

Frontiers of
Nonequilibrium
Statistical Physics

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Series B: Physics

Frontiers of Nonequilibrium Statistical Physics

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PREFACE

The four-week period from May 20 to June 16, 1984 was an intensive period of advanced study on the foundations and frontiers of nonequilibrium statistical physics (NSP). During the first two weeks of this period, an advanced-study course on the "Foundations of NSP" was conducted in Albuquerque under the sponsorship of the University of New Mexico Center for High-Technology Materials. This was followed by a two-week NATO Advanced Study Institute on the "Frontiers of NSP" in Santa Fe under the same directorship. Many Students attended both meetings.

This book comprises proceedings based on those lectures and covering a broad spectrum of topics in NSP ranging from basic problems in quantum measurement theory to analogies between lasers and Darwinian evolution.

The various types of quantum distribution functions and their uses are treated by several authors. Other tools of NSP, such as Langevin equations, Fokker-Planck equations, and master equations, are developed and applied to areas such as laser physics, plasma physics, Brownian motion, and hydrodynamic instabilities. The properties and experimental detection of squeezed states and antibunching are described, as well as experimental tests of the violation of Bell's inequality. Information theory, mean-field theory, reservoir theory, entropy maximization, and even a novel nonlinear generalization of quantum mechanics are used to discuss nonequilibrium phenomena and the approach toward thermodynamic equilibrium.

The areas of bifurcation theory, fractals, strange attractors, and routes to chaos in nonlinear dynamical systems have been very active recently, and these concepts are dealt with at length, including applications to optical multistability and phase-transition critical phenomena. A geometrical classification of bifurcations based on catastrophe theory is also presented.

The opening lecture at the ASI was delivered by Professor Willis E. Lamb Jr. on the approach to equilibrium. The ideas presented in this talk were based on his 1973 paper "Approach to Thermodynamic Equilibrium (and other Stationary States)", which we are pleased to reprint here as the opening chapter of this book.

This book also contains two other reprinted articles. One is a paper by A. O. Barut and P. Meystre on a classical model of the EPR experiment. This generated considerable discussion at the ASI which led Professor A. Aspect to write a comment on this paper for these proceedings. The other is a paper by M. O. Scully on the relation between quantum mechanics and hidden-variable theory.

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DEDICATION

We dedicate this book to the memory of two pioneers in nonequilibrium statistical physics, Marc Kac of the University of Southern California and Stanislaw M. Ulam of Los Alamos National Laboratory. Though death prevented these good friends from contributing directly to this book, the legacy of their work can be found here in the writings of all those who learned so much from them.

Gerald T. Moore and Marlan O. Scully
Albuquerque, July 1985

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