Gamma - ray emission in yhe CF-252 spontaneous fission process

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Gamma Ray Emission in the ^{252}Cf Spontaneous Fission Process

In a recent Letter, van der Ploeg *et al.* [1] reported the observation of a large anisotropy of photons emitted in the spontaneous fission of ^{252}Cf. In the energy region between 8 and 12 MeV, gamma-ray emission parallel to the fission direction was found to be strongly enhanced. In the analysis of van der Ploeg *et al.* sum-up effects were neglected. However, sum up of gamma rays and neutrons from the same fission process may be very important, since neutrons are strongly boosted in the fission direction.

We have measured the angular distribution of gamma rays accompanying the spontaneous fission of ^{252}Cf with the setup shown in Fig. 1. Fission fragments were detected by means of five Al_2O_3 foils and microchannel plate (MCP) detectors. For the gamma rays we used six BaF_2 + BGO detectors. Neutrons with an energy below 25 MeV could be discriminated by their time of flight.

Because of the combined symmetry of the fission process and the measuring apparatus, the gamma-ray anisotropy could be determined,

$$\frac{W(0^\circ)}{W(90^\circ)} = \frac{\{N[(\gamma_1 \vee \gamma_2) \wedge (MCP_1 \vee MCP_2)] - N[(\gamma_1 \wedge \gamma_2 \wedge (MCP_1 \vee MCP_2)]\}N[(\gamma_3 \vee \gamma_4) \wedge MCP_3]}{\{N[(\gamma_3 \vee \gamma_4) \wedge (MCP_1 \vee MCP_2)] - N[(\gamma_3 \wedge \gamma_4 \wedge (MCP_1 \vee MCP_2)]\}N[(\gamma_1 \vee \gamma_2) \wedge MCP_3]}.$$

N [coincidence requirement] denotes the number of coincidences indicated. The second term within the curly brackets is a correction for sum-up effects. The $(\gamma_1 \wedge \gamma_2)$ in this term not only stands for a coincidence requirement but also for a software summation for each registered event of the energies in the two detectors. The anisotropy was determined for different energy intervals both with and without sum-up correction. The result is present in Fig. 2.

The importance of the sum-up correction is clearly demonstrated in our result. A large anisotropy, similar to that reported in Ref. [1], was found for the 8–12 MeV energy region when no sum-up correction was applied. However, after the proper correction no anisotropy remains for high-energy gamma rays.

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[1] H. van der Ploeg, R. Postma, J. C. Bacelar, T. van den Berg, V. E. Jacob, J. R. Jongman, and A. van der Woude, Phys. Rev. Lett. **68**, 3145 (1992); **69**, 1148(e) (1992).

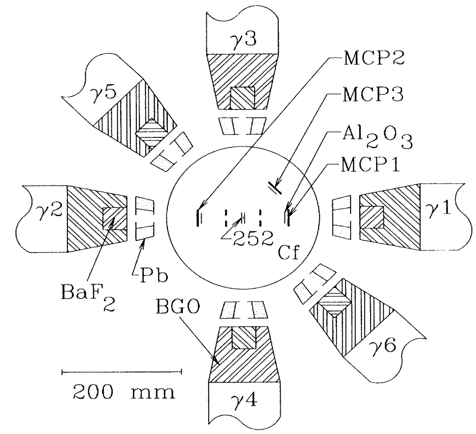

FIG. 1. Experimental setup. The ^{252}Cf source is sandwiched between Al_2O_3 foils providing the electrons for the start signal from the two ring shaped MCP's.

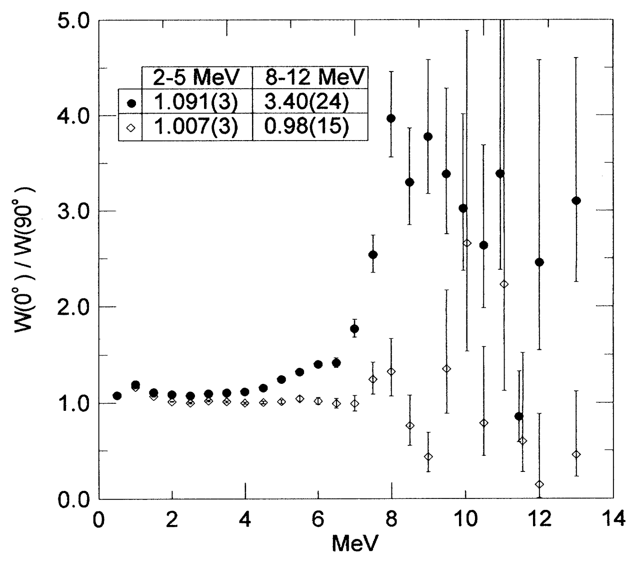

FIG. 2. Angular correlation ratios (cf. text) as a function of the energy deposited in the gamma-ray detectors. Filled circles and unfilled diamonds show the ratios without and with sum-up corrections, respectively. The inserted table gives the integrated ratios for two energy intervals.

