
Contents

Abstract	iii
Declaration	vi
Certificate	vii
Acknowledgments	ix
1 Introduction	1
1.1 Complex plasma as a branch of plasma physics	2
1.2 Key properties of dusty plasma	4
1.2.1 Macroscopic neutrality	4
1.2.2 Debye Shielding	4
1.2.3 Characteristic frequencies	5
1.2.4 Coulomb coupling parameter	5
1.3 Particle charging in dusty plasma	6
1.4 Occurence of dusty plasma	8
1.4.1 Dusty plasma in space	8
1.4.2 Dusty plasma in laboratory	11
1.5 Forces on a dust grain in complex plasma	14
1.6 Collective modes in complex plasmas	16
1.7 Strongly coupled dusty plasmas	19
1.8 Self-organization in complex plasmas	21
1.9 Finite clusters in dusty plasmas	24
1.10 Magnetic field effects in complex plasma	26
1.11 Magnetized dust cluster	28
1.12 Methodology	28
1.12.1 Numerical simulation of finite dust clusters	28

1.12.2 Static and dynamic diagnostic quantities :	31
1.13 Scope of this thesis	34
2 Structure and dynamics of finite three-dimensional Yukawa clusters: Newtonian versus Langevin Dynamics	37
2.1 Introduction	38
2.2 Model description	40
2.3 Simulation scheme	41
2.4 Results and discussion	43
2.4.1 Static structural properties	43
2.4.2 Dynamic properties	52
2.4.3 Disappearance of coherent rotational motion	61
2.4.4 Mean Squared Displacement	65
2.5 Conclusions	67
3 Phase transition of finite-sized three-dimensional clusters of charged dust particles in a plasma environment	69
3.1 Introduction	70
3.2 The Model	73
3.3 Simulation scheme	74
3.4 Results and Discussion	75
3.4.1 Dynamics of the charged particles as a function of magnetic field and Coulomb coupling parameter	76
3.4.2 Phase transition	79
3.4.3 Structure dynamics of dust particles	83
3.5 Conclusions	85
4 Collective and single particle behaviour of finite dust clusters under a transverse external magnetic field	89
4.1 Introduction	90
4.2 The Model	93
4.3 Langevin dynamics simulation	94
4.4 Results and Discussion	95
4.4.1 Linear chain in the presence of a perpendicular magnetic field	96

4.4.2 2D Yukawa cluster in the presence of a perpendicular mag-	
netic field	101
4.5 Summary and Conclusions	122
5 Conclusion and future outlook	125
List of publications	129
List of Conferences	131
References	i