

# Preface

This volume contains the lecture notes of the conference held in the Center of Physics of Les Houches, France, on February 18-22 2002. The lectures connected through the heading “Dynamics and Thermodynamics of Systems with Long-Range Interactions”, explored a variety of topics involving long-range interactions.

This field is entering the 21st century in an interesting and exciting way. Properties of systems with long-range interactions are to a large extent only poorly understood although they concern a wide range of problems in physics (astrophysics, nuclear physics, plasmas physics, Bose–Einstein condensates, atomic clusters, hydrodynamics,...). However, recently, the disclosure of new methodologies to approach the study of these systems has revealed its importance also in a trans-disciplinary perspective. The main challenge of this workshop was represented by the construction of a thermodynamic treatment of systems with long-range forces and by the understanding of analogies and differences between the numerous domains of applications.

Some promising results in this direction have been recently obtained in the attempt of combining tools developed in the framework of usual statistical mechanics with concepts and methods of dynamical systems. Particularly arduous, but very exciting, is the understanding of phase transitions that shows several new features like negative specific heat, non-extensivity, inequivalence of ensembles, etc. Moreover, such systems are a perfect laboratory for studying aspects related to non-equilibrium phenomena and their description in terms of dynamical concepts (self-consistent chaos, slow relaxation, formation and role of structures,...).

This fundamental and methodological study should help us to detect the depth and the origin of the analogies found in the different domains mentioned above or, on the contrary, emphasize their specificities. In particular, we would like to put a special emphasis on Bose–Einstein Condensation (BEC), which could be an important field of applications, since experiments and theoretical ideas have reached an impressive quality in the last decade. In that domain, inequivalences between ensembles have been reported and should be clarified. Moreover, long range interactions in BEC have opened very exciting new perspectives to consider BEC as a model for other systems.

The main lecturers of the Les Houches school were Ofer Biham (University of Jerusalem), Pierre-Henri Chavanis (University of Toulouse), Philippe

Chomaz (CEA, Caen), Eddie Cohen (University of Rockefeller), Jean Dalibard (ENS Paris), Diego Del Castillo-Negrete (Oak Ridge National Laboratory), Yves Elskens (University of Marseille), Dieter Gross (HMI, Berlin), Martin Holthaus (University of Oldenburg), Gershon Kurizki (Weizmann Institute), Ulf Leonhardt (University of Saint Andrews), David Mukamel (Weizmann Institute), Thanu Padmanabhan (Pune, India), Andrea Rapisarda (University of Catania), Constantino Tsallis (University of Rio de Janeiro). Additional materials such as slides of conferences and written contributions by people who have attended the conference are available on the electronic site <http://www.ens-lyon.fr/~tdauxois/procs02/>.

Here we would like to express our sincere gratitude to the lecturers for all their efforts in preparing, presenting and finally writing up their lectures. Our thanks are also due to the main sponsors of this conference: the “Département Sciences Physiques et Mathématiques” of CNRS, the program “Quantum degenerate dilute systems Bose–Einstein condensation and beyond” of the European Science Foundation and the Conseil Régional Rhône-Alpes. Support for this school comes also from the Groupement de Recherche CNRS “Phénomènes hors d’équilibre” and from the “Ecole Doctorale de Physique et d’Astrophysique de Lyon”. Finally, we would like to thank the director of the Center of Physics of Les Houches, Martial Ducloy, for his continuous interest and assistance. We also acknowledge the staff of the secretary office of the school for the help in all the aspects of the organization.

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