these measurements was found to be 3.1×10^{10} dynes/cm² while the value for the modulus computed from the velocity measurements in the electrostatic method gave 5.1×10^{10} dynes/cm² at 24.3°C. When this value is corrected for temperature, it is in fair agreement with values just published by Rinehart.[6]

These differences in the velocities come apparently from the fact that under a high stress, a cold flow occurs.[7] Froman[3] has shown an increase in Young's modulus at small stresses for metals. The authors expect to continue measurements at small loads and make a complete report later.

[1] Louis R. Weber and Frank P. Goeder, J. Colo.-Wyo. Acad. (1939).
[2] E. Gruneisen, Ann. d. Physik 22, 801 (1907).
[3] D. K. Froman, Phys. Rev. 35, 264 (1930).
[4] Louis R. Weber and Frank P. Goeder, J. Colo.-Wyo. Acad. (1941).
[5] John M. Ide, Rev. Sci. Inst. 6, 296 (1935).
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[7] J. Delmonte, Modern Plastics 49 (1940).

Diurnal Variation of Extensive Showers

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REGISTRATIONS of the number of extensive showers have been made at sea level (Paris) with a set of two unshielded coincidence counters, separated by a horizontal distance of three meters. The counts were automatically recorded every hour during a period of two and a half months, from January to April, 1940. The results are given on the curves of Fig. 1, the mean number of counts per

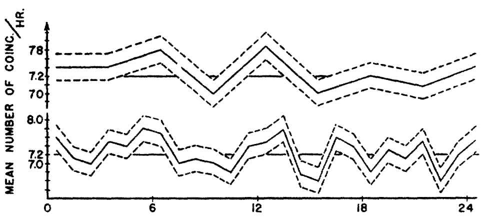

FIG. 1. Mean number of counts per hr. *vs.* solar mean time.

hour being plotted against the mean solar time. In the upper curve the means have been taken over periods of three hours. The dotted curve indicates the probable errors. All readings were corrected for barometric effect.

There is only a feeble maximum (6 percent) at noon, in agreement with the results of Kolhorster. This maximum may be due to a thermal effect. The particles responsible for the production of the big air showers, because of their high energy, are probably completely insensitive to the magnetic field of the earth and of the sun. These particles should then have an isotropic space distribution outside of the solar system. So, either the sources of the particles or the fields in which they are accelerated are uniformly distributed around us, or there must exist very strong causes of disturbance which scatter the initial directions of the particles before they reach the atmosphere.

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Single Scattering of Fast Electrons

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ELASTIC scattering of fast electrons (Ra B+C) by the nuclei of nitrogen, fluorine and argon is investigated with a cloud chamber (magnetic field = 450 oersteds). The length and curvature of the tracks were measured by means of stereoscopic projection. In order to avoid large errors in the determination of the energy, scattered tracks shorter than 2 cm were disregarded. Corrections were made for this and for the finite depth of the illuminated area (1 cm) in the cloud chamber.

For comparison with the Mott theory, the whole energy-range was subdivided into three groups (0.2–0.5; 0.5–1; 1–3 Mev). For each of these energy-groups angular cells were formed with the limits 15°, 20°, 30°, 45°, 60°, 90°, 180°. The total amount of scattering seems to be somewhat higher than theoretically expected. (See Table I.)

TABLE I.

Nucleus	Length of path	Number of collisions	n_{exp}/n_{th}
A	708 m	153 (>20°)	1.5
F	910 m	113 (>15°)	1.2
N	515 m	42 (>15°)	1.3

The scattering cross section as a function of energy and angle is in agreement with theoretical predictions within the limit of statistical errors. The anomalies reported for the scattering by nitrogen[1] are not confirmed. The values of the cross sections for argon and nitrogen agree well with those of Randels, Chao, and Crane.[2]

There are no measurements available to compare with our results for fluorine.

[1] Skobeltzyn and Stepanowa, Nature 137, 456 (1936); Bosshard and Scherrer, Helv. Phys. Acta 14, 85 (1940).
[2] Randels, Chao, and Crane, Phys. Rev. 58, 201 (1940).

Some Discharge Characteristics of Self-Quenching Counters

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January 2, 1942

IN a previous publication[1] it was shown that the counter discharge mechanism proposed by C. G. Montgomery and D. D. Montgomery[2] satisfactorily explains the dependence of pulse size upon counter wire capacity and counter length for a non-self-quenching gas mixture. Similar studies made with a self-quenching gas provide equally satisfactory agreement and illustrate nicely the essential difference between the two types of counter operation. As anticipated the self-quenching mixture provides no mechanism for insuring a constant pulse size (for varying capacity and length) and the total voltage swing of the wire for a given cylinder potential is simply $l\alpha/c$. Here l is the effective counter length, c is the total capacity of the wire system and α is the charge per unit length in

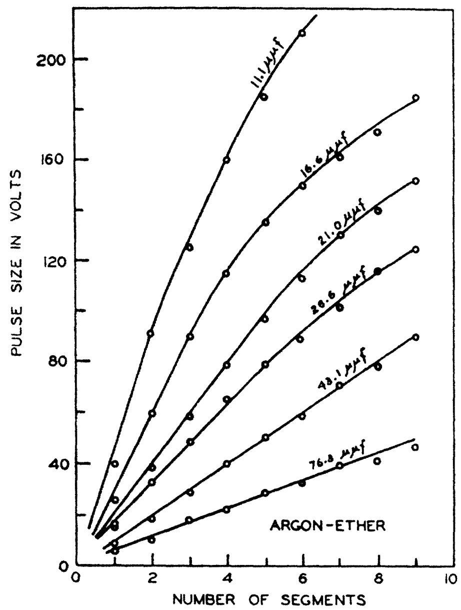

FIG. 1. Pulse size *vs.* length and capacity of counter.

the positive ion sheath which surrounds the counter wire during the discharge.

Figure 1 displays a family of curves showing the dependence of pulse size upon length and capacity while Table I gives the values of α as calculated from the slopes of the separate curves at $l=0$. For small c and large l a departure from the simple relation indicated is observed and corresponds to that found in the non-self-quenching mixture where c is small and l is large. It has been previously shown[1] that the voltage pulse can be represented best by the expression $(l/c)[\alpha-(\beta l/c)]$, where $\beta l/c$ is negligible except for a long counter with a small total wire capacity. For both types of gases the departure is to be expected if a time of the order of magnitude of 10^{-7} second is required for the discharge to spread the entire length of the tube. Such a time delay permits the potential of the wire to change while the positive ion sheath is being established in certain portions of the counter. For this reason the positive charge in the sheath is not constant over the wire length and the average value decreases as we decrease c and increase l. The theory has, with justification, assumed

TABLE I. Values of α, the charge per unit length in the positive ion sheath.

Capacity $\mu\mu$f	Volts/Segment	α in coulombs
11.1	40	4.4×10^{-10}
16.6	26	4.3×10^{-10}
21.0	19.5	4.1×10^{-10}
26.6	16.2	4.3×10^{-10}
32.1	13.0	4.2×10^{-10}
43.1	10.0	4.3×10^{-10}
54.2	8.2	4.4×10^{-10}
65.2	6.5	4.2×10^{-10}
76.3	5.5	4.2×10^{-10}

that, following the passage of the original ionizing particle, photons from the first electron avalanches create discharge centers throughout the counter in extremely short times. It has, therefore, naturally invoked the assumption that, for its purpose, the ionization starts instantaneously at all points along the wire. That this is not strictly true follows from the fact that the spreading process depends upon electrons moving appreciable distances through the gas. Therefore the absence, rather than the appearance, of a small correction term would occasion some surprise.

Figure 2 of reference 1 is a diagram of the counter used. In order to vary the effective counter length *without* changing the wire capacity the cylinder is made to consist of nine separately insulated segments whose voltages may be independently assigned. The number of segments at a fixed value above the starting potential determines the effective counter length. All other segments are at a given voltage well below the Geiger counter threshold. The total capacity of the wire system was varied by adding capacitors between wire and ground. The pulses were observed on an electron tube oscillograph under conditions which gave more than adequate time for the complete collection of the charge involved in the discharge process.

[1] W. E. Ramsey and Wayne L. Lees, Phys. Rev. **60**, 411 (1941).
[2] C. G. Montgomery and D. D. Montgomery, Phys. Rev. **57**, 1030 (1940).

Directional Properties of Self-Quenching Counters

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H. G. STEVER[1] has recently reported a very interesting way in which to endow a Geiger-Mueller counter with directional properties. He finds that small beads of glass mounted on the wire of a counter filled with a self-quenching mixture effectively confines the discharge to those sections of the tube traversed by the original ionizing ray. Thus the pulse size from the wire is proportional to the number of segments traversed and is an indication of the path taken by this ray.

The ability to limit the discharge in self-quenching counters in this way is a consequence of the fact that in these counters not only is the active discharge confined to the immediate vicinity of the wire, as in all counter action, but also to the fact that no photoelectrons are formed in remote parts of the counter as a consequence of photons originating in this region. Emmett L. Hudspeth, using an arrangement employed by the author for studying the distribution of photons in time during the discharge in a non-self-quenching mixture,[2] found this absence of photoelectrons in the case of the self-quenching gas. Thus in the self-quenching mixture the ***entire*** ionization process is confined to the vicinity of the wire.* Started at a point (or a few points) by the passage of the ionizing ray, it must spread along the wire from this point to another very close to it. It is clear that the discharge may be confined to a desired section of the counter *by any procedure which*