(the other terms are of higher order). The first term takes into account the effect of c_g on the amplitude of the field, while the second essentially expresses the "phase shift" associated with the finiteness of c_g. Thus, in principle, c_g can be obtained from a measurement of E_R. In reference 5 it is proposed to measure the phase shift to obtain c_g; however, it should be noted that while reference 5 claims this phase shift to be a first-order effect (kR), it is really of third order, $ik^3R^3/2 \approx iv^3/c_g^3$, as is evident from (1) (v is the amplitude associated with the linear velocity of the oscillator). For the experiment proposed in reference 5, it would be necessary to measure an angle $\approx 10^{-17}$ radian, taking $c_g = 3 \times 10^{10}$ cm/sec. At the present time, phase shifts of $10^{-5} - 10^{-6}$ radian are known to have been measured.[7]

From (1) we see that the decrease in amplitude is frequency dependent and at a frequency $\omega/2\pi \sim 200$ cps, and at a distance R = 1 m, we have $k^2R^2/2 \approx 10^{-11}$. Such a small decrease in amplitude can be measured if the oscillator frequency is modulated at some low frequency, ≈ 0.5 cps, and the signal detected synchronously. With such an arrangement, the band-width could be decreased to $\approx 10^{-3}$ cps.

As a detector of the gravitational field, Weber[1] has proposed a piezoelectric transducer, together with associated amplifiers. Such a transducer would consist of a piezoelectric crystal between two sufficiently large masses; the inhomogeneous gravitational field due to the oscillator would lead to a stress in the crystal. We note a number of technical difficulties which would have to be solved before such a scheme would work.

The frequency response of transducer plus amplifiers would have to be horizontal to at least one part in 10^{11}. This implies that the transducer and the reactive elements in the amplifier would have to be temperature controlled within 0.1° C. After demodulation, the signal, proportional to k^2R^2, has an amplitude of only 10^{-10} volts.

Such small signals can be measured with the photo-electric amplifier built by Kozyrev.[8] The oscillator can be a mechanical rotator with diameter $D_0 = 2$ m, operating at a frequency 25 — 50 cps, and with four additional masses distributed along its circumference. The stress appearing upon rotation is $\approx 10^3$ kg/cm^2 which is not too large for the usual grades of steel.

In conclusion the authors would like to thank V. V. Migulin and M. S. Akulin for their discussions of versions of the experiments.

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197

ON THE RADIATIVE CORRECTION IN WEAK-INTERACTION PROCESSES

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It has been shown in a number of papers[1-4] that, in first order in α, the radiative corrections to μ-meson decay lead to a finite renormalization of the interaction constants (with different renormalization for the vector and axial-vector parts). At the same time the analogous correction for β decay, for example that of the neutron, diverges, and moreover this divergence cannot be removed by ordinary mass renormalization.

The cause of the different behavior is that the diagram for μ decay is of a type analogous to the diagram for the emission of a photon. In fact, the interaction Hamiltonian for the decay of a μ meson can be written either in the ordinary V-A form

$$H = \frac{G}{\sqrt{2}} \langle \nu | \gamma_\alpha (1 + \gamma_5) | \mu \rangle \langle e | \gamma_\alpha (1 + \gamma_5) | \nu \rangle, \qquad (1)$$

or in the equivalent form

$$H = \frac{\bar{G}}{\sqrt{2}} \langle e | \gamma_\alpha (1 + \gamma_5) | \mu \rangle \langle \nu | \gamma_\alpha (1 + \gamma_5) | \nu \rangle; \qquad (2)$$

the change from form (1) to form (2) consists only in interchange of two particles of the same helicity, ν and e. In the latter expression the radiation corrections affect only the first factor (there are no charged particles in the second), which differs from the electrodynamic current $\langle e | \gamma_\mu | e \rangle$ by the fact that the mass of the particle changes in the transition, and also by the presence of the factor γ_5 (the current axial vector is $\gamma_5\gamma_\alpha$).

Since, as is well known, the divergent integrals in electrodynamics do not depend on the mass of the particle, the fact that it changes cannot invalidate the conclusion from Ward's theorem[5] that the vertex-part and self-mass divergences cancel. The factor γ_5 can also change nothing in this connection, since the replacement of the wave function ψ by $\gamma_5\psi$ leads only to a change of the mass.

It follows that a finite result will be obtained when one calculates the radiative corrections to μ-meson decay (and to any other process of interaction of μ mesons with electrons: $\mu \rightarrow e + \nu + \bar{\nu} + \gamma$, $e + \nu \rightarrow e + \nu$, $\mu + \nu \rightarrow \mu + \nu$, and so on) in any order (in e^2) of perturbation theory.

In the case of the β decay of the neutron or the capture of a μ meson by a proton the Hamiltonian does not reduce to the electrodynamic form. In fact,

$$H = \frac{G}{\sqrt{2}} \langle p | \gamma_\alpha (1 + \gamma_5) | n \rangle \langle e | \gamma_\alpha (1 + \gamma_5) | \nu \rangle \quad (3)$$

and it is not possible by interchanging particles of the same helicity to group the charged particles in one factor — to do so one must interchange n and e. This latter interchange does not leave the Hamiltonian in the same form, but changes it to[6]

$$H = \sqrt{2} G \langle e | (1 - \gamma_5) | \bar{p} \rangle \langle \bar{n} | (1 + \gamma_5) | \nu \rangle, \quad (4)$$

which, as is well known, is not renormalizable (even if one does not take into account the magnetic moment of the neutron). It can be seen from this that only for processes in which no particles appear except electrons, μ mesons, neutrinos, and photons is it possible to calculate the radiative corrections.

In this connection one cannot at the present time predict theoretically the relative size of the constants calculated, on one hand, from the lifetime of the neutron, and on the other hand from β transitions between nuclei of spin zero ($0^+ \rightarrow 0^+$ transitions); the experimental determination of this ratio is an important problem.

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198

ON AN ESTIMATE OF THE MINIMUM RADIUS OF TWO-PARTICLE INTERACTIONS AT HIGH ENERGIES

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It is impossible in practice to carry out a phase-shift analysis at high energies, owing to the large number of partial waves participating in the interaction. It is therefore important to establish what information may be extracted from the experimental data.

In this note we show how to determine the minimum number of partial waves L_{min} necessary to describe the experimentally known total elastic scattering cross section σ_{el} and the differential cross section at a given angle $\sigma(\vartheta_1)$. The following inequalities may be proved:

a) Spinless particles:

$$\Sigma_0 \geqslant 4\pi\sigma(\vartheta_1)/\sigma_{el}. \quad (1)$$

b) Interaction between particles of spin 0 and $\frac{1}{2}$:

$$\max\{\Sigma_0, \Sigma_1\} \geqslant 4\pi\sigma(\vartheta_1)/\sigma_{el}. \quad (2)$$

c) Not identical Dirac particles:

$$\max\{\Sigma_0, \Sigma_1, \Sigma_2\} \geqslant 4\pi\sigma(\vartheta_1)/\sigma_{el}. \quad (3)$$

d) Identical Dirac particles:

$$\max\{\Sigma_0', \Sigma_0'', \Sigma_1', \Sigma_1'', \Sigma_2', \Sigma_2''\} \geqslant 4\pi\sigma(\vartheta_1)/\sigma_{el}. \quad (4)$$

In these inequalities

$$\Sigma_m = \sum_{l=m}^{L} (2l+1) \frac{(l-m)!}{(l+m)!} [P_l^{(m)}(\cos\vartheta_1)]^2,$$

$$\Sigma_m' = \sum_{l=m}^{L} [1-(-1)^l](2l+1) \frac{(l-m)!}{(l+m)!} [P_l^{(m)}(\cos\vartheta_1)]^2,$$

$$\Sigma_m'' = \sum_{l=m}^{L} [1+(-1)^l](2l+1) \frac{(l-m)!}{(l+m)!} [P_l^{(m)}(\cos\vartheta_1)]^2. \quad (5)$$

The largest of the entries in the curly brackets is to be used on the left hand sides of Eqs. (2) — (4).