Instabilities in Integral Equations for Two-dimensional Vortex Liquids in High-temperature Superconductors

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The parquet resummation method for studying two-dimensional vortex liquids in high-temperature superconductors is an analytic and non-perturbative method [1]. In a previous paper [1], an infinite subset of Feynman diagrams were summed by using the bare vertex which is the simplest irreducible vertex among infinitely many irreducible vertices. This calculation is called the "parquet approximation method". When we applied a simple case of one more irreducible vertex (1st non-parquet contribution) in our previous study [2], we found that two-dimensional vortex liquids showed more crystalline order than the previous calculation. The 1st non-parquet contribution to the irreducible vertex can be expressed in terms of the Feynman diagram which has four vertex functions. These vertex functions are divided into two classes. The first class is that results from the parquet approximation (γ), and the second one is the full vertex function (Γ). We perform various calculations according to which vertex function is applied to which vertices in the irreducible function. There are 9 different kinds of calculations that can be made. In this work, we first present the structure factor of vortex liquids for each case. This calculation is presented in decreasing temperature. Then, we show that there are instabilities below which we cannot find a solution. Next, we discuss what these instabilities mean, and we compare the temperature of instabilities with the temperature of phase transition found in the Monte Carlo simulations..

[1] J. Yeo and M. A. Moore 1996 *Phys. Rev. Lett.* 76 1142
[2] J. Yeo, H. Park and S. Yi, 2006 J. *Phys.: Condens. Matter* 18. 3607

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