The New Isotope $^{270}110$ and its Decay Products ^{266}Hs and ^{262}Sg

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Synthesis and investigation of heavy even-even nuclei provide especially clear data for comparison with theoretical predictions. The absence of unpaired nucleons results in unhindered α decay or spontaneous fission. Also the low-energy level scheme is expected to be relatively simple. However, the synthesis of even-even nuclei is more difficult by the fact, that in fusion reactions with ^{208}Pb and neutron rich projectiles 2 neutrons must be evaporated, or the target must be replaced by ^{207}Pb. In both cases the measured cross-sections for the synthesis of nuclei beyond rutherfordium revealed a stronger decrease than in 1n reactions using ^{208}Pb targets. Consequently, only few even-even nuclei are known beyond rutherfordium with ^{264}Hs being so far the heaviest one produced in reactions with ^{207}Pb targets [1]. Evidence of heavier even-even nuclei ($^{262}116$) was obtained from recent work in Dubna [2]. In this work we present results obtained in an experiment at the GSI SHIP aiming at the synthesis of the even-even nucleus $^{270}110$ using the reaction ^{64}Ni + ^{207}Pb. A more detailed discussion of the results will be published in [3].

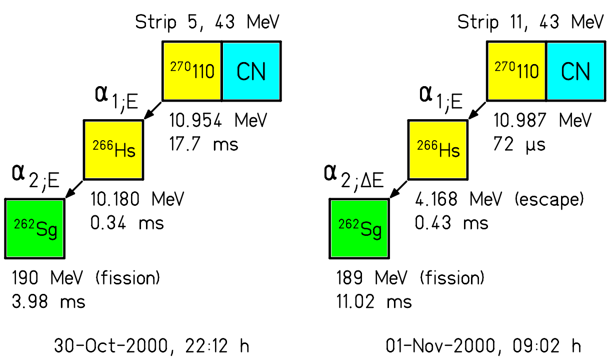

Figure 1: Two representative decay chains observed in irradiation of a ^{207}Pb target with ^{64}Ni projectiles. The chain on the left side starts with a relatively long lived α decay of $^{270}110$ which is attributed to a high spin K isomer. The chain on the right side represents the decay of the short lived ground-state.

A total of eight α-decay chains was measured during an irradiation time of seven days. Two representative chains are plotted in Fig. 1. The ground-state of $^{270}110$ decays by α emission with an energy of 11.03 MeV and a half-life of 100 μs. In addition we measured an isomeric level in $^{270}110$ which decays with a half-life of 6.0 ms. Alpha rays with energies of 10.95, 11.15, and 12.15 MeV were attributed to the decay of the isomer. A tentative assignment of the 12.15-MeV α particle to a transition into the ground-state of ^{266}Hs results in an energy of the isomer at 1.13 MeV. The spin of the isomer was estimated from retardation of the α-decay probability to be approximately (10 $\pm$ 2) $\hbar$. A γ/IC branching of $\approx$30 % to the ground-state seems possible, but could not be definitely established.

The decay properties of the ground-state of $^{270}110$ are in agreement with predictions of the macroscopic-microscopic model and with self-consistent Hartree-Fock-Bogoliubov calculations with Skyrme-Sly4 interaction. The HFB calculations resulted also in two quasiparticle excited levels, one of them could be the origin of the isomeric state. Their configuration and energy is $\{\nu[613]_{7/2^+}\ \nu[725]_{11/2^-}\}_{9^-}$ at 1.31 MeV and $\{\nu[615]_{9/2^+}\ \nu[725]_{11/2^-}\}_{10^-}$ at 1.34 MeV.

The new nuclei ^{266}Hs and ^{262}Sg were identified as members of the α-decay chain. The nucleus ^{266}Hs decays by α emission with an energy of 10.18 MeV and a half-life of 2.3 ms. However, it is also possible as indicated by the decay data, that the α decay has two components with half-lives of 0.35 and 6.3 ms. In that case an isomeric level would exist also in ^{266}Hs which could originate from states analogue as in the case of $^{270}110$. Their energies in ^{266}Hs are predicted to be at 0.90 and 0.94 MeV using HFB calculations. For both nuclei fission was not observed. Using calculated fission half-lives, we estimated fission branchings of 0.2 and 1.4 % for the nuclei $^{270}110$ and ^{266}Hs, respectively.

The nucleus ^{262}Sg decays by fission with a half-life of 6.9 ms and a total kinetic energy of the fission fragments of 222 MeV. Alpha decay was not measured, an upper limit for the α branching is 22 %. This value is in agreement with an estimate of 15 % α-branching, using a half-life deduced from a calculated value for the α energy of ^{262}Sg.

The measured cross-section of 13 pb was unexpectedly high. It is shared equally between ground-state and isomeric state.

Future experiments at longer irradiation time and higher beam dose will certainly provide a more detailed decay scheme and low-energy level scheme of $^{270}110$ and its daughter nuclei. Coincidence experiments using large Ge detectors are promising to search for transitions within the rotational band in ^{266}Hs after α decay of $^{270m}110$. The low-energy rotational levels can be studied via fine structure of the α decay. The measurement of the excitation function will provide data on the population of ground-state and isomeric state. The daughter nucleus ^{266}Hs could possibly be studied directly using the radiative capture reaction of ^{58}Fe and ^{208}Pb. An important next step using ^{207}Pb target is the investigation of $^{276}112$. The result will demonstrate if the synthesis of even-even nuclei in cold fusion reactions could be applied also for still heavier systems.

References

[1] G. Münzenberg et al., Z. Phys. A **328** (1987) 49
[2] Yu.Ts. Oganessian et al., PR C63 (2000) 011301
[3] Hofmann, S. et al., EPJ A, to be published (2001)