CONDENSATION ENERGY FOR SPIN FLUCTUATIONS MECHANISM OF PAIRING IN HIGH-T_c SUPERCONDUCTORS

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Abstract: The condensation energy for the antiferromagnetic spin fluctuations mechanism of pairing are considered. For the calculation the method of functional integrals was used. It has been shown that the condensation energy in high-Tc superconductors is highly sensitive to the doping level, and is greatly reduced in underdoped region.We consider that this effect is due to the decreasing of the number of hot quasiparticles, which are responsible for the interaction with antiferromagnetic spin fluctuations. It is in qualitative agreement with experiment.

Key words: Condensation energy, spin fluctuation mechanism of pairing, thermodynamic, underdoped region, pseudogap

1. INTRODUCTION

The condensation energy is fundamental property of cuprate superconductors. During last years many experiments investions of the condensation energy in high-Tc superconductors. One of the puzzling features of high-Tc cuprates is that the superconducting condesation energy at T=0 , U_0 is greatly reduced in underdoped region [1,2]. This issue has been considered a clue to understanding the mechanism of high-Tc superconductivity and problem of pseudogap. The main problem of theory of superconductivity is the determining of the mechanism of electron

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pairing. In this report we will discuss some thermodynamics properties of the high T_c superconductors on basis of the conception of spin-fluctuations mechanism of pairing. Antiferromagnetic spin fluctuations play important role in high-T_c superconductors[3]. Electron scattering on these fluctuations may cause of electron pairing [4].

In this present paper we'll calculated the condensation energy on basis of antiferromagnetic spin fluctuation mechanism of pairing in high-Tc superconductors.

2. THEORETICAL BACKGROUND

Early was proposed to used the functional integral methods for calculation the thermodynamic properties of high-Tc superconductors including antiferromagnetic spin fluctuations [5].

The antiferromagnetic antiferromagnetic spin fluctuations which result in d-pairing in cuprate superconductor are described by the Lagrangian in lattice representation [5-7]:

$$e^{-\beta\Omega} = N \cdot \int \prod_{n} d\, S_i(n)\, d\,\psi_\alpha^+(n,\tau)\, d\psi_\alpha(n,\tau) \exp\left(-\int_0^\beta d\tau\, \mathrm{L}(\tau) \right), \qquad (1)$$

where L(t) is Lagrangian in lattice representation which are described the spin fluctuations mechanism of pairing [3] :

$$\mathrm{L}(\tau) = \sum_{n} \psi_\alpha^+(n,\tau) \left(\frac{\partial}{\partial\tau} - \mu \right) \psi_\alpha(n,\tau) - t \sum_{n,p} \psi_\alpha^+(n,\tau) \psi_\alpha(n+p,\tau) +$$

$$+ g \sum_{n} \psi_\alpha^+(n,\tau) \left(\frac{\sigma^i}{2} \right)_{\alpha,\beta} \psi_\beta(n,\tau) S_i(n,\tau) + \frac{1}{2} \sum_{n,m} S_i(n,\tau)\, \chi_{i,j}^{-1}(n,m,\tau)\, S_j(m,\tau), \qquad (2)$$

where the summation is made over all knots of infinite lattice, where Ω – is the thermodynamical potential, $\beta = 1/kT$, L – is the Lagrangian in the lattice representation , p – is a unit vector, which connects the neighboring knots, S_i – is the spin of spin fluctuations in the lattice representation , N – is a normalization multiplier, t – is a band halfwidth , μ – is a chemical potential, $\chi_{i,j}(m, n, \tau)$ – is the spin correlation function in lattice representation., which is modulated by