Binder K, ed. *Monte Carlo methods in statistical physics.*
Berlin, FRG: Springer-Verlag, 1979. 376 p. (Chapters by Binder K, Ceperley D M, Landau D P, Levesque D, and Müller-Krumbhaar H, as first authors.)
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This book deals with the computer simulation of thermodynamic properties of many-body systems. Both the theoretical background and practical realization of simulations using random numbers are described, and the rich information gained on static and dynamic phenomena in various systems is reviewed. [The *SCI*® indicates that this book has been cited in over 670 publications.]

Computer Simulation— A Third Branch of Physics

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My interest in the Monte Carlo method dates back to 1967, when I started my doctoral thesis at the Technical University of Vienna with G. Ortner and H. Rauch; the latter carried out neutron depolarization studies of ferromagnets, and my task was to provide a more detailed theoretical understanding of spin correlations near criticality.

At this time critical phenomena still were quite mysterious, although famous ideas like "scaling laws"[1] emerged. When I learned in a seminar in P. Weinzierl's group that a standard tool for studying pair correlations in fluids was the Monte Carlo method, originally invented by N. Metropolis *et al.*[2] to compute the equation of the state of hard disks, I asked myself: Why not try this method for critical spin correlations? Doing this for both Ising and Heisenberg ferromagnets, I ran into a lot of interesting problems: in a finite lattice there is no broken symmetry in a strict sense, sharp phase transitions do not occur but rather are rounded and shifted, and so on. Theoretical ideas about these facts were then only just emerging.[3] However, I found these problems rather fascinating and studied critical phenomena by Monte Carlo methods in a series of papers from 1968 to 1974, showing that the finite size effects could in fact be handled and that one could even use them as a tool to extract critical exponents by invoking M.E. Fisher's[3] finite size scaling theory.

With H. Müller-Krumbhaar I discussed the dynamic interpretation of Monte Carlo methods in terms of master equations, which form the basis for studies of critical dynamics, of diffusion and unmixing phenomena, and so on. With D. Stauffer I started to explore "clusters" in the Ising model in an attempt to elucidate nucleation theory, while since 1975 I have interacted with D.P. Landau on the Monte Carlo simulation of multicritical phenomena and of adsorbed surface layers. All these very successful studies showed clearly that the Monte Carlo method is a powerful tool for all kinds of interacting many-body systems, and thus this work found more and more attention.

After I had presented several aspects of this work in invited talks at various conferences, H. Lotsch from Springer-Verlag asked me in 1977 whether there was a need for a book describing these methods. Since I had already written an extensive review,[4] I knew that the applications of Monte Carlo methods in statistical physics were too diverse to be discussed by a single person. Thus, I decided the only solution was to edit a book collecting the most pertinent contributions of leading experts. While I wrote the introductory chapter and also reviewed Monte Carlo studies of relaxation phenomena (with M.H. Kalos) and of disordered systems (with Stauffer), Landau reviewed both Monte Carlo studies in surrace physics and phase diagram calculations of mixtures and magnetic systems. Müller-Krumbhaar reviewed simulations of "small systems" and of crystal growth; D.M. Ceperley and Kalos dealt with quantum many-body problems; and, last but not least, simulation of classical fluids was described by D. Levesque, J.-J. Weis, and J.-P. Hansen. In fact, only due to the fruitful collaboration with all these colleagues was this book possible!

It is now clear that this book did fill an urgent need. As C. de Dominicis once put it, "The 60's were the years of Green's functions, the 70's were the time of the renormalization group, but the 80's is the age of Monte Carlo." Not only are we understanding this method better, developing further theoretical and practical insight, but the method becomes more powerful due to the availability of faster computers. In fact, even the construction of special-purpose processors dedicated to Monte Carlo simulation[5] is in progress. Meanwhile, both the present book and a companion volume[6] intending to update it have seen a second edition,[7] and in the last two years various other books on Monte Carlo methods have appeared. Truly, computer simulation is a *third branch of physics*, intermediate between the traditional branches—experimental and theoretical physics—and complementing them!

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