IDENTIFICATION OF EXCITED STATES IN ^{226}U * **

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Two experiments have been performed at the Accelerator Laboratory of the Department of Physics, University of Jyväskylä, Finland, and are reported here. The first experiment was a recoil-decay tagging study intended to delineate the level scheme of ^{226}U for the first time. The subsequent experiment, the observation of fine structure in the α decay of ^{230}Pu, was to obtain an improved measurement of the excitation energy of the first excited 2^+ state, which was tentatively assigned in the first experiment.

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1. Introduction

It is now well established that actinide nuclei with $Z = 88$–92 and $N \simeq 134$ exhibit properties that can be associated with octupole correlation effects. These nuclei are difficult to populate via compound nucleus reactions, due to strong fission competition and a lack of suitable beam and target combinations. Recently, multinucleon transfer reactions have been employed in order to study the high- spin behaviour of isotopes of Rn and Ra [1]. These studies, along with previous measurements of isotopes of Th [2], show that only five nuclei in this region (^{222,224,226}Ra and ^{224,226}Th) exhibit rotational alignment properties expected for octupole deformation. Calculations predict that ^{224,226}U should possess deep minima in the potential energy surface for non-zero β_3, with gains in potential energy over that for a reflection-symmetric shape similar to the isotopes of Ra and Th listed above [3]. The maximum cross-section for production of ^{226}U using the reaction ^{208}Pb(^{22}Ne,4n)^{226}U is approximately 6 μb. It is therefore necessary to employ some form of channel selection to extract the γ rays of interest from the large fission background.

2. Recoil-decay tagging study of ^{226}U

The recoil-decay tagging (RDT) [4,5] experiment utilised the RITU gas-filled recoil separator [6] in conjuction with the JUROSPHERE array of Ge detectors. A complete description of the experiment and relevant references can be found in Ref. [7]; a brief outline of the main results will be presented here.

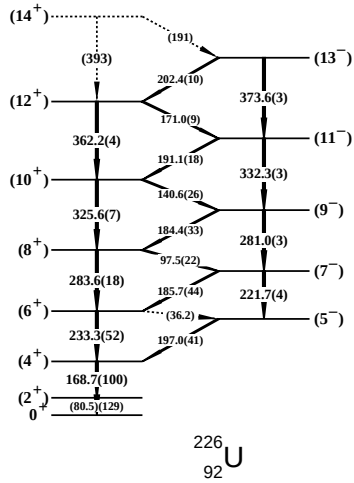

Fig. 1. Partial level scheme of ^{226}U. The figures in brackets are total transition intensities normalised to that of the 4^+ to 2^+ transition.

The level scheme deduced from this work is shown in figure 1. Two interleaved bands of opposite parity can be seen, connected by strong electric dipole transitions. Such structure is characteristic of a nucleus with strong octupole correlations. The weighted mean value of the ratio of the intrinsic dipole to quadrupole moment, $|D_0/Q_0|$, measured from $E1/E2$ branching ratios was $7.9(5) \times 10^{-4}$ fm^{-1}. The difference in aligned angular momentum, Δi_x, between the negative- and postive-parity bands is shown in figure 2. The behaviour of Δi_x follows closely that of ^{224}Th and ^{222}Ra. This is consistent with the behaviour expected for a rotating reflection-asymmetric shape. The contrasting behaviour of ^{220}Rn is due to the rapid alignment of an octupole phonon with the rotation axis. See Refs [1,8] for further details of these effects.

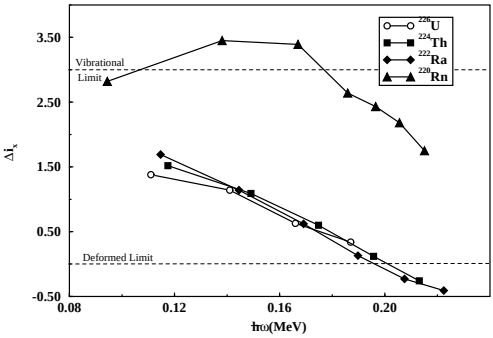

Fig. 2. Plot of the difference in aligned angular momentum between the positive- and negative-parity bands as a function of rotational frequency. Data for ^{224}Th and ^{222}Ra,^{220}Rn are taken from Refs [2,1] respectively.

3. Fine structure in the α decay of ^{230}Pu

The subsequent experiment employed the ^{208}Pb(^{26}Mg,4n)^{230}Pu reaction. Fusion- evaporation products were magnetically separated from fission products and primary beam using the RITU device, and implanted into a silicon-strip detector placed at the focal plane. The technique of delayed coincidences [9] was used to extract the α-decays corresponding to ^{230}Pu.

The spectrum of events correlated to α decay of either ^{226}U (7.565 MeV) or ^{222}Th (7.982 MeV), within a maximum time interval of 900 ms is shown in figure 3. Two groups of events can be seen, the lower energy group corresponds to the α decay of ^{230}Pu into the first excited 2^+ state of ^{226}U. Since the transition energy is expected to be around 80 keV, the effect of internal conversion electrons summing with the energy deposited by the emitted α particles must be taken into account, since this will shift the

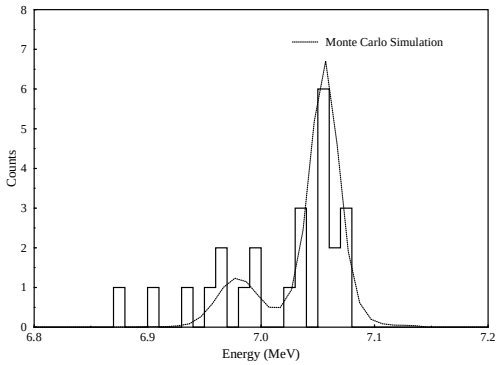

Fig. 3. Events correlated to the α decay of either ^{226}U or ^{222}Th, within a maximum time interval of 900 ms. The dotted line is a Monte Carlo simulation.

observed centroid of the fine structure peak to higher energy. This is done by use of a Monte Carlo simulation. The energy of a particular event is calculated using the following input parameters: the ground state to ground state α-decay energy, the excitation energy of the excited state, the relative branching ratios, the detector resolution, the implantation depth and the relevant internal conversion coefficients and electron binding energies. In this case, the excitation energy of the excited state is not known, thus the transition energy is varied. The centroid separation of the two peaks is then measured as a function of transition energy. This allows a determination of the transition energy through comparison with the experimental data. Through this analysis, the energy of the 2^+ to 0^+ transition in ^{226}U was found to be 96(25) keV. Further analysis and a more detailed description of the experiment can be found in Ref. [10].

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