International Nuclear Physics Conference INPC2013: 2-7 June 2013, Firenze, Italy

Agata modules as Compton polarimeters for the measurement of gamma-ray linear polarisation

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We have investigated the ability of AGATA modules to measure the linear polarisation of gamma rays, exploiting the dependence of the Compton scattering differential cross section on the azimuthal angle. To this aim, partially polarised gamma rays have been produced by Coulomb excitation of the first excited state of ^{104}Pd and ^{108}Pd which deexcite to the ground state by emission of gamma rays of 555.8 keV and 433.9 keV, respectively. The position of the Agata array was chosen to select gamma rays at angles not far from 90 degrees to the beam direction. The azimuthal distributions, with respect to the reaction plane, of the first Compton scattering for a properly selected sample of these gamma rays have been evaluated and compared with the corresponding distribution for the unpolarised 661 keV gammas from a ^{137}Cs source. The instrumental distortions in the measured distributions appear to cancel almost exactly in the ratio $R(\phi)$ of the COULEX data to those of the 661 kev gammas, and a clear signal of linear polarisation becomes apparent. A typical (symmetrised) angular distribution is shown in Fig.1. The amplitude a_2 of the $\cos(2\phi)$ modulation apparent in the figure has been compared to the theoretical linear polarisation of γ rays from Coulomb excitation (calculated with the help of the GOSIA code) to deduce the experimental analysing power, which turns out to be about 45% in both cases. A "theoretical" value of the average analysing power has been deduced from the values calculated, for each of the selected events, as a function of the Compton scattering angle, taking into account the experimental uncertainty on the coordinates of the interaction points. A satisfactory agreement between theoretical and experimental values has been found.

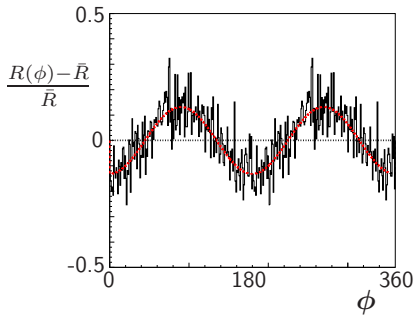

Figure 1: *Deviation of the ratio $R(\phi)$ from its average value $\bar{R}$ for the 555.8 keV γ ray from Coulomb excitation of ^{104}Pd, referred to the 661 keV γ rays. The continuous line is the result of the fit with a function $a_2 \cos(2\phi)$ to $[\, R(\phi) - \bar{R}\,]/\bar{R}$.*