and ψ_q, the basic term in the integral B_{q1} is introduced by the second term of the expansion, and in B_{q0} and C by the first term.

In Eq. (9) we will keep only the basic terms, neglecting the part containing the matrix element of the operator $[qxS]_z$ and the quantity $-vq_z/2M$ in the parentheses. It is not hard to see that the terms we have here dropped give small corrections, whose calculation would hardly make sense, since we have made the approximations a) − d).

We now go over from a consideration of the probability amplitude to the cross section, sum over S and m, average over m_0, and integrate over $d^3 q$ as was done in Ref. 1. Let us write

$$\varepsilon = k^2/M, \quad \varepsilon_S = \alpha_S^2/M, \quad 1/\Gamma = v^{-1}(\varepsilon + \varepsilon_1)R_0 \ll 1.$$

Integration over the angle ϑ gives the distribution over ε ($0 \leqslant \varepsilon \leqslant \varepsilon_{max} = v/R_0 - \varepsilon_1$)

$$\sigma_{1\to1}(\varepsilon)\,d\varepsilon = \frac{8}{3}\left(\frac{Z}{137v}\right)^2 \frac{\sqrt{\varepsilon_1\varepsilon^3}\,d\varepsilon}{M(\varepsilon + \varepsilon_1)^4} \qquad (13)$$

$$\times\left[\ln\frac{\Gamma^2 - v^2}{1 - v^2} - v^2\frac{\Gamma^2 - 1}{\Gamma^2 - v^2}\right],$$

$$\sigma_{1\to0}(\varepsilon)\,d\varepsilon = \frac{2}{3}\left(\frac{Z}{137}\right)^2 (\mu_p - \mu_n)^2 \qquad (14)$$

$$\times\frac{\sqrt{\varepsilon_1\varepsilon}(\sqrt{\varepsilon_1} + \sqrt{\varepsilon_0})^2\,d\varepsilon}{M^2(\varepsilon + \varepsilon_0)(\varepsilon + \varepsilon_1)^2}\left[\ln\frac{\Gamma^2 - v^2}{1 - v^2} - \frac{\Gamma^2 - 1}{\Gamma^2 - v^2}\right].$$

Equation (13) goes over into Dancoff's equation[1] if the expression in square brackets is designated by $\ln \Gamma^2$.

Integration over ϵ is carried out numerically. The figure shows the variation of the integral cross sections $\sigma_{1\to1}$ and $\sigma_{1\to0}$ in the energy interval $E_d = 0.2 - 10$ bev for $R_0 = 1.1 \times 10^{-13}$ cm.

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*We are employing a system of units in which $c = \hbar = 1$.

**It can be shown that in this way the diffraction disintegration of the deuteron, which is not connected with the electric field close to the nucleus (see Ref. 2), is eliminated from the consideration; the whole cross section for disintegration is given by the sum $\sigma_{dif} + \sigma_{el}$, and the interference term is absent in the approximations a) − d).

[1] S. Dancoff, Phys. Rev. 72, 1017 (1947).

[2] A. I. Akhiezer and A. G. Sitenko, Dokl. Akad. Nauk SSSR 107, 3 (1956).

Translated by E. J. Saletan
83

On the Paper by N. I. Steinbok "Basic Characteristics of Ionization Chambers"

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IN the paper by N. I. Steinbok[1], it is asserted that the solution of the equation of the volt-ampere characteristics of ionization chambers obtained by him are more rigorous and complete than those previously described in the literature (see, for example, Refs. 2, 3). This conclusion is obtained on the basis of the supposition that, if the ionization is relatively weak, it is possible to ignore the space charge ; however, no basis for the justification of this supposition is advanced in this paper and the error arising out of this supposition is not evaluated. What is more, it is possible to demonstrate that even where weak ionization exists, the part played by space charge in ionization chambers is quite significant, and therefore the conclusions drawn in Ref. 1 are in error.

Let us examine the problem of the variation in intensity of the electrical field between the anode and the cathode in a flat, air-type ionization chamber. Let us designate by h the distance between the anode and cathode and draw an axis x perpendicular to their surface. Seeliger[4] demonstrated that the value of the intensity of field E in the space between the anode and the cathode is completely determined by the numerical value of the ratio i/I_0, where I_0 is the strength of the saturation current and i is the strength of the current in the absence of saturation; upon variation of the strength of ionization and of the magnitude of I_0, only the absolute value of E changes at all points in the field. In the following table the values of E are given in relative units for various values of i/I_0 for cross sections of the chamber at various distances from the anode $x = 0, 0.33h, 0.42h, 0.67h,$ and h.

From this table and Seeliger's graph (Ref. 4, p. 348, Fig. 3; see also Ref. 3, Fig. 82) it can be seen that even in the vicinity of the zone of saturation $i/I_0 = 0.949$ the minimum value of intensity of the electrical field E at $x = 0.42h$ is lower by 18% than the maximum value of E at $x = h$; at $i/I_0 = 0.406$ the minimum value of the field differs from the maximum by a factor of 2.5.

From the foregoing it follows that parameter λ, which enters into the system of differential equations derived by Steinbok for ionization chambers and which contains E^2 in the denominator, cannot

i/I_0	0	0.33h	0.42h	0.67h	h
0.406	52	26	25	29	67
0.576	53	29	28	34	68
0.728	56	36	35	40	70
0.949	91	83	82	85	97

be considered a constant factor, but is rather a function of the coordinate $\xi = x/h$. As a result of this, in Eq. (5) the variables μ and ν cannot be separated and all the relationships subsequently given cannot be obtained. Thus, the expressions obtained in Ref. 1 are not, in fact, solutions of the equation for the volt-ampere characteristics of ionization chambers. This, of course, is the reason why the approximate expressions obtained by Steinbok differ from the approximate solutions of Mi and Seeliger.

Steinbok also gives a comparison of his experimental data which he obtained during the measurement of ionization by the compound $RaCl_2$. It is difficult to understand the fact that the experimental data for the ionization of α-particles do not conform to the dependence, characteristic for the ionization column, of the strength of the current on the difference in potential (see, for example, Ref. 3, Fig. 80) applied to the ionization chamber.

From the foregoing it follows that the volt-ampere characteristic of ionization chambers obtained in Ref. 1 and the description of the work of the ionization chambers on the basis of the characteristics derived by the author cannot pretend to rigor and accuracy. It is hardly possible to use these results in working with ionization chambers, since the question of the erroneousness of the equations is left open.

[1] N. I. Steinbok, J. Exptl. Theoret. Phys. (U.S.S.R.) 27, 5, 615, 1954.

[2] V. I. Veksler, L. V. Groshev, and B. M. Isaev. *Ionization methods of investigating radiation*, Gostekhizdat, 1949.

[3] K. K. Aglintsev, *Dosimetry of ionizing radiations*, Gostekhizdat, 1950.

[4] H. Seeliger, Ann. Physik 33, 319 (1910)

Translated by A. Certner
84

Disintegration of Positive Ions in Collision with Molecules

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IN the mass spectra of some compounds broad peaks are observed whose centers of gravity do not coincide with the integral mass numbers. The apparent mass M^* is

$$M^* = M_K^2 / M_H, \qquad (1)$$

where M_H and M_K — are the ionic masses before and after disintegration. The observed peaks are caused either by spontaneous disintegration of metastable ions[1,2] or by disintegration caused by collisions with molecules or atoms.[3-7]

We investigated some broad peaks in the mass spectra of carbon monoxide, carbon dioxide, methyline iodide and bromide, acetylene and ethylene (see Table). The investigation was carried out on a standard equipment MS-1 with ionic energy 2500 ev, electron energy 70 ev and electron beam current 0.5 ma. The pressure in the analyzer was 3×10^{-5} mm Hg. Mass spectra were automatically scanned by change in magnetic field and recorded by an electronic potentiometer. Ionic currents were measured at the maximum of the peaks.

We found that the intensity of broad peaks I^* in the first approximation is

$$I^* = \alpha I p. \qquad (2)$$

where p is the pressure of the gas entering the analyzer of the apparatus, measured with an ionization gauge of the type LM-2, I is the intensity of the developed positive ions and α is a constant. As