Preface

In continuum mechanics and the irreversible thermodynamics the existence of the continuous fields is postulated. Their derivation is made in nonequilibrium statistical mechanics starting from the Liouville equation valid in the phase space associated to the microscopic discrete system. In this book we present a new method to derive the continuous fields by means of a space-time coarse-grained average of the quantities associated to the microscopic particles. The new method can be applied to discrete systems with more general characteristics than those usually considered: the particles number is arbitrary; the structure and the interactions of the microscopic particles are arbitrary and the dynamic laws of their motion have not to be known; the particles may appear and disappear due to instantaneous processes; the physical quantity associated to a particle is arbitrary.

In fact the problem of the derivation of the balance equations is composed by three distinct problems: the existence of the balance equations; the continuity of the macroscopic fields and the existence of the constitutive relations. The separation of these problems clarifies the methods that can be used to associate continuous fields to the corpuscular systems, even if they are formed by only a few of particles.

The space-time coarse-grained averages are defined in Chapter 4 and we prove that they satisfy some mathematical identities which are not the balance equations, but have their form. Their importance resides in the very general conditions under which they are derived, their existence being proved for any physical system with a corpuscular structure, no matter the laws governing the motion of the constituent particles. The smoothness characteristics to the macroscopic continuous fields is obtained under the hypothesis that in the phase space there is a probability density satisfying the Liouville equation. In the same time the usual balance equations presented in the first three chapters are obtained too. These results are used in the Chapter 5 in order to formulate the conditions that a Liouville type equation exists in a projection of the phase space and to demonstrate that the quantum theory with hidden parameters can not exist.

While in the first part of the book we present the theoretical derivation of the balance equations, the second part contains several applications

in various domains of the statistical physics: the evaluation of the space-time scale of the diffusion of particles moving according to the random walk algorithm, the derivation of the balance equations for the one-dimensional granular flows, the modeling of the lipid bilayer, the continuous description of the evolution of a financial market, and the estimation of the monotone trend of a time series. For some of these applications we discuss also the constitutive relations characteristic to the corpuscular system.

During the time when I obtained the main results presented in this book, I enjoyed the collaboration with my colleagues Prof. Adelina Georgescu and Dr. Nicolae Suciu. I express my gratitude for the assistance during the preparation of the PhD thesis to my advisor Prof. Gheorghe Nenciu and to Prof. Viorica Florescu, head of the department of statistical physics and quantum mechanics at the Physics Faculty, Bucharest University. This book is the extended form of my PhD thesis "Contributions to the description by means of macroscopic continuous fields of the corpuscular systems".

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