

DEVELOPMENT OF METHODS FOR COMPUTER IDENTIFICATION OF NEUTRON CAPTURE GAMMA SPECTRA

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It is known that neutrons capture gamma-radiation spectra of various isotopes contain hundred lines. Spectra of elements and especially objects of complex structure are so difficult, that it is rather labor-consuming to identify them. Therefore, researches were carried out rather intensively to create mathematical, technical bases of computer decoding complex neutron capture gamma spectra. By this one can have the results equivalent to those obtained at improvement of power sensitivity resolution of gamma-spectrometer.

We develop mathematical bases and programs for decoding scale of spectra of samples of complex structure (it is especial, measured by a scintillation gamma-spectrometer) for their analysis. Thus as a basis known methods of decoding complex scale of spectra on reference spectra, on models of monochromatic gamma-radiation, methods based on Shannon theorems [1] are applied, etc.

The basic integrated equation of restoration of spectra

$$y(x) = \int_0^{E_{\max}} S(E, x) T(E) dE, \quad (1)$$

we shall present as the discrete sums, i.e.

$$y_i = \sum_j S_{ij} T_j, \quad (2)$$

where y_i the measured size of a spectrum of interaction $y(x)$ in a i^{th} channel, T_j is the total number of gamma rays in energy group ΔE_j and S_{ij} is the value of the j^{th} standard spectrum channel i . We represent equation (1) in the matrix form

$$ST = Y, \quad (3)$$

and solutions of this system we shall find application for the system, the following orthogonal transformations:

$$CZ = F, \quad (4)$$

where $C = PSQ$, $F = PY$, matrix C usually is two-diagonal, P and Q are orthogonal matrixes of reflection or rotation. Then solving system (4) with a two-diagonal matrix, for (3) we find the decision as $T = QZ$.

The resulted orthogonal transformations are steady against errors of a rounding off [2] and as investigation promote to find solutions of system (3) maximum precisely.

The developed methods are applied for decoding spectra of the modeling samples measured by a scintillation gamma-spectrometer which show efficiency of the methods developed by us for on-line the analysis on scale to radiation of neutron capture.

Applicability of a method is checked up by the example of decoding a spectrum of radiating capture of the sample, consisting of iron (20 %) and sulfur (80 %) (fig. 1). Weight of such sample made 1 g.

The reference spectrum of sulfur possesses the expressed peak at $E_1 = 4.4$ MeV in limits from $x = 37$ up to $x = 42$ channels of the analyzer, and the reference spectrum of iron possesses the sharp peak, the limited channels from $x = 59$ up to $x = 64$ at energy $E_2 = 6.6$ MeV (fig. 1). At the same time the spectrum of the sample has appreciable peak at energy E_1 , but has no expressed peak at E_2 and on this spectrum it is directly impossible to define the contents of iron and sulfur in a sample.

The decision of the basic the equation restoration of spectra has been received by the critical-component method [2] which algorithmic realization it is carried out in software package JINRLINPACK [3]. The received results with application of the critical-component method, acceptance as elements of matrix S in (2) spectra of reference samples of clean iron and sulfur in weight of 1 g., are resulted in table 1.

Table 1. Results definition of element structure of sample Fe+S

Element	T , response function	m , mg	Relative error, %
Fe	0.1845	184.5	7.75
S	0.8154	815.4	1.94

Apparently from Table 1, that the applied method yields the most exact results by definition of weight of elements of a two-componental sample.

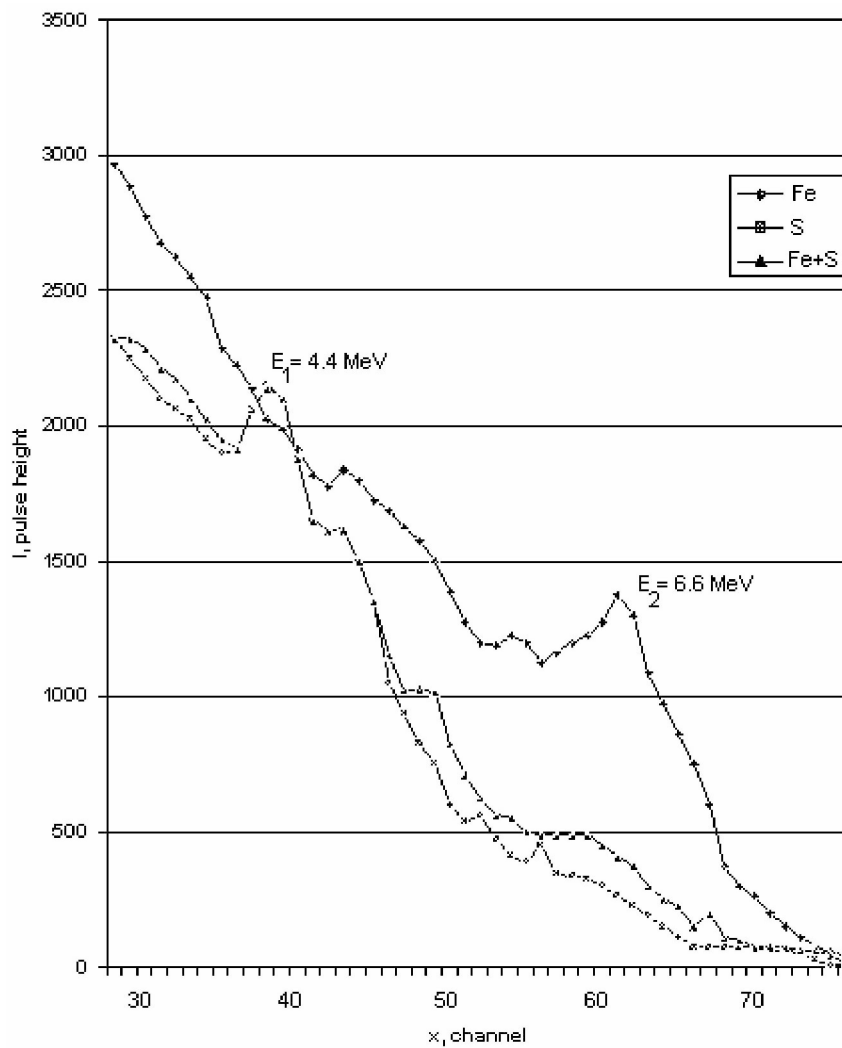


Fig. 1. A spectrum of sample S+Fe and reference samples S and Fe

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