

The Physics of the Two-Dimensional Electron Gas

Edited by

J. T. Devreese

and

F. M. Peeters

University of Antwerp
Antwerp, Belgium

Plenum Press

New York and London

Published in cooperation with NATO Scientific Affairs Division

CONTENTS

THE INTEGER AND THE FRACTIONAL QUANTUM HALL EFFECT

The Quantum Hall Effect	1
K. von Klitzing	
Theory of the Integer Quantum Hall Effect - an Introductory Survey	27
J. Hajdu	
1. Klaus von Klitzing's discovery	27
2. The Hall effect	28
3. Quantum mechanics of an electron in a magnetic field	31
4. Different ways of calculating the Hall conductivity	33
5. Disordered systems	36
6. High field limit	39
7. The gauge argument	42
8. Topological approach	44
9. Scattering theoretical approach	47
10. Field theoretical approach	49
11. Conclusions	49
References	50
Experimental Aspects of the Fractional Quantum Hall Effect	51
G.S. Boebinger	
1. Introduction	51
2. Theoretical background	56
3. Experimental configurations	60
4. Experimental results	66
5. Other experiments and conclusions	90
Acknowledgments	93
References	93
Interactions in 2D Electron Systems	97
P.M. Platzman	
1. Some qualitative aspects of itinerant 2D systems	97
2. Excitations in the Fractional Quantum Hall Effect - magneto-rotons	108
3. Transport and impurity effects in the magneto-roton picture	127
References	129

ELECTRON-PHONON INTERACTION

Electron-Phonon Interaction in Two-Dimensional Systems:	
Polaron Effects and Screening	131
J.T. Devreese and F.M. Peeters	
Introduction	131
1. The free polaron in two dimensions - single particle approximation	132
2. Many-particle problem in two dimensions - effect of screening of the electron-phonon interaction	138
3. The 2D polaron system subjected to a static magnetic field	145
References	153
Appendix A: Theory of the cyclotron resonance spectrum of a polaron in two dimensions	155
Appendix B: Influence of many-body effects on the cyclotron resonance mass of two-dimensional polarons with application to GaAs-AlGaAs heterostructures . .	169
Hot Carrier Effects in Quasi-2D Polar Semiconductors	183
J. Shah	
1. Introduction	183
2. Basic concepts	184
3. Electron-phonon interactions in 3D	185
4. Theoretical investigations in quasi-2D systems	197
5. Experimental investigations	203
6. Summary	217
Acknowledgments	218
References	218
Anomalous Current Oscillations in Semiconductor-Insulator-Semiconductor Structures and Related Devices	227
J.P. Leburton	
1. Introduction and historical background	227
2. Experiments	228
3. Theoretical models	236
4. Conclusions	254
Acknowledgments	255
References	255

BAND STRUCTURE

k.p Theory for Two-Dimensional Systems	259
R. Lassnig	
1. Introduction	259
2. Fundamentals - 3D theory	261
3. k.p theory for 2D systems	271
4. Heterostructures	274
5. Wave function matching	277
6. Variational solution	278
7. Numerical results	280
8. Spin splitting	282
9. Tunneling through semiconductor barriers	284
Acknowledgments	291
References	291
Inversion Electrons in InSb in Crossed Electric and Magnetic Fields	293
U. Merkt	
1. Introduction	294

2. Classical trajectories of inversion electrons in crossed fields	295
3. One-band model for crossed fields: energy levels and transition probabilities	298
4. Experiments: diamagnetically shifted intersubband resonance vs cyclotron resonance	311
5. Two-band model in crossed fields: analogy to relativistic electrons	320
6. Experiments: destruction of Landau quantization in strong electric fields	333
Acknowledgments	339
References	339
 Electric Properties of II-VI Compound Superlattices	341
J.M. Berroir and M. Voos	
1. Introduction	341
2. Band structure of bulk HgTe and CdTe	345
3. Growth of II-VI compound superlattices	345
4. Magneto-optical investigations of HgTe-CdTe superlattices	347
5. Optical absorption studies	356
6. HgTe-CdTe superlattices as infrared materials	359
7. Some aspects of CdTe-Cd _{1-x} Mn _x Te superlattices	360
8. Some prospects about Cd _{1-x} Mn _x Te-Cd _{1-y} Mn _y Te heterostructures	360
9. Conclusion	362
Acknowledgments	363
References	363
 SPECIAL TOPICS	
 Density of States of Two-Dimensional Systems in High Magnetic Fields	365
E. Gornik	
Abstract	365
1. Introduction	366
2. Specific heat	367
3. Magnetization	375
4. Activated resistivity	376
5. Magnetocapacitance	381
6. Cyclotron resonance spectroscopy	383
7. Conclusions	390
Acknowledgments	391
References	391
 Electrons on Liquid Helium	393
F.M. Peeters	
1. Introduction	393
2. Surface state electrons on liquid helium	394
3. Wigner crystal	399
4. Self-trapping	406
Acknowledgments	419
References	419
 Author index	421
Material Index	431
Subject Index	433