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TRANSMISSION EFFICIENCY OF ISOTROPICALLY EMITTED NUCLEAR DECAY AND REACTION PRODUCTS FROM THE RADIOACTIVE SOURCE

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The successful study and detection of radioactive nuclei, produced in nuclear reactions or transformations inside the body of a target source, is not solely dependent upon their high rates of production, but also from the high efficiency of transmission of the produced recoils through the target's material. There exists an interest of correctly estimating the transmission efficiency of alpha-, beta-particles and fission products from a fissile target, produced by thermal neutron irradiation, for the purposes of nuclear spectroscopic studies of the exotic nuclei[1,2]. All of these cases will share the same mathematical derivation for the transmission efficiency formula as regardless of the means of production, nuclear transformation or thermal neutron fission reaction, the recoil products will have isotropic angular distribution from any center of production inside the radioactive source. By simply using software like the SRIM/TRIM program one can reconstruct the spatial distribution of thermalized ions in a given medium and estimate from it the transmission efficiency through the medium, generated only from a monoenergetic unidirectional beam of charged particles, which is emitted from a single point source[3,4].
In this work we will provide the derivation of the spatial distribution and transmission efficiency formulas in the more general case of monoenergetic isotropic beam of charged particles from a realistic (3D) source.
First of all in this work we present the mathematical derivation of the formula of spatial distribution of thermalized nuclear reaction products inside the target source material, emitted isotropically from a single radioactive point source, which represents the simplest case of a presence of a single radioactive atom inside the whole target material. Then the spatial distribution from a single radioactive point source is being generalized to a more realistic case of spatial distribution from a three dimensional radioactive target source, which represents the case of a realistic radioactive target, in which every atom is a potential radioactive point source. From this result then the transmission efficiency of nuclear reaction products emitted isotropically from a realistic three dimensional radioactive source is being calculated and compared in the general cases of rectangular, cylindrical and spherical target source geometry.
The results obtained will be useful in planning projects with the study of exotic nuclides, for example, the PITRAP project at the "Kurchatov Institute".

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Primary author: SIMONOVSKI, Dimitar (Saint Petersburg State University)

Co-author: NOVIKOV, Yury (Petersburg Nuclear Physics Institute of 'Kurchatov Research Center')

Presenter: SIMONOVSKI, Dimitar (Saint Petersburg State University)

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