Integer quantum Hall effect at finite temperature

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Since the discovery of the integer quantum Hall effect in 1980 [1], more than two decades have passed. And yet, the microscopic mechanism of the effect is still not clarified. There seems to be two different approaches in the theoretical attempts. In the MOSFET experiment [1], the fundamental problem that divides these two approaches is the relation between the gate voltage and the electron number density. In the theory based on the electron localization hypothesis [2], a simple linear relation between these two quantities is assumed. On the other hand, in the theory based on the electron reservoir hypothesis [3][4][5], the electron number density is given as the quantum statistical expectation value of the grand canonical ensemble, where the gate voltage appears as the shift of the chemical potential. The latest experimental results seem to support solidly the electron reservoir hypothesis [6]. In this paper we examine the effects of finite temperature on the Hall conductivity on the basis of the reservoir hypothesis in view of possible experimental observation [7].

References

[1] K. von Klitzing, G. Dorda, and M. Pepper, Phys. Rev. Lett. **45** 494 (1980).

[2] H. Aoki and T. Ando, Solid State Commun. **38**, 1079 (1981).

[3] G. A. Baraff and D. C. Tsui, Phys. Rev. B **24**, 2274 (1981).

[4] T. Toyoda, V. Gudmundsson, and Y. Takahashi, Phys. Letters **102A**, 130 (1984).

[5] T. Toyoda, V. Gudmundsson, and Y. Takahashi, Physica **132A**, 164 (1985).

[6] A. Raymond, S. Juillaguet, I. Elmezouar, W. Zawadzki, M. L. Sadowski, M. Kamal-Saadi, and B. Etienne, Semicond. Sci. Technol. **14**, 915 (1999).

[7] T. Toyoda and N. Aoyama, unpublished.