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HIGH RESOLUTION CORRELATION STUDIES OF CONTINUUM GAMMA RAYS OF ^{170}Hf

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We have performed a high resolution gamma-gamma energy correlation study using 18 anti-Compton shielded Ge detectors in the Spin Spectrometer along with 52 NaI elements. The fusion reaction ^{130}Te + ^{44}Ca was produced with a 200-MeV ^{44}Ca beam from the HHIRF tandem accelerator. A total of 5 x 10^8 two-and higher-fold Ge coincidence events, along with the associated information from the 52 NaI detectors of the Spin Spectrometer were recorded. The data were first corrected for the variation in gains of the detectors and then the total pulse height of the gamma ray (H) and the coincidence fold (k) for each event were calculated. From these data, we can extract the spin and excitation energy dependence of the correlation properties of the continuum gamma rays.

Coincidence spectra of Ge detectors were generated by gating on gamma rays in an energy range from 0.7 to 1.1 MeV in 3 keV steps and by using six different gates on H and k. To improve the statistics, several gated spectra were shifted to align the gating gamma ray and then these were added. Singles spectra, gated by (H,k), were also generated and they were shifted and added by using the same procedure. Figure 1 shows single and coincidence spectra gated by a 700 keV γ ray both with k > 16.

A comparison of the gated and singles spectra shows many interesting features. First of all, in the gated spectrum a dip is clearly seen centered at the energy of the gating gamma ray. Secondly, two well-defined peaks are observed at the edge of the dip. Finally, beyond the peaks, additional dips and peaks can be seen, but with much reduced intensity. The two strong peaks are separated by 0.12 MeV, and from this separation we can determine the value of the dynamic moment of inertia $\mathscr{I}^{(2)}/\hbar^2 = 67$ MeV^{-1}. The areas of the peaks and the dip per 60 keV region are shown in Table I. The widths of the peaks are also shown. The average width of the peak is about 15 keV which is considerably larger than the energy resolution of the detector (3 keV). The observed area of the dip is larger than the area of the peaks.

To understand the separation of the peaks and their width, we have carried out simulation calculations using the known rotational bands in nuclei around ^{170}Hf. The results are shown in Fig. 2. For the spectrum gated by 700 kev γ-ray, the simulation gives a peak separation of 114 keV and peak width of 19 keV. This indicates that the γ rays in the peak are most likely from bands with similar properties as near yrast bands in neighboring nuclei. Figure 3 shows the intensity of the components of the γ ray as a function of the γ ray energy. It shows at 1 MeV, the intensity of the correlated γ ray can only account for about 30% of the total.

Table I. Properties of peaks and valleys in the gated spectra from ^{130}Te + ^{44}Ca reaction

E_γ (keV)	$2 \times \Delta E_\gamma$ (keV)	Low Peak		High Peak		Valley
		area	width (keV)	area	width (keV)	area
700	118	0.74	11	0.65	14	0.89
800	119	0.57	20	0.16	8	0.60
900	112	0.22	17	0.20	12	0.43
1000	96	0.19	18	0.15	19	0.23

DISCLAIMER
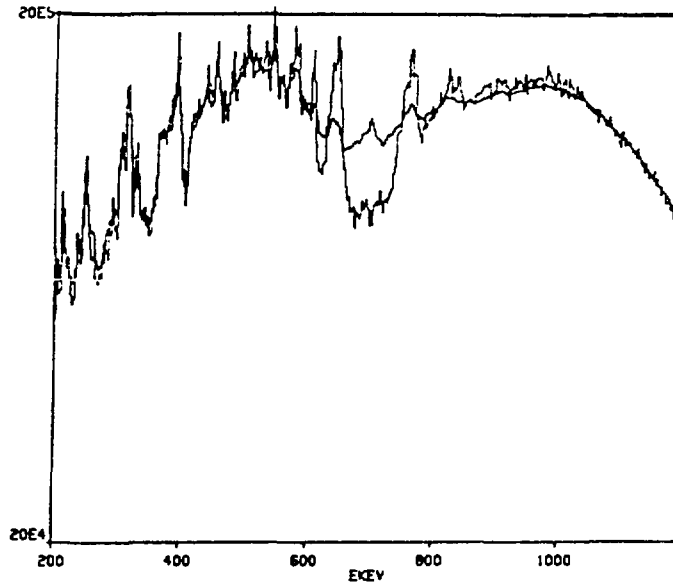
Figure 1 Singles and gated Ge spectra with entry-state selection K > 16.
The gating gamma ray has an energy of 0.7 MeV. The gated spectra show a
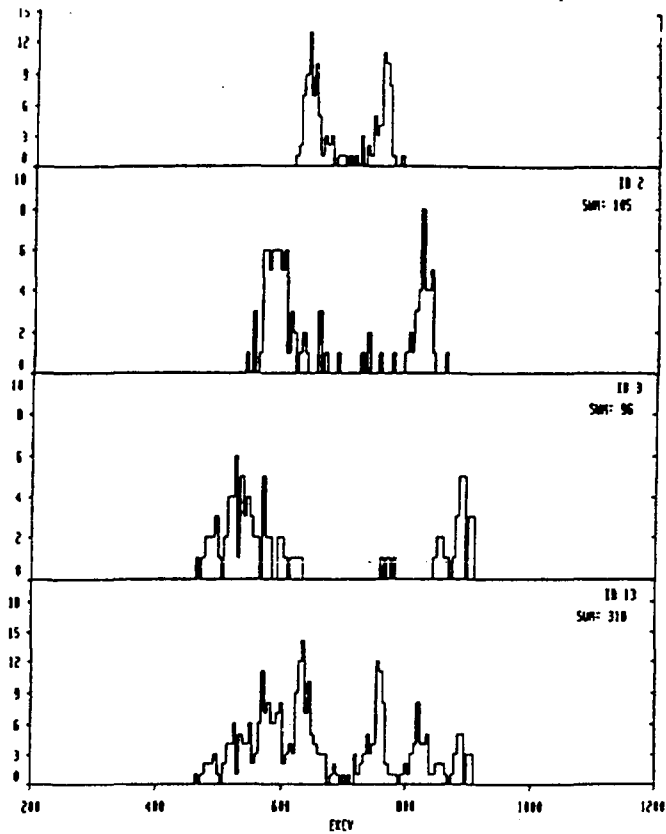dip centered at 0.7 MeV and peaks on both sides of this dip.

Figure 2 Results from a simulation calculation in which about 50 known bands
in 14 nuclei neighboring ^{170}Hf were used to generate the gated spectra.
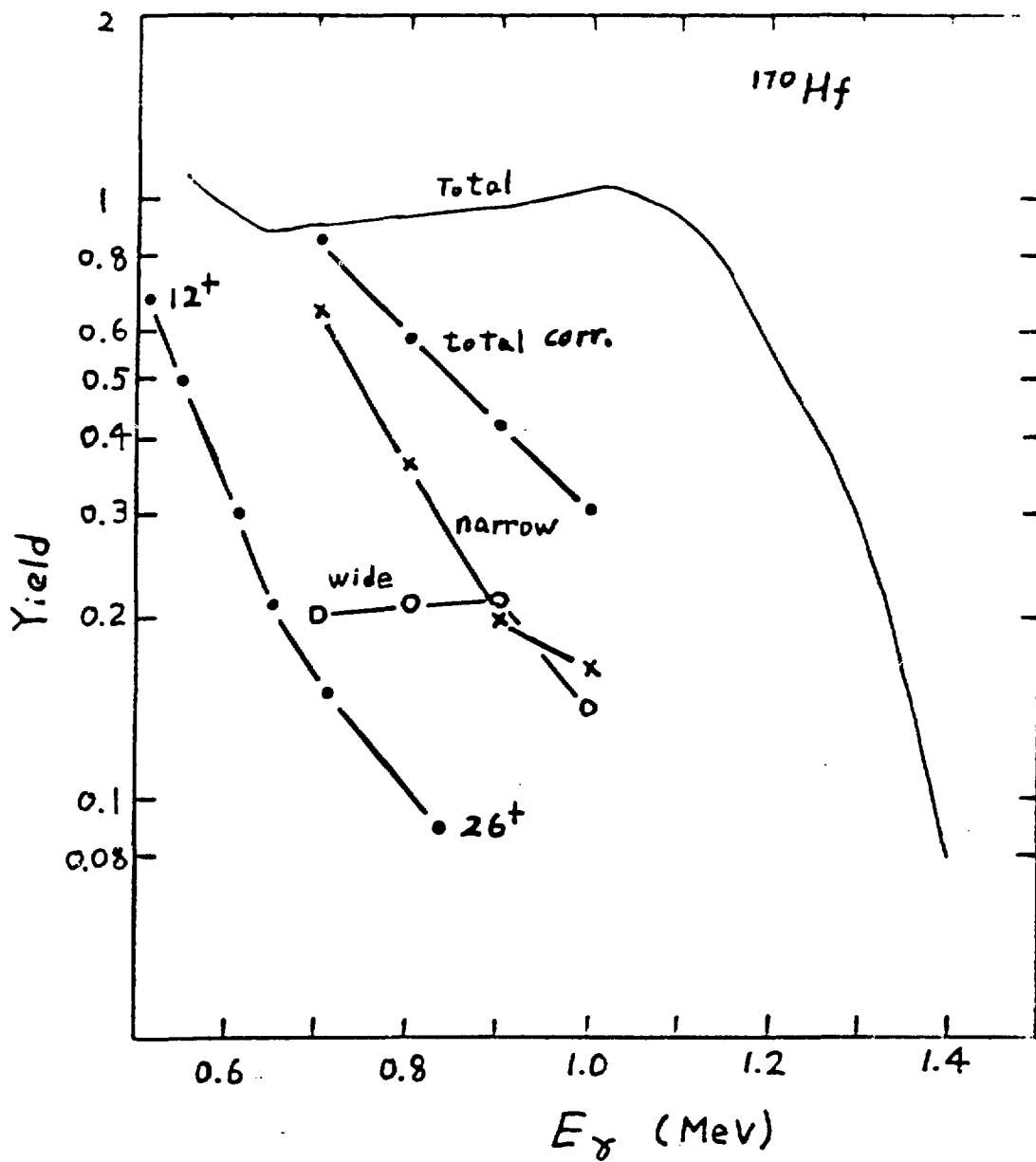The spectra of the first, second, and third ridges and their sum are shown.

Figure 3

The component of γ-rays of ^{170}Hf as determined from γ-γ energy correlation.