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11000 BEOGRAD - Kneza Miloša 9/IV - Tel/faks 011-3233-957 - E-mail etran@EUnet.yu

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FUZZY MEDIAN FILTER ADAPTED FOR FITTING THE MEASURED SPECTRA IN SCATTERING EXPERIMENTS

Dragutin Šević, Institute of Physics, Belgrade
Radmila Panajotović[1], Institute of Physics, Belgrade,
Bratislav Marinković, Vladimir Pejčev, Institute of Physics, Belgrade

Abstract - In this paper we propose a new fitting technique based on fuzzy median filter to improve the quality of deconvolution of resonance profile from instrumental broadening. Fuzzy rules are adapted to purpose of elimination of errors caused by nonresonant contributions to the scattering amplitude.

1. INTRODUCTION

Various modifications of the basic median filter are proposed recently [1,2,3,4,5]. The fitting technique described here is based on fuzzy median filter, proposed in [6]. Operation of proposed median filter is controlled by fuzzy rules which are adapted to purpose of elimination of certain types of errors caused by background, and, at the same time, preserving the shape of the resonance profiles. Data are acquired using multi channel analyzer, so numerical data are stored in successive channels (there are 1024 of them). Amplitude of each channel corresponds to the intensity of the scattered beam.

Elastic cross section (CS) of electron - zinc scattering, in the observed energy range, is shown in Figure 1. The resolution of the electron spectrometer was about 60 meV. To simplify the processing, intensity is normalised to unit value.

2. FUZZY MEDIAN FILTER ADAPTED FOR FITTING THE MEASURED SPECTRA IN SCATTERING EXPERIMENTS

We consider the median value of some of the elements (possibly all), which satisfy certain condition, inside an eleven point window, centered at the (x)th channel. In order to remove errors caused by background, the median filter uses following fuzzy rules:

1) IF ABS$(L(x) - L(x+j)) < \alpha$,
$j \in (-5,-4,-3,-2,-1,0,1,2,3,4,5)$,
THEN $c = c + L(x+j)$, $d = d + 1$.

2) IF ABS$(L(x) - c/d) > \beta$,
THEN $L_s(x) = c/d$, ELSE $L_s(x) = L(x)$.

where:

$L(x)$ - Amplitude of the (x)th channel,
$L_s(x)$ - filter output for the (x)th channel,
α, β - parameters of the fuzzy median filter,
c - sum of the elements obeying the fuzzy rule 1),
d - counter.

For each calculation of $L_s(x)$, c and d are initialized as $L(x)$ and 0, respectively. First rule means that the median value of elements which are inside an eleven point window centered at the (x)th channel and which differ from (x)th channel by less then α is calculated. Second rule means that value of (x)th channel is corrected to median value of window only if the difference between the (x)th channel and the median value is larger then the β. Defined like this, median filter removes errors caused by background. It preserves real edges of signal in the following way: if there are many elements inside the window which are too different from the (x)th channel, that means that they are probably real edge signals. so they are not taken into account for correction of (x)th channel value.

For best results, parameters α and β should be adapted to measured spectra.

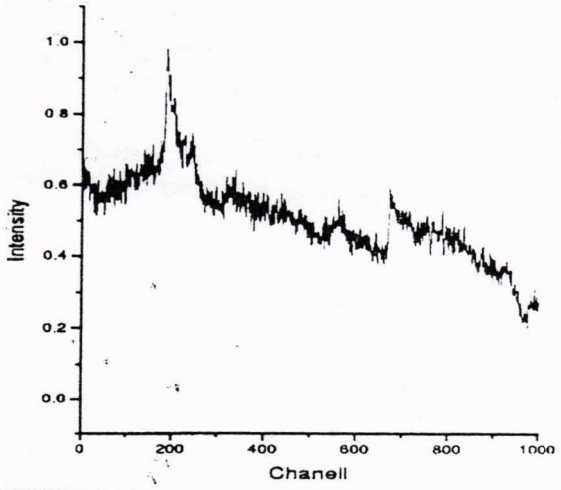

Figure 1. Elastic CS for e - zinc scattering, original data.

[1] AMPL, RSPhysSE, Australian National University, Canberra

3. A SIMPLE METHOD OF OBTAINING RESONANCE ENERGIES FROM BROADENED PROFILES IN SCATTERING EXPERIMENTS

When cross sections for collision or absorption processes are measured as a function of the energy E of the incident projectile or photon, they often show sharp resonances as the energy passes some value E_0. However, observed asymmetric resonance profiles may suffer from instrumental broadening. A simple and accurate method of determining the true resonance center of such broadened profile is described in [7]. However, our experimental results where too much distorted by the finite resolution of our apparatus, so some kind of fitting was necessary before using the method described in [7].

4. AN APPLICATION OF FUZZY MEDIAN FILTER TO FITTING OF OUR EXPERIMENTAL RESULTS

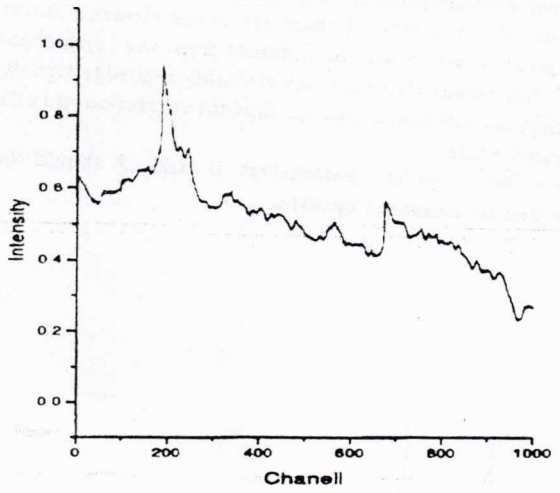

Figure 2. Elastic CS for e - zinc scattering, data obtained after fitting with fuzzy median filter.

An example of fitting the measured cross sections of electron - zinc scattering is shown in Figure 2. For normalized intensity, optimal results were obtained for α=0.1 and β=0.01.

5. CONCLUSION

In this paper we propose a new fitting technique of measured spectra in scattering experiments based on fuzzy median filter. Fuzzy rules are adapted to purpose of elimination of errors caused by background, and, at the same time, preserving the shape of the resonance profiles.

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