where m_μ is the mass of the mu meson and m_0 is the mass of the electron. Numerically the term δ_2 is seen to be of the same order of magnitude as the usual fourth-order correction.

This note was stimulated by recent advances in experimental techniques for the measurement of the magnetic moment of the mu meson. It does not seem inconceivable that it will be possible to measure both the mass and the magnetic moment of the mu meson with an accuracy sufficient to test these radiative corrections. The experimental accuracy will almost certainly be sufficient to test the correction of order α.

In this connection we wish to draw attention to a note by Berestetskii, Krokhin, and Khlebnikov[3] concerning the effect on the magnetic moment of the mu meson of a modification of quantum electrodynamics at small distances.

We are indebted to Dr. T. D. Lee and Dr. C. N. Yang for informing us about recent experiments in the field and to Dr. Norman M. Kroll for helpful discussion.

We use this opportunity to express our gratitude to The Institute for Advanced Study and its Director, Dr. Robert Oppenheimer for kind hospitality shown us during our stay here.

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Magnetic Moment of the μ Meson

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IN the very recent past, the experimental g value—and thus the magnetic moment—of the μ^+ meson was still so uncertain that it did not allow one even to decide whether its spin was $\frac{1}{2}$ or $\frac{3}{2}$. Now, new and powerful methods, due to Garwin, Lederman, and Weinrich,[1] have already determined it to be $+2.00 \pm 0.1$. Moreover these authors have designed a magnetic resonance experiment to determine the magnetic moment to $\sim 0.03\%$. This is only one order of magnitude bigger than the α^2 corrections to this moment, and it seems to be worthwhile, owing to these rapid improvements of the experimental situation, to look into the predictions of quantum electrodynamics.

For the μ meson, with spin $\frac{1}{2}$, the results of Schwinger[2] and Karplus and Kroll[3] can be applied, but one has to consider, in the fourth-order corrections, one more term, the contribution of which is not negligible. It is due to the vacuum polarization effect by electrons during the virtual photon propagation. Its contribution to the magnetic moment is given, in units of $e\hbar(2Mc)^{-1}$, by the integral

$$\mu_P = \frac{\alpha^2}{\pi^2}\int_0^1 du \int_0^1 dv \frac{u^2(1-u)v^2(1-v^2/3)}{u^2(1-v^2)+\lambda(1-u)},$$

with $\lambda = 4m^2/M^2$, m and M being the electron and the μ-meson masses, respectively.

This yields

$$\mu_P = \frac{\alpha^2}{\pi^2}\left[\tfrac{1}{6}\ln(1/\lambda)+\tfrac{1}{3}\ln 2 - \frac{25}{36}+\epsilon\right],$$

the error ϵ being shown to be less than $O(\lambda^{\frac{1}{2}})$. With $M = 207.2m$, the numerical value is

$$\mu_P = (\alpha^2/\pi^2)(1.08),$$

and together with the results of the previous authors, the magnetic moment of the μ meson amounts to

$$\mu = \left[1+\frac{\alpha}{2\pi} - \left(\frac{\alpha^2}{\pi^2}\right)1.89\right](e\hbar/2Mc).$$

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K^+ Production in p-p Collisions at 3.0 Bev*

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FOR some time K^+ particle beams emanating from heavy nuclei have been observed at the Cosmotron and Bevatron,[1–5] first by emulsion and then by counter techniques. The direct observation of strange particle production by π^- mesons of kinetic energy ~ 1.4 Bev incident on hydrogen has been studied by the Brookhaven hydrogen diffusion cloud chamber group[6] and by other groups,[7] and it has been found that, of the total $\pi^- + p$ inelastic cross section of ~ 25 millibarns, about 1 millibarn corresponds to strange particle production of the type

$$\pi^- + p \rightarrow \text{hyperon} + K \text{ meson}.$$

The observation[3–5] of K^+ mesons produced in heavy nuclei at various angles (60–90°) and lab momenta (300–500 Mev/c) gave relative cross sections, expressed in terms of the K^+/π^+ ratio at the target, of $\sim 1/20$ to 1/100.

Using the known order of magnitude cross sections for production of high-energy pions and the previously stated cross section of ~ 1 millibarn for the $\pi^- + p$ interaction leading to strange particle production, one could explain the order of magnitude of the observed production[8] of K^+ and other strange particles from heavy nuclei by a two-step process. First a high-energy pion is produced, which then subsequently interacts with another nucleon in the nucleus producing the K^+.[9] Hence the evidence for direct production in nucleon-nucleon collisions was not conclusive.

One case of K^+ and hyperon production in a p-p collision has been previously reported in a hydrogen diffusion chamber.[10] Several other events of strange particle production of varying degrees of definiteness of interpretation have been observed.[11] However, the situation regarding the p-p production of K mesons and hyperons was still in a very indefinite state and in fact there was some recent experimental evidence[12] that it was anomalously low or even possibly absent.

One might note here that the π^-+p events involve the isotopic spin $\frac{3}{2}$ and $\frac{1}{2}$ states while the p-p case involves $T=1$ and the n-p case involves $T=0$ and $T=1$. One could not rule out the preference of strange particle production for particular isotopic spin states or modes of production.

To investigate this problem an experiment was started using a counter telescope to detect K^+ particles emitted at various angles from a hydrogen target and also a Cu target upon which the external 2.95 ± 0.05 Bev proton beam of the Brookhaven Cosmotron is incident. The counter system included Čerenkov counter elements in coincidence and anticoincidence to select a velocity interval, and a magnet was used to select a momentum interval such that the combination required a positive particle of rest mass equivalent to 495 ± 100 Mev in order to count. This excluded all known particles except K^+. The background due to the accidentals in the telescope was less than 5%. This was checked both by monitoring background and by several range curves taken with the Cu target.

The K^+/π^+ ratio from Cu at 425 Mev/c was observed to correspond to about $1/(80\pm12)$ at the target,[13] while in a short preliminary hydrogen run twelve K^+ counts from hydrogen were observed. The background due to all sources of accidentals in the telescope was monitored during the hydrogen run and would correspond to less than 4%. The telescope did not see the end walls of the Styrofoam H_2 target which in any event were quite thin and even if seen would provide a K^+ rate $<1/10$ that observed. An estimate of the possibility of a high-energy π meson created in the hydrogen or front and back walls of the target which subsequently interacts again in the hydrogen target to yield a K^+, gives an upper limit of the order of 5%. Hence the background events of all types other than direct K^+ production in a p-p collision could at most account for 10% of the observed rate. The estimated probability that the observed rate in this preliminary measurement is a background fluctuation or other spurious effect is less than 10^{-5}.

The K^+/π^+ ratio observed in H_2 in this measurement corresponds to a value at the target of $1/(200\pm70)$. This is lower than the value in copper, by a factor of 2.5 ± 1. However, the lack of Fermi momentum would tend to account for at least part of this. Hence these data imply that direct K^+ production in p-p collisions exists[14] and contributes to the K^+ production from heavier nuclei.

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[9] We wish to thank R. M. Sternheimer for making a more accurate calculation of this effect for us, which gives the result that about one-half (or even possibly all) of the K^+ production in copper can be explained by this process.

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[12] G. Collins had informed us that, in observations of γ rays from decaying neutral strange particles produced in hydrogen and heavier elements, the cross section for hydrogen was found to be less than $\frac{1}{6}$ of the cross section per nucleon for heavier nuclei and was within errors consistent with zero.
[13] This is consistent with previous measurements at somewhat different momenta (see references 3 and 5).
[14] After completion of this experiment the authors were informed by G. Harris and J. Orear that an emulsion experiment to detect K^+ particles produced by 3.0-Bev protons incident on a hydrogen target observed at 0° had yielded a preliminary indication that the cross section is not zero and a preliminary indication that the K^+/π^+ ratio from hydrogen seems to be smaller than from Cu.