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Part 1
Quantum Point Contacts and Quantum Wires

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Preface

This is the first of a series of Landolt-Börnstein volumes [1]) summarizing our current knowledge of the transport phenomena of mesoscopic quantum systems with spatial extensions between those of atoms and ordinary macroscopic solids. At low temperatures, they are said to become "quantum mechanically coherent" with states that extend over the whole system.

In this range of temperatures and length scales, a large number of unusual transport properties appear. Their understanding is very important for some of the basic issues of the quantum mechanical understanding of matter. One of the most fundamental examples is the the metal-insulator transition induced by disorder which is completely driven by quantum fluctuations. Another example is the quantum Hall effect where the interplay between effects of the magnetic field, disorder as well as correlations between the electrons seems to be important for the understanding of the physics. Furthermore, one can suspect that gaining insight into the physical mechanisms behind the recently discovered superconductivity at high temperatures in the ceramic materials will be considerably influenced by the understanding of mesoscopic transport phenomena in correlated electron systems.

In addition, there are applied aspects; it is now already clear that in roughly ten years time the diameters of conventional transistors will be about 10 nm, which is of the order of the diameter of an electron-hole excitonic state in GaAs. Quantum effects will have to be considered, and novel, quantum-based devices will very probably compete alongside with conventional transistors.

The mesoscopic transport field has developed extremely rapidly during the past two decades. Current research activitiy shows no sign of abating, but it seems that indications of a certain maturity can be observed; effects that have been previously discovered are more carefully studied experimentally as well as theoretically. New discoveries have become slightly less frequent than was the case about half a decade ago. Therefore, it seemed that the right time had come for summarizing present achievements and attempting a snapshot of what is the present state of affairs.

The present Subvolume B(1) concentrates on the effects observed in quantum wires and quantum point contacts which are fabricated starting from an appropriate semiconducting material, mainly GaAs. However, most of the mesoscopic transport phenomena are governed by features that do not depend on the properties of the materials used. For instance, persistent currents are observed in metallic rings as well as in electron rings made from the inversion layer in a heterostructure. Therefore, and also in order to introduce non-specialists to the field, we present in the introductory survey of Part I an overview of the quantum transport effects discovered during the past two decades, irrespective of the material. In Parts II and III, we will consider quantum point contacts and quantum wires, respectively, based only on semiconducting systems. Each of the parts comes with its references and author index. The latter consists of an index of references and an index of authors. Using both, it is easy to trace within the text every author working in the field. The subject index is established via the very detailed Table of Contents.

Of course, completeness cannot be claimed in this still rapidly developing field of physics. However, we have made a serious attempt to collect systematically all of the material that has appeared in the literature until December 1999.

Hamburg, October, 2000 The Editor

[1]) This subvolume has been prepared within the European TMR network \Quantum Transport in the Frequency and Time Domains"

Survey of Volume III/34

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Electronic Transport — **Subvolume B**

Quantum Point Contacts and Quantum Wires — **Part 1**

Optical Properties — Subvolume C