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Power-Law Corrections to the Kubo Formula Vanish in Quantum Hall Systems

M. Klein and R. Seiler

Technische Universität Berlin, Fachbereich Mathematik MA 7–2, D-1000 Berlin 12

Abstract. In first order perturbation theory conductivity is given by the Kubo formula, which in a Quantum Hall System equals the first Chern class of a vector bundle. We apply the adiabatic theorem to show that these topological constraints quantize the averaged conductivity to all orders of perturbation theory. Hence the Kubo formula is valid to all orders.

I. Introduction

Integrality of conductivity in Quantum Hall Systems has its origin in the topology of its underlying parameter space: the two torus. This fact has emerged from the work of Laughlin [L] and of Thouless, Kohomoto, Nightingale, and de Nijs [TKN^2] and became clear in the work of Thouless and Niu [TN 1, TN 2], and Avron and Seiler [AS]; there it was shown that the Kubo formula for the Hall conductivity is the first Chern number of a line bundle over the torus.

The topological nature of Kubo's formula for the Hall conductivity is very satisfactory because of the astounding experimental precision of the phenomenon. However the question of the validity of the Kubo formula and the corrections to Ohm's law had to be tackled in order to give a satisfactory picture. For that reason charge transport or– what is the same – the time averaged conductivity was analyzed in [ASY]. It was shown that – provided the gap condition holds – conductivity is given by Kubo's formula and that the correction terms are at least quadratic in the electric potential V. It is the purpose of this article to prove the stronger statement that the corrections to Ohm's law are of order V^∞.

We shall now give a short review of the model, methods and results. For technical details we refer to the later sections. The model is basically the same as in [AS]. This time however we use a rectangular configuration space and not the two hole geometry. This is irrelevant for all major results. Interaction with impurities and among electrons is included. For concreteness we choose Coulomb forces although the specific form of the electron interaction is irrelevant. The electric field is generated by a vector potential proportional to ϕ_1. As in [ASY] it is switched on