graph the polyethylene membrane and the inner neck of the storage Dewar, and (3) a heater in the storage Dewar that would boil off cold helium gas on command in order to cool those components near the radiometer beam. Unfortunately, this flight ended in the complete destruction of the apparatus when a malfunction in the balloon command electronics terminated the flight prematurely during the ascent.

In summary, the raw data provide upper limits for the isotropic background radiation and indicate that it may not have a thermal spectrum. The corrections given, which are reasonable upper limits, only accentuate the nonthermal nature of the radiation. Finally, although one cannot recover the spectrum uniquely from these measurements, the data are not inconsistent with a 3°K black body on which is superposed a strong line between 10 and 12 cm^{-1}.

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EXPERIMENTAL LIMIT ON NEUTRINO-ELECTRON SCATTERING

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From an analysis of electron production in the CERN neutrino spark-chamber experiment, it is concluded that the cross section for neutrino-electron scattering is less than $40\sigma_{V-A}$ with 90% confidence.

Recently, experimental evidence[1] for electron neutrino-electron scattering

$$\nu_e + e^- \to e^- + \nu_e \tag{1}$$

has been reported. The above reaction was searched for, notably since Gell-Mann et al.[2] have emphasized that no connection need exist between diagonal interactions like (1) and other weak processes. In their theory the corresponding coupling constant $G_{\nu e}$ could be much larger than the usual Fermi constant G. As a matter of fact, the experiment mentioned above seems to indicate a cross section about a thousand times that predicted by the universal $V-A$ theory.[3]

Accordingly, it seemed worthwhile to extract an experimental limit on ν_e-e scattering from the available data on electron production during the 1963-1964 CERN neutrino spark chamber experiment.[4] During this experiment, 30 electron events with an electron energy above 1 GeV were observed, which were compatible with elastic electron production:

$$\nu_e + n \to e^- + p. \tag{2}$$

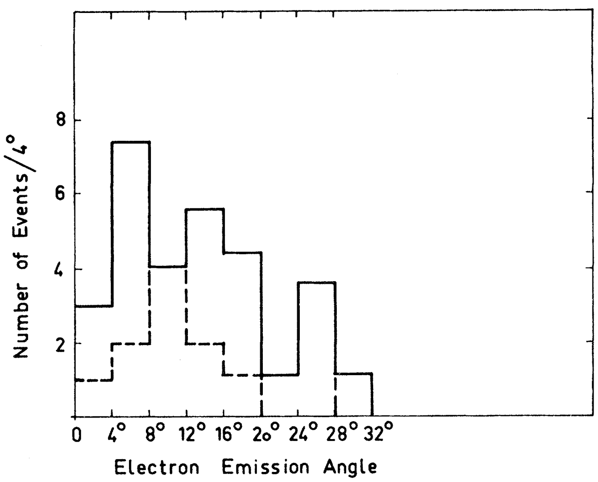

FIG. 1. Laboratory angular distribution of electrons for all events compatible with $\nu_e + n \rightarrow e^- + p$ with $E_e > 1$ GeV. Dashed histogram: subsample of events with no visible recoil.

Their angular distribution is given in Fig. 1. The electron angular distribution for process (1), however, is limited to very small angles, due to kinematics. For electrons with $E_e > 1$ GeV the maximum angle is 2°. Since the measurement errors are 2° (an uncertainty of the neutrino direction of 1.5° included), 90% of the electrons from Reaction (1) are confined to a cone of <4° around the average neutrino direction.

Thus, in order to single out possible candidates for (1), two criteria were applied: (1) The electron must not be accompanied by a visible recoil. (2) The electron must be emitted within ±4° around the direction of the impinging neutrino. As seen in Fig. 1, one event fulfilled both criteria.

The number of ν_e-e scatterings expected from $V-A$ theory was calculated from the conventional differential cross section σ_{V-A},[3-5] the dection efficiency of our setup, and the computed ν_e spectrum from K_{e3} decays,[6] which is shown in Fig. 2. Taking into account the uncertainty in the neutrino flux of 30%, we expect 0.11 ± 0.04 events below 4°. By comparing this number with the one event observed, assuming Poisson statistics, we conclude

$$\sigma_{\nu e} < 40\sigma_{V-A} \text{ or } G_{\nu e} < 6.3G,$$

with 90% confidence.

This result is in disagreement with the result

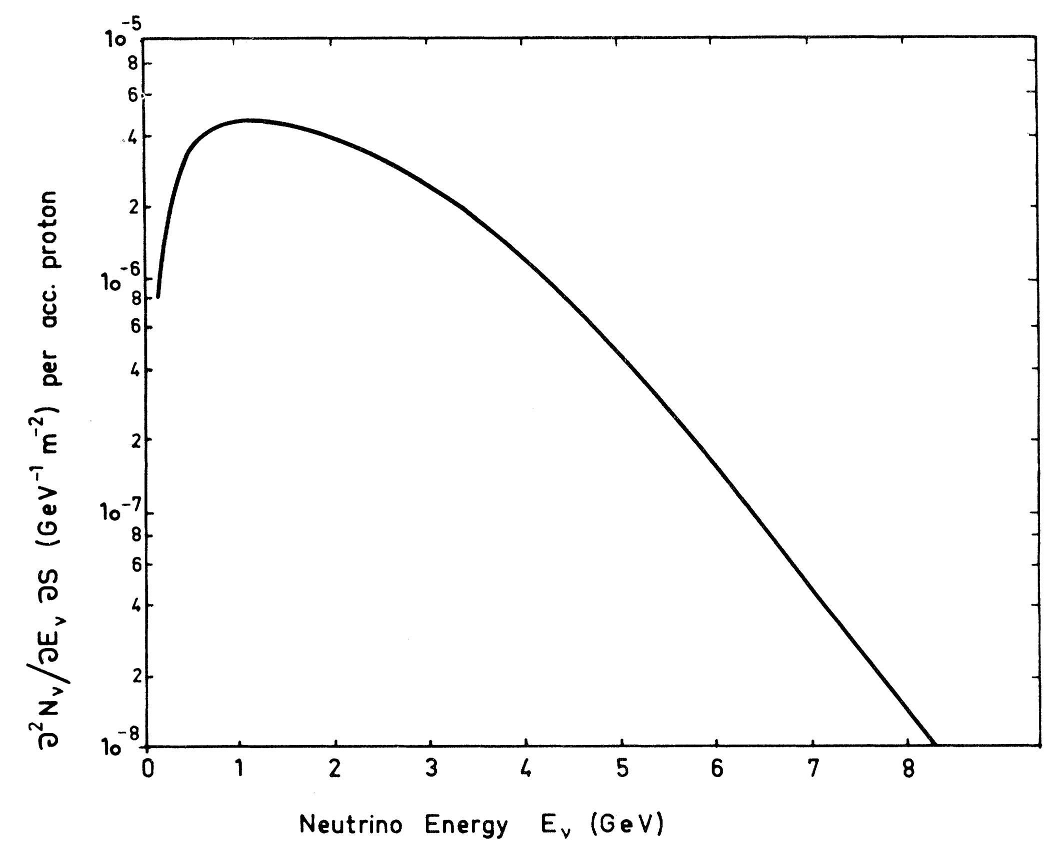

FIG. 2. Computed energy spectrum of electron neutrinos from K_{e3} decays.

reported by Reines and Gurr. Even using their most conservative estimate of $\sigma_{\nu e} = 100_{V-A}$ we should have observed 11 events in the first bin of Fig. 1.

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SEARCH FOR T-INVARIANCE VIOLATION IN THE INELASTIC SCATTERING OF ELECTRONS FROM A POLARIZED PROTON TARGET*

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We have searched for an asymmetry in the inelastic scattering of electrons from a polarized proton target in the region of resonance excitation, at values of four-momentum transfer squared of 0.4, 0.6, and 1.0 $(\mathrm{GeV}/c)^2$. Data were also taken using an incident positron beam in order to distinguish any possible effect of time-reversal invariance violation from that due to higher-order (α^3) contributions to the scattering. No sizable violation of time-reversal invariance was found.

Following the discovery[1] of CP invariance violation in the decay of the $K_L{}^0$ meson, Bernstein, Feinberg, and Lee[2] pointed out that the violation might result from the existence of a part of the hadronic electromagnetic current that violates time-reversal (T) invariance. Christ and Lee[3] proposed a test of this hypothesis involving the inelastic scattering of electrons from a polarized proton target, in which only the scattered electron is detected. Let $\sigma\uparrow$ ($\sigma\downarrow$) denote the cross section, summed over all outgoing hadronic states Γ, for the reaction

$$ep \rightarrow e\Gamma, \tag{1}$$

where the target proton spin is along (opposite to) the normal $\hat{n}$ to the electron scattering plane,

$$\hat{n} = \vec{p}_{\mathrm{in}} \times \vec{p}_{\mathrm{out}} / |\vec{p}_{\mathrm{in}} \times \vec{p}_{\mathrm{out}}|, \tag{2}$$

defined by the momentum vectors of the incident ($\vec{p}_{\mathrm{in}}$) and scattered ($\vec{p}_{\mathrm{out}}$) electron. Then, in the single-photon-exchange approximation, the asymmetry

$$A = (\sigma_\uparrow - \sigma_\downarrow)/(\sigma_\uparrow + \sigma_\downarrow) \tag{3}$$

must vanish unless T invariance is violated. (For elastic scattering, A can be shown to vanish independently of T, from current conservation and Hermiticity alone.) A nonzero value of A