the result of the action of the generalized function $\psi(\tau)$ on the Cauchy kernel $(1/2\pi i)[1/(\zeta-\tau)]$ is a function which is analytic in ζ (off the positive semiaxis):

$$U_\psi(\zeta)=\sum_{\nu=0}^{\infty}\frac{1}{2\pi i}\int_0^\infty\frac{d\sigma_\nu(\tau)}{(\zeta-\tau)^{\nu+1}}. \tag{8}$$

The Cauchy formula for the function $\varphi(\tau)$, in the test-function space, implies

$$(\psi,\varphi)=\int_{C_\varphi}U_\psi(\zeta)\,\varphi(\zeta)\,d\zeta. \tag{9}$$

The retarded asymptotic amplitude $F_\infty^{\mathrm{ret}}(\omega;t)$ is, for any fixed $t\le 0$, just the Fourier transform of the generalized function $\psi(\tau;t')$, i.e., the value of this functional for the test function $i\exp(i\omega\tau)$, $\mathrm{Im}\,\omega>0$, belonging to the test function space. Equations (6)—(8) imply that this transform is an analytic function of ω in the upper half-plane $\mathrm{Im}\,\omega>0$ and increases slower than any exponential function $\exp(\epsilon|\omega|)$, $\epsilon>0$. According to [3] this fact implies that the amplitude $F_\infty^{\mathrm{ret}}(\omega;t)$ satisfies a dispersion relation with n subtractions if and only if the corresponding integral along the cut converges. The behavior of the function on the large circle need not be considered at all. The asymptotic advanced amplitude possesses similar properties. We note that just these properties are necessary in order to establish the asymptotic equalities between the cross sections for particles and antiparticles. Therefore all the results obtained in [4] and [5] acquire in terms of the asymptotic amplitudes a more direct character.

I am glad to express my profound gratitude to M. V. Terent'ev for numerous important discussions.

1)For $x_0\to+\infty$, $\langle p'|j(x/2)\,j(-x/2)|p\rangle$ converges to $\langle p'|_{\mathrm{out}}(x/2)\,j_{\mathrm{in}}(-x/2)|p\rangle$. In Eq. (3) and following, $\langle p'|j(x/2)\,j(-x/2)|p\rangle$ will denote the difference between these two expressions. The Fourier transform of the pure asymptotic amplitude produces the pole terms in the amplitude.

1 Bogolyubov, Medvedev, and Polivanov, Voprosy teorii dispersionnykh sootnosheniĭ (Problems of the Theory of Dispersion Relations), Fizmatgiz, Moscow, 1958.

2 H. Lehmann, Nuovo cimento 10, 579 (1958).

3 N. N. Meĭman, in the collection "Voprosy fiziki élementarnykh chastits (Problems of Elementary-particle Physics), Erevan, 1963, p. 123

4 N. N. Meĭman, JETP 43, 2277 (1962), Soviet Phys. JETP 16, 1609 (1963).

5 N. N. Meĭman, JETP 46, 1039 (1964), Soviet Phys. JETP 19, 706 (1964).

Translated by M. E. Mayer
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STUDY OF THE DECAY OF THE K_2^0 MESON INTO THREE NEUTRAL PIONS

A. S. ALEKSANYAN, A. I. ALIKHANYAN, A. M. GAL'PER, R. L. KAVALOV, V. G. KIRILLOV-UGRYUMOV, L. P. KOTENKO, L. A. KUZIN, E. P. KUZNETSOV, and G. I. MERZON

P. N. Lebedev Physics Institute, Academy of Sciences, U.S.S.R.; Moscow Engineering Physics Institute; Physics Institute, State Atomic Energy Commission, Erevan

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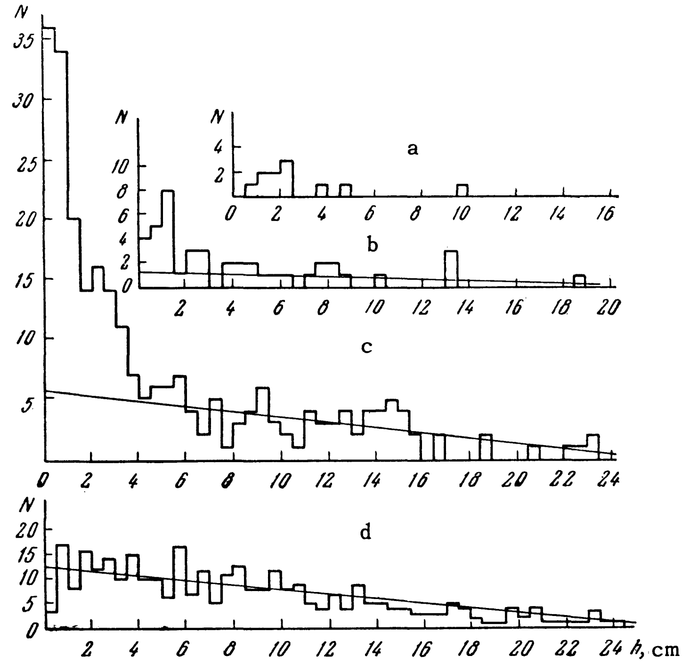
So far there are a few data on $K_2^0\to3\pi^0$ decays [1,2]. We investigated these decays with the aid of a 570-liter freon bubble chamber [3], which was placed in a neutral-particle beam from the proton synchrotron of the Joint Institute of Nuclear Research. A description of the experiment and preliminary results were reported earlier [4].

Some 50,000 stereo photographs were taken during the irradiation. The possible cases of K^0-meson decay were classified as events with 3, 4, 5, or 6 electron-positron pairs directed approximately towards the same points, and also V-events. As a measure of the convergence of the quanta producing the pairs we chose the maximum distance h from the point of intersection of the trajectories of the two nearest γ quanta to the trajectories of the other γ quanta. The distribution of events with 6, 5, 4, and 3 electron-positron pairs relative to the convergence parameter h is shown in Figs. a, b, and c. In the construction of the histograms we used the largest of the values of h, measured in two projections. The distribution of events with three electron-positron pairs, obtained by the Monte Carlo method, is shown in Fig. d. A comparison of the histograms shown in the figure indicates that there exist definite physical causes that lead to the appearance of three and more electron-positron pairs whose vertices are directed approximately towards the same point.



Distribution of events relative to the convergence parameter h: events with six and five (a), four (b), and three (c) electron-positron pairs; d—events with three electron-positron pairs obtained by the Monte Carlo method. Straight lines on the histograms b, c, and d approximate the distribution of the background events due to the random superpositions.

The results of the experiment are illustrated by the table. In the second column of the table is given the total number of cases N_{tot} corresponding to $h < 4.5$ cm. We note that these results do not change (within the limits of statistical errors) when the limiting value of h is chosen to range from 3.5 to 10 cm. In the third column is given the number of events N connected with the random superpositions. The fourth column lists the contribution of events due to decay of the K_1^0-mesons regenerated in the chamber into two neutral pions.

Under the conditions of our experiment, practically all the regenerated K_1^0 mesons are deflected less than 15°. We chose 182 V-events which did not contradict the kinematics of the $K_1^0 \rightarrow \pi^+\pi^-$ decay, and whose planes made angles $\leq 15°$ with the beam direction. Inasmuch as in our chamber the probability of conversion of a γ quantum with energy ~ 150 MeV is equal to 0.43, we can expect the $K_1^0 \rightarrow 2\pi^0$ decays to lead to the appearance of not more than three events with four electron-positron pairs and 17 events with three pairs.

The fifth column gives the estimates of the number of events due to inelastic nuclear interactions of the neutrons and K_2^0 mesons, which are accompanied by three and more electron-positron pairs. A study of the nuclear interactions in our chamber has shown that in 60% of the cases they should be accompanied by the appearance of slow protons. Therefore the contribution of the nuclear interactions can be estimated from the number of investigated events with tracks of slow protons near the point of intersection of the γ-quanta trajectories.

The subtraction of the number of events given in the third, fourth, and fifth columns of the table from the total number of events yields 110 cases with three and more electron-positron pairs. The origin of these events can be attributed only to $K_2^0 \rightarrow 3\pi^0$. The result obtained can be regarded as dependable proof of the existence of a $K_2^0 \rightarrow 3\pi^0$ decay. Its reliability does not depend on the accuracy with which the γ-quantum registration efficiency is determined, or on other corrections.

Number of electron-positron pairs in the event	N tot, $h < 4.5$ cm	No. events appearing as result of different processes except $K_2^0 \rightarrow 3\pi^0$ decays			No. of $K_2^0 \rightarrow 3\pi^0$ decays
		N_{rand}	N $(K_2^0 \rightarrow 2\pi^0)$	N_{nuc}	
six	1 *	0	0	0	1
five	8	2	0	0	6
four	28	8	3	0	17
three	157	46	17	8	86
Sum	194	56	20	8	110

*Convergence parameter h = 2.1 cm.

In addition to these cases, 1855 V-events were registered in the chamber. (This figure takes into account the scanning efficiency, which was the same for V-events and events with three and more electron-positron pairs.) 21% of these events should be attributed to nuclear interactions and to $K_1^0 \to \pi^+\pi^-$. Having 110 cases of the decay $K_2^0 \to 3\pi^0$ with three and more electron-positron pairs, and knowing that the efficiency with which the chamber registers γ quanta of energy ~ 100 MeV amounts to 0.4, we can find that the probability of the $K_2^0 \to 3\pi^0$ decay relative to all the decays of the K_2^0 meson amounts to 0.2 ± 0.06. The reduced error, in addition to statistical errors, indicates the uncertainty in the efficiency of registration of the γ quanta from the $K_2^0 \to 3\pi^0$ decay. This result agrees with the data obtained in [1] and with theoretical predictions (23.6%) obtained assuming that the $\Delta T = 1/2$ rule holds [5].

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[1] Anikina, Zhuravleva, Kotlyarevskiĭ, Mandzhavidze, Mestvirishvili, Neagu, Okonov, Petrov, Rusakov, Taktamyshev, Chkhaidze, and Wu, Preprint, Joint Inst. Nuc. Res. R-1332, Dubna, 1963.

[2] Darmon, Rousset, and Six, Phys. Lett. **3**, 57 (1962).

[3] Aleksanyan, Alikhanyan, Veremeev, Gal'per, Kirillov-Ugryumov, Kotenko, Kuzin, Kuznetsov, and Merzon, PTÉ No. 6, 34 (1961).

[4] Aleksanyan, Alikhanyan, Gal'per, Kavalov, Kirillov-Ugryumov, Kotenko, and Kuzin, Coll. Voprosy fiziki élementarnykh chastits (Problems in Elementary-particle Physics), ArmSSR, Erevan, 1963, p. 324.

[5] L. B. Okun', Slaboe vzaimodeĭstvie élementarnykh chastits (Weak Interaction of Elementary Particles), Fizmatgiz, 1963.

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INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE SATURATION MAGNETIZATION OF Gd

V. E. RODE, R. HERRMANN, and L. M. KOROLEV

Moscow State University

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THE purpose of the present work was to investigate the temperature dependence of the saturation magnetization of Gd at low temperatures (from 4.2 to 30°K). The investigation was carried out using the method described in detail earlier,[1] i.e., we measured the magnetization change ΔI when the temperature was altered from T to that of liquid helium. The sample was in the form of a polycrystalline gadolinium cylinder, 110 mm long and 8 mm in diameter, containing the following impurities: 1.0% I, 0.01% Ca, 0.06% Fe, 0.02% Cu.

It is known[2,3] that the intrinsic temperature dependence of the saturation magnetization should be investigated in sufficiently strong magnetic fields. The intensity of such fields can be found by analyzing the dependence of ΔI on H. Figure 1 shows the experimental dependence of ΔI on H for Gd. If the measurements are made in fields H stronger than 15,000 Oe, the results obtained reflect well the intrinsic temperature dependence of the saturation magnetization.

Our measurements were carried out in a field H = 18,600 Oe. Figure 2 shows the experimental dependence of ΔI on T. The value of ΔI was determined to within 5%. The error in the determination of T between 4.2 and 10–12°K amounted to 7–5%; above 12°K, it was 2%.

The experimental points do not fit the curve described by the law $I = I_0(1 - CT^{3/2})$. We may at-

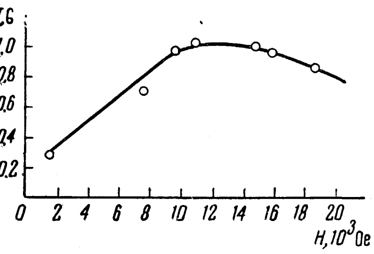

FIG. 1