

# Preface

This book is written for an interdisciplinary readership of graduate students and researchers interested in nonlinear dynamics, stochastic processes, statistical mechanics on the one hand and high energy physics, quantum field theory, string theory on the other. In fact, one of the goals that I had in mind when writing this book was to make particle physicists become interested in nonlinear dynamics, and nonlinear physicists become interested in particle physics. Why that? Didn't so far these two subjects evolve quite independently from each other? So what is this book about?

Mathematically, the subject of the book are coupled map lattices exhibiting spatio-temporal chaotic behaviour. Physically, the subject is a topic that lies at the heart of elementary particle physics: There are about 25 free parameters in the standard model of electroweak and strong interactions, namely the coupling strengths of the three interactions, the fermion and boson masses, and various mass mixing angles. These parameters are not fixed at all by the standard model itself, they are just measured in experiments, and a natural question is why these free parameters take on the numerical values that we observe in nature and not some other values. It will turn out that the answer is closely related to certain distinguished types of coupled map lattices that we will consider in this book as suitable models of vacuum fluctuations. These dynamical systems, called 'chaotic strings' in the following, are observed to have minimum vacuum energy for the observed standard model parameters. They yield an extension of ordinary quantization schemes which can account for the free parameters.

In this sense this book deals with both, nonlinear dynamics and high energy physics. So far only very few original papers have been published

on this very new subject. With the current book I hope to make these important new applications for coupled chaotic dynamical systems accessible to a broad readership.

The book consists of 12 chapters. The first few chapters will mainly concentrate onto the theory of the relevant class of coupled map lattices, their use for second quantization purposes, and their physical interpretation in terms of vacuum fluctuations. In the later chapters concrete numerical results are presented and these are then related to standard model phenomenology. Sections marked with an asterisk can be omitted at a first reading, these sections deal with interesting side issues which, however, are not necessary for the logical development of the following chapters. In view of the fact that (unfortunately!) many readers may not have the time to read this book from the beginning to the end, I included a very detailed summary as a self-contained chapter 12. This summary contains the most important concepts and results of this book and is written in a self-consistent way, i.e. no knowledge of previous chapters is required.

The research described in this book developed over a longer period of time at various places. I started to work on the relevant types of coupled map lattices during my stay at the Niels Bohr Institute, Copenhagen, in 1992 and continued during a stay at the University of Maryland in 1993. Some important numerical results, now described in section 7.2 and 8.5, were obtained at the RWTH Aachen in 1994 as well as during a visit to the Max Planck Institute for Physics of Complex Systems, Dresden, in 1996. The main part of the work was done at my home institute, the School of Mathematical Sciences at Queen Mary, University of London, as well as during long-term research visits to the Institute for Theoretical Physics at the University of California at Santa Barbara in 2000 and to the Newton Institute for Mathematical Sciences at Cambridge in 2001. The hospitality that I enjoyed during these visits was very pleasant, and the nice research atmosphere was really inspiring.

The number of people from which I learned during the past years and who thus indirectly contributed to this book is extremely large— too large to list all these individuals separately here! So at this point let me just thank all of them in one go.

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