2) The concept of a united electromagnetically-weak interaction was developed in the papers of Schwinger [11], Zel'dovich, and especially Salam and Ward[12]. This notion presupposes that $g = e$ and that the intermediate boson has a large mass $M \approx 30\ m_p$. The concrete expression used here for the connection between the weak and the electromagnetic interactions corresponds to the author's paper [10].

3) The most direct, although presently very uneconomical, way of constructing a unified electromagnetic weak interaction with broken isotopic symmetry consists in increasing further the number of intermediate X-fields in (1) with additional currents of the (V + A) type and "neutrino-flip" transitions $(\nu_e\text{-}\mu^+)$ and $(\nu_\mu\text{-}e^+)$. Such a model can be reconciled with all the available data. An analysis of this interesting problem will be published elsewhere.

4) According to (1), a contribution to parity nonconservation effects in electromagnetic processes should be made by the self-action term of the singlet current $g^2 f^2 j^{u(0)} j^{u(0)}$. In addition, such effects, of course, appear in second order in C.

5) The requirement that the parity nonconservation in electromagnetic phenomena have a magnitude $\beta(\alpha C)$ can be satisfied, for example, by means of the following choice of constants:

$$M^2_{V(\pm)} = M^2_s = M^2, \quad M^2_{V(0)} = M^2_{\gamma(0)} = M^2/2(1/\beta + 1), \quad \kappa^2 = \pm M^2/2(1/\beta - 1)$$

where the plus sign is for $\beta < 1$ and the minus sign for $\beta > 1$.

VECTOR PAIRING IN SUPERCONDUCTORS OF SMALL DIMENSIONS

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It has been suggested in several papers [1,2] that electron pairing takes place in some superconductors in a state with unity orbital angular momentum, thus explaining the results of experiments on the Knight shift. However, the theoretical analysis of the vector pairing was made for infinite space, whereas the experiments were performed on samples with dimensions much smaller than the depth of penetration of the magnetic field.

It will be shown below that vector pairing vanishes when the pair dimensions are larger than the sample dimension or the electron mean free path. In ordinary scalar pairing the transition temperature is independent of both the sample dimensions and the impurity concentration. The reason for this difference is that in vector pairing the wave function F of the pair depends on the direction of the relative momentum of the electrons forming the pair, and vanishes when the momentum uncertainty becomes of the order of the pair dimensions.

Let us consider first the influence of impurities on vector pairing. We average the equations for the Green's functions in the same manner as in scalar pairing [4], obtaining the proper-energy parts $\overline{G}$ and $\overline{F}$

$$(i\omega_n + i\overline{G} - \xi)G + (\Delta + \overline{F})F^+ = 1$$
$$(i\omega_n + i\overline{G} + \xi)F^+ + (\Delta^+ + \overline{F}^+)G = 0 \tag{1}$$

where

$$\overline{G} = in\int|u(\underset{\sim}{p} - \underset{\sim}{p}')|^2G(\underset{\sim}{p}')[dp'/(2\pi)^3]; \qquad \overline{F} = n\int|u(\underset{\sim}{p} - \underset{\sim}{p}')|^2F(\underset{\sim}{p}')[d\underset{\sim}{p}'/(2\pi)^3] \tag{2}$$

n is the impurity concentration, and u(q) is the Fourier component of the potential of interaction between the electron and the impurity atom.

We assume that attraction in the p-state (symmetrical in the spin indices) predominates in the interaction between the electrons:

$$\hat{V} = g(\underset{\sim}{n}\cdot\underset{\sim}{n}')(\sigma^y \sigma^i)_{\alpha\beta}(\sigma^y \sigma^i)_{\gamma\delta}, \qquad \underset{\sim}{n} = \underset{\sim}{p}/p_0 \tag{3}$$

The quantity Δ in (1) and (2) is a matrix in the spinor indices, and satisfies the equation

$$\Delta_{\alpha\beta}(\underset{\sim}{p}) = \sum_{\omega_n}\int V_{\alpha\beta\gamma\delta}(\underset{\sim}{p},\underset{\sim}{p}')F_{\delta\gamma}(\underset{\sim}{p}')[d\underset{\sim}{p}'/(2\pi)^3] \tag{4}$$

Equations (1) and (4) have several solutions. The solution corresponding to the lowest energy is one in which the spin and orbital momenta of the pair, each equal to unity, add up to yield zero total angular momentum, i.e., $\Delta_{\alpha\beta}(\underset{\sim}{p}) = \sigma^y(\underset{\sim}{\sigma}\cdot\underset{\sim}{n})\Delta$. Equations (1) remain the same after exclusion of the spin and angular dependences. The essential difference from the scalar pairing arises in formulas (2). As in the case of scalar pairing, $\overline{G}$ is proportional to the total cross section for scattering by the impurity, while $\overline{F}$ contains the first harmonic of the cross section, since $\overline{F}(\underset{\sim}{p})$ is proportional to the first harmonic of the vector $\underset{\sim}{p}$. The solution of (1), (2), and (4) is best written parametrically:

$$\omega_n = \Delta\tan\varphi - \sin\varphi/2\tau_{tr}, \qquad 1 = g\rho\sum_{\omega_n}\cos\varphi$$
$$\tau_{tr}^{-1} = [nmp_0/(2\pi)^2]\int|u(\theta)|^2(1 - \cos\theta)\,d\Omega \tag{5}$$

The equation for the critical temperature is obtained from (5) with $\Delta \to 0$:

$$1 = g\rho\sum_{\omega_n}[|\omega_n| + (2\tau_{tr})^{-1}]^{-1}, \qquad \ln(T_{c0}/T_c) = \Psi[1/2 + (4\pi\tau_{tr}T)^{-1}] - \Psi(1/2) \tag{6}$$

When $\tau_{tr} = \Delta^{-1}$ the critical temperature vanishes.

Formulas analogous to (5) and (6) arise in problems involving superconductors with paramagnetic impurities [4] or small-size superconductors in strong magnetic fields [5,6]. Formulas and plots for the thermodynamic quantities are given in [6]. It is necessary to replace the parameter α in these formulas by $(2\tau_{tr})^{-1}$.

A small superconductor behaves in the same manner as a contaminated superconductor in which the electron mean free path is of the order of the sample dimensions. To verify this, we write down the equation for the critical temperature

$$\Delta_{\alpha\beta}(\underset{\sim}{p},\underset{\sim}{r}) = \sum_{\omega}\int V_{\alpha\beta\gamma\delta}(\underset{\sim}{p}\cdot\underset{\sim}{p}')G^{0}_{\omega}(\underset{\sim}{r},\underset{\sim}{r}')G^{0}_{-\omega}(\underset{\sim}{r},\underset{\sim}{r}')\Delta_{\delta\gamma}(\underset{\sim}{p}',\underset{\sim}{r}')\,dp'dr' \tag{7}$$

Here $G^{0}(\underset{\sim}{r},\underset{\sim}{r}')$ are the Green's functions of the electron interacting with the sample walls. We solve the linear integral equation (7) by variational principles, assuming that the solution is of the form $\Delta = \sigma^{y}(\underset{\sim}{\sigma}\cdot\underset{\sim}{p})$ and does not depend on $\underset{\sim}{r}$. To calculate the Green's functions of the electron in a sample **of finite** dimensions, we use the method of classical trajectories [7,8]. As a result, Eq. (7) takes the form

$$1 = g\rho\sum_{\omega}\int_{0}^{\infty} dt[\exp(-2|\omega|t)]\varphi(t); \quad \varphi(t) = \langle(\underset{\sim}{n}\cdot\underset{\sim}{n_1})w(\underset{\sim}{n},\underset{\sim}{n_1},t)\rangle \tag{8}$$

where $w(\underset{\sim}{n},\underset{\sim}{n_1},t)$ is the probability that an electron with momentum $p_0\underset{\sim}{n}$ at $t = 0$ will have a momentum $p_0\underset{\sim}{n_1}$ at the instant t. The angle brackets denote averaging over the initial states and summation over the initial states with energy on the Fermi surface.

For scattering by impurities we have $\varphi(t) = \exp(-t/\tau_{tr})$ and (8) leads to (6). In a small sample $\varphi(t)$ has a more complicated form, but it is essential that after several collisions with the walls the correlation between the directions of the momenta vanish and $\varphi(t)$ decrease after a time $t \sim R/v$. Calculating the integral in (8) with logarithmic accuracy, we obtain

$$1 = g\rho\,\ln(\omega_D R_C/v), \quad R_C \simeq v/\Delta_0 \tag{9}$$

Thus, the critical dimensions of the sample are of the order of the pair dimension.

We have considered above only one form of a state with vector pairing. However, Eq. (7), which determines the critical temperature, is valid also for other solutions [9]. When the normal state is checked for stability, (7) determines the point at which the electron scattering amplitude has a pole at zero frequency. Further decrease of the temperature leads to the occurrence of growing excitations in the normal states.

The experiments on the Knight shift [3] can therefore not be attributed to the existence of vector pairing. So far, the only natural explanation for these experiments is spin-orbit interaction with the impurities [10,6].

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