Special issue of the International Conference on Computational and Experimental Science and Engineering (ICCESEN 2014)

Investigation of Production Reaction Cross Section for ^{137}Cs Used in Radiotherapy

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During the production of the radiation source that used in radiotherapy may occur nuclear reactions are very important in terms of human health. ^{137}Cs is used in radiotherapy that consists of fission the ^{235}U core. Because of physical half-live of ^{137}Cs is 30 years, it is advantage for the radioactive half-lives. In this study, radionuclide production reaction cross section for ^{235}U (n,f)^{137}Cs is calculated with TALYS 1.6 nuclear simulation code that based on Monte Carlo.

DOI: 10.12693/APhysPolA.128.B-363
PACS: 82.20.Pm, 52.59.–f

1. Introduction

Radiotherapy called as irradiation, is a mode of treatment that based on impact of cell with high energy particles such as X-rays, gamma rays, electrons or protons. In radiotherapy is given minimal damage to the healthy tissue around the tumor and radiation dose as necessary, is aimed to stop advanced division of cell or continuous reproductive of diseased cells in tumor.

Radiotherapy is divided into three groups according to the route of administration;

1. external beam therapy (treatment done from a distance). The distance between the source and the patient skin is 5–350 cm. X-rays, Co–60 γ-rays and shaped particles (usually electrons) radiation are used,

2. brachytherapy (treatments done at close range). The skin of the radioactive sources is done by placing the tissue between the body cavity. γ-rays that closed source and β particles are used,

3. internal treatment (liquid and colloidal radioisotopes are applied to the body). β particles and γ-rays, which use open sources.

() Sealed radioactive sources used in brachytherapy for interstitial treatment are Ra-226, Co-60, Cs-137, Ir-192, I-125, Ta-182, Au-198, Cf-252, Pd-103, Sm-145 radioisotopes. For placement in body cavity sources of Co-60, Cs-137 and Ir-192 long-lived radioisotopes are preferred. By superficial treatment Ra-226, Co-60, Cs-137, P-32 and Sr-90 radioisotopes are used. For this reason Cs-137 is very important radioisotope for very kind of radiotherapy.

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Photon radiation, early radiation therapy used X-rays like those used to take pictures of bones, or gamma rays. X- and γ-rays are high energy rays composed of massless particles of energy called photons. The distinction between the two is that γ-rays originate from the decay of radioactive substances (like radium and cobalt-60, cesium-137), while X-rays are generated by devices that excite electrons (such as cathode ray tubes and linear accelerators) [1].

Particle radiation, is radiation delivered by particles that have mass. Proton therapy has been used since the early 1990s. Proton rays consist of positively charged atomic particle, rather than photons, which have neither mass nor charge. Neutron therapy is another type of particle radiation. Neutron rays are very high-energy rays. They are composed of neutrons, which are particles with mass but no charge. The type of damage they cause to cells is much less likely to be repaired than that caused by X-rays, γ-rays, or proton rays [1].

Nuclear reactions may occur during the production of radiation sources used in this treatment that very important for human health. ^{137}Cs is used in radiotherapy that consists of fission the ^{235}U core. Physical half-live of ^{137}Cs equal to 30 y is advantage of this source.

In this study, ^{137}Cs radionuclide production reaction cross section for ^{235}U(n,f) is calculated with TALYS 1.6 [2] that is a nuclear simulation code based on Monte Carlo method. Information to be obtained are thought to benefit for research and observation on effect to human health.

2. Models and results

TALYS is a nuclear reaction simulation computer code system for the analysis and prediction of nuclear reactions. The basic objective behind its construction is the simulation of nuclear reactions that involve neutrons, photons, protons, deuterons, tritons, 3He-and alpha particles. TALYS integrates the optical model, direct, preequilibrium, fission and statistical nuclear reaction models in one calculation scheme and gives a prediction for all the open reaction channels. The calculated (n,f) reaction cross sections have been displayed in Fig. 1 for ^{235}U target. The results have been compared with earlier experimental works EXFOR [3] databases in literature.

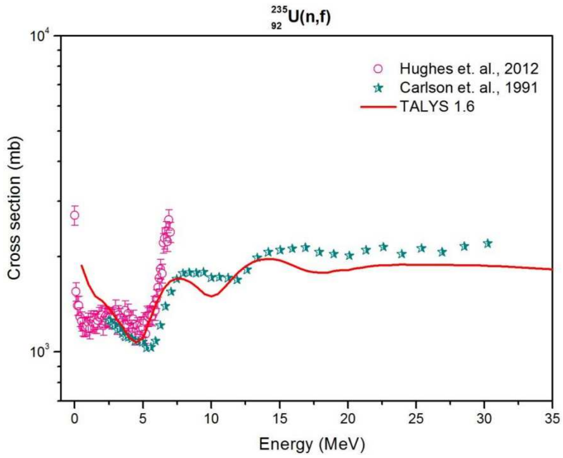

Fig. 1. The cross section for ^{235}U(n,f) reaction.

3. Conclusion

Radiation therapy is a form of cancer treatment that uses radiation to destroy malignant cells [4]. For this purpose, ^{137}Cs is used in radiotherapy because of physical half-live and it consists of fission the ^{235}U core. It can be seen from figure1 that the calculated ^{235}U(n,f) reaction cross section results are in good agreement with the experimental data. Especially calculated (n,f) reaction cross section is the best agreement with the experimental data for Carlson et. al. [5]. From these results, the obtained results of cross section Cs-137 radioisotope are important for radiation therapy that is administered to the patient. And it is also clear seen that the TALYS 1.6 nuclear reaction simulation code can be used safely if data is needed where there is no experimental data available.

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