New isotopes ^{233}Cm and ^{234}Cm

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In a study of neutron deficient isotopes of curium we were aiming to produce isotopes beyond the known ^{238}Cm [1] and to investigate the decay of their daughter products. The experiment was performed at SHIP in April and August 2001. Two new curium isotopes, ^{233}Cm and ^{234}Cm were produced using the reaction ^{198}Pt (^{40}Ar,xn) $^{238-x}$Cm, x = 4,5 at average beam currents of 1 pμA. An isotopically enriched (95.7 %) self-supporting ^{198}Pt target, (1.36 - 1.42) mg/cm^2 thick, was mounted on a rotating target wheel.

Both isotopes were identified using the method of α - α - correlation. The result of the measurement using a time window of 1500 s and a position window of 1 mm is shown in Fig. 1. To minimize the number of accidental coincidences one of the α events had to occur in the pause between the beam pulses. A previously unknown α-activity with an energy of (7239 ± 10) keV was detected as mother activity of an α - decay chain characterized by the sequence $E_{\alpha1}$(7239 keV) → $E_{\alpha2}$(7057 keV) → $E_{\alpha3}$(7560 keV) → $E_{\alpha4}$ (7979 keV) → $E_{\alpha5}$(17470 keV). $E_{\alpha1}$ is attributed to ^{234}Cm, since $E_{\alpha2}$, $E_{\alpha3}$, $E_{\alpha4}$ are in perfect agreement with the α particle energies of ^{230}Pu, ^{226}U and ^{222}Th reported in literature [1,2] and $E_{\alpha4}$ corresponds to the sum of the α energies of ^{218}Ra and the fast decaying ^{214}Rn.

A total amount of 175 chains of this type were observed. In addition 26 spontaneous fission events were recorded and tentatively attributed to ^{234}Cm resulting in a α/fission ratio of 0.94 ± 0.09. A half-life of $T_{1/2}$ = (51 ± 12) s was measured for ^{234}Cm which is in good agreement with predictions. Calculated values of EC decay half-lives (240 s [3] and 138 s [4]) suggest an EC branch of about 50 %. Taking into account the measured α to fission ratio a spontaneous fission half-life of about 1500 s is determined for ^{234}Cm.

Five different beam energies of E_{lab} = 184, 192, 196, 200 and 208 MeV were used to measure the excitation function of the 4n-reaction channel. A maximum value of (1.3 ± 0.1) nb was measured for the yield of α particles from the ^{234}Cm decay at an excitation energy 45 MeV in the centre of the target.

Twelve α-decay chains measured at E_{lab} = 208 MeV were attributed to the decay of ^{233}Cm. An alpha energy of E_α = (7340 ± 10) keV was measured. The half-life could not be determined using the correlation method because of the high background rate in the energy region, where the recoils were expected.

New and improved data for the decay of ^{229}Pu and ^{230}Pu were obtained. Half-life values of (102 ± 10) s for ^{230}Pu and (90^{+71}_{-27}) s for ^{239}Pu were determined.

The measured decay properties are summarized in Tab. 1.

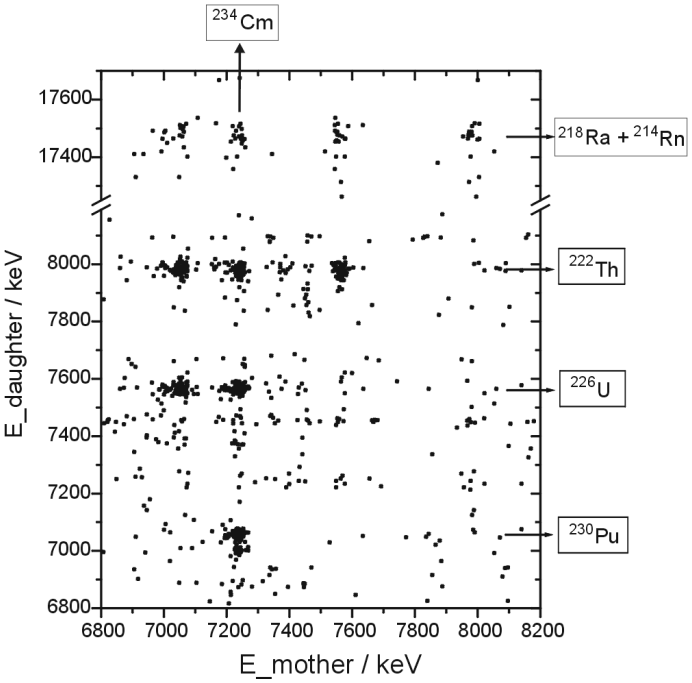

Fig. 1: α - α correlation plot for the decays of ^{234}Cm → ^{230}Pu → ^{226}U → ^{222}Th → (^{218}Ra + ^{214}Rn) (see text for details)

Isotope	E_α [keV]	i_α	$T_{1/2}$ [s]
^{234}Cm	7239 ± 10		51 ± 12
^{233}Cm	7340 ± 10		
^{230}Pu	7057 ± 10	0.81 ± 0.04	102 ± 10
	6999 ± 15	0.19 ± 0.04	
^{229}Pu	7465 ± 10		90^{+71}_{-27}
^{226}U	7560 ±10	0.86 ± 0.03	0.258 ± 0.013
	7384 ± 20	0.14 ± 0.03	

Table 1: Summary of measured decay properties.

References

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