$$F_o = \int dx\, dy \left\{ \frac{1}{4m_x} \left[\left| \left(-i\frac{\partial}{\partial x} - \frac{2e}{c}A_x \right) \Psi_a \right|^2 + \left| \left(-i\frac{\partial}{\partial y} - \frac{2e}{c}A_y \right) \Psi_b \right|^2 \right] \right.$$

$$\left. + \alpha \left[\tau \left(|\Psi_a|^2 + |\Psi_b|^2 \right) + \eta\, |\Psi_a + \Psi_b|^2 + (1/2n)\left(|\Psi_a|^4 + |\Psi_b|^4 \right) \right] + \frac{H^2 d}{8\pi} \right\} \tag{13}$$

where

$$\alpha = \frac{2(\pi T_c)^2}{7\zeta(3)\mu_1}, \quad \tau = \frac{T - T_c}{T_c}, \quad \eta = \frac{|\lambda_2|}{(\lambda_1 + |\lambda_2|)^2}.$$

The chemical potential μ_1 is calculated with respect to the bottom of the band. The term with $\alpha\tau$ is negative below T_c and it keeps $\Psi_{a,b}$ attached to a certain vicinity, whereas the term with $\alpha\eta$ corresponds to hopping between them. With increasing $|\tau|$ the motion becomes more one-dimensional, and eventually the orbital motion is unable to destroy superconductivity, i.e., $H_{c2} \to \infty$. For sufficiently small values of η this can happen even close to T_c (see Fig.11).

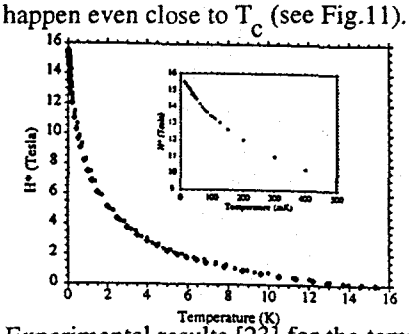

Fig. 10. Experimental results [23] for the temperature dependence of the upper critical field H_{c2}.

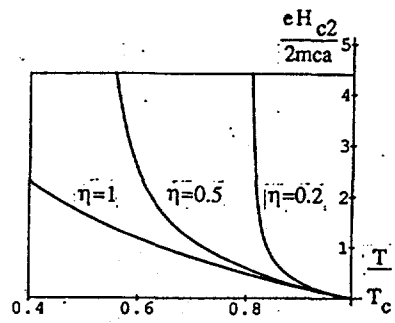

Fig. 11. Theoretical dependence of $eH_{c2}/(2mc\alpha)$ on T/T_c for different values of η.

In the immediate vicinity of T_c

$$H_{c2} \approx \frac{4mc}{e}\alpha|\tau|\left(1 + \frac{|\tau|}{\eta}\right) \tag{14}$$

For sufficiently high fields another mechanism becomes important, namely the paramagnetic destruction of Cooper pairs. Unfortunately, the account of this effect leads to the restoration of a negative curvature at lower temperatures and larger fields. This does not fit the experimental data (see [24]).

There was an interesting suggestion [25] that in the cases of reduced dimensionality (films, wires in longitudinal field), where the orbital destruction becomes impossible, the paramagnetic effect leads to a sequence of phase transitions between different inhomogeneous LOFF (Larkin-Ovchinnikov-Fulde-Ferrell) phases with increasing critical fields. This is a possible origin of the positive curvature at very low temperatures.

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