pressions for the nucleon form factors given by Hofstadter.[13]

The existence of a reasonable set of values of F_0, F_{ch}^V, F_{mag}^V, and F_x (Table I) itself indicates that the inclusion of a term containing the meson-exchange contributions to the charge form factors of H^3 and He^3 is consistent and is probably correct. It is seen from Table I that the magnitude of F_{ch}^V is of the order 0.02-0.03 at all available values of q^2. F_{ch}^V remains positive and almost constant, while F_{mag}^V falls off quickly as q^2 increases. No direct comparison of the above results is made with those given by Levinger,[5] as different normalizations have been used. The influence of various different assumptions on quantities determined from the form factors of He^3 and H^3 is being analyzed at present and detailed results will be published shortly. The comparison of these and other results with the theory of exchange meson currents given by the author[14] will be made in another publication.

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FLUX OF PRIMARY COSMIC-RAY ELECTRONS OF RIGIDITY ABOVE 4.5 BV

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Previous experiments[1,2] on the intensity of primary electrons in the cosmic radiation have been made at high latitudes (cutoff rigidity 0.7 and 0.1 BV, respectively), and at a period of still active sun (June and November 1960, respectively). Since one of the objects of these measurements is to determine the density of electrons which can emit the synchrotron radiation which is assumed to be responsible for the nonthermal component of galactic radio noise,[3] it is of interest to obtain a value of the electron flux as free as possible from the effect of solar modulation, which is known to be least effective at minimum solar activity and on high-energy particles.

A first balloon flight was therefore carried out on 5 November 1963 at Air-sur-Adour (southern France, cutoff rigidity 4.5 BV). The apparatus employed[4] consists of a cylindrical spark chamber, 26-cm diameter and 17-cm height, containing nine aluminum plates 10×10 cm square. On each of the central five plates is laid one radiation length of lead. The chamber is triggered by a fast (30-nsec) coincidence between two plastic scintillators, corresponding to the passage of one or more singly charged fast particles in the upper scintillator and four or more in the lower scintillator. When the pulse height in the upper scintillator exceeds that corresponding to one singly charged fast particle, an indicator lamp is lit. The apparatus had been previously calibrated in momentum-analyzed beams of protons, π^+ mesons, and electrons in the momentum range 0.5 to 12 BeV/c, in order to determine the efficiency of detection of electron showers and nuclear interactions, and to establish an empirical relation between shower size and electron energy. The detailed description of these measurements is given elsewhere.[5,6]

The chamber was photographed during 37 minutes of flight, during which time it was at an altitude of between 36 and 37 km, corresponding to 4.9 and 4.3 g/cm² residual atmosphere. A dead time of 0.87 second was applied to the instrument to allow for the recovery of the high-tension supply after triggering; the total sensitive time was $(22.2^{+3.2}_{-6})$ minutes, the error being due to drift of the dead time during flight.

The film was scanned and only those events were accepted in which the direction of the primary particle was such as to lie within the geometric volume defined by the two scintillators and the visual field of the chamber. Rejected events include interactions occurring above, below and around the chamber, and interactions in the chamber, in which the direction and position of the primary lay outside the geometric criteria and the coincidence was due to secondary particles. The geometric factor of the instrument under these conditions of selection was 24 cm² sr.

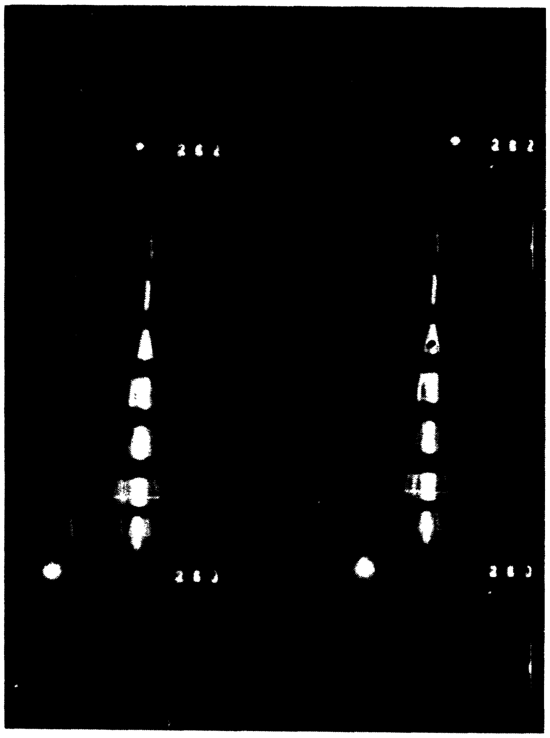

FIG. 1. A cosmic-ray electron (altitude 36-37 km).

116 interactions and showers occurring in the lead plates were selected in this way; of these, 32 were identified as interactions due to primaries with charge 2 or more; of the remaining 84 events due to singly charged particles, 18 showed the typical electromagnetic cascade development (Fig. 1).

A proton interaction can simulate an electron shower if the greater part of the energy is given to a π^0 meson whose γ decay initiates an electromagnetic cascade. A check on the importance of this contamination is given by examining the frequency of interactions and showers as a function of their plate of origin (Fig. 2). The expected distribution for nuclear interactions is shown, and the excess of origins in the first two radiation lengths, characteristic of

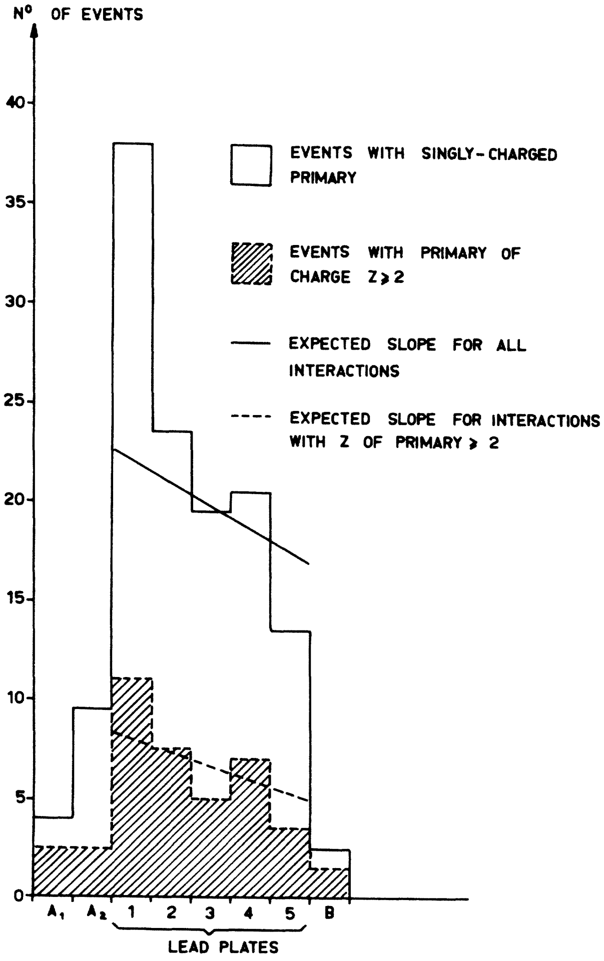

FIG. 2. Distribution of the plate of origin of interactions and showers.

electron-induced showers, is clear. The number of electrons deduced from this distribution is (18 ± 4), in good agreement with the visual identification. This number of electrons corresponds to a flux of $(6.6^{+2.8}_{-1.7})$ electrons $\mathrm{m}^{-2}\ \mathrm{sec}^{-1}\ \mathrm{sr}^{-1}$.

In absence, in the flight, of a direct counting of the number of incident protons, one can derive the ratio of the number of electrons to protons by applying to the number, 66, of observed proton interactions, the interaction cross section, and the efficiency of detection of interactions of a given multiplicity determined in the calibration measurements. The value obtained for the ratio, electrons to protons, is $(1.5 \pm 0.4) \times 10^{-2}$, compared with the ratio $(1.1^{+0.4}_{-0.3}) \times 10^{-2}$ obtained by dividing the electron flux by the accepted value of (620 ± 30) protons per m^2 sec sr at this latitude at solar minimum.

The electrons observed can be a mixture of true primaries, re-entrant albedo, and secondary electrons produced by nuclear interactions in the overlying atmosphere. Re-entrant albedo electrons are expected to have a steep energy spectrum terminating at the cutoff rigidity.[7] The flux of secondary electrons is expected to be not more than 0.3 % of the proton flux for electron energy greater than 1 BeV and 0.1 % for energy above 4.5 BeV. The energy spectrum of the primary electrons can reasonably be expected to be of the form $N(E)dE = kE^{-\gamma}dE$. Radioastronomic measurements at frequencies in the

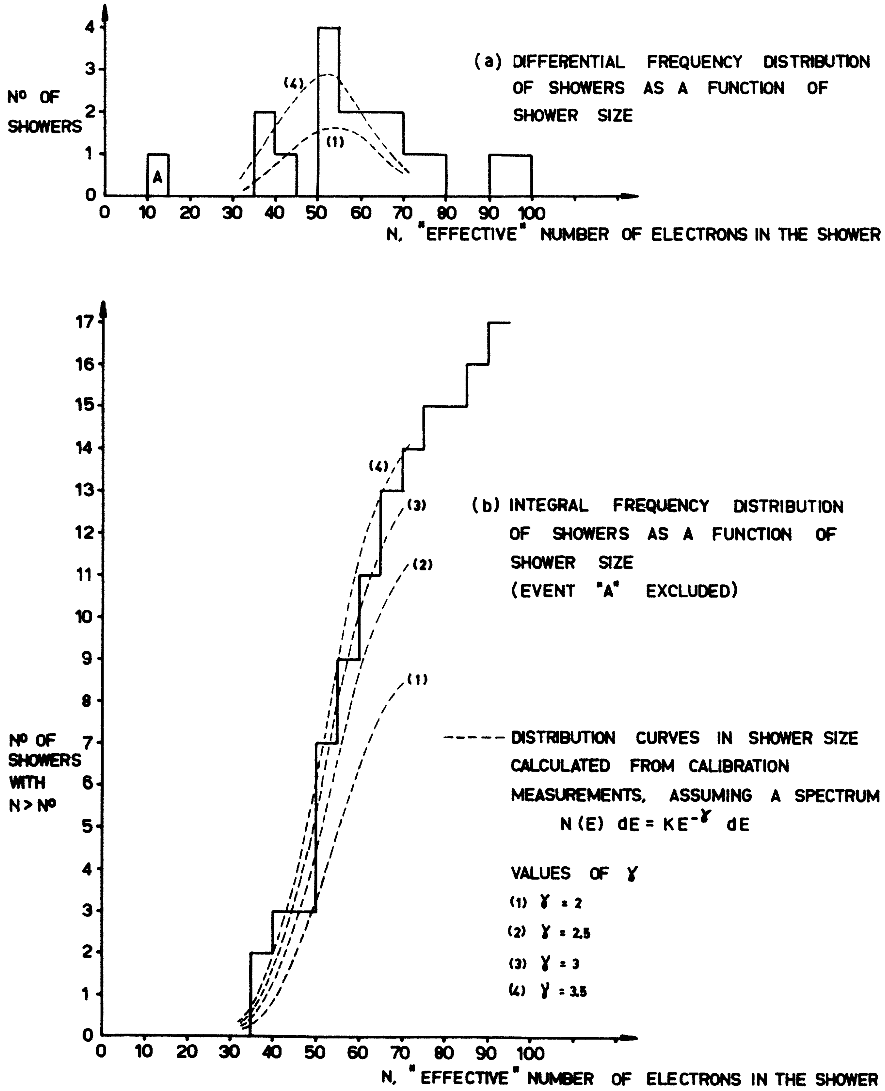

FIG. 3. Distribution of showers as function of shower size.

region of 300 Mc/sec[8] indicate a value of γ of about 2.6. The frequency distribution of the 18 showers as a function of the total effective number of sparks in the shower is shown in Fig. 3. In order to ascertain if this distribution is compatible with that to be expected for primary electrons with a geomagnetic cutoff at 4.5 BV, spectra of the type $kE^{-\gamma}$, with values of γ between 2 and 3.5, have been converted to shower-size distributions, using the mean value and spread of the distributions obtained during calibration measurements on 3, 4.5, 6, and 8 BeV/c electrons.[6] The experimental distribution is found to be compatible with the assumption that all but one [event A of Fig. 3(a)] of the electrons have momenta above the geomagnetic cutoff value and follow roughly the type of spectrum assumed. It is clear, however, that, with the present statistics, this distribution cannot be used to obtain a precise value of γ. A reliable determination of the energy spectrum requires much larger statistics and, as is planned, measurements of intensity at various latitudes during quite sun conditions.

The electron intensity measured here (which includes particles of both signs) would correspond, on the assumption of an energy spectrum of the type $kE^{-2.5}$ and of a magnetic field of 3×10^{-6} gauss, to a power of synchrotron emission of $(1.7\pm0.5)\times10^{-40}$ erg cm^{-3} Hz^{-1} sec^{-1} at a frequency of 10^9 cps, the critical frequency corresponding to 4.5 BeV/c.

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PHENOMENOLOGICAL ANALYSIS OF VIOLATION OF CP INVARIANCE IN DECAY OF K^0 AND $\bar{K}^0$[†]

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1. It was recently discovered[1] that the long-lived component $K_{\rm L}^0$ of K^0-$\bar{K}^0$ decays into the $\pi^+\pi^-$ mode. Now if CP invariance holds, the $CP=+1$ and $CP=-1$ components of K^0-$\bar{K}^0$ decay independently. The $\pi^+\pi^-$ mode in the S-wave state has $CP=1$. Hence either the short-lived component $K_{\rm S}^0$, or $K_{\rm L}^0$, does not decay into $\pi^++\pi^-$, in contradiction to the new discovery.

Accepting the experimental result of reference 1, one is thus forced to the conclusion that CP invariance is violated in K^0-$\bar{K}^0$ decay, as explicitly stated in reference 1. Notice that this conclusion is independent of the details of the Weisskopf-Wigner formulation[2] of decay amplitudes, as applied to the K_0-$\bar{K}_0$ case by Lee, Oehme, and Yang,[3] whose notation we shall follow.[4] (In particular, small corrections to the exponential decay rule of the formalism cannot alter the conclusion that CP invariance is violated.)

In the present note we shall analyze the decay properties of K^0-$\bar{K}^0$, mostly from the *phenomenological viewpoint*. Possible further experiments will be discussed for their theoretical significance.

We shall assume CPT invariance, the validity of the Weisskopf-Wigner formulation,[2,3] and that for the strong and electromagnetic interactions, separate C, P, and T invariance hold.

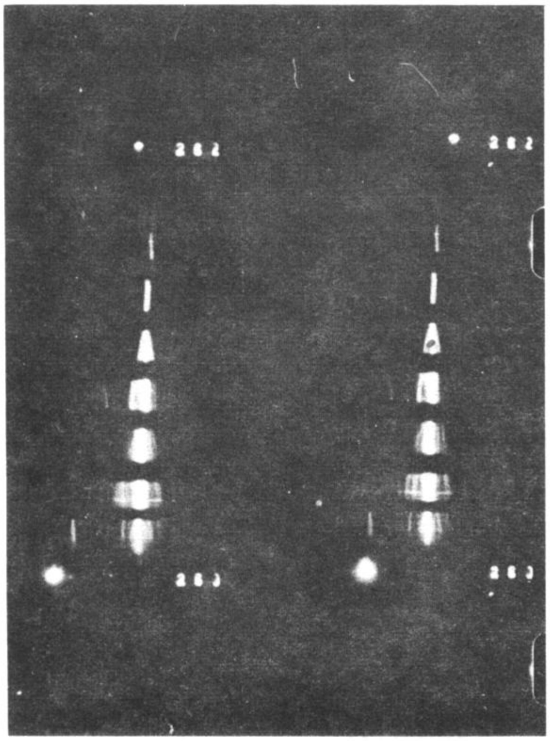

FIG. 1. A cosmic-ray electron (altitude 36-37 km).