СООБЩЕНИЯ
ОБЪЕДИНЕННОГО
ИНСТИТУТА
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ

Дубна

E13-96-83

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THE PARALAX CORRECTION METHOD FOR THE STRUCTURE INVESTIGATIONS BY SMALL ANGLE SCATTERING WITH USING ONE-DIMENSIONAL GASEOUS DETECTORS

1996

1. INTRODUCTION

One-dimensional gaseous position-sensitive detectors are often used in structure investigations of matter by small angle scattering of X-ray (CuK_α, MoK_α and AgK_α) [1]. They have high quantum efficiency of registration (Fig.1) and good «own» space resolution. These detectors allow one to investigate a small quantity of matter within a reasonable short period of time [2]. But quite big thickness of the detector even at higher pressure of gas results in essentially worse space resolution due to geometrical paralax. The method to correct errors caused by this effect in one-dimensional gasseous detectors is considered below. It lies in counting and following subtraction errors from the experimental data. Moreover, another errors (own detector resolution, etc.) must be smaller than paralax.

2. DESCRIPTION OF THE METHOD

This method is base on the law of exponentional decrease of radiation intensity in gas. It is simple enough.

Suppose that radiation in the first detector channel falls without paralax and then quanta $J'(1)$ are registered with the detector. In this case the intensity of guanta per unit of length is

$$J(1) = J'(1)/[1 - \exp(-\alpha d)\ \text{step}],$$

where α is absorbtion coefficient of radiation in the detector gas; d is thickness of detector, step is channel width.

The radiation falls in the second channel at an angle φ. Knowing the experimental geometry and value $J'(2)$ it is possible to calculate $J(2)$. Besides, it is necessary to calculate $J'(2 \to 3)$ — quntity of quanta absorbed by the neighbouring channel.

For the third channel, one should subtract $J'(2 \to 3)$ from $J'(3)$ and define $J(3)$, $J'(3 \to 4)$ and probably $J'(3 \to 5)$, etc. If to continue this mode for all the next channels one can get rid of systematic errors connected with paralax.

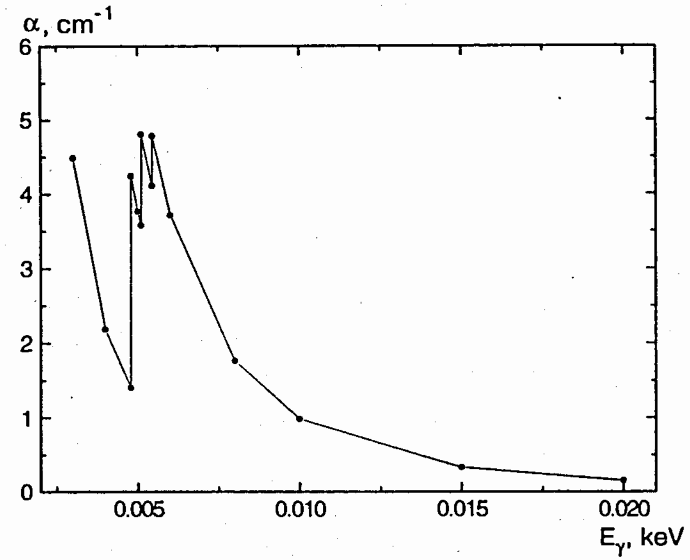

Fig.1. Radiation absorbtion coefficient for Xe under normal pressure depending on energy

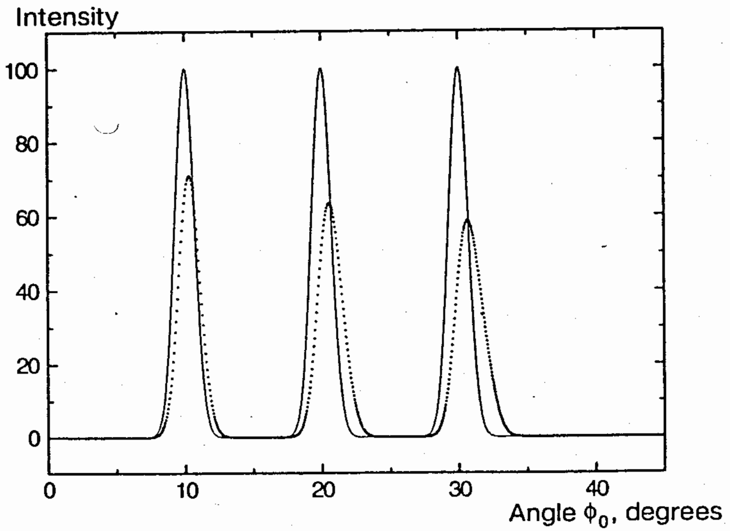

Fig.2. Falling (solid line) and registered (dotted line) spectra

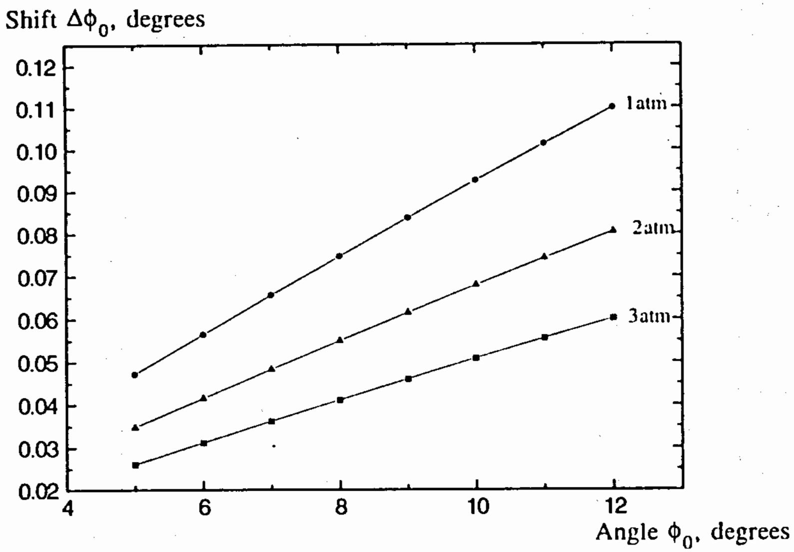

Fig.3. Shift $\Delta\varphi_0$ dependence φ_0. Width of falling peak b is 1°

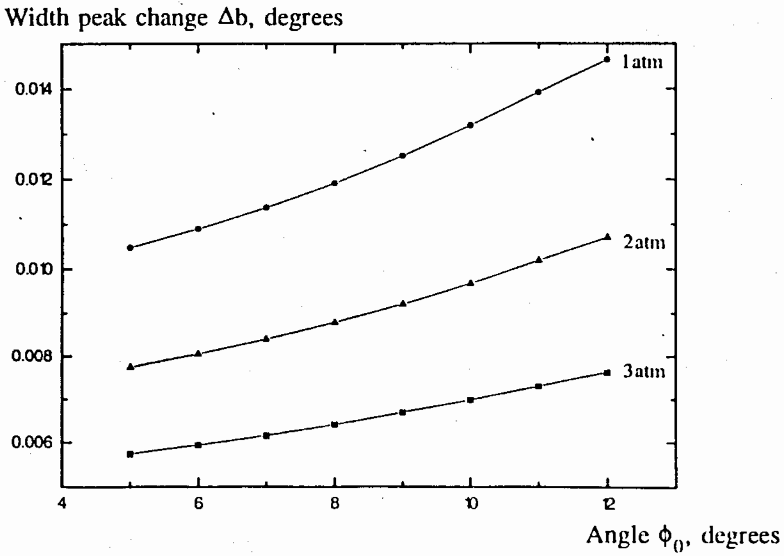

Fig.4. Dependence of width peak change Δb on φ_0. Width of falling peak is 1°

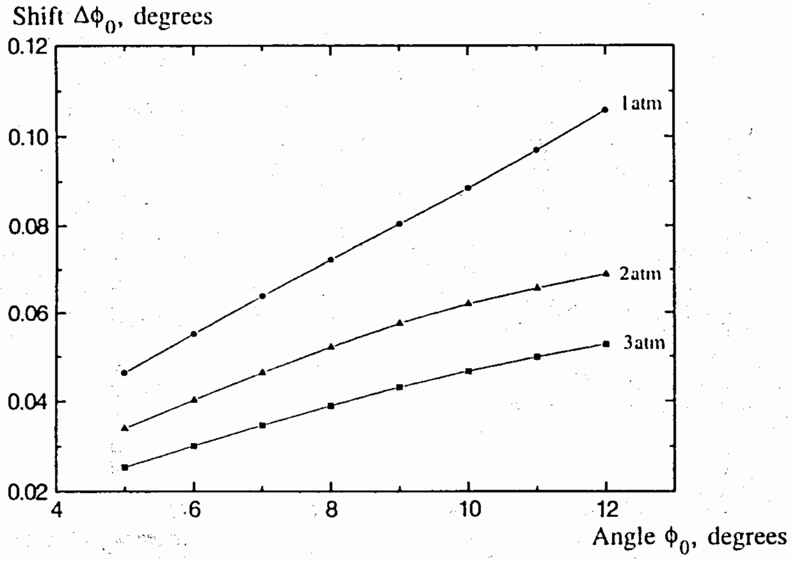

Fig.5. Shift $\Delta\varphi_0$ dependence φ_0. Width of falling peak b is 0.1°

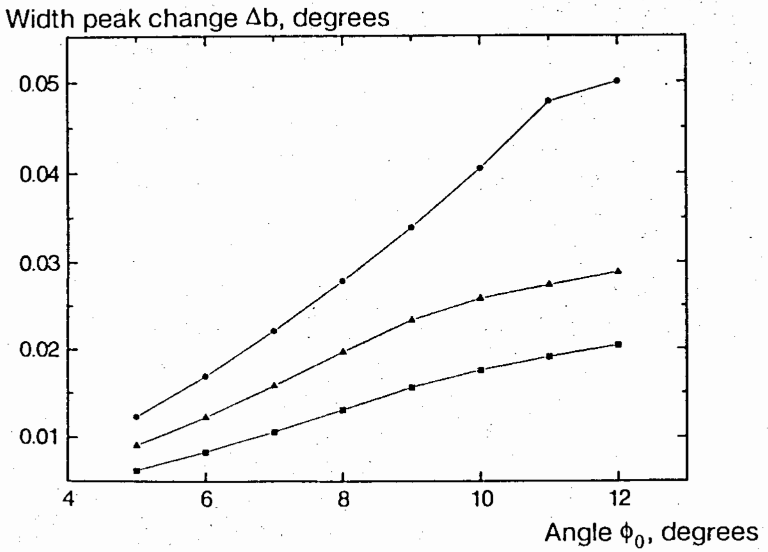

Fig.6. Dependence of width peak change Δb on φ_0. Width of falling peak b is 0.1°

To investigate this case a special computer program has been written. At first, this program generates the falling spectrum and then spoils it using the paralax effect.

3. RESULTS

It is supposed that γ-quanta are absorbed due to conversion and the electron cloud of the point size appears as a result of it. This approximation can take place for the Xe gaseous mixture under pressure of several atmospheres. If the conditions of the measurements are not ideal, then some special mathematical corrections may be used.

The generated peaks were gaussian

$$A_{\mathrm{exp}}(-[(\varphi - \varphi_0)/b]^2),$$

where φ_0 is peak position and b is peak width measured in degrees. The influence of paralax is illustrated in Fig.2. The solid line is the falling spectrum; and the dotted line, the spectrum registred with the detector. So, paralax widens and shifts the registered peaks.

This work resulted in defenitions of shifts ($\Delta\varphi_0$) and width changes (Δb) depending on angles, own width b, and gas pressure in the detector.

The following parameters remained constant:

— gaseous mixture — Xe/CH_4 (85/15),
— γ-quanta energy — 8 keV,
— distance betweem the sample and detector — 400 mm,
— detector length — 100 mm,
— number of channels — 1000,
— detector thickness — 10 mm,
— radiation fall in the first channel without paralax,
— detector resolution ≤ width of the detector channel.

The first results are shown in Figs.3,4 for width of the falling gaussian $b = 1°$. The angle of 0.01° corresponds to 0.07 mm. So, the shift attains 0.7 mm for gas pressure of 1 atm, but the width changes insignificantly.

Results of analogous calculations for 0.1° are shown in Figs.5,6. The shift keeps the value of about 0.7 mm but Δb increases by 1.5 times at the edge of the detector. Thus, it is necessary to correct the influence of paralax, especially for narrow peaks.

4. CONCLUSION

The paralax correction method has been developed for the one-dimensional gaseous position-sensitive detectors. It is a promising tool to correct paralax errors and increase resolution by 3 ÷ 10 times. This method could be appled to investigate the CuK_α, MoK_α, AgK_α radiation.

REFERENCES

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2. Chernenko S.P. et al. — Nucl. Instr. and Meth., 1994, A348, p.261.

Received by Publishing Department
on March 7, 1996.