FORMATION OF NUCLEI ISOMERIC STATES IN THE PHOTOFISSION REACTION

Yu.Pylypchenko, Z.Bigan, I.Kobal

Institute of Electron Physics, Ukrainian National Academy of Sciences,
Universytetska St. 21, Uzhhorod, 88016, Ukraine

Independent isomeric yield ratios of ^{131}Te, ^{133}Te and ^{135}Xe have been determined in the 16.5 MeV gamma induced fission of ^{238}U and ^{232}Th using gamma spectrometric techniques. To obtain the independent isomeric yield ratios of these isotopes the precursor yield correction was performed. The obtained data and the reference data for the same fragments show the following important features: the value of the independent isomeric yield ratios depends on nuclear structure effect such as shell closure proximity as well as on the entrance channel parameters

Introduction

The angular momentum of fission fragments is an important quantity for understanding fission mechanism because it provides an information about the shape of the fissioning nucleus at the scission configuration and the situation at the moment of the fragment separation. Experimental investigation of fragment angular momentum in low energy gamma induced fission also provides information about the role of the entrance channel parameters, e.g. excitation energy and input angular momentum. Studies of fragment angular momentum in low energy gamma induced fission of actinides provide information about the effect of the nuclear structure (e.g. the effect of shell closure proximity and the odd-even effect). The angular momentum of highly excited nuclei can be deduced from the isomeric yield ratio. Therefore, measurements of isomeric yield ratios are important for the determination of the fragment angular momentum.

In the present work, the independent isomeric yield ratios for ^{131}Te and ^{135}Xe have been determined in 16.5 MeV gamma induced fission of ^{238}U and ^{232}Th using gamma spectrometric technique. The independent isomeric yield ratio was defined as the ratio of the independent yield of high spin isomer to that of the ground state of the element. These data, along with the data for the same fission products in alpha, deutron, neutron and gamma induced fission of ^{238}U and ^{232}Th were analysed to examine the role of excitation energy as well as input angular momentum. The effect of the nuclear structure have also been discussed.

Experimental and results

The experiment was carried out at the variable energy Microtron M-30 with the maximal bremsstrahlung energy of 30 MeV in Uzhhorod. Stacks of natural uranium and natural thorium target plates and aluminium catcher foil were irradiated using an 16.5 MeV bremsstrahlung beam. After the irradiation, the aluminium catcher foils were extracted from the target and the measurement of gamma spectra from aluminium foils was started after small time. This allowed to take into account the precursor contribution.

The spectrum measurements had been carried out by Ge(Li) detector coupled to the analyser NTA in live time mode. The resolution of the detector system was 2.0 keV at the 1274.0 keV and the dead time during the counting was always less than 20% to avoid the pile-up effect. Counting was carried out over a different times to confirm the purity of the individual photopeak of the concerned radionuclide.

The isobaric decay chains are as follows:

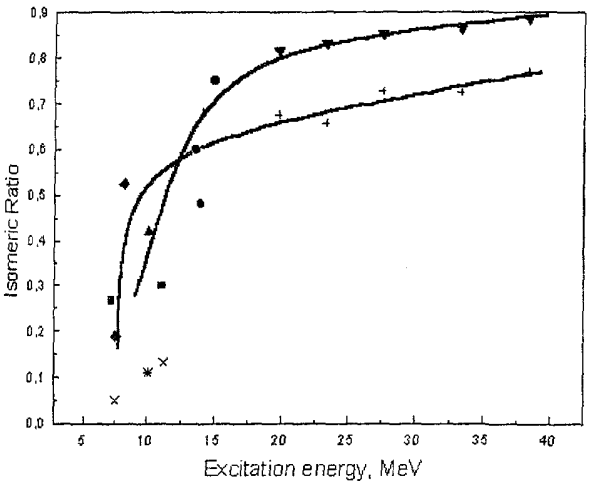

Fig. 1. The plot of the isomeric ratio of various fission products as a function of excitation

Isomeric ratio are depended on excitation energy. On the other hand, the excitation energy affects the excitation of fragments with the high spin in the exit channel. Among the tabulated isomeric yield ratios, the isomeric ratios of ^{133}Te are smaller than ^{131}Te. This is probably because of the shell effect. For ^{133}Te, its primary fragment is expected to be a neutron shell nuclide ^{133}Sb (N=82).

It is also seen that the values obtained in low energy fission induced by gamma are sharply lower than the values obtained in medium energy fission induced by charge particle. This is probably because of the effect of the nuclear structure (shell closure proximity and the odd-even effect, which are more expected in low energy fission as compared to medium energy fission). The low isomeric ration obtained in low energy gamma induced fission also indicate the role of input angular momentum. Besides, the small independent isomeric yield ratio values of ^{135}Xe are probably because of the rapid exchange of nucleon configuration at the moment of separation.

Conclusions

The isomeric ratio increases with the increase of excitation energy and input angular momentum, indicating the effect of entrance channel parameters. The close proximity of even-Z fragments to 82n shell plays significant role in the forming isomeric state in low energy fission.

In order to clarify all the problems it is necessary to perform further experiments, such as energy dependence of isomeric ratio in low energy gamma induced fission.

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УТВОРЕННЯ ІЗОМЕРНИХ СТАНІВ ЯДЕР У РЕАКЦІЇ ФОТОПОДІЛУ

Ю.Пилипченко, З.Біган, І.Кобаль

Інститут електронної фізики НАН України,
вул. Університетська, 21, Ужгород 88016

Методами гамма-спектрометрії визначено незалежні ізомерні відношення виходу ^{131}Te, ^{133}Te і ^{135}Xe при 16.5 MeV гамма-індукованому поділі ^{238}U і ^{232}Th. Для отримання незалежних ізомерних відношень виходу цих ізотопів зроблено поправку на вихід попередників. Отримані результати та літературні дані для цих же уламків виявляють такі важливі особливості: значення незалежних ізомерних відношень виходу залежить від ядерно-структурних ефектів, зокрема, від близькості оболонок та від параметрів вхідного каналу.