Type II Superconductivity and Diffusion Effects

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ABSTRACT: One has used the exponentially arising solution of the diffusion equation in purpose to explain the extremely high values of the induction of magnetic field needed to the destruction of the superconducting state of the type II superconductors.
One has compared the diffusion effects in the case of the exponential solution with the phenomena accompanying the Stark effect.

The condition of the disappearing of the total current in the state of equilibrium:

$$\mu\, n\, E \;+\; D \frac{dn}{dx} \;=\; 0 \tag{1}$$

so:

$$n(x) \;\sim\; \exp\left(\frac{-\mu E x}{D}\right)$$

But there may be both $E > 0$ and $E < 0$.

So the solution of the diffusion equation in the general case has the shape:

$$n_1(x) = A \exp(\alpha x) \;, \qquad n_2(x) = B \exp(-\beta x) \qquad \alpha, \beta \;>\; 0 \tag{2}$$

The first solution can't be rejected. It explains why the magnetic field destructing the type II superconductivity is a few orders of magnitude greater than the value foreseen theoretically [1]. Simply, it is more difficult to whirl with a bigger number of notions than with a smaller one.
Mass, which should whirl in the magnetic field, increases exponentially.
That is the fact that $n(x)$ describes the state of equilibrium when the current doesn't flow, but after all the motion is relative and depends on the reference system.
So the static equilibrium corresponds to the dynamic equilibrium in another reference system.

It is implicated by the Newton dynamic principles. There is the equilibrium if the body rests or moves uniformly.
Simply, the solution (2) for a big A corresponds to the type II superconductivity.

The second term corresponds to the type I superconductivity, and the first term to the type II superconductivity.

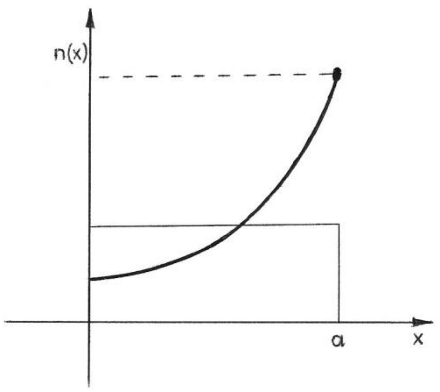

Fig. 1

$$n(x) = \; A\, e^{\alpha x} \qquad (3)$$

$A > 0$
$\alpha > 0$
$x \; \leq d$

Figure 1 and equation (3) explain why the magnetic field penetrates partially into the type II superconductor before it destroys the superconducting state.

Naturally, the reality is described in the general case by both solutions (2), but not by both solutions at the same time.
The phenomenon of two different signs of the field E corresponds to the known effect in which the atoms can be attracted to the electric field or repulsed from it [2].
In this article there is certain “relativity” – electrons move in the same direction in both cases but the sense of the vector of the electric field changes.
This is a next example that one shouldn’t reject solutions ”discrepant with the common sense”.

References:

[1] C. Kittel, “Introduction to Solid State Physics”
[2] J. Ginter, private communication