

## Table of Contents

DECLARATION BY THE CANDIDATE	I
CERTIFICATE OF THE SUPERVISOR	II
Acknowledgements	III
List of Publications	VII
Preface	VIII
CHAPTER 1: Peek into world of next generation Wonder material - Graphene	
1.1 Background	2
1.1.1 Carbon and its allotropes	2
1.1.2 Graphene	5
1.1.3 Bilayer graphene	13
1.1.4 Gapped Graphene	15
1.1.5 Graphene Superlattice	16
1.2 Many Particle Aspects	18
1.3 Essential theoretical Formalism	23
1.3.1 Density-density response function	23
1.3.2 RPA bare bubble diagram	25
1.4 Dielectric function	26
1.4.1 Work done in past	28
1.4.1.1 Structure factor and pair correlation function	28
1.4.1.2 <i>Screening charge density and screened potential</i>	31
1.4.1.3 <i>Self Energy</i>	31
1.4.1.4 <i>Compressibility</i>	33
1.4.1.5 <i>Energy loss</i>	33
1.4.1.6 <i>Wake effects</i>	35
1.5 Collective excitations	37
1.6 Objective of thesis	40
1.7 References	42

Chapter 2 :Many Particle Aspects of Graphene	50
2.1    Introduction	51
2.2    Essential Formalism	56
2.2.1    The Structure Factor and pair distribution function	57
2.2.2    Self Energy	60
2.2.3    Screening Charge Density and Screened Potential	60
2.2.4    Compressibility	60
2.3    Results and Discussions	61
2.3.1    The Structure Factor and Pair Distribution function	61
2.3.2    Self Energy	80
2.3.3    Density of Screening Charge and screened Potential	84
2.3.4    Compressibility	92
2.4    References	93
Chapter 3 : Structure factor, Energy loss and Wake effects in Gapped Graphene	96
3.1    Introduction	97
3.1.1    Structure Factor and Energy loss	99
3.1.2    Wake-effects	101
3.2    Formalism	102
3.2.1    Structure Factor and Energy loss	102
3.2.2    Wake effects	107
3.3    Results and discussion	110
3.3.1    Structure Factor and Energy loss	110
3.3.2    Wake effects	122
3.4    References	132
Chapter 4: Plasmon-Phonon coupling and Energy-loss in Graphene Superlattice	135
4.1    Introduction	135
4.2    Formalism	139
4.3    Results and discussion	141
4.3.1    Plasmon-Phonon coupling and their damping	141
4.3.2    Energy Loss	155
4.4    References	159
Chapter 5: Summary And Conclusions	163
Glossary	172