Zero-field vortex-induced Hall effect and polar Kerr effect in chiral p-wave superconductors near Kosterlitz-Thouless transition

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In this work, we investigate ac Hall and Ohmic conductivity induced by vortex dynamics in a chiral p-wave superconducting thin film near Kosterlitz-Thouless (KT) transition[1] without explicitly applying magnetic field. Dynamical theory developed by Ambegaokar, Halperin, Nelson, and Siggia[2] is generalized in such film. A matrix dielectric function describing vortex screening is obtained and related to the conductivity tensor. Polar Kerr effect due to the nonzero Hall conductivity is also studied. While the frequency and temperature dependence of Ohmic conductivity near KT transition in chiral p-wave context behave similarly to those of s-wave results, the Hall conductivity exhibits some novel features. Kerr angle is shown be proportional to the imaginary part of off-diagonal component of the dielectric function in certain parameter regime. As a result, Kerr angle measurement in experiment provides a probe of vortex dynamics described in this work. Contributions from bound pair as well as free vortex motion are demonstrated explicitly. In bound pair dynamics picture, we derive transverse and longitudinal response functions of a vortex-antivortex pair subjected to driving current, which contribute to many features in the conductivity tensor.[3]

1. J. M. Kosterlitz and D. J. Thouless, J. Phys. C **6**, 1181 (1973).
2. V. Ambegaokar, B. I. Halperin, D. R. Nelson, and E. D. Siggia, Phys. Rev. B **21**, 1806 (1980).
3. C. K. Chung and Y. Kato, arXiv:1303.3678 (2013).

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