Additional and Loop Dimensions in Josephson's Effect

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ABSTRACT: Investigating the mathematical formalism connected with the Josephson effect it has been shown that the complex charge and the complex electric voltage appear in this effect, what testifies to the existence of the additional or loop dimensions. The possibility to discover these dimensions or loops using the Josephson effect has been suggested.

1. The Josephson effect means that the whole Cooper's pairs are tunneling through the slit between two superconductors. These currents present the oscillations in the function of the induction of the magnetic field which can be measured.
   The tunneling may take place in the additional or loop dimensions in which both superconductors are conjugated by the superconducting field.
   These additional or loop dimensions can be present in the slit too.

2. We start from the wave equation, taking under consideration the tension (compare [1]). There are components of the Dirac equation:

$$i\hbar \frac{\partial \psi_1}{\partial t} = \frac{qV}{2} \psi_1 + k\psi_2$$

$$i\hbar \frac{\partial \psi_2}{\partial t} = -\frac{qV}{2} \psi_2 + k\psi_1$$

V – the difference of the potentials between two superconductors
ψ_1, ψ_2 – wave function of the superconducting state of both superconductors

We postulate their shape:

$$\psi_1 \;=\; \sqrt{\varrho_1}\; e^{i\Theta_1}$$

$$\psi_2 \;=\; \sqrt{\varrho_2}\; e^{i\Theta_2}$$

ϱ_i - electron densities
Θ_i - phases

We introduce the symbol:

$$\delta \;=\; \Theta_2 - \Theta_1$$

We have:

$$\psi_1 \;=\; \sqrt{\varrho_1}\, e^{i\Theta_1} \;=\; \sqrt{\varrho_1'}\, e^{i(\Theta_{1\,1} + \mathrm{i}\Theta_{1\,2})}$$

$$\psi_2 \;=\; \sqrt{\varrho_2}\, e^{i\Theta_2} \;=\; \sqrt{\varrho_2'}\, e^{i(\Theta_{2\,1} + \mathrm{i}\Theta_{2\,2})}$$

So, we obtain:

$$\Phi_1 \;=\; \Theta_{1\,1} \;+\; \mathrm{i}\Theta_{1\,2}$$

$$\Phi_2 \;=\; \Theta_{2\,1} \;+\; \mathrm{i}\Theta_{2\,2}$$

And we find:

$$\dot{\varrho}_1' \;=\; \frac{2}{\hbar}\; K\,\sqrt{\varrho_1'\varrho_2'}\;\; sin\delta$$

$$\dot{\varrho}_2' \;=\; -\frac{2}{\hbar}\; K\,\sqrt{\varrho_1'\varrho_2'}\;\; sin\delta$$

and then:

$$\dot{\Phi}_1 \; = \; \frac{K}{\hbar}\sqrt{\frac{\varrho_1'}{\varrho_2'}}\; cos\delta \; - \; \frac{qV}{2\hbar}$$

$$\dot{\Phi}_2 \; = \; \frac{K}{\hbar}\sqrt{\frac{\varrho_1'}{\varrho_2'}}\; cos\delta + \frac{qV}{2\hbar}$$

δ is expressed by a complex number, so in the superconductors either V is a complex number or q is a complex number or both.

The particular case:

$\sqrt{\frac{\varrho_1'}{\varrho_2'}} = \sqrt{\frac{\varrho_1}{\varrho_2}}$ and $\dot{\Phi}_1 = \dot{\Phi}_2$

isn’t interesting, but it is only one of many possibilities.

The complex dimensions in the Josephson effect correspond with the complex charge or complex voltage. In the complex dimensions the complex charge and complex voltage are accomplished.

The tunnel effect in the Josephson effect and in the tunnel microscope may give the contribution to the discovery of the additional dimensions [2,3].

References:

[1] R. P. Feynman, R. B. Leighton, M. Sands, “Feynman Lectures on Physics”, vol. III
[2] Z. Morawski, “Number of Dimensions of the Universe”, this website
[3] Z. Morawski, “Implications of Complex Mass”, this website