stance that leads to the mutual transformations of different particles of an isotopic multiplet (the phenomenon of charge exchange scattering). In particular, as was pointed out to us by Ya. B. Zel'dovich, the very existence of antiproton exchange scattering ($\tilde{p} + p \rightarrow \tilde{n} + n$) implies a ρ^0-π^0 mass difference.

In a subsequent communication we shall describe the main features of an experimental setup which is being used in the search for ρ^0 mesons and report preliminary results of completed measurements.

We are extremely grateful to L. I. Baz', V. B. Belyaev, B. N. Zakharev, L. B. Okun', and Ya. A. Smorodinskiĭ for numerous discussions.

*It is easy to see that for a three-particle final state the threshold singularity practically disappears.[2]

†We have recently been informed that V. I. Gol'danskiĭ and Ya. I. Smorodinskiĭ proposed and analogous method.

‡Barrier effects, having to do with high orbital angular momentum, may appreciably slow down[4] the decay of the ρ^0 meson into four π mesons if its mass is only slightly larger than the sum of the four π-meson masses.

**Private communication from D. Frish to V. I. Gol'danskiĭ.

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SINGULARITIES OF THE S MATRIX AND THE ρ^0 MESON

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THE hypothesis that another neutral meson (ρ^0 meson) exists with zero spin and strangeness has been discussed in several papers. All the methods proposed for verifying this hypothesis were based on the observation of some reaction producing the ρ^0 meson or on the detection of its decay products.

We wish to point out here that still another method exists, based on an essentially different idea, which may turn out to be considerably more convenient for actual experiments. It has to do with the study of singularities in the energy dependence of a reaction near the threshold for the production of a new particle. This method was first studied in a general form by Wigner.[1] Later Baz'[2] indicated the interesting consequences resulting from an application of this method to nuclear reactions (see also the work by Breit and others,[3] which was published simultaneously).

The same idea was used in a study of photodisintegration near threshold for the γn reaction[4] and in a study of K-meson properties.[5] This same method was used[6] to detect the dineutron in a study of the energy dependence of elastic neutron scattering by nuclei near the threshold for the (n, 2n) reaction.

It is natural to apply the consideration of Baz' et al.[6] to a study of the analogous problem concerning the existence of the ρ^0 meson. Specifically let us consider elastic scattering on protons of π mesons with energy in excess of 270 Mev.* The scattering cross section for the process may exhibit two types of singularities.

a) Singularities connected with the "isobaric" state, e.g., $\pi^+ + p \rightarrow$ "isobar" ($T = 3/2$, $I = 3/2$). A pole in the S matrix in the complex energy plane corresponds to this type of singularity; and near this pole, for real values of the energy, the cross section curve has the well known resonance shape.

b) The threshold for the production of a new particle, e.g., $\pi^- + p \rightarrow \rho^0 + n$. A branch point on the real axis corresponds to the threshold of such a reaction.† At such a point the derivative (in our case, the first derivative) of the cross section is discontinuous. It is this type of singularity that we are interested in. Its existence leads to the appearance of breaks in the cross section curve in the form of a "step" or "valley" or "peak" type cusps (cf. reference 2), and these should be found experimentally. In the first two cases the singularity can be interpreted unambiguously. If, however, the singularity is of the "peak" type then it may easily be mistaken for a resonance. In that case the fact that the peak should, generally speaking, be rather narrow (of the order of 10 — 20 Mev) may help to identify it. This last circumstance makes the possibility unlikely that the observed maxima for $T = 1/2$ for π mesons of energies 680 and 940 Mev (private communication from D. Frish) could be due to the production of the ρ^0 meson ("ρ^0-mass" — 1200 and 1520 electron masses). Another method for distinguishing resonance and threshold singularities may be based on a comparison of interactions in systems with the same energy but different isotopic spin. Thus, for example, if the singularities in π^-p scattering at 680 and 940 Mev are threshold singularities then corresponding singularities should appear in K^-p scattering at K-meson energies of 520 and 810 Mev (in the $T = 0$ state).

A study of the magnitude of the singularity would permit an estimate of the upper limit for the possible production cross section of the ρ^0 meson. To this end it is convenient to make use of the quantity

$$2\left(\frac{\delta\sigma(\varepsilon)}{\sigma(\varepsilon)}\right)^2 = \left(\frac{\sigma(E_0+\varepsilon)-\sigma_{\text{thr}}}{\sigma_{\text{thr}}}\right)^2 + \left(\frac{\sigma(E_0-\varepsilon)-\sigma_{\text{thr}}}{\sigma_{\text{thr}}}\right)^2,$$

where E is the threshold energy and is the elastic cross section. It is easy to show that

$$\delta\sigma(\varepsilon)/\sigma(\varepsilon) = (k/4\pi)\,\sigma_\rho(\varepsilon)/\sqrt{\sigma(\varepsilon)}.$$

Here k is the π-meson wave vector and σ_ρ is the ρ^0 production cross section at a π-meson energy $E + \epsilon$.

In conclusion we note that the same idea was proposed independently by Pontecorvo et al.[7] to whom we are grateful for useful discussions.

*If the threshold for ρ^0 production were to correspond to a π-meson energy of less than 270 Mev then the relatively fast decay $K^+ \to \pi^+ + \rho^0$ ($\Delta T = 1/2$) would be possible, which however, has not been observed.

†This is connected with the fact that the scattering phase shift δ_0 becomes complex above threshold (near threshold): $\delta_0 = \delta_{01} + i\delta_{02}$, with δ_{01} an even function of k (the ρ^0 wave vector) and δ_{02} an odd function. Hence below threshold δ_{02} is imaginary and therefore δ_0 is real.

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ANISOTROPY OF THE ABSORPTION COEFFICIENTS OF ULTRASONICS IN SUPERCONDUCTORS

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It is known that both the energy gap at $T = 0$ and the temperature dependence of the gap width (ϵ_0) can be determined from measurements of ultrasonic attenuation in superconductors.[1] The agreement between experiment and theory is satisfactory.

There have also been determinations of the effect of isotopic constitution[2] and of unidirectional lattice deformation[3] on T_K, and consequently on the gap width too. One might expect anisotropy of the lattice to have a greater influence than isotopic constitution.

In this note we report the results of an experimental determination of the attenuation of 70-Mcs ultrasound in the superconducting and normal states. The arrangement was such that at each temperature the absorption coefficient could be measured along the twofold (C_2) and the fourfold (C_4) axes for a spherical tin specimen.

The results are shown in the table, and also the values of ϵ_0 calculated from them according to the Bardeen, Cooper, and Schrieffer theory.[4] It can be seen that the temperature dependence of the ratio of absorption coefficients, α_s/α_n, is different in the two directions. Better agreement