumulated. The arrow shows the α-energy detection threshold. The position resolution was derived by examining the ^{nat}Yb+^{48}Ca data for escaping α-particles depositing varying amounts of energy in the focal plane detector.

Since decay chains of the Z=118 nuclides are expected to end in SF, we first searched through the data for spontaneous fission events. A total of 18 SF events were detected in our experiment, see Fig. 3, and the measured summed energies are given in Fig. 5a. These include events with coincident fission fragments detected by both the focal-plane and side detectors and those with fragments absorbed only in the focal-plane detector. Of the latter we selected events characterized by a measured energy $\overline{E}_{tot}$>150 MeV. The observed SF events can be separated into two groups by energy value: the majority (16 events) with E_{tot} from 125 MeV to 175 MeV ($\overline{E}_{tot}$=158 MeV), and two events with higher energies, 207 MeV and 223 MeV.

For every SF event we searched for preceding EVR signals in the corresponding strips and position windows with respect to the position of the SF. In our case, the counting rate of recoils depends on their magnetic rigidity and, consequently, on the strip number in the detector array, see Fig. 3. For

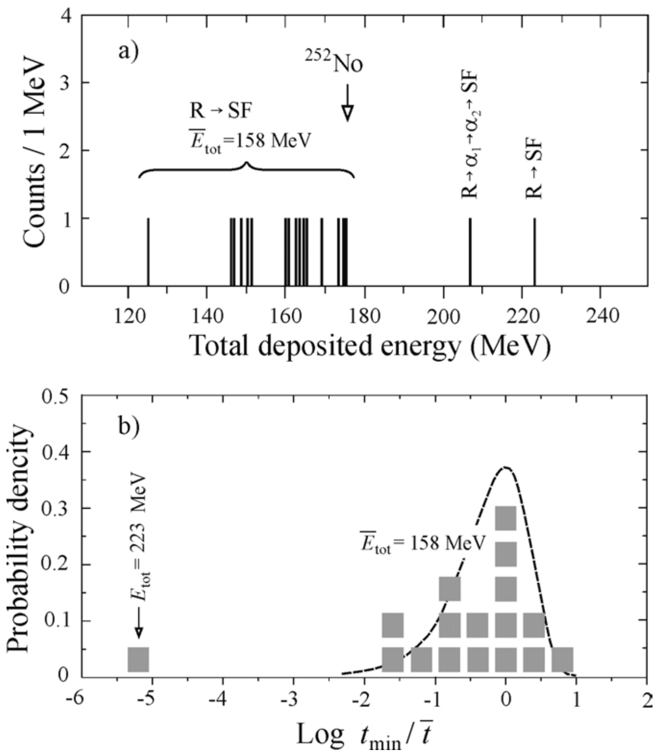

Fig. 5. a) Sum energies of fission fragments detected in the present experiment. The arrow shows $\bar{E}_{tot}$ for ^{252}No measured in the ^{206}Pb+^{48}Ca calibration experiments. b) The distribution of EVR-SF time intervals vs. $t_{min}/\bar{t}$ (see text). The dashed curve represents the calculated probability of chance correlations. An arrow shows the value of $t_{min}/\bar{t}$ for the detected event with E_{tot}=223 MeV; $\bar{t}$=527 s for this event.

each fission event we determined the time interval between the observed fission and the closest recoil, t_{min}, and for all SF events, the average time interval, $\bar{t}$, in the corresponding strips and in the position windows that corresponded to a 95% probability of their observation. For the 16 SF events with $\bar{E}_{tot}$=158 MeV the minimum time intervals are given in Fig.5b, in units of $t_{min}/\bar{t}$. The smooth curve shows the calculated random time distribution for this group of fission fragments. The corresponding lower limit of the "effective" half-life for this group can be estimated as $_{sf}$>0.5 h. Most probably these fragments can be ascribed to long-lived nuclides around Cf-Fm that are produced (as in the case of ^{248}Cm+^{48}Ca [2]) in incomplete fusion reactions and whose yield is suppressed by more than 5 orders of magnitude by means of the gas-filled separator.

The two fission events with E_{tot}=207 MeV and 223 MeV are preceded by recoil signals detected in appropriate position windows with time distances of 0.56 s and 3.16 ms, respectively. The probabilities of detecting random recoil-like signals within the given intervals are 9×10^{-3} and 6×10^{-6}, respectively [11].

For these two events, we searched within their respective time intervals t_{min} for α-particle signals preceding the SF. In the case of the event with E_{tot}=207 MeV (TKE~230 MeV), we found that the nearest recoil-like event has an energy and TOF signal close to the expected values for a Z=118 nucleus; this was followed in 2.55 ms by an 11.65-MeV α-particle detected by the focal-plane detector. Furthermore, 42.1 ms later, the focal-plane and side detectors recorded another α-particle with an energy of 10.71 MeV (1.41 MeV in the focal-plane, 9.30 MeV in the side detector), which was followed in 0.52 s by an SF, detected as two fragments with energies of 188 MeV (focal-plane detector) and 19 MeV (side detector). The probability of observing a random sequence of 4 signals EVR-α_1-α_2-SF in strip 3 (even without taking into account the vertical position correlation) is 1.5×10^{-6} [11], which points to a strong correlation of the observed decays. This decay chain is presented in Fig. 6a. The figure also gives respective positions measured from the top of the detector. The 6-mm position deviation observed for the second α-particle is caused by the low amount of energy (1.41 MeV) deposited in the focal-plane detector, as is illustrated by the dependence shown in Fig. 4.

This event was observed at an instantaneous beam energy value of 245.6 MeV, corresponding to an excitation energy of E^*=29.8±2.0 MeV in the compound nucleus ^{297}118.

For the second high-TKE SF event (strip 8), no signals were detected during the short EVR-SF t_{min} time interval of 3.16 ms. Here, the SF was also detected as two coincident fragments, with energies of 137 MeV (focal-plane detector) and 86 MeV (side detector), with the focal-plane signal in position correlation with the preceding recoil signal; see Fig. 6b. For this event, the corresponding instantaneous beam energy was 246.1 MeV, corresponding to a compound nucleus excitation energy of E^*=30.2±2.3 MeV.

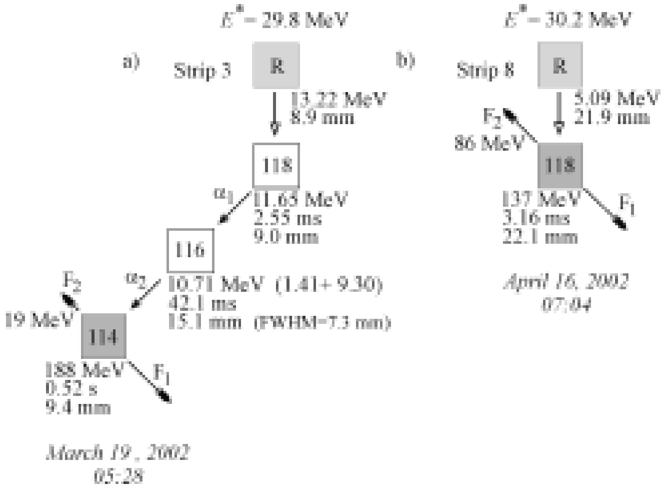

Fig. 6. Decay chains of nuclei ending in SF with E_{tot}=207 MeV (a) and 223 MeV (b). Excitation energies (E^*) of ^{297}118 are shown, corresponding to the instantaneous beam energy associated with the detection of the decay events.

V. DISCUSSION

Both events with a total detected fission energy above 200 MeV were associated with an excitation energy of the compound nucleus of about 30 MeV. This is well below the optimum energy value for the 4*n* evaporation channel, which is calculated to reach its maximum value of less than 0.1 pb at $E^*\approx$40 MeV; see Fig. 1. At $E^*\sim$30 MeV the most probable channels are those involving the evaporation of two or three neutrons, resulting in the production of *Z*=118 isotopes with mass 295 and 294, respectively.

Two sequential α-decays of the even-odd ^{295}118, the 2*n* evaporation product, would lead to ^{287}114. This isotope was recently produced in the reaction ^{242}Pu(^{48}Ca,3*n*)^{287}114 [12]. The decay chains observed in the reaction ^{249}Cf+^{48}Ca do not lead to those produced in the ^{242}Pu+^{48}Ca reaction. From the above considerations, we may suppose that the detected decay chains originate from the even-even parent nuclide ^{294}118, produced in the ^{249}Cf+^{48}Ca reaction via the 3*n*-evaporation channel.

Now let us consider both position-correlated decay sequences in detail. In the first event sequence, the parent nucleus undergoes two α-decays with a subsequent spontaneous fission decay. For the allowed α-transitions in even-even nuclides, the decay energy Q_α and decay probability (or half-life T_α) are correlated and depend only on the *Z* of the decaying nucleus. This relation of Q_α and T_α is known as the Geiger-Nuttall relationship and all 68 known even-even nuclides with *Z*>82 and *N*>126 follow this rule. Applying this relation in the form of the Viola-Seaborg formula, one can calculate the atomic number *Z* of the nuclides that undergo α-decay prior to SF. As far as the two observed α-decays are genetically linked, such α-transitions correspond to the *Z*=118→116→114 decay chain with a probability of *P*>87%.

In the observed sequence, one cannot completely rule out that the final nucleus, ^{286}114, undergoes α-decay along with SF, since the decay time t_{SF} is close to the expected t_α. Additional information is needed for drawing more definite conclusions.

In Table 1 we compare values of Q_α(exp) measured for this decay chain with the results of Q_α calculations made for ^{294}118, ^{290}116 and ^{286}114. Fig. 7a also shows them together with the known data on Q_α(exp) for the even-even nuclides with 100≤*Z*≤116 and theoretical values Q_α(th) calculated with the macroscopic-microscopic nuclear model [5]. As can be seen from Figure 7, the experimental values Q_α(exp) for ^{294}118, as well as for its descendants, the new isotopes of elements 116 and 114, agree well with the earlier data on heavier even-even isotopes with *Z*=114, 116, and show a similar trend in

Table 1. Comparison of experimental Q_α-values with the results of various model calculations.

Z	N	A	Decay mode	Q_(exp) MeV	T_(exp) ms	Q_ [a] MeV	Q_(th) MeV MM [5]	HFB [6]	RMF [7]
118	176	294	α	11.81 ± 0.06	$1.8^{+8.4}_{-0.8}$	11.8	12.11	11.3	11.03
116	174	290	α	10.86 ± 0.17	29^{+140}_{-33}	10.8	11.08	10.1	11.59
114	172	296	SF	≤ 10.4[b]	≥100[b]	10.4	10.86	9.8	10.01

a) Q_ value is calculated by extrapolating the neighboring even-even isotopes.

b) For the 95% confidence interval

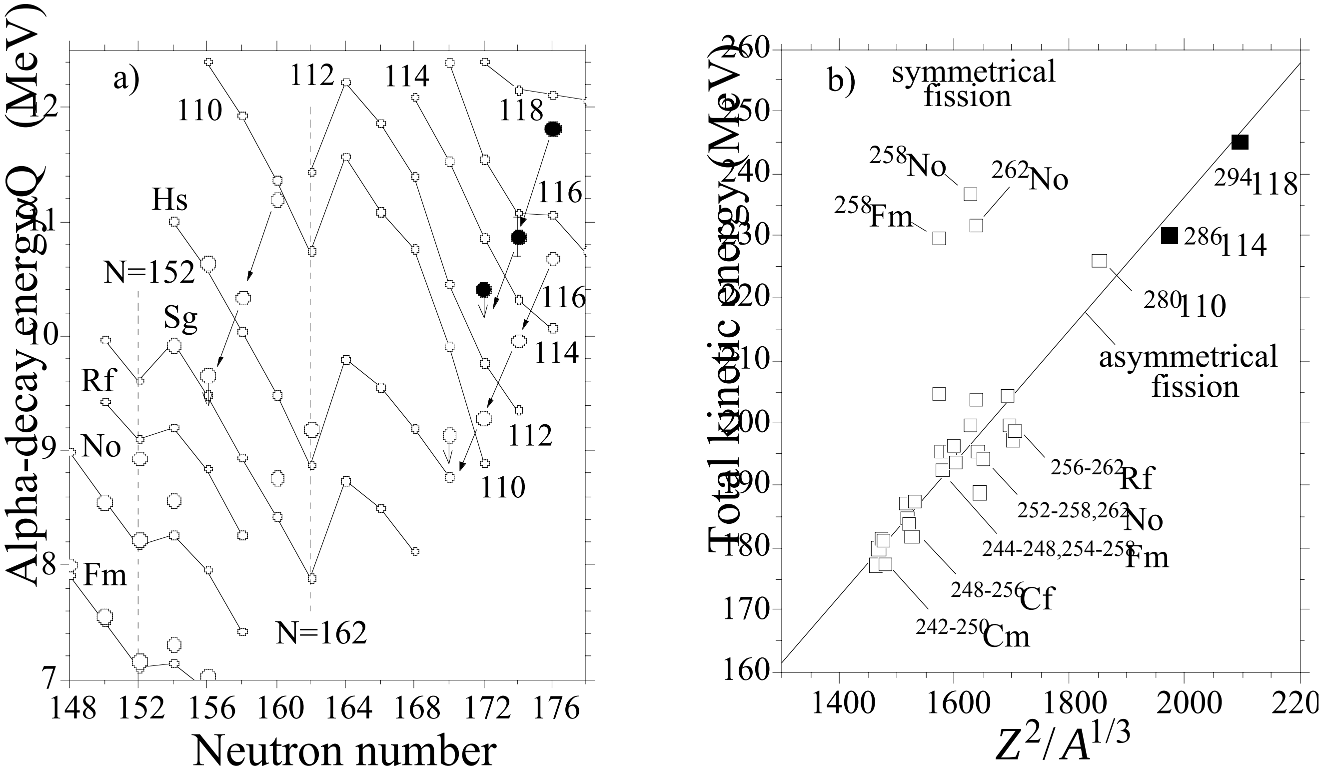

Fig. 7. Systematics of Q_α and $\overline{TKE}$ for even-even nuclei with $Z \geq 100$ and $Z \geq 96$, respectively. a) Solid lines –values of Q_α(th) calculated in macroscopic-microscopic model [5], circles - experimental data Q_α(exp) [1,2,13-17]. Solid dots - data of the present work. Arrows show correlated decays. b) Open squares - experimental values of $\overline{TKE}$ vs. parameter $Z^2/A^{1/3}$ (see Ref. [19] and references therein). Solid squares – experimental data from the present work, assuming the assignment of the two fission events as described in the text. The solid line is the linear fit [20].

deviating from Q_α(th) toward lower values. Note also that the spontaneous-fission decay lifetime of the final nuclide in the detected chain agrees with the calculated value of T_{SF}=1.5 s for ^{286}114 [18].

For the second event sequence (EVR-SF) the probability of missing two α-particles in a 3-ms time interval is less than 2%. This decay does not reproduce the first one and should be considered separately. It is noteworthy that the decay time t_{SF}=3.16 ms is quite close to the first α-decay time (t=2.55 ms) in the previous chain. One can suppose that the observed SF with E_{tot}=223 MeV (TKE~245 MeV) is related to the SF decay branch of ^{294}118 itself.

Fig.7b shows the values of $\overline{TKE}$ vs. the parameter $Z^2/A^{1/3}$ for all the known spontaneously fissioning nuclei with $Z \geq 96$. This includes the most recent results on ^{280}110 [1,2] and the data of the present experiment for ^{286}114 taken from the first decay chain and ^{294}118 from the second. One can see that the increase in $\overline{TKE}$ released in SF agrees well with the trend observed in the asymmetric fission of the heaviest nuclides. It also matches expectations based on observations of the prompt fission of the excited superheavy compound nuclei [21].

However, the very fact of observing SF in transition from a nuclide with Z=116 (N=176) to a heavier one with Z=118 (N=176) may point to the close approach to the border of stability of superheavy nuclei on the high-Z side. Although calculations of SF life-times of spherical superheavy nuclei have an uncertainty of several orders of magnitude, this result disagrees with calculations [5] that predict a sharp decrease of T_{SF} with increasing Z at N=176 for the nuclei with Z=120 (T_{SF}~70 ms) but not for Z=118 (T_{SF}~10^3 s). Because the SF probability of a nuclide that has 4 protons more and 8 neutrons less than Z=114 and N=184 differs by more than five orders of magnitude, the extent of the region of stability of the superheavy elements must be limited. More definite conclusions concerning limits of stability of superheavy nuclei against spontaneous fission require further investigation.

Further experiments aimed at the production of Z=118 nuclei and the study of their decay properties in the reaction ^{249}Cf+^{48}Ca will be performed in the near future.

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