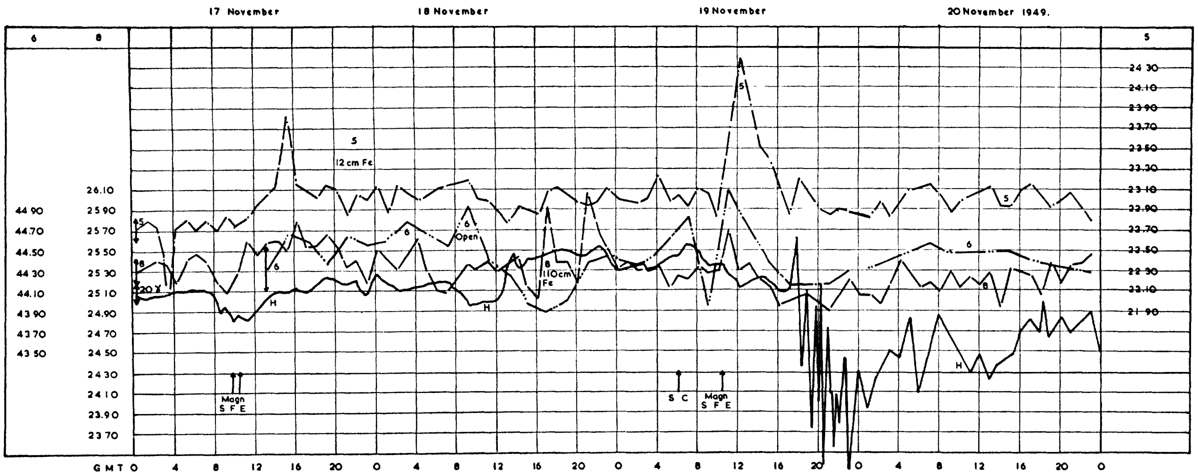

FIG. 1. Observed cosmic-ray intensity and horizontal component of the earth's magnetic field for the period November 17 to 20, 1949.

In this way it is possible to reach an accuracy of 0.1 percent; the last half year however our accuracy has been lowered to 0.2 percent due to frequency changes of the electric network, for which we have corrected as well as possible.

The use of different layers of absorbing material affords us a notion of the energies of the cosmic-ray particles which occur during solar flares. We know at the moment that the observed solar flare effects show great differences in this respect.

The normal case seems to be the following: frequently a small decrease in cosmic-ray intensity and a "sudden commencement" earth magnetically are observed shortly before the flare. But in any case immediately after the flare the earth's magnetic field shows the characteristic solar flare effect, followed within 20 min. to 2 hr. by a steep increment of cosmic-ray intensity, the size of which, however, differs greatly in the cases observed. Then in a decrease generally extending over several hours, the intensity comes down to a level below normal. In most cases considerable magnetic disturbances or a magnetic storm is simultaneously observed. The normal intensity is not regained till one or two days afterward.[4]

Variations of this general behavior of cosmic rays in a case of solar flare have been reported; e.g., by Broxon and Boehmer and by Rose. Broxon and Boehmer[5] found no increment during the flare of May 10, 1949. Our observations on this day give only an excess smaller than one percent in both the unshielded vessel and the one shielded with 12 cm Fe, with a retardation of many hours, but no increment was found under 110 cm Fe. During this flare apparently only particles of low energies were ejected, the greater part of them not being able to penetrate the atmosphere. This is confirmed by Schein's observation on the same day of an increment of 75 percent at very great height.

After the flare of November 19, 1949, Rose[6] did not find a decrease of cosmic-ray intensity, but during the magnetic disturbance setting in about 19.00 found an intensity higher than normal. On November 19 a solar flare of importance 3 was observed by the Wendelstein Solar Observatory (Bavaria), beginning at 10.29 and ending at 11.19 G.M.T. with a maximum at 10.34. Magnetic Station Witteveen of the K.N.M.I., Holland, reports on the same day a sudden commencement of 15γ in H at 6.04 G.M.T., followed by a solar flare effect at 10.30 to 11.00. This solar flare effect is confirmed by a Dellinger fade-out of the Noordwijk radio station (NDRA). After 19.00 on November 19 a magnetic disturbance set in with a maximal range in H of 215γ.

In Fig. 1, which is corrected for changes in barometric pressure, we give the intensities for the various chambers in terms of the compensation voltages, and also the horizontal intensity of the earth's magnetic field. The intensity changes of the cosmic rays here are curious. Before the point marked S.C. there is a small decrease until 6.00 G.M.T., except in the unshielded chamber. Then a minor maximum occurs, followed immediately by a dip, which is negligible, however, in the hard component. The influence of the solar flare of 10.29 G.M.T. is different in our three vessels. The hard component shows an increase of one percent in the period 10.30–11.30, and in the interval 10.00–12.00 the total intensity attains a value somewhat higher than that before the dip. The behavior of the component observed under 12 cm Fe is remarkable. Here we find in the two intervals 10.15–11.15 and 11.15–12.15 a steep increase of nearly seven percent in total. The decrease to normal values lasts in all of the vessels until 17.00 G.M.T. We cannot confirm the observation of Rose, however, that during the magnetic disturbance following the flare the cosmic-ray intensity is higher than before the flare, our mean hour values for the three chambers being somewhat larger on November 18 than on November 20, although we must agree that after such an important flare a larger decrease would be expected.

The Cosmic Relations Bulletin No. 7 (1949) of New Zealand mentions on November 19, 1949 an increment of 15 percent in cosmic-ray intensity followed by a more or less exponential decrease to *normal* values.

Taken all in all, we should conclude that no difference is to be observed between the intensities before and after this flare, which is abnormal.

We are very much indebted to Mr. A. J. Dijker for his help with the classification of the bulky material on this subject for the last four years.

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The Photo-Disintegration of the Deuteron

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IN a previous paper[1] L. Hulthén and the present writer have given results of theoretical calculations on the photo-disintegration of the deuteron for the γ-energies 2.62, 2.76, and 6.2 Mev. As experiments are being carried out using γ-rays from radio

TABLE I. Calculated photo-disintegration cross sections of the deuteron (units of 10^{-28} cm^2).

Deuteron binding energy	Theory[a]	Meson mass	σ_m	σ_e	σ $(=\sigma_m+\sigma_e)$	$\left[\frac{\sigma(0)}{\sigma(\pi/2)}\right]_{\text{c.m.}}$	$\left[\frac{\sigma(0)}{\sigma(\pi/2)}\right]_{\text{lab}}$
2.187 Mev	*N*	200	3.47	10.18	13.65	0.185	0.214
2.187 Mev	*O*	200	3.47	9.28	12.75	0.200	0.230
2.187 Mev	*MR*	200	3.47	9.06	12.52	0.203	0.235
2.187 Mev	*N*	300	3.62	7.77	11.40	0.237	0.274
2.187 Mev	*O*	300	3.62	7.57	11.19	0.242	0.279
2.187 Mev	*MR*	300	3.67	7.50	11.17	0.246	0.284
2.237 Mev	*N*	200	3.75	8.07	11.82	0.236	0.276
2.237 Mev	*O*	200	3.75	7.39	11.14	0.253	0.295
2.237 Mev	*MR*	200	3.75	7.22	10.96	0.257	0.300
2.237 Mev	*N*	300	3.92	6.21	10.13	0.296	0.346
2.237 Mev	*O*	300	3.92	6.04	9.96	0.302	0.353
2.237 Mev	*MR*	300	3.97	5.99	9.96	0.307	0.358

[a] *MR* denotes the Møller-Rosenfeld theory, *N* the corresponding neutral theory, and *O* the case of no ^3P-interaction (see reference 1).

gallium[2] the calculations have been extended to 2.52 Mev. Table I gives the calculated values of the photomagnetic and photoelectric cross sections (σ_m and σ_e) in 10^{-28} cm^2 as a unit and the intensity ratio $\sigma(0)/\sigma(\pi/2)$ in the center-of-mass system (c.m.) as well as in the laboratory system (lab.). The average ratio $[(\sigma(0)+\sigma(\pi))/2\sigma(\pi/2)]_{\text{lab}}$ is about one percent higher than $[\sigma(0)/\sigma(\pi/2)]_{\text{c.m.}}$.

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An Anomalous Effect Observed in Self-Quenching Counters Containing Neon

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IN the course of some experiments on self-quenching Geiger counters which are to be reported elsewhere, the following phenomenon was observed. Counters filled to 10 cm total pressure with neon-quenching constituent mixtures containing less than 0.1 percent of ethyl acetate or butane exhibited a Geiger plateau region at a higher voltage across the counter than a preceding region of continuous discharge. The counter characteristics from this point on are observed to follow the usual pattern.

As the partial pressure of the quenching constituent is decreased below the point where the above phenomenon sets in, the continuous discharge region preceding the plateau becomes longer while the plateau itself grows shorter, until the latter completely disappears. The starting potential for counters of 0.95 cm cathode radius in this region is between 250 and 300 volts. The effect is most striking with ethyl acetate, and less so with butane. It also occurs to a limited extent with methane, though at a higher partial pressure of this quenching gas.

In counters of smaller cathode radius the effect either does not occur at all or does so only to a limited extent. A counter of 0.14 cm cathode radius does not exhibit this "late plateau" at all, self-quenching action having apparently ceased before a low enough partial pressure of quenching constituent had been reached. A counter of 0.25 cm cathode radius exhibits a region of multiple discharges at a lower voltage across the counter than the plateau region which comes after it but does not have a region of continuous discharge at this lower voltage. Counters having cathode radii of 0.64, 0.95, 1.27, and 1.84 cm all exhibit this "late plateau" effect. In the counter of 0.95 cm cathode radius, however, the phenomenon is more striking than in the counters of both larger and smaller dimensions.

This effect has not been observed at all in counters containing self-quenching gas mixtures in which either argon or helium is the noble gas component.

Further investigation of this phenomenon is now under way in this laboratory and the results will be reported in detail at a later date.

Differential Identities in Three-Field Renormalization Problem

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MATTHEWS[1] has pointed out that for renormalization to be effective for the combined interaction of charged spinless mesons (scalar interactions), nucleons and electromagnetic field, certain conditions must be satisfied, and has verified these conditions to the lowest order by direct calculation. Here a more general proof is attempted.

Following Dyson[2] we define $\Sigma_P^*(p)$ as the function arising from adding together all integrals corresponding to proper self-energy parts inserted into a proton line of momentum p. Besides the self-energy part consisting of a single point, there are in fact just two irreducible self-energy parts, one arising from the proton's interaction with the electromagnetic field, the other from its interaction with the meson. Define $\Sigma_M^*(p)$ as the corresponding function for meson self-energy graphs. Let $\Lambda_\mu{}^a(p, p')$ be the function arising from adding together integrals corresponding to proper vertex parts with one external photon and two proton lines, while $\Lambda_\mu{}^b(p, p')$ stands for vertex parts with one photon and two meson lines. Also let $\Theta_{\mu\nu}(p, p', q)$ be the function arising from adding integrals corresponding to proper C parts (parts with two external meson and two photon lines) defined as capable of replacing the factor $\delta_{\mu\nu}$ from a four-vertex.

From general considerations $\Sigma_M^*(p)$ is at most quadratically, $\Sigma_P^*(p)$ and $\Lambda_\mu{}^b(p, p')$ are at most linearly, $\Lambda_\mu{}^a(p, p')$ and $\Theta_{\mu\nu}(p, p', q)$ are at most logarithmically divergent. From invariance considerations their forms are

$$\Sigma_P^*(p)=(A-2\pi i\delta\kappa_0)+B(p\gamma-i\kappa_0)+S_c(p)(p\gamma-i\kappa_0)$$

$$\Sigma_M^*(p)=(A'+\pi i\delta\kappa_0{}^2)+C(p^2+\kappa^2)+\Pi_c(p)(p^2+\kappa^2)$$

$$\Lambda_\mu{}^a(p, p')=L^a\gamma_\mu+\Lambda_{\mu c}{}^a(p, p')$$

$$\Lambda_\mu{}^b(p, p')=L^b(p_\mu+p_\mu{}')+M^b(p_\mu+p_\mu{}')(p^2+\kappa^2+p'^2+u^2)+\Lambda_{\mu c}{}^b(p, p')$$

$$\Theta_{\mu\nu}(p, p', q)=R\delta_{\mu\nu}+\Theta_{\mu\nu c}(p, p', q)$$

$$\text{where}\quad S_c(p)=\Lambda_{\mu c}{}^a(p, p)=0\quad\text{for}\quad i\gamma p+\kappa_0=p^2+\kappa_0{}^2=0$$

$$\Pi_c(p)=0\quad\text{for}\quad p^2+\kappa^2=0,\quad \Lambda_{\mu c}{}^b(p, p')=\frac{\partial\Lambda_{\mu c}}{\partial p_\nu}=\frac{\partial\Lambda_{\mu c}}{\partial p_\nu{}'}=0$$

$$\text{for}\quad p=p'\quad p^2+\kappa^2=0\quad\text{and}\quad \Theta_{\mu\nu c}(p, p', q)=0\quad\text{for}$$

$$p=p'\quad q=0\quad\text{and}\quad p^2+u^2=0.$$

The possible divergent constants B, C, L etc., are double power series in e and f.

In order to prove our identities, we extend the differential identity $-(1/2\pi)(\partial S_F(p)/\partial p_\mu)=S_F(p)\gamma_\mu S_F(p)$ first given by Ward.[3] For mesons, we have

$$-(1/2\pi i)(\partial\Delta_F(p)/\partial p_\mu)=\Delta_F(p)2p_\mu\Delta_F(p).$$

The insertion of an external photon line (with its energy-momentum set equal to zero) in a charged meson line is described correctly by a single differentiation. The important extension is that a second differentiation of the above with respect to p_ν describes not only the insertion of another photon three-vertex on the same meson line but also the complication of the first three-vertex into a four-vertex. Even while dealing with the three-field problem we can always arrange that the momentum p should follow the charge in any connected graph, so that the internal lines corresponding to neutral particles (neutrons and photons) do not get differentiated. (With certain conditions, closed charged loops