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/.

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Thierry Dauxois, Stefano Ruffo
Ennio Arimondo, Martin Wilkens

List of Contributors

Ennio Arimondo
INFM
Dipartimento di Fisica
Università di Pisa
Via Buonarroti 2
I-56127 Pisa, Italy
arimondo@mail.df.unipi.it

Alexandre Artemiev
Department of Physics
Texas A&M University
College Station,
Texas, 77843-4242, USA
artemiev@chemphys.weizmann.ac.il

Fulvio Baldovin
Centro Brasileiro de Pesquisas Físicas
Rua Xavier Sigaud 150
22290-180 Rio de Janeiro, RJ, Brazil
baldovin@cbpf.br

Julien Barré
Laboratoire de Physique
ENS Lyon
46, allée d'Italie
F-69007 Lyon, France
Julien.Barre@ens-lyon.fr

Ofer Biham
Ofer Malcai
Racah Institute of Physics
The Hebrew University
Jerusalem 91904, Israel
biham@phys.huji.ac.il

Dave Boers
Fachbereich Physik
Carl von Ossietzky Universität
D-26111 Oldenburg, Germany
boers@marvin.physik.
uni-oldenburg.de

Pierre-Henri Chavanis
Laboratoire de Physique Quantique
Université Paul Sabatier
118, route de Narbonne
31062 Toulouse, France
chavanis@irsamc2.ups-tlse.fr

Philippe Chomaz
GANIL (DSM-CEA/IN2P3-CNRS)
B.P.5027
F-14021 Caen cedex, France
chomaz@ganil.fr

Eddie G. D. Cohen
Center for Studies in Physics
and Biology
The Rockefeller University
1230 York Avenue
New York, NY 10021, USA
egdc@mail.rockefeller.edu

Jean Dalibard
Laboratoire Kastler Brossel
24 rue Lhomond
75005 Paris, France
Jean.Dalibard@lkb.ens.fr

Thierry Dauxois
Laboratoire de Physique

ENS Lyon
46, allée d'Italie
F-69007 Lyon, France
Thierry.Dauxois@ens-lyon.fr

Diego del-Castillo-Negrete
Oak Ridge National Laboratory
Oak Ridge
TN, 37831-8071, USA
delcastillod@ornl.gov

Yves Elskens
UMR 6633 CNRS
Université de Provence
Equipe turbulence plasma
case 321, campus Saint-Jérôme
13397 Marseille cedex 20, France
elskens@newsup.univ-mrs.fr

Stefano Giovanazzi
Department of Chemical Physics
Weizmann Institute of Science
76100 Rehovot, Israel
stevbolz@yahoo.it

Dieter H. E. Gross
Hahn-Meitner Institute
Freie Universität Berlin
Fachbereich Physik
Glienickerstr. 100
14109 Berlin, Germany
gross@hmi.de

Francesca Gulminelli
GANIL (DSM-CEA/IN2P3-CNRS)
B.P.5027
F-14021 Caen cedex, France
gulminelli@caelav.in2p3.fr

Martin Holthaus
Fachbereich Physik
Carl von Ossietzky Universität
D-26111 Oldenburg, Germany
martin.holthaus@uni-oldenburg.de

Iaroslav Ispolatov
Departamento de Física
Universidad de Santiago de Chile
Casilla 302, Correo 2
Santiago, Chile
iispolat@usach.cl

Gershon Kurizki
Department of Chemical Physics
Weizmann Institute of Science
76100 Rehovot, Israel
Gershon.Kurizki@weizmann.ac.il

Vito Latora
Dipartimento di Fisica e Astronomia
Universitá di Catania
Corso Italia 57
95129 Catania, Italy
latora@ct.infn.it

Ofer Malcai
Racah Institute of Physics
The Hebrew University
Jerusalem 91904, Israel
malcai@phys.huji.ac.il

Oliver Morsch
INFM
Dipartimento di Fisica
Università di Pisa
Via Buonarroti 2
I-56127 Pisa, Italy
morsch@df.unipi.it

David Mukamel
Department of Physics of Complex Systems
The Weizmann Institute of Science
Rehovot 76100, Israel
fnmukaml@wisemail.weizmann.ac.il

Duncan O'Dell
Sussex Centre for Optical
and Atomic Physics, C.P.E.S.
University of Sussex
Brighton BN1 9QH, UK
D.H.J.Odell@sussex.ac.uk

Thanu Padmanabhan
IUCAA
Pune University Campus
Ganeshkhind
Pune - 7, India
nabhan@iucaa.ernet.in

Andrea Rapisarda
Dipartimento di Fisica e Astronomia
Universitá di Catania
Corso Italia 57
95129 Catania, Italy
andrea.rapisarda@ct.infn.it

Stefano Ruffo
Dipartimento di Energetica
"S. Stecco"
Università di Firenze
via S. Marta, 3
I-50139 Firenze, Italy
ruffo@avanzi.de.unifi.it

Constantino Tsallis
Centro Brasileiro de Pesquisas Físicas
Rua Xavier Sigaud 150
22290-180 Rio de Janeiro, RJ, Brazil
tsallis@cbpf.br

Martin Wilkens
Universität Potsdam
Institut fuer Physik
Am Neuen Palais 10
14469 Potsdam, Germany
martinw@elektra.quantum.physik.uni-potsdam.de