Preface

Probabilistic approaches have played a prominent role in the study of complex physical systems for more than 30 years. Two outstanding protagonists of this approach are Jürgen Gärtner and Erwin Bolthausen, to whom this volume is dedicated. Each of them was honored with a workshop in 2010; these took place at Technische Universität Berlin, where they both worked for decades. The conferences were devoted to the most important aspects of their interests: 'Random media' and 'Probabilistic techniques in complex physical systems'. They were organized by the DFG Research Unit FOR718 *Analysis and Stochastics in Complex Physical Systems* on the occasion of Jürgen's 60th birthday and Erwin's 65th birthday.

Jürgen and Erwin have been recognized for decades as outstanding experts in the probabilistic treatment, spiced with a dash of analysis, of problems in statistical mechanics and related fields. Their high esteem and profound impact are reflected by their great number of students and collaborators and by their large number of invitations to conferences, editorships, etc. over the years.

Erwin started his career with various distributional limit results of central limit and martingale type, but soon turned to problems coming from large-deviation analysis, like Laplace approximations and the maximum entropy principle. One of the main types of problems that accompanied his career for decades are intricate questions about the extremal behavior of the volume of the path of a random walk or a Wiener sausage and of the intersection of two independent such objects. Here he has derived a number of striking and deep results over the years. Another core area of his research, which is closely related, is the description of paths under the influence of a self-attracting or self-repellent force, partially motivated by the polaron problem. In particular, Erwin derived several fundamental properties of polymers with various kinds of interactions. His results also had a strong influence on the understanding of interface models with gradient-type interactions. Some of his favorite subjects in recent years have been random walks in random environments, and spin glasses and the little-understood phenomenon of ultrametricity.

Jürgen was educated within the Russian school in the 1970s, pioneering the application of large deviation analysis to various models in statistical mechanics.

One of the fundamental tools, the Gärtner–Ellis theorem, is a side-result of his thesis. Later he built up a theory of large deviations for projective limits. Also his contributions to the McKean–Vlasov equation remain a vital element of the theory. Over the last two decades, he has been one of the most active researchers on the parabolic Anderson model, the Cauchy problem for the heat equation with random potential.

Many of the above results were derived in close collaboration with students, colleagues, and friends, many of whom also presented talks on the occasion of the two 2010 workshops. The present volume collects 20 research and review papers by participants in the fields in which Jürgen and Erwin are best known for their contributions. Most of these papers are, in some way or another, influenced by Jürgen's and Erwin's work, and all of them present state-of-the-art results in topics that accompanied the two for decades and received significant impacts from them over the years. All papers have been peer-refereed according to highest standards.

Almost half of the contributions to this volume are devoted to the parabolic Anderson model, one of the most active research fields of Jürgen. For more than 20 years, Jürgen has formed and extended this subject like nobody else. Jürgen's co-authors and students and their students and colleagues give an impressive account on some of the latest developments for the parabolic Anderson model, among which there are results on the long-time behavior for various time-dependent and time-independent potentials, and novel aspects like several moving catalysts, acceleration/deceleration, and front propagation.

Another main topic covered by this volume is random polymers interacting with random and nonrandom environment and their critical behavior, a topic that received much attention from Erwin and his coauthors. Furthermore, special aspects of branching processes and interacting measure-valued processes are considered, topics that Jürgen studied many years ago. Finally, this volume offers a choice of results on various models that Erwin worked on or was interested in for many years, like Parisi's formulas for the generalized random energy model, metastability, hydrodynamic limits for gradient models and dimers.

In total, the collection of 20 papers in this volume presents important contributions to and surveys on research areas that are of current interest and have been strongly influenced by these two eminent mathematicians. It is not too much to say that these fields have benefited tremendously from their work.

Berlin
June 2011

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http://www.springer.com/978-3-642-23810-9

Probability in Complex Physical Systems
In Honour of Erwin Bolthausen and Jürgen Gärtner
Deuschel, J.-D.; Gentz, B.; König, W.; von Renesse, M.;
Scheutzow, M.; Schmock, U. (Eds.)
2012, XX, 512 p., Hardcover
ISBN: 978-3-642-23810-9