ORIGIN OF SUPERCURRENT IN SUPERCONDUCTORS

I.B.Pestov[1]

[1]*Joint Institute for Nuclear Research, Bogoliubov Laboratory of Theoretical Physics*

E-mail, pestov@theor.jinr.ru

On the phenomenological level of particles and quasi particles there are different approaches to the supercurrent generation mechanism in superconductors (London, Ginzburg-Landau, BCS and other theories). On the fundamental field-theoretical level we attribute essence of supercurrent to physics that contains the gauge potential of the electromagnetic field. In the Classical Mechanics and Electrodynamics this gauge potential is a primary entity since it is not defined by some another quantity. However, in the framework of Quantum Mechanics we can define quantum gauge potential that is defined by a complex scalar field. The quantum gauge potentials can be considered as local topologically nontrivial excitations of the ground state of the electromagnetic field that are characterized by the index equal to integer number of the quants of magnetic flux. From the ordinary and quantum gauge potentials a gauge invariant effective vector potential is created which can be observed like the electric and magnetic fields. This leads to the modification of the Maxwell equations: appearance of the constant of dimension length and localization of the electromagnetic interactions. All these circumstances give a handle to identify the effective vector potential with supercurrent. We also consider interactions of the new form of the electromagnetic field with matter presented here by the Dirac spinor field. This form of charged fermi-matter is characterized by two parameters. From the phenomenological point of view these parameters originate from the electron charge and mass but in general they should be defined by the system itself. Of course, the localization of the electromagnetic interactions in the extended electrodynamics is conserved. A special case is marked when the electromagnetic field is presented only by the quantum gauge potential that carries quants of the magnetic flux. The localization of the electromagnetic interactions can be considered as the quantum physical effect and the main physical reason of superconductivity. We believe, it will help to elucidate the so called high temperature superconductivity in the framework of the fundamental field-theoretical approach. In any case, the experimental observation of the new form of the electromagnetic field (”superconducting light”) is the first needed step.