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Full-energy peak efficiency of asymmetrical polyhedron germanium detector

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Abstract:

To understand the nuclear structure for most elements, it is essential to investigate the nuclear excitations by using high precision gamma-ray spectroscopy in which intensive measurements should be carried out. This is becoming a new challenge for the radiation scientific community nowadays, where the instrumentations and technical advances must be developed to be used in a wide range of applications. To discover the weakest nuclear reaction, the maximum probability of the detection system of the total energy of any released individual photon must be determined. In this work, a new mathematical method to calculate the absolute full-energy peak efficiency of asymmetrical polyhedron germanium detector is presented. This type of detector can be arranged in array, forming “complex detectors of encapsulated germanium crystals”, with the solid angle reaching 82 % of total solid angle coverage, i. e., with the highest possible efficiency and with a good quality of spectral response. In addition, the photon path length was enclosed in the mathematical method to determine its attenuation through different materials such as, the detector active medium and any other material in-between source-detector system during the measuring process. The comparison between the efficiency calculated in this work and that of the published Monte Carlo simulation showed a good agreement and a small variation. However, the method discussed in the current work can be useful in nuclear safeguards, in overcoming the huge difficulties in identification of the energy range of radioactive isotopes and their quantities in nuclear waste.

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