

CONCERNING THE REALITY OF THE NONSTATIONARY MODEL OF THE INTERMEDIATE STATE

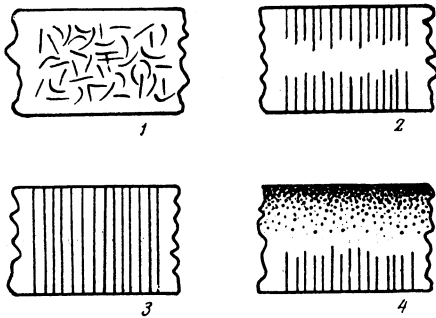
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GORTER¹ has suggested a model of the intermediate state of superconductors with currents, in which continuous shifting of the boundaries between the superconducting and normal phases takes place. In the case of a cylindrical sample with current flowing parallel to the axis, this model leads to the formation of cylindrical regions and rings, moving and gradually constricting from the periphery to the axis of the cylinder. Under the joint action of a magnetic field perpendicular to the axis of the cylinder, and current, these regions, directed along the current and the field, move perpendicular to the axis of the cylinder.



Our observations of the intermediate state do not agree with the Gorter picture. Thus, B. Balashova, using a toroidal sample in which a superconducting current was excited by a field, observed an extremely sharp distribution of regions of normal and superconducting phases, having the form of layers situated perpendicularly to the axial line. However, this picture was obtained under nonstationary conditions, and to eliminate objections associated with this, we undertook experiments in which the picture of the distribution was observed with a constant current flowing through a cylindrical sample.

Two series of measurements were carried out: in the first series, the variable component of the magnetic field of the current on the surface of a monocrystalline tin sample (2 mm in diameter and 10 cm long) was measured using a bismuth microprobe. In the frequency range from 40 to 30,000 cps, no periodic or nonperiodic signals were observed with amplitudes exceeding $10 \mu\text{v}$ (noise level), which would have occurred with changes of the magnetic field (at $T = 3.5^\circ \text{K}$ and $H_K = 30$ oersted) of the order of 0.02 oersted. Also, no effect was observed under the joint action on the sample of the current and an external magnetic field.

In the second series of experiments, a sample 8 mm in diameter and 50 mm long was used. Magnetic powder was used to display the structure of the intermediate state. The following experiments were performed (see figure).

1. The sample was cooled to $T = 3.5^\circ \text{K}$ in a field exceeding H_C , and the picture of a disordered distribution of normal and superconducting regions was observed.

2. The sample was cooled to $T = 3.5^\circ \text{K}$, after which a field exceeding $H_C/2$ was switched on. In this case the powder distribution was reminiscent of the pictures obtained by Balashova on a toroid, except that the layers perpendicular to the generator of the cylinder do not intersect in its central part. Similar pictures were observed by Schawlow² on plane samples.

3. The samples were cooled to $T = 3.5^\circ \text{K}$ in a magnetic field exceeding $H_C/2$. Then a current $\sim 15\%$ of critical was sent through the sample. After applying magnetic powder, a very sharp regular picture was observed of the distribution of regions of normal and superconducting phases, situated perpendicularly to the axis of the cylinder. In fields of 60, 75, and 90% of H_C , the distance between the regions varied from 0.4 to 1 mm, respectively.

4. With currents greater than 15% of I_C , and with relatively small transverse fields, the picture remained just as sharp, but regions of normal phase appeared in the parts of the cylinder at which the total field exceeded critical.

Thus, the structure predicted by Gorter did not occur experimentally.

The regularity of the distribution of the layers of normal and superconducting phases may undoubtedly be utilized for the measurement of the surface stresses of superconductors.

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¹C. J. Gorter, *Physica* **23**, 45 (1957).

²A. L. Schawlow, *Phys. Rev.* **101**, 573 (1956).

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SPINS AND PARITIES OF THE HYPERFRAGMENT H_{Λ}^4 AND OF THE K MESON

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IN this note we shall give a summary of the angular correlations in the cascades:

$$\pi^- + \text{He}^4 \rightarrow H_{\Lambda}^4 + K, H_{\Lambda}^4 \rightarrow \text{He}^4 + \pi, K \rightarrow \pi + \pi; \quad (1)$$

$$K^- + \text{He}^4 \rightarrow H_{\Lambda}^4 + \pi, H_{\Lambda}^4 \rightarrow \text{He}^4 + \pi \quad (2)$$

for several variants of spins in parities of H_{Λ}^4 and K.

We assume at first that the spin of the K meson is zero. If in cascade (1) the first reaction takes place near the threshold (kinetic energy of the π^- mesons in the laboratory is 620 to 640 Mev), then it is natural to assume that H_{Λ}^4 and K are formed predominantly in the s state if π (the product of the parities of π^- , He^4 , H_{Λ}^4 , and K) is $(-1)^i$ (i is the spin of the hyperfragment), and in the p state if $\pi = (-1)^5$ (in this case the production in the s state is forbidden). The distribution about the angle γ

Parity variant	Spin variant		
	0	1	2
$\pi = (-1)^i$	1	$3 \cos^2 \gamma$	$5/4 (1 - 6 \cos^2 \gamma + 9 \cos^4 \gamma)$
$\pi = -(-1)^i$	Forbidden reaction	$3/2 (1 - \cos^2 \gamma)$	$15/2 (\cos^2 \gamma - \cos^4 \gamma)$

between the direction of the incident pions and the H_{Λ}^4 decay products (in the system where H_{Λ}^4 is at rest), given in the table, has been obtained under these assumptions. As can be seen, it is possible in principle to determine not only i , but also the products of the parities of H_{Λ}^4 and K (assuming that the product of the parities of the π^- and He^4 is -1).

Cascade (1) contains three reactions, and it therefore permits also the determination of the spin of the

K meson by the Adair method¹ (true, if $k \neq 0$, the product of the parities of H_{Λ}^4 and K is no longer determined by the angular correlations). For this purpose one first selects such cases of the reaction $\pi^- + \text{He}^4 \rightarrow H_{\Lambda}^4 + K$, in which the hyperfragment and the K meson make (in the center of mass system) small angles $\vartheta_f \approx 0$ with the direction of the incident pions (aligned with the z axis). If the H_{Λ}^4 decays associated with the $K \rightarrow \pi + \pi$ decays are further selected such that the pions make small angles $\vartheta \leq \Delta\vartheta$ with the same z axis, then the distributions about γ , which are chosen on the basis of this selection and which determine the spin i , will be the same as on the threshold in the variant $\pi = (-1)^i$ (see table). If one chooses instead the decays $K \rightarrow \pi + \pi$, associated with the H_{Λ}^4 decays along the z axis, it is possible to determine k . The correlation relative to the angle between the z axis and the direction of the decay products of K (in the system where the K meson is at rest) is given as a function of k in the same first line of the table.¹ The value of the permissible intervals of small angles ϑ_f and ϑ ($\Delta\vartheta_f$ and $\Delta\vartheta$) diminishes with increasing l'_{max} —the maximum important orbital momentum of the products of the reaction $K^- + \text{He}^4 \rightarrow H_{\Lambda}^4 + K$ —and spin k respectively. If $l'_{\text{max}} = 1$, we get $\Delta\vartheta_f \approx 20^\circ$.

Cascade (2) was first proposed by Dalitz,³ and Gell-Mann⁴ gives a set of correlations for this cascade. If $k = 0$, these correlations have the same form as in the table, but relative to another angle θ , see Ref. 4. We emphasize here only that these formulas must be compared with the experimental distributions, obtained for the reactions $K^- + \text{He}^4 \rightarrow H_{\Lambda}^4 + \pi^0$ without preliminary formation of a mesonic atom. If we verify somehow that the reaction took place "in flight," one can expect that at K-meson energies up to