Statistical Physics of two Model Dynamical Systems: Magnets and Trading Markets

Thesis submitted for the degree of Doctor of Philosophy (Science) of Jadavpur University

Arnab Chatterjee

Theoretical Condensed Matter Physics Division

Saha Institute of Nuclear Physics

Kolkata, India

June, 2007

Contents

1 Introduction **1**

1.1 Brief description of the thesis 3

2 Field pulse induced magnetization reversal transition **6**

2.1 Introduction 6

2.2 Model and the Transition 8

2.3 Mean-field study 10

2.4 Monte-Carlo study and the results 16

2.5 Discussions 23

3 Study of the fourth order cumulant **24**

3.1 Monte-Carlo study 24

3.2 Magnetization reversal transition with thermal pulse 29

3.2.1 Model and the Transition 30

3.2.2 Monte-Carlo study and the results 30

3.3 Discussions 33

4 Statistical mechanics and trading markets **34**

4.1 Econophysics: a brief review 34

4.2 Empirical studies of income and wealth distributions 36

4.3 Modelling of income and wealth distributions 41
4.3.1 Early models 41
4.3.2 Lotka-Volterra models 42
4.3.3 Bouchaud-Mézard model 44
4.3.4 Model for evolving society 45
4.3.5 Asset exchange models 48
4.4 Gas-like models 49
4.4.1 Model with uniform savings 52

5 Model with distributed savings 56
5.1 Numerical simulation results 57
5.2 Analytic results 63
5.2.1 Distribution of money difference 63
5.2.2 Master equation and its analysis 66
5.2.3 Alternative solution of the steady state master equation (5.13) 68
5.3 Model with 'annealed' savings 69
5.4 Further studies 71
5.5 Discussions 74

6 Market in presence of a non-consumable commodity 76
6.1 Model and dynamics 77
6.2 Numerical simulation results 79
6.3 Discussions 81

7 Summary and Conclusion 85
7.1 Summary of the work 85

7.2 Conclusions 87