1) the peak of the elastically reflected electrons and the peak of the nonelastically reflected electrons when $V_p - V_k = 1.8$ v are resolved well on curve 2 of Fig. 1, and in the photograph in Fig. 2 these two peaks unite into one wide peak; 2) on the photograph there is a peak when $V_p - V_k \sim 13$ v which, in fact, corresponds to the minimum (see Fig. 1, curve 2). This is explained by the fact that the sign of the output of the amplifier, characterizing the derivative, is presented to the oscillograph in the form of a variable voltage, and, therefore, the sign of the derivative cannot be shown--the minima will be recorded in the form of peaks, just as the maxima.

Considering the investigation of nonelastically reflected electrons from cuprous oxide[6] when $V_p = 21.5$ v, there were discovered three values of discrete losses from which it was possible to compare two with the values obtained by means of the formula (1), and the third value when $V_p - V_k \sim 2$ v was not explained. However, by means of the formula (2) there are obtained values of the discrete losses of energy which correspond well with all the experimental values of $V_p - V_k$ obtained by us (Table II).

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K-Shell Gamma Ray Internal Conversion Coefficients

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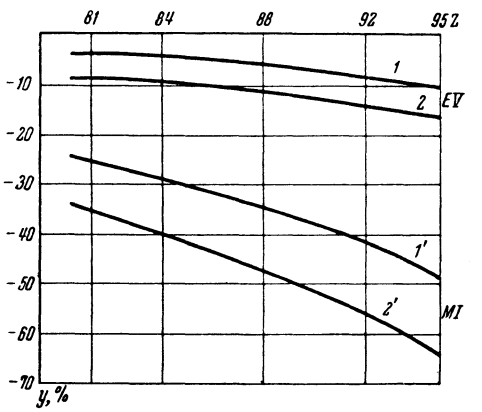
THE most complete of the tables of the K-shell gamma ray internal conversion coefficients * which we have at present (Rose' s tables) were established without accounting for the influence of the finite dimensions of the nucleus and of the screening effect. Besides that, there are no data in them for small values of the energies.[1] Consequently, we undertook anew work on the establishment of tables of coefficients of internal conversion (c. i. c.) which would not possess the defects indicated.

Calculations were carried out for 16 elements from $Z = 25$ to $Z = 98$ and for 13 values of energy beginning with energies close to the threshold values and going to $k = 5$ (in units of mc^2). The values of the energies were chosen by such a method that later on it might be possible to interpolate with a sufficient degree of accuracy. In each point the c. i. c. were obtained for the first five electrical and the first five magnetic multipoles.

The relativistic wave functions of the electron were calculated from the potential which inside of the nucleus corresponds to a uniform distribution of the charge and outside of the nucleus has the following form:

$$V = -(\alpha Z/r)\,\varphi(r) - D + K.$$



For the curves 1, 1′, $k = 0.5$, for the curves 2, 2′, $k = 5$.

TABLE 1

The K-shell coefficients of internal conversion for uranium (Z=92) (in parentheses are given the powers of ten by which one must multiply the appropriate number)

K	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5
0.25	2.17 (−1)	2.04 (−1)	1.19 (−1)	5.81 (−2)	2.74 (−2)	8.85 (0)	3.90 (1)	4.89 (1)	3.10 (1)	1.48 (1)
0.30	1.43 (−1)	2.09 (−1)	2.88 (−1)	4.01 (−1)	5.79 (−1)	5.28 (0)	2.13 (1)	3.87 (1)	5.54 (1)	7.34 (1)
0.35	1.00 (−1)	1.79 (−1)	3.30 (−1)	6.29 (−1)	1.23 (0)	3.41 (0)	1.28 (1)	2.67 (1)	4.90 (1)	8.72 (1)
0.40	7.39 (−2)	1.47 (−1)	3.14 (−1)	6.89 (−1)	1.55 (0)	2.34 (0)	8.23 (0)	1.82 (1)	3.73 (1)	7.52 (1)
0.50	4.47 (−2)	1.01 (−1)	2.43 (−1)	5.94 (−1)	1.46 (0)	1.26 (0)	3.98 (0)	9.09 (0)	2.00 (1)	4.38 (1)
0.70	2.16 (−2)	5.39 (−2)	1.38 (−1)	3.42 (−1)	8.38 (−1)	4.95 (−1)	1.37 (0)	3.02 (0)	6.54 (0)	1.42 (1)
1.00	1.05 (−2)	2.78 (−2)	6.91 (−2)	1.61 (−1)	3.62 (−1)	1.88 (−1)	4.67 (−1)	9.45 (−1)	1.89 (0)	3.78 (0)
1.50	4.92 (−3)	1.34 (−2)	3.11 (−2)	6.49 (−2)	1.29 (−1)	6.38 (−2)	1.47 (−1)	2.68 (−1)	4.79 (−1)	8.50 (−1)
2.00	2.97 (−3)	8.11 (−3)	1.77 (−2)	3.43 (−2)	6.26 (−2)	2.98 (−2)	6.70 (−2)	1.16 (−1)	1.92 (−1)	3.14 (−1)
3.00	1.50 (−3)	3.98 (−3)	8.15 (−3)	1.44 (−2)	2.37 (−2)	1.02 (−2)	2.33 (−2)	3.79 (−2)	5.79 (−2)	8.61 (−2)
4.00	9.33 (−4)	2.39 (−3)	4.71 (−3)	7.92 (−3)	1.23 (−2)	4.72 (−3)	1.13 (−2)	1.80 (−2)	2.63 (−2)	3.72 (−2)
5.00	6.50 (−4)	1.61 (−3)	3.08 (−3)	5.02 (−3)	7.54 (−3)	2.58 (−3)	6.53 (−3)	1.03 (−2)	1.47 (−2)	2.01 (−2)

Here $\varphi(r)$ is the Thomas-Fermi-Dirac function which we obtained for different elements by the use of the tables of Ref. 2; D is the exchange correction; [3] K is the correction which is introduced for the functions of the free electrons, taking into account the change of potential as a result of the departure of the s-electron.

The potentials of the transition within the nucleus were determined from assumptions on the charge distribution in the volume and on the currents distribution on the surface of the nucleus. The radius of the nucleus is assumed to be equal to $1.2\,A^{1/3} \times 10^{-13}$ cm. As it was shown in Ref. 4, the making of all of the enumerated assumptions more precise can change the final result only by a small percentage. The determination of c. i. c. is made with an accuracy to within 0.5 %. However, the assumptions which are fundamental to the calculations decrease the accuracy of the tables by 2–3 %. All the calculations were carried out on a high-speed electronic calculating machine BESM of the Academy of Sciences. In Table 1 the c. i. c. are given for uranium ($Z = 92$).

The values of c. i. c. which we calculated are everywhere less than the values given by Rose. This is illustrated by Table 2 in which the per cent of decrease of the c. i. c. is shown in comparison with these data (assumed for 100 %). In so far as the calculation of the screening effect in this area gives an unknown correction ($\sim$ 1 %), the decrease of the c. i. c. obtained shows how great is the influence of the calculation of the final measurements of the nucleus.

In the Figure, there are introduced the curves of departure y (in per cent) of the c. i. c. from Rose's data for the transitions *MI* and *EV* depending on Z. A similar dependence on Z takes place also for other multipoles. For $Z < 40$ the calculation of the final measurements of the nucleus does not play a practical role, but the influence of the screening effect grows.

For $Z = 25$ our results coincide with Rose's results (with consideration of the screening effect) with an exactness to within 2 %, everywhere exceeding them. That they exceed his results is the consequence of the fact that the exchange correction, which was not calculated in Rose's computations, was included by us in the potential V.

The full tables of c. i. c. will be published shortly.

*For small energies the c. i. c. were determined only for four Z, with consideration of screening.

TABLE 2

The deviation (decrease) in % of the c. i .c. from the calculations of Rose (Z=92)

K	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5
0,5	1	5,3	9,2	9,9	8,8	41,8	21,3	17,2	14,5	11
1	1,7	9,8	12,3	13	13,2	44,4	22,2	18	16	14,8
4	3,42	14	14,5	14,2	14	54,2	26,2	20,7	18,1	16,6
5	3,1	13	14,3	14,3	14,1	56,5	27,7	21,1	18,6	17,2

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Selection Rules for Antiproton Annihilation Into π – Mesons

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IN a previously published article Amati and Vitale[1] have given selection rules for the annihilation of antiprotons into two and three π– mesons. However, following from general considerations which take into account the strong interaction of π– mesons with nucleons, and also on the basis of the already available experimental data[2], the greatest practical interest lies in the effects of the multiple meson annihilation of antiprotons. The present article is devoted to a possible generalization of the selection rules to an arbitrary number of π – mesons being produced, and also contains some remarks on the dependence which follows from these rules of the effective cross sections for annihilation on the velocity of the antiproton in the region of nonrelativistic energies. We shall restrict ourselves to a consideration of strict selection rules which are based on the requirement that the laws of conservation of the total angular momentum and of the space and charge parities be satisfied simultaneously.

We recall that the requirement indicated above leads to the fact that the annihilation of antiprotons in singlet states of the nucleon-antiproton system into two π – mesons is strictly forbidden. On the other hand, in triplet states of such a system, the effects

$$1)\ \tilde{p}+p\to\pi^-+\pi^+,\quad 2)\ \tilde{p}+n\to\pi^-+\pi^0$$

can occur only under the condition

$$L_i=0\to L_f=1,\quad L_i=2n\to L_f=2n\pm1, \qquad (a)$$

or

$$L_i=1\to L_f=0,\quad L_i=2n\pm1\to L_f=2n \qquad (b)$$

$$(n=1,2,\ldots),$$

where L_i is the orbital angular momentum of the nucleon-antiproton system; L_f is the orbital angular momentum of the system of two π – mesons. Thus in the triplet nucleon-antiproton system annihilation into two π – mesons [effects (1) and (2)] may occur only under the condition

$$\Delta L=L_f-L_i=\pm1.$$

A characteristic property of the selection rules for the annihilation into two neutral π – mesons

$$3)\ \tilde{p}+p\to\pi^0+\pi^0$$

is the additional restriction on the states of the π – mesons being formed which comes from the requirement that the wave function of the final system should be symmetric with respect to interchanges of identical particles. The last requirement excludes the possibility of states of odd parity for a system of two π^0 – mesons and leads to