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THE NEW NUCLIDE ^{230}Pu

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Experiment

The experiments were performed with a ^{26}Mg beam from the U-400 cyclotron of the Laboratory of Nuclear Reactions, JINR, Dubna. The beam energy was 135 MeV on the target and the average beam intensity was about 1.5* 10^{11} particles per second. An isotopically enriched (95 %) ^{208}Pb target (0.7±0.1) mg/cm^2 thick evaporated onto a 1.6 mg/cm^2 aluminium backing was mounted on a rotating target wheel. The evaporation residues recoiling from the target were separated in-flight from projectiles and from the products of different transfer reactions by the kinematic separator VASSILISSA [1]. After passing two large-area time-of-flight detectors and a thin mylar absorber of 150-200 μg/cm^2 they were implanted into an array of seven independent surface-barrier detectors where their subsequent α-decays were measured. The total active area of the detector array was equal to 35 cm^2.

The efficiency of our setup for evaporation residues from the (xn)-channel reaction is equal to (1.8±0.2)%, while for those from the (α,xn)-channel it is reduced by a factor of about 6-10 [2]. The energy resolution of the detector array cooled to 265^{o}K is 35 keV FWHM for α-particles in the energy region of 6-9 MeV. The calibration error is estimated to be ±15 keV in that region , and ±50 keV in the region between 17 and 18 MeV, corresponding to pile-up pulses. Double events with time spacing in excess of 5 μs were fully resolved by an electronic setup and those coming at time intervals shorter than 1 μs were fully summarized.

Results

The isotope identification was performed using the method of α-α correlation analysis. The α-decay at the alpha mother energy $E_\alpha(M)=(7570\pm15)$ keV was found to be correlated with α-decays of $E_\alpha(D1)=(7980\pm15)$ keV, $T_{1/2}=(2.6\pm0.6)$ ms, which fit to the known decay properties of ^{222}Th. Thus the isotope ^{226}U is identified to be the source of this correlation. Also, the identification of this isotope was supported by α-α correlation at the alpha-mother energy $E_\alpha(M)=(7570\pm15)$ keV with alpha daughter energies $E_\alpha(D)=17400\pm50$ keV resulting from complete pile-up of signals of α-decay chains ^{226}U-(^{218}Ra-^{214}Rn) ($E_\alpha(D2)=8390$ keV, $T_{1/2}(D2)=14$ μs; $E_\alpha(D3)=9040$ keV, $T_{1/2}(D3)=0.27$ μs;). The measured decay energy for ^{226}U is perfectly in line with our published one [2].

The α_m-α_d correlation plot for the alpha mother energy E(M)=6.7-7.3 MeV and alpha-daughter energy E(D)=7.0-18.0 MeV for a time window of 100-400 ms is shown in fig.1.

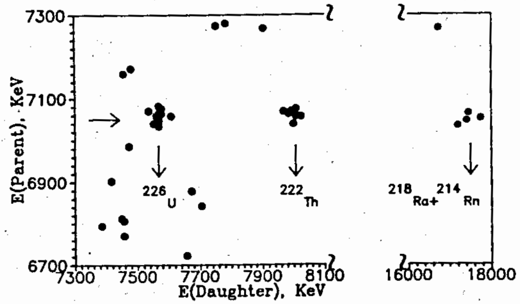

Fig.1

The new isotope ^{230}Pu was identified according to the α-α correlation to decays of its daughter nuclei ^{226}U, ^{222}Th and (^{218}Ra+^{214}Rn), see fig.1:

$E_\alpha(P)=7050\pm15$ keV - $E_\alpha(D1)=7570\pm15$ keV : ^{230}Pu-^{226}U - 13 events;

$E_\alpha(P)=7050\pm15$ keV - $E_\alpha(D2)=7980\pm15$ keV : ^{230}Pu-^{222}Th - 7 events;

$E_\alpha(P)=7050\pm15$ keV - $E_\alpha(D3+D4)=17400\pm40$ keV : ^{230}Pu-(^{218}Ra+^{214}Rn) - 4 events;

The half-life measured for all these correlations, $T_{1/2}=200\pm50$ ms is in agreement with the half-life for ^{226}U [2]. The measured value $Q_\alpha=7170\pm15$ keV for ^{230}Pu is well compatible with the calculated one [3]. According to the latter paper, for ^{230}Pu with such α-decay energy the half-life value is expected to be $T_{1/2}\simeq200$ sec. Because this value is much longer than the average time interval between recoil events in detectors we could not measure the half-life for ^{230}Pu.

Assuming the α-branch to be about 100%, which is in agreement with calculations [3], the production cross-section for ^{230}Pu was determined to be $\sigma=100$ nb at a beam energy of E(^{26}Mg)=135±1 MeV on the target.

References

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Андреев А.Н. и др. E7-90-348
Новый изотоп ^{230}Pu

В продуктах реакции полного слияния $^{208}Pb + {}^{26}Mg$ при энергии бомбардирующих ионов 135 МэВ идентифицирован новый нуклид ^{230}Pu. Измерена энергия его α-распада: $E_\alpha = 7050 \pm 15$ кэВ. Уточнен период полураспада для изотопа ^{226}U: $T_{1/2} = 200 \pm 50$ мсек. Эксперименты выполнены с использованием кинематического сепаратора ВАСИЛИСА.

Работа выполнена в Лаборатории ядерных реакций ОИЯИ.

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The New Nuclide ^{230}Pu

In the heavy-ion complete fusion reaction $^{208}Pb + {}^{26}Mg$ at a beam energy of 135 MeV the new nuclide ^{230}Pu was produced. The measured α-decay energy was found to be $E_\alpha = 7050 \pm 15$ keV. The new isotope was identified after in-flight separation with the kinematic separator VASSILISSA, followed by its implantation into a silicon surface-barrier detector and the observation of the genetic relationships of subsequent α-decays. The half-life of ^{226}U was measured more accurately.

The investigation has been performed at the Laboratory of Nuclear Reactions, JINR.

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