Dissipative dynamics of topological excitations:topological excitations in frustrated background

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The magnetic phase of Nd doped $La_{2-x}Sr_xCuO_4$(0.02¡x,0.05) (LSCO) is a spiral spins phase [1]. The spiral spins alignment is caused by magnetic dipole moment induced by a hole in the underlying antiferromagnetic environment. A fraction of dipoles form the collinear ordered superstructure (incommensurate) making a spins system highly anisotropic without violation of homogeneous charge distribution. There are spin topological excitations (TE) - non-Abelian Z_2 vortices in spiral spins phase because the order parameter space of spiral is a rotation group SO(3) manifold. It is natural to assume that the charge carriers are attached to the spin topological excitations. In that case the motion of spin TE is directly related to the electrical charge transport in cuprates. The separated Z_2 vortices having infinite mass (i.e. energy) can not move. The vortex-antivortex pair has a finite mass, however there is no direct experimental confirmation (there are not Kosterlitz-Touless phase transition) that such pairs exist in LSCO. We claim that the relevant spin TE in LSCO are Z_2 vortices which fields are screened in the frustrated background. Due to the screening the mass of Z_2 vortices become finite. For a quantitative description we represent the frustration by a gauge field of SO(3) group. The Hamiltonian of the frustrated spiral spins phase is the Hamiltonian of an order parameter field of the spiral phase φ (φ- the three SO(3) group parameters) interacting(in minimal coupling approximation) with a gauge field of background. The obtained effective Hamiltonian is the Hamiltonian of non-Abelian Higgs like model. We have found the vortex solution with finite mass in that model. The vortex mass becomes finite due to interaction of an order parameter φ with a gauge field of background. The Z_2 vortex motion is expected to be diffusive because of the scattering of magnons on it. We have derived a Hamiltonian of interaction of magnons with vortex and then we have evaluated the vortex damping coefficient. It enables us, using Drude model of conductivity, to evaluate the temperature dependence of the cuprates resistivity [2]. Since the strong anisotropy of spins system the resistivity of cuprates is anisotropic. The presented model indicates the possibility of mechanism (based on spins degree of freedom) of formation of a strong conductivity anisotropy in cuprates without breaking the homogeneity of charge distribution.

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