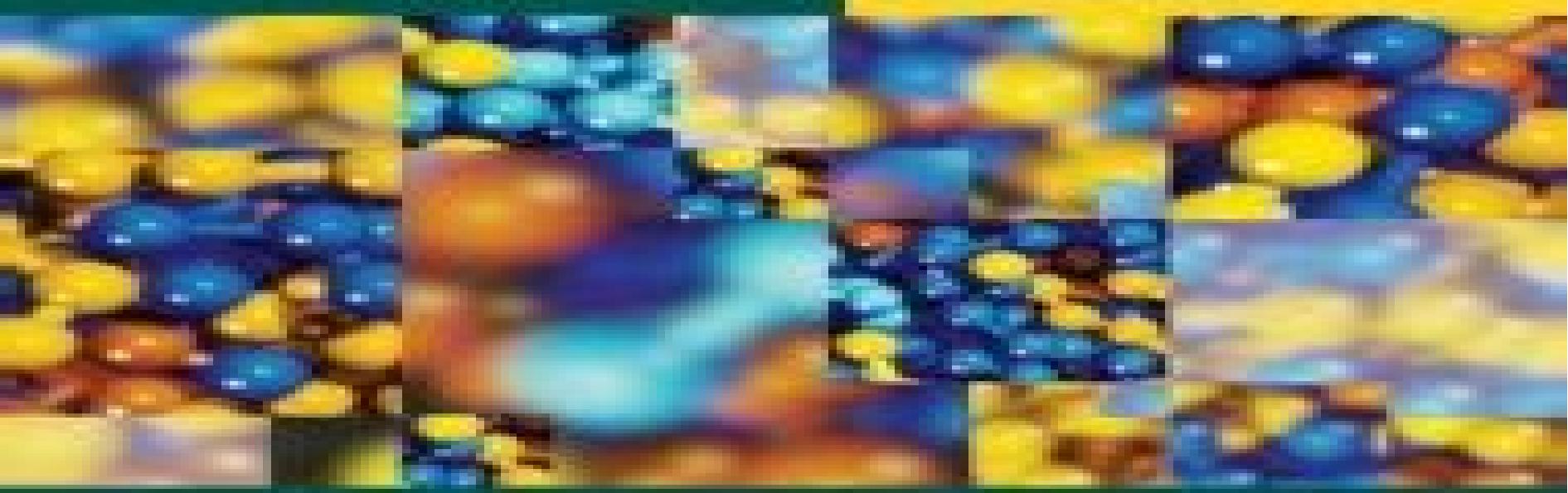# A Guide to
Monte-Carlo Simulations in
Statistical Physics

David P. Landau &
Kurt Binder

Monte Carlo Simulation In Statistical Physics

Rusy Baker

Monte Carlo Simulation In Statistical Physics:

Monte Carlo Simulation in Statistical Physics Kurt Binder,Dieter W. Heermann,2013-11-11 When learning very formal material one comes to a stage where one thinks one has understood the material Confronted with a realiife problem the passivity of this understanding sometimes becomes painfully elear To be able to solve the problem ideas methods etc need to be ready at hand They must be mastered become active knowledge in order to employ them successfully Starting from this idea the leitmotif or aim of this book has been to elose this gap as much as possible How can this be done The material presented here was born out of a series of lectures at the Summer School held at Figueira da Foz Portugal in 1987 The series of lectures was split into two concurrent parts In one part the formal material was presented Since the background of those attending varied widely the presentation of the formal material was kept as pedagogic as possible In the formal part the general ideas behind the Monte Carlo method were developed The Monte Carlo method has now found widespread appli cation in many branches of science such as physics chemistry and biology Because of this the scope of the lectures had to be narrowed down We could not give a complete account and restricted the treatment to the ap plication of the Monte Carlo method to the physics of phase transitions Here particular emphasis is placed on finite size effects **A Guide to Monte Carlo Simulations in Statistical Physics** David P. Landau,Kurt Binder,2000-08-17 This book describes all aspects of Monte Carlo simulation of complex physical systems encountered in condensed matter physics and statistical mechanics as well as in related fields such as polymer science and lattice gauge theory The authors give a succinct overview of simple sampling methods and develop the importance sampling method In addition they introduce quantum Monte Carlo methods aspects of simulations of growth phenomena and other systems far from equilibrium and the Monte Carlo Renormalization Group approach to critical phenomena The book includes many applications examples and current references and exercises to help the reader **A Guide to Monte Carlo Simulations in Statistical Physics** David Landau,Kurt Binder,2021-07-29 Dealing with all aspects of Monte Carlo simulation of complex physical systems encountered in condensed matter physics and statistical mechanics this book provides an introduction to computer simulations in physics The 5th edition contains extensive new material describing numerous powerful algorithms and methods that represent recent developments in the field New topics such as active matter and machine learning are also introduced Throughout there are many applications examples recipes case studies and exercises to help the reader fully comprehend the material This book is ideal for graduate students and researchers both in academia and industry who want to learn techniques that have become a third tool of physical science complementing experiment and analytical theory A Guide to Monte Carlo Simulations in Statistical Physics David P. Landau,Kurt Binder,2009-09-10 Dealing with all aspects of Monte Carlo simulation of complex physical systems encountered in condensed matter physics and statistical mechanics this book provides an introduction to computer simulations in physics This edition now contains material describing powerful new algorithms that have appeared since the

previous edition was published and highlights recent technical advances and key applications that these algorithms now make possible Updates also include several new sections and a chapter on the use of Monte Carlo simulations of biological molecules Throughout the book there are many applications examples recipes case studies and exercises to help the reader understand the material It is ideal for graduate students and researchers both in academia and industry who want to learn techniques that have become a third tool of physical science complementing experiment and analytical theory *Monte Carlo simulation in statistical physics: an introduction* Binder K.,D. W. Heermann,1992 **Monte Carlo Methods in Statistical Physics** Kurt Binder,2012-12-06 In the seven years since this volume first appeared there has been an enormous expansion of the range of problems to which Monte Carlo computer simulation methods have been applied This fact has already led to the addition of a companion volume Applications of the Monte Carlo Method in Statistical Physics Topics in Current Physics Vol 36 edited in 1984 to this book But the field continues to develop further rapid progress is being made with respect to the implementation of Monte Carlo algorithms the construction of special purpose computers dedicated to exe cute Monte Carlo programs and new methods to analyze the data generated by these programs Brief descriptions of these and other developments together with numerous addi tional references are included in a new chapter Recent Trends in Monte Carlo Simulations which has been written for this second edition Typographical correc tions have been made and fuller references given where appropriate but otherwise the layout and contents of the other chapters are left unchanged Thus this book together with its companion volume mentioned above gives a fairly complete and up to date review of the field It is hoped that the reduced price of this paperback edition will make it accessible to a wide range of scientists and students in the fields to which it is relevant theoretical phYSics and physical chemistry con densed matter physics and materials science computational physics and applied mathematics etc Applications of the Monte Carlo Method in Statistical Physics K. Binder,2012-12-06 Monte Carlo computer simulations are now a standard tool in scientific fields such as condensed matter physics including surface physics and applied physics problems metallurgy diffusion and segregation etc chemical physics including studies of solutions chemical reactions polymer statistics etc and field theory With the increasing ability of this method to deal with quantum mechanical problems such as quantum spin systems or many fermion problems it will become useful for other questions in the fields of elementary particle and nuclear physics as well The large number of recent publications dealing either with applications or further development of some aspects of this method is a clear indication that the scientific community has realized the power and versatility of Monte Carlo simula tions as well as of related simulation techniques such as molecular dynamics and Langevin dynamics which are only briefly mentioned in the present book With the increasing availability of recent very high speed general purpose computers many problems become tractable which have so far escaped satisfactory treatment due to prac tical limitations too small systems had to be chosen or too short averaging times had to be used While this approach is admittedly rather expensive two cheaper alternatives have become available too i

array or vector processors specifical ly suited for wide classes of simulation purposes ii special purpose processors which are built for a more specific class of problems or in the extreme case for the simulation of one single model system   Monte Carlo Methods in Statistical Physics ,1999-02-11 This book provides an introduction to Monte Carlo simulations in classical statistical physics and is aimed both at students beginning work in the field and at more experienced researchers who wish to learn more about Monte Carlo methods The material covered includes methods for both equilibrium and out of equilibrium systems and common algorithms like the Metropolis and heat bath algorithms are discussed in detail as well as more sophisticated ones such as continuous time Monte Carlo cluster algorithms multigrid methods entropic sampling and simulated tempering Data analysis techniques are also explained starting with straightforward measurement and error estimation techniques and progressing to topics such as the single and multiple histogram methods and finite size scaling The last few chapters of the book are devoted to implementation issues including discussions of such topics as lattice representations efficient implementation of data structures multispin coding parallelization of Monte Carlo algorithms and random number generation At the end of the book the authors give a number of example programs demonstrating the applications of these techniques to a variety of well known models   A Guide to Monte Carlo Simulations in Statistical Physics David Landau,Kurt Binder,2021-07-29 Unique coverage of Monte Carlo methods for both continuum and lattice systems explaining particularly analysis of phase transitions   *Monte Carlo Simulation in Statistical Physics* Kurt Binder,Dieter Heermann,2014-01-15   Monte Carlo Methods in Statistical Physics K. Murthy,2004 Monte Carlo simulations comprise a substantial part of the new and third major arm of investigation in the physical sciences that has emerged in recent times to augment the traditional ones of experiment and theory With the advent of high speed digital computing numerical simulations techniques like Monte Carlo have been very successful in extracting real world observations out of seemingly intractable theoretical models   **A Guide to Monte Carlo Simulations in Statistical Physics** Rusy Baker,2017-03-22 Dealing with all aspects of Monte Carlo simulation of complex physical systems encountered in condensed matter physics and statistical mechanics this book provides an introduction to computer simulations in physics This edition contains extensive new material describing numerous powerful algorithms not covered in previous editions in some cases representing new developments that have only recently appeared Older methodologies whose impact was previously unclear or unappreciated are also introduced in addition to many small revisions that bring the text and cited literature up to date This edition also introduces the use of petascale computing facilities in the Monte Carlo arena Throughout the book there are many applications examples recipes case studies and exercises to help the reader understand the material   **Monte Carlo Methods in Statistical Physics** K. Binder,1979 The Monte Carlo method is a method of computer simulation of a system with many degrees of freedom and thus has widespread applications in science It has its name from the use of random numbers to simulate statistical fluctuations in order to numerically generate probability distributions which otherwise may

not be known explicitly since the considered systems are so complex While the method would work in principle also with random numbers generated at a roulette table an ef fective and economic use of this method requires the use of high speed digital computers Thus the first successful application of this method to a problem of statistical thermodynamics dates back only to 1953 when Metropolis and co workers studied a fluid consisting of hard disks Since then this technique has experi enced an impetuous development which is likely to even speed up in the future since better computers now available allow many fascinating applications What are then the specific advantages of Monte Carlo computer experiments To answer that question one first notes that Monte Carlo methods yield information on model systems where specific assumption about the effective forces between the atoms have been made which in principle is numerically exact i e the results are accurate apart from statistical erros which can be made as small as desired if only enough computing time is invested **Monte Carlo Simulation in Statistical Physics** Kurt Binder,Dieter W. Heermann,2002 Monte Carlo Simulation in Statistical Physics deals with the computer simulation of many body systems in condensed matter physics and related fields of physics chemistry and beyond to traffic flows stock market fluctuations etc Using random numbers generated by a computer probability distributions are calculated allowing the estimation of the thermodynamic properties of various systems This book describes the theoretical background to several variants of these Monte Carlo methods and gives a systematic presentation from which newcomers can learn to perform such simulations and to analyze their results This fourth edition has been updated and a new chapter on Monte Carlo simulation of quantum mechanical problems has been added To help students in their work a special web server has been installed to host programs and discussion groups http wwwcp tphys uni heidelberg de Prof Binder was the winner of the Berni J Alder CECAM Award for Computational Physics 2001 **Vorticity, Statistical Mechanics, and Monte Carlo Simulation** Chjan Lim,Joseph Nebus,2007-07-28 This book is drawn from across many active fields of mathematics and physics It has connections to atmospheric dynamics spherical codes graph theory constrained optimization problems Markov Chains and Monte Carlo methods It addresses how to access interesting original and publishable research in statistical modeling of large scale flows and several related fields The authors explicitly reach around the major branches of mathematics and physics showing how the use of a few straightforward approaches can create a cornucopia of intriguing questions and the tools to answer them **Monte Carlo Methods in Simulation in Statistical Physics** Kurt Binder,1988 **Applications of the Monte Carlo Method in Statistical Physics** K. Binder,1984-03-01 Monte Carlo computer simulations are now a standard tool in scientific fields such as condensed matter physics including surface physics and applied physics problems metallurgy diffusion and segregation etc chemical physics including studies of solutions chemical reactions polymer statistics etc and field theory With the increasing ability of this method to deal with quantum mechanical problems such as quantum spin systems or many fermion problems it will become useful for other questions in the fields of elementary particle and nuclear physics as well The large number of recent publications dealing

either with applications or further development of some aspects of this method is a clear indication that the scientific community has realized the power and versatility of Monte Carlo simula tions as well as of related simulation techniques such as molecular dynamics and Langevin dynamics which are only briefly mentioned in the present book With the increasing availability of recent very high speed general purpose computers many problems become tractable which have so far escaped satisfactory treatment due to prac tical limitations too small systems had to be chosen or too short averaging times had to be used While this approach is admittedly rather expensive two cheaper alternatives have become available too i array or vector processors specifical ly suited for wide classes of simulation purposes ii special purpose processors which are built for a more specific class of problems or in the extreme case for the simulation of one single model system   A Guide to Monte Carlo Simulations in Statistical Physics David P. Landau,2009 Expanding the topic of Monte Carlo simulation for graduate students and researchers in physics   **A Guide to Monte Carlo Simulations in Statistical Physics** Russell Duffy,2017-11-29 new material describing numerous powerful algorithms not covered in previous editions in some cases representing new developments that have only recently appeared Older methodologies whose impact was previously unclear or unappreciated are also introduced in addition to many small revisions that bring the text and cited literature up to date This edition also introduces the use of petascale computing facilities in the Monte Carlo arena Throughout the book there are many applications examples recipes case studies and exercises to help the reader understand the material It is ideal for graduate students and researchers both in academia and industry who want to learn techniques that have become a third tool of physical science complementing experiment and analytical theory   The Monte Carlo Method in Condensed Matter Physics Kurt Binder,2012-12-06 The Monte Carlo method is now widely used and commonly accepted as an important and useful tool in solid state physics and related fields It is broadly recognized that the technique of computer simulation is complementary to both analytical theory and experiment and can significantly contribute to ad vancing the understanding of various scientific problems Widespread applications of the Monte Carlo method to various fields of the statistical mechanics of condensed matter physics have already been reviewed in two previously published books namely Monte Carlo Methods in Statistical Physics Topics Curro Phys Vol 7 1st edn 1979 2ndedn 1986 and Applications of the Monte Carlo Method in Statistical Physics Topics Curro Phys Vol 36 1st edn 1984 2nd edn 1987 Meanwhile the field has continued its rapid growth and expansion and applications to new fields have appeared that were not treated at all in the above two books e g studies of irreversible growth phenomena cellular automata interfaces and quantum problems on lattices Also new methodic aspects have emerged such as aspects of efficient use of vector com puters or parallel computers more efficient analysis of simulated systems con figurations and methods to reduce critical slowing down at i hase transitions Taken together with the extensive activity in certain traditional areas of research simulation of classical and quantum fluids of macromolecular materials of spin glasses and quadrupolar glasses etc

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