Erratum: Orbital magnetism and transport phenomena in two-dimensional Dirac fermions in a weak magnetic field [Phys. Rev. B 76, 113301 (2007)]

Masaaki Nakamura

(Received 28 January 2008; published 24 March 2008)

DOI: 10.1103/PhysRevB.77.129903 PACS number(s): 73.43.Cd, 71.70.Di, 81.05.Uw, 72.80.Le, 99.10.Cd

In the argument of this article, the following corrections are needed:

(1) In the argument of the orbital magnetism, the results of susceptibility obtained by the weak-magnetic field formalism [(2), (4)–(8), and Fig. 1(a)] are two times larger than the original value (per spin and per valley). This should be corrected.

(2) The eigenvalue problem of the 2D Dirac fermion in a magnetic field with $eB>0$ is solved as

$$\hat{\mathcal{H}}_0 \, |k\rangle\rangle = M_k \, |k\rangle\rangle, \quad M_k = \mathrm{sgn}(k)\sqrt{2|k|\frac{\hbar^2 v^2}{l^2}+\Delta^2} \; (|k| \in \mathbf{N}), \quad M_0 = -\Delta,$$

$$|k\rangle\rangle = \begin{bmatrix} \sqrt{(M_k+\Delta)/2M_k}\,||k|-1\rangle \\ \mathrm{sgn}(k)\sqrt{(M_k-\Delta)/2M_k}\,||k|\rangle \end{bmatrix} (|k| \in \mathbf{N}), \qquad |0\rangle\rangle = \begin{bmatrix} 0 \\ |0\rangle \end{bmatrix},$$

so that Eqs. (9) and (10) should be replaced by the above results.

(3) The argument of the magnetic susceptibility based on the Landau quantization formalism [Eqs. (11)–(14)] should be corrected in the following way: The thermodynamic potential is given by

$$\Omega(B) = -\frac{1}{\beta}\sum_{n=-\infty}^{\infty} \mathrm{Tr}\ln(-\mathrm{i}\tilde{\omega}_n + \hat{\mathcal{H}}_0/\hbar) = -\frac{V}{2\pi l^2\beta}\sum_{n=-\infty}^{\infty}\left[\sum_{k=0}^{\infty}\ln\left[(\mathrm{i}\tilde{\omega}_n)^2 - v^2\left\{\frac{2(k+1/2)}{l^2}+\frac{eB}{c\hbar}+\frac{\Delta^2}{\hbar^2 v^2}\right\}\right] + \ln\left[-\mathrm{i}\tilde{\omega}_n + M_0/\hbar\right]\right].$$

Here degeneracy of a Landau level is $V/2\pi l^2$. For $B\to 0$ limit, we apply the following Euler-Maclaurin formula

$$\sum_{k=a}^{b-1} g\left(k+\frac{1}{2}\right) \simeq \int_a^b g(x)dx - \frac{1}{24}[g'(b)-g'(a)],$$

except for the term with M_0. Then $\chi = -\frac{1}{V}\frac{\partial^2\Omega}{\partial B^2}|_{B=0}$ gives the same value of that of the weak-magnetic field formalism.

(4) The right-hand side of Eq. (23) should be multiplied by -1:

$$\tilde{\Pi}_{\mu\nu}(\boldsymbol{0},\mathrm{i}\nu_m) = -i\frac{B}{c\hbar}\cdots \Rightarrow \tilde{\Pi}_{\mu\nu}(\boldsymbol{0},i\nu_m) = i\frac{B}{c\hbar}\cdots.$$

The author thanks L. Hirasawa for a helpful discussion.

