duction in electron-electron beams becomes greater than the cross section for μ-meson pair production in electron-positron beams. If such energies and angles were experimentally attainable, we would have a convenient method for an experiment with electron-electron beams.

The estimate given below has been made both for the integral and differential cross sections, using the Weizsäcker-Williams method. For the integral cross section for the $e^- + e^+ \rightarrow e^- + e^+ + \mu^+ + \mu^-$ reaction we have, in the c.m.s.,

$$\sigma_{sc} \approx \frac{28}{27}\frac{r_0^2}{\pi}\alpha^2\frac{m^2}{\mu^2}\left(\ln\frac{E}{m}\right)^3,$$

where $\hbar = c = 1$, m is the electron mass, μ is the μ-meson mass, r_0 is the classical electron radius, $\alpha = 1/137$, and E is the energy of the incident electron in the rest system of the other electron ($E = 2E_{cms}^2/m$). The differential cross section at small angles is

$$\frac{d\sigma_{sc}}{d\Omega} \approx \frac{\alpha^2 r_0^2}{12\pi^2}\frac{m^2}{\mu^2}\left(\ln\frac{2E_{cms}^2}{\mu^2}\right)^4, \quad \theta \ll \mu/E_{cms}$$

where θ is the angle of the μ meson in the c.m.s.

The range of the angles under consideration decreases with the energy. However, in the experiments using colliding beams, small angles are for technical reasons completely uninteresting, and for large angles we obtain

$$\frac{d\sigma_{sc}}{d\Omega} \approx \frac{2\alpha^2 r_0^2}{\pi^2}\frac{m^2}{\mu^2}\left[A(\beta) + \frac{B(\beta)}{1-\varphi^2}\right];$$

$$\frac{\pi}{2} - \theta \equiv \varphi \ll 1, \qquad \beta = \frac{2E_{cms}^2}{\mu^2},$$

$$A(\beta) = \tfrac{1}{16}\ln^3\beta + \tfrac{3}{8}\ln 2\ln^2\beta - \tfrac{15}{16}\ln^2 2\ln\beta + \tfrac{1}{4}\ln^3 2,$$

$$B(\beta) = \tfrac{1}{15}\ln^3\beta + (0.4\ln 2 - 0.6)\ln^2\beta + (1.2\ln 2 - \ln^2 2)\ln\beta + \tfrac{4}{15}\ln^3 2 - 0.6\ln^2 2.$$

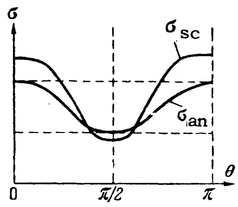
In the limit of very high energies ($\ln\beta \gtrsim 6$) we obtain a simpler expression

$$\frac{d\sigma_{sc}}{d\Omega} \approx \frac{2\alpha^2 r_0^2}{\pi^2}\frac{m^2}{\mu^2}\left(\ln\frac{2E_{cms}^2}{\mu^2}\right)^3\left[\frac{1}{16} + \frac{1}{15}\frac{1}{1-\varphi^2}\right].$$

Let us compare this with the differential cross section for the μ-meson pair production in electron-positron annihilation, which, as is well known, is given by the equation[1]

$$\frac{d\sigma_{an}}{d\Omega} = \frac{r_0^2 m^2}{16}\frac{\sqrt{E_{cms}^2 - \mu^2}}{E_{cms}^3}\left(1 + \frac{\mu^2}{E_{cms}^2} + \frac{E_{cms}^2 - \mu^2}{E_{cms}^2}\cos^2\theta\right).$$

From the comparison it follows in particular that, for an electron energy $E_{cms} \sim 1.5-2$ BeV, σ_{sc} is greater than the annihilation cross section for practically all angles. The change from $\sigma_{an} > \sigma_{sc}$ to $\sigma_{sc} > \sigma_{an}$ occurs approximately at ~ 1.2 BeV in the c.m.s., and even at energies only a little lower than the critical value there is a large range of angles near $\theta = \pi/2$ in which $\sigma_{an} > \sigma_{sc}$, as can be seen from the expression for the cross section and the figure.



The author would like to thank I. L. Rozental' for suggesting the problem and discussion.

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Translated by H. Kasha
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SPIN ECHO IN A LOCAL FIELD

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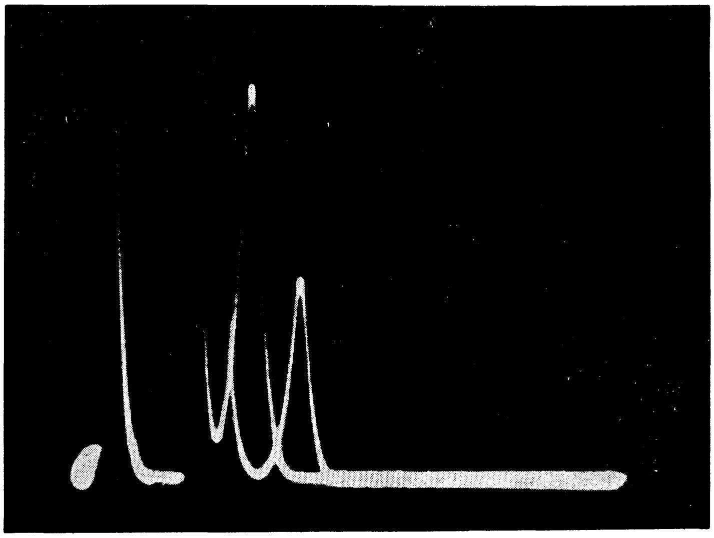
In conventional experiments on spin echo the signal is due to the reversible merging of individual magnetic moments due to inhomogeneities in the external magnetic field. It is not possible to make use of the inhomogeneities of the internal local field due to neighboring nuclei, because the second (180°) pulse simultaneously changes the direction of the nuclear magnetization as well as of the local field.[1] Such an echo has been observed[2] in ferromagnetic substances, in which the local field is due to electrons.

We have observed spin echo of F^{19} nuclei in the inhomogeneous field of the paramagnetic ions Gd^{3+}, present in the form of an impurity with concentration $\sim 0.01\%$ in the single-crystal CaF_2 under study. The effect was absent at room and at liquid nitrogen temperatures and was easily observable at 4.2°K and below.



Double exposure of echo signals from F^{19} in CaF_2 single crystal at temperature 0.38°K. The interval between pulses is 70 and 90 μsec; value of $T_2 = 136$ μsec; crystal axis [111] $\parallel H_0$.

The 3370 Oe external magnetic field was sufficiently homogeneous (of the order of 10^{-5}) so that the conventional echo could not be observed.

The amplitude of the echo signals is substantially smaller than that of the free precession signal, since not all nuclei participate in the formation of the echo but only those that lie in the field of the ion. The envelope of the echo amplitudes has a Gaussian form and at 0.3°K the times T_2 vary between 90 and 140 μsec, depending on the orientation of the crystal (largest value occurs for [111] $\parallel H_0$). T_2 decreases from 140 to 70 μsec at 4.2°K.

The width of the echo signal, which characterizes the local field, decreased from 30—40 G at 0.3°K to 20—30 G at 4.2°K; no explicit anisotropy in the width was observed.

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[1] Emshwiller, Hahn, and Kaplan, Phys. Rev. **118**, 414 (1960).

[2] Weger, Hahn, and Portis, J. Appl. Phys., Suppl. **32**, 124S (1961).

Translated by A. M. Bincer
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THE η^0 MESON AND THE MASS DIFFERENCE OF THE K_1^0 AND K_2^0 MESONS

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WHEN attempts are made to calculate theoretically the magnitude and sign of the mass difference Δm for the K_1^0 and K_2^0 mesons, it is very important to know the value of the K-π transition constant, which determines the additional mass $\Delta m(K_2^0)$ of the K_2^0 meson, along with the K_2^0-3π transition and the K_2^0-meson transitions to higher mass states[2]. To calculate the contribution of the one-pion diagram to the K_2^0-meson mass, Bose[3] made the assumption that the non-lepton decay of the Σ hyperon proceeds via its virtual dissociation into a $\bar{K}$ meson and a nucleon with subsequent $\bar{K}$-π transition.

In the present note we wish to use for the estimate of the K-π transition another circumstance, which has been frequently discussed of late. We refer to the single pole mechanism of the η^0- and K-meson decay into three pions[4-9] via a virtual pion. This mechanism is a specific consequence of the recently determined η^0-meson quantum numbers (0^{-+}) and the known selection rule $\Delta T = 1/2$ in K decay, which lead in both cases to a