

HIGH FIELD INTERACTIONS IN SEMICONDUCTORS
AND DIELECTRICS

Bishnu P. Pal

Thesis submitted to Indian Institute of Technology, Delhi
for partial fulfilment of the degree of
Doctor of Philosophy

1974

ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to Prof. M.S.Sodha and Dr. A.K.Ghatak for their valuable guidance, encouragement and inspiration without which the present work would not have been possible.

I am also greatly indebted to Dr. Satish K.Sharma, Dr. S.Sharma and Dr. U.P.Phadke for their constant help and advice. Thanks are due to Messrs. G.D.Gautama, A.Chakravarti, A.K.Agarwal, A.Kumar and other colleagues of our Electrophysics Group for their co-operation and help from time to time.

I am grateful to Prof. S.C.Dutta Roy of the Electrical Engineering Department, I.I.T. Delhi and Prof. S.D.Chatterjee of the Indian Association for the Cultivation of Science, Calcutta for their encouragement and inspiration.

I am thankful to the National Council of Educational Research and Training, New Delhi for continuation of the N.S.T.S. award at the Post-M.Sc. level.

Finally I wish to thank Mr. T.N.Gupta for the efficient typing of the thesis.

Biswampada Das

CONTENTS

CHAPTER	Page
ACKNOWLEDGEMENTS	
PREFACE	1
<u>PART-I</u>	
HIGH ELECTRIC AND MAGNETIC FIELD EFFECTS IN SEMICONDUCTORS	21
I Hot Electron Magnetic Susceptibility of Degenerate Semiconductors at Low Temperatures	22
<u>Sec.A:</u> Hot Carrier Magnetic Susceptibility in Parabolic Semiconductors	23
A.1 Introduction	23
A.2 Theory	26
A.3 Determination of the Electron Temperature	29
A.4 Numerical Results and Discussion	33
<u>Sec.B:</u> Hot Carrier Magnetic Susceptibility in Nonparabolic Semiconductors	38
B.1 Introduction	38
B.2 Theory	
B.3 Determination of Electron Temperature	44
B.4 Numerical Results and Discussions	52
II Hot Electron Transport in Degenerate Parabolic Semiconductors	62
2.1 Introduction	62
2.2 Velocity Distribution Function of Electrons in dc Electric and Magnetic Fields.	65
2.3 Velocity Distribution Function of Electrons in the Presence of an ac Electric Field and a dc Magnetic Field	71
2.4 Transport Coefficients	74
2.5 Numerical Results and Discussion	80
III Effect of Nonparabolicity on the Damping of Helicons in Semiconductors in the Extreme Quantum Limit	86
3.1 Introduction	86
3.2 Theory	88
3.3 Numerical Results and Discussions	99

PART-II

	FOCUSING OF EM BEAMS IN DIELECTRICS AND SEMICONDUCTORS	106
IV	Focusing of EM Beams in Dielectrics and Semiconductors	107
	<u>Sec.A:</u> Enhancement of Harmonics due to Self Focusing	108
	A.1 Introduction	108
	A.2 Theory	109
	A.3 Numerical Results and Discussion	112
	<u>Sec.B:</u> Focusing of EM Waves in Semiconductors by Inhomogeneous Magnetic Fields	113
	B.1 Introduction	113
	B.2 Theory and Discussion	114

PART-III

	BREMSSTRAHLUNG FROM ELECTRON-POLAR-MOLECULE COLLISIONS	121
V	Bremsstrahlung from Electron-Polar-Molecule Collisions	122
	5.1 Introduction	122
	5.2 Formulation of the Problem	123
	5.3 Frequency Spectrum	127
	5.4 Bremsstrahlung per unit volume	129
	5.5 Absorption Coefficient and Conductivity	133
	5.6 Results and Discussion	135