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ABSTRACT

Considerable amounts of tedious labor are required to manually scan high-resolution 1D slices of two dimensional $\gamma\gamma$ coincident matrices for relevant and exciting structures. This is particularly true when the interesting structures are of weak intensity. We are working on automated search methods for the detection of rotational band structures in the full 2D space using pattern recognition techniques. For nominal sized data sets (1024x1024), however, these techniques only become computationally feasible through the use of Fourier Transform methods. Furthermore the presentation of data matrices as images rather than series of 1D spectra has been shown to be useful. In this paper we will present the data manipulation techniques we have developed.

INTRODUCTION

By examining a two-dimensional data set as a multi-dimensional entity, features that are obscured by interfering lines in the one-dimensional gated slices can be characterized. Fast fourier transform methods allow the use of generalized correlation techniques to detect and characterize patterns in the full two-dimensional space.

We use these correlation techniques to search a $\gamma\gamma$ coincident matrix for a fixed pattern of gaussian peaks in two dimensions, which is representative of the decay of a high spin rotational band. These methods extend our detection capability to include groups of very low intensity peaks.

PATTERN LOCATION

The correlation technique provides only the probable location of the centroid of patterns matching a given mask pattern in our data set, but with the proper choice of mask pattern, additional visually useful clues can be extracted. If the mask is chosen to have about half the extent of the pattern in the data set, multiple centroids will be indicated. If, in addition, the mask is configured with a fixed spacing and an odd number of rows and columns, the centroid of the mask corresponds to a point that falls on the middle row and middle column of the mask pattern, thus the indicated centroids will lie on many of the corresponding peaks in the data set.

ROTATIONAL BANDS

The correlation mask is determined by the pattern that one is searching for, in this case the gamma energies characteristic of high spin rotational bands. These energies are given by:

$$E_{\gamma} = \frac{\hbar^2}{2J} (4I - 2) \quad (1)$$

Thus theory tells us that the band members are evenly spaced. Furthermore, in a γ - γ coincidence matrix the peaks will be found in a square matrix with the diagonal absent. Figure 1 shows a typical 5x5 correlation mask with a spacing of 40 keV, which is characteristic of the rotational structures of interest.

ANALYSIS METHOD

To perform this analysis we first compress the data matrix by a factor of four and apply an uncorrelated background removal.¹ A correlation mask is then built with the expected gamma-ray energy spacing. The cross correlation of the mask and the γ - γ coincidence matrix is calculated and the correlation spectrum is examined for peaks indicating a pattern match. The peaks thus detected

FIGURE 1: An example of a 5x5 correlation mask designed with a spacing of 40 keV.

are then characterized in the background subtracted data matrix.

To increase the sensitivity of the correlation process, additional transformation can be performed on the data matrix. The most common examples are upper limit thresholding to reduce the contribution of large ground state peaks to the correlation spectrum, and lower limit thresholding to eliminate artifacts resulting from the background removal process.

SUMMARY

Our preliminary results with this method indicate that the use of two-dimensional correlation techniques increases our ability to detect and characterize weak rotational band structures. We are continuing to develop this and other multi-dimensional analysis methods to characterize the shapes and the intensities of rotational band transitions.

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¹ O. Andersen et al., Phys. Rev. Let. 43 687 (1979)