energy in the region close to the ionic emission causes a disintegration increase 2-4 times. The dependence shown in Fig. 2 is similar to that of the peak with the apparent mass 1/2 investigated in the paper [8] in hydrogen ionization. We would like to mention that the influence of the electron energy on the disintegration of CH^+ and CH_2^+ in the investigated cases is different from that in methane ionization.[9] . In the last case the disintegration probability increases strongly in the region of ionic emission potentials.

The observed increase of probability of processes forming fractional peaks in disintegrations shown in the Table with an increase of electron energy is probably connected with the number and degree of excitation of emission ions. The second possible cause seems to be the increase of the initial kinetic energies of the fragmentation ions with the increase of the electronic energy.[10] An increase of ionic energy up to 3000 ev increases the probability of disintegration. The character of this dependence is influenced by the type of disintegration and by the nature of molecules involved in the collision process.

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Beta-Spectrometer Investigation of Conversion Electrons with Aid of Nuclear Emulsions

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WITH present-day magnetic β-spectrometers, there are in use basically two methods for recording electrons --with the help of counters (gas discharge or luminescent) and photographically, by observing the intensity of darkening.[1] The photorecording method possesses the well-known advantage that it can be used in the study of very short-lived radioactive isotopes, whereas this possibility is practically excluded in work with counters. However, the sensitivity of the photographic method is low and one must use β-emitting sources of high activity.

The requirements become particularly demanding in those cases where the energy range of the β-spectrum does not exceed several hundred kev. The combination of high source activity and small thickness requires the use of compounds with high specific activity, often very difficult to obtain. A further serious drawback of the photorecording method appears to be the difficulty of measuring the relative intensities of the electron lines, due to the dependence of the intensity of darkening on the electron energy.

The above difficulties may be avoided by using thick electron-sensitive photographic emulsions and determining the number of electrons directly from the number of tracks, rather than from intensity variations. Analogous methods have been used earlier for investigating α-spectra with magmetic spectrometers, and have given positive results.*[2] The difficulty in using this method in β-spectroscopy is that the tracks are relatively thin and are quite tangled due to the strong scattering of the electrons. This makes it difficult to count the electrons against the granular background of the film.

The aim of the present work was to show the feasibility of using thick emulsions for recording electrons in a β-spectrometer, in particular for the study of conversion electrons. We employed a Danish-type spectrometer with semi-circular focussing and uniform transverse magnetic field. Its resolving power was 0.7 -1.0%. For recording

high energy electrons which produced rectilinear paths in the emulsion, a cassette was provided with a photographic plate tilted at 30° to the plane of incidence of the electrons, in order that the projected electron paths might be visible.

The source of conversion electrons was a Cs^{137} compound evaporated in layers on a mica strip 40 x 0.5 mm. to a depth of 0.2 mg/cm^2. The electron-sensitive plates were NIKFI type R with a grain density of 30-40 per 100 μ.

The tracks were counted with the aid of a binocular microscope, type MBI-2, having a compound drive. For convenience in counting, a grid was inserted in the microscope eyepiece. The number of electrons was recorded by a push-button counter. With this simple arrangement, scanning of the film took 2-3 hours.

In developing the method we tried out films with different thicknesses of emulsion, 200, 100, and 50 μ. The best results were obtained with the 50 μ thickness, which after developing and drying had a total thickness of 15-18 μ. This emulsion thickness proved to be quite satisfactory for distinguishing tracks against the granular background of the emulsion. In addition, the R-50 type film has the advantage that its photo-processing does not require a large expenditure of time or special equipment.

We investigated especially carefully the question of exposure time for a given source activity, and the degree of magnification in the microscope for the various films tested. The optimum exposure time for the film depended on the following: on the one hand, the number of electron tracks should not be too large, else the tracks become entangled and difficult to count, while on the other hand, for reduced statistical fluctuations, it is desireable that the number of tracks in the field of view of the microscope should not be too small. Investigation showed that with a magnification of X 300-450 the most efficient exposure was one for which the number of electrons in the microscope field of view ranged from several dozen to 300. This number could be increased to 400-500 if the film was saturated with a 5 - 10% solution of glycerin. In such swollen emulsions, the electron tracks expand toward the vertical so that the microscope focusses on a smaller region of the paths, in which the electron do not have time to scatter significantly. Such paths are easy to distinguish and count.

We used freshly poured emulsions, whose storage time did not exceed 7 days.

Figure 1 shows the β-spectrum obtained from

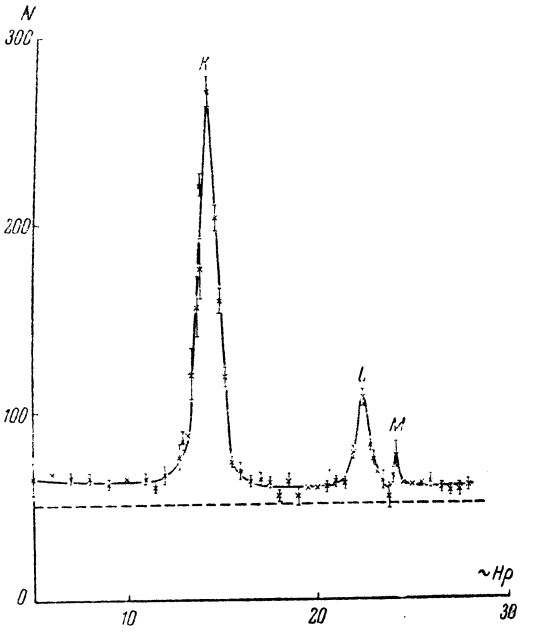

FIG. 1. Conversion Electron Spectrum of Cs^{137}

the internal conversion of γ-rays from Cs^{137} (Ba^{137*}) ($h\nu$=661.6 kev). The numbers along the abscissa are proportional to $H\rho$, while the ordinate is N, the number of electrons in the field of view of the microscope at a magnification of X 420. The spectrum was obtained by exposing the plate for 2.5 hours to a 6 μ Cu source of Cs^{137}. It represents the average value of four curves taken from the same film. For each new curve the plate was shifted slightly toward the vertical. This made it possible to get good statistics from a single plate. As may be seen from Fig. 1 the errors in measurement do not exceed 8% and could be reduced with better statistics. A control film from the same batch showed that 51 ± 1 electrons accumulated in the background during the storage time. In the figure this background is shown as a straight dotted line. The remaining electrons in the general background, on which are distributed the K, L, and M peaks, belong to the β-spectrum of Cs^{137}, which accounts for about 8% of the total number of disintegrations.

Comparison of the areas of the K, L, and M peaks gave the ratios of the conversion coefficients for the γ-rays of Cs^{137}:

$$\alpha_K : \alpha_L : \alpha_M = (5.9 \pm 0.1) : 1.0 : (0.28 \pm 0.02).$$

The errors here represent mean square values from the processing of 7 plates. The results are in good agreement with those given by other authors[4-8] and obtained in β-spectrometers with recording by β-counters.

Thus the method of recording electrons in thick photographic emulsions proved to be entirely adaptable to β-spectroscopy. For a comparison of the exposure times necessary to darken an x-ray film appreciably, with that required by the photoemulsion method, we carried out a measurement using the same 2.65 mCu Cs^{137} preparation for both. The data obtained showed that the use of the emulsion permitted the investigation of isotopes 300-500 times weaker in intensity. This increase in sensitivity of counting, together with the other advantages of the photographic method will permit the study of many short-lived isotopes and may be of value in deciding a number of questions in β-spectroscopy.

In conclusion, I would like to thank I. M. Frank and I. V. Estulin for the interest they showed and for assistance with the work.

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*It became known to the author afte the completion of the present work that a similar method had been used successfully by Pnievski[3] for investigating the β-spectra of RaD.

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Elastic Scattering of 5.4 Mev Protons by Various Nuclei

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A STUDY of the scattering of nucleons by atomic nuclei is one of the main sources of information about the form of a nucleus – the characteristics of the nuclear potential and the range of action of nuclear forces. Because of the success of the optical model for the scattering of neutrons by atomic nuclei[1] increased interest in proton scattering recently arose [2-5].

In the present work the elastic scattering of protons with initial energy of 5.4 mev by the following nuclei was studied: Be, C, F, Mg, Al, Ca, Mn, Ni, Cu and Zn. The measurements were made in the following manner. Fast protons, obtained from a linear accelerator, after going through a magnetic analyzer and a row of collimating diaphragms with diameters 2, 2.12, and 2.2 mm, were scattered by the target situated in a vacuum chamber. The scattered protons were registered by photoplates at various angles. The geometry of the experiment and the position of the photoplates are shown in Fig. 1. The angular resolution for the detectors nearest to the target was $\pm 2.5°$.

Because the photoplates, situated to the right and to the left of the beam (see Fig. 1), were simultaneously exposed, and the intensity of the Coulomb scattering is proportional to $\sin^{-4}(0/2)$ (where 0 is the angle of observation), the distances to the photoplates in the region of small angles were chosen in such a manner that the relationship $r \sin^2(0/2) = \text{const}$ would hold (r is the distance from the target to the detector.)

The targets for all metals studied were obtained in the form of thin foils or films of a couple microns thickness by evaporating metal in a vacuum, with the exception of nickel whose foil was obtained by electrolysis, and carbon which was prepared as a thin free film from aquadag (a graphite lubricant). For the study of scattering from fluorine thin films of MgF_2 and Li^6F were used, and for calcium films of CaF_2.

After the exposure of the photoplates and their photochemical development, first, a study of the energy spectrum of protons which were scattered by the target at 90° and 160° angles with respect to the primary beam was made. This study was made on the paths left by protons in the photoemulsion. The energy resolution of this method