Mathematisches Forschungsinstitut Oberwolfach

Transport Theory and Statistical Mechanics

January 12 – 18, 1997

Tagungsbericht 2/1997

Introduction

The meeting was chaired by Eric Carlen (Atlanta) and Ruedi Seiler (Berlin).

Transport theory as a part of nonequilibrium statistical mechanics has been and still is one of the most fascinating problems in Mathematical Physics. This is true for both classical and quantum transport. The problems in this field are being treated by a wide variety of mathematical methods: Probabilistic, geometric, analytic, numerical as well as methods of dynamical systems. In the past decade substantial progress has been made by these different schools; so we felt time had arrived to bring together participants in these scientific groups to share their perspectives on these problems. Moreover we were pleased to be able to do this with a collection of participants from many different places and with many young participants present.

Given the variety of backgrounds we chose to spend more time than is perhaps usual on longer talks. In each of the morning sessions we had just two talks of 90 minutes duration where the first half was an introduction for participants from outside the school of the speaker. This format kept the discussion lively and the interchange of ideas was very active.

All participants appreciated the marvellous facilities of Oberwolfach which fostered a sense of community and which kept the participants together to discuss through dinner and afterwards. For a number of participants this was the first visit to Oberwolfach. To mention just one typical case: Fraydoun Rezahkanlou (Berkeley) presented a new and deep result on the derivation of the Boltzmann equation from microscopic dynamics. This was not only his first visit to Oberwolfach, but to Western Europe, and many participants met him for the first time.

During the meeting, an article appeared in „Le Monde“ on the Alan Sokal affair by Jean Bricemont (Louvain), one of the participants. This resulted in a great deal of discussions, certainly the loudest discussions of the conference, on postmodernism, hermeneutics and the relations of natural and social sciences. Another highlight was a piano concert by Peter Levay (Budapest), who performed a program picturing Bach, Chopin and some of his own compositions.

Gefördert durch DFG Deutsche Forschungsgemeinschaft

The schedule for the meeting was as follows:

- Monday: Approach to Equilibrium and Turbulence:

am	0900 – 1030	J.-P. Eckmann:	Return to Equilibrium for Classical Systems Coupled to a Heat Bath, after Jaksic and Pillet.
	1100 – 1215	E. Carlen:	Dissipation bounds in kinetic theory.
pm	0300 – 0345	A. Kupianen:	Universality and Turbulence: the passive scalar case.
	0400 – 0530	I. Procaccia:	Theory of Hydrodymanical Turbulence.
	0545 – 0630	P. Markowich:	Homogenization Limit and Wigner Transform.

- Tuesday: Transport:

am	0900 – 1030	J.Bellissard:	Transport Theory Revisited and Anomalous Electronic Transport.
	1100 – 1215	R. Seiler:	Transport, Indicies and Adiabatic Curvature.
pm	0300 – 0345	J. Avron:	Geometric Forces on Aharonov Bohm Flux Tubes.
	0400 – 0445	M. Aizenmann:	Localization bounds and Integral Quantum Hall effect.
	0500 – 0545	R. Kotecky:	Metastability and Approach to Equilibrium for Lattice Models.

- Wednesday: Mathematics of Chaotic and Random Systems:

am	0900 – 1030	J. Bricmont:	Renormalization Group Pathologies.
	1100 – 1215	L. Bunimovich:	Transport Coefficients from a Reversible Microdynamic.

After lunch we propose a walk to St. Roman (2 hours), a scenic Schwarzwald village. The return is by bus. We depart on foot at 0130 pm. Please sign up today so that we can make the bus reservation.

The lectures resume at 0500 pm only:

pm	0500 – 0545	G. Toscani:	Diffusive scaling of finite velocity models.
	0545 – 0630	B. Wennberg:	Kinetic scaling of an absorbing, periodic Lorentz gas.

After Dinner Recital: P. Levay will play Bach, Chopin and some modern pieces, drawn from compositions of himself and of some of his friends.

- Thursday: Hydrodynamic Limit:

am	0900 – 1030	H. Spohn:	Transport coefficients in models of Statistical Mechanics.
	1100 – 1215	F. Rezakhanlou:	Kinetic limit for point particles with random collisions.
pm	0300 – 0345	C. D. Levermore:	Macroscopic Dynamics without Dissipation.
	0345 – 0430	B. Perthame:	A transport equation for the motion of a dilute phase in a potential flow.
	0500 – 0545	A. Joye:	Upper Bounds on Expectation Values in Time-Dependent Quantum Mechanics.
	0545 – 0630	P. Levay:	Landau Hamiltonians on Riemann Surfaces. (Results and open problems).

- Friday: Scaling:

am	0900 – 1030	A. Knauf:	Classical and Quantum Motion in Periodic Potentials.
	1100 – 1215	J. Chayes:	Finite–Size Scaling and Scale Invariance in Post–modernism as well as Percolation.

Titles and Abstracts

M. Aizenmann
Princeton University

Localization bounds and Integral Quantum Hall Effect

The integral quantum hall effect can be seen within the one–particle effective Hamiltonian picture, in which the collection of electrons in a metal is modelled by a Fermi gas of particles with a one–body Hamiltonian of the form

$$H = K_{xy} + U_x^{per} + \lambda V_x$$

acting on $l^2\left(\mathbb{Z}^d\right)$ with $K_{xy} = e^{i\varphi xy}\,\delta_{|x-y|,1}$ incorporating a constant magnetic field U_x^{per} denotes an optional periodic potential and $\{V_x\}$ is a collection of independently distributed random variables.

The talk reviewed arguments establishing exponential localization for such operators in spectral regimes characterized by high disorder, extremal energies or weak disorder, far enough from the unperturbed spectrum. For these regions one can prove the localization condition

$$\mathbb{E}\left(\left| \frac{1}{H - E + i\eta}(x,y) \right|^s \right) \le A_s e^{-\mu s|x-y|}, \quad (0 < s < 1),$$

which implies for the spectral projections

$$\mathbb{E}(\mid P_{\le E}(x,y) \mid) \le \tilde{A} e^{-\overline{\mu}|x-y|}.$$

Analysis developed by Avron, Seiler, Simon and Bellissard, von Elst and Schulz–Baldes yields that under such condition the Hall conductance

$$\sigma_{i,j} = \mathbb{E}(< 0|P_{\le E} [[P_{\le E}, X_i], [P_{\le E}, X_j]]\ 0 >) \cdot \frac{e^2}{h}$$

is integer and constant in energy intervals of uniformed bounded localization length (μ^{-1}) [Theorem formulated by Bellissard et al]. The integer can be viewed alternatively as a Chern number corresponding to the geometry of a long and wide wire, or charge deficiency: number of states moved over the Fermi level by a single flux tube (Avron, Seiler, Simon).

J. Avron
Technion, Israel

Fories on Aharonov Bohm Flux Tubes

The forces that act on flux tubes in filled Landau level can be computed explicitly by studying the adiabatic curvature. We find that there is no Magnus/Lorentz type force on a moving vortex in the plane and that the vortex responds to external electric fields as if it was charged. This is joint work with P. Zograf.

J. Bellissard
Université Paul Sabatier Toulouse France and
Institut Universitaire de France

Electronic Anomalous transport: transport theory revisited

We first motivate the need to look back to transport theory for quantum systems by considering transport in Quasi crystal and the so–called „Moll hopping Conductivity“. Even though many of the very good metals such as Al, Cu, Fe, quasi crystal, are almost insulators at low temperature.

This is due to existence of very slow diffusion which makes it into an insulator. Mott hopping conductivity occurs whenever, at very low temperatures, the density of states is low. This phenomenon seems to dominate the accuracy of the plateaux in the quantum Hall effect.
With Hermann Schulz-Baldes, we have proposed a one particle model with collision, which gives rise to a Kubo formula. This is mathematically under control. Scaling exponents occur to characterize spectral and transport properties and we proved that the Drude formula is modified by the occurance of anomalous quantum diffusion, leading to an explanation of the low conductivity in Quasi Crystals. Moreover, if collision time does not follow a Poisson law, namely if they rather follow a Levy law, we get also a strong lowering of the conductivity. We argue that this is a possible mechanism occuring in the Mott hopping conductivity.

J. Bricmont
University of Louvain

Renormalization group pathologies

We introduce a notion of Gibbs states which is a slight generalization of the usual notion and for which several renormalized measures, from „pathological“ Renormalization Group transformations are Gibbsion. So, the R.G. pathologies turn out to be similar to the Griffiths singularities are not so pathalogical after all.

L. Bunimovich
Ga. Institute of Technology, Atlanta

Transport Coefficients from a Reversible Microdynamic

Transport coefficients (diffusion, viscosity and thermal conductivity) describe the rates of approach to equilibrium states. They correspond to the conservation of mass, momentum and energy of a system. My talk presents rigorous results on the existence and nondegeneracy of transport coefficients for systems with deterministic (invertible) dynamics, generated by a motion and interaction of particles. The existence and nondegeneracy of a diffusion coefficient and viscosities has been proven for the simplest models, while the problem of existence of thermal conductivity remains open.

E. Carlen
Ga. Institute of Technology, Atlanta

Dissipation Bounds in Kinetic Theory

The mathematical description of a physical system depends on the scale on which it is described. Certain phenomena happen „fast" on a given scale, or on times of order one on that scale, or „slowly" on that scale. The equations on mathematical physics can be derived by assuming the slow things never happen, and the fast ones have happened instantly, which leaves only a smaller number of degrees of freedom whose evolution is to be described.
It is of considerable interest to quantitatively control this approximation. In particular, to obtain precise bounds on the rate at which „fast" things happen.
We consider several problems of this type in kinetic theory and long range (local mean field) Glauber dynamics. In particular, we present a recent result of Carlen, Gabetta and Toscani that identifies the exact constant in the exponent in the rate of convergence to equilibrium for a spatially homogeneous Maxwellian gas. In particular, it is shown that this constant is on the order of the mean time between collisions, i.e. it does live on the physically expected time scale. Previous results gave exponential decay but with no bound on the time constant. This in principle allowed it to be a time constant on the macroscopic scale. Related bounds for related problems are discussed as well.

J. T. Chayes
Institute for Advanced Study, Princeton and
UCLA, Los Angeles

Finite–Size Scaling and Scale Invariance in Postmodernism as well as Percolation

This seminar reports on joint work with C. Borgs, H. Kesten and J. Spencer. We address the question of finite–size scaling in percolation by studying density p bond percolation in a finite box. As a function of the linear size n of the box, we determine the scaling window about which the system behaves critically. We characterize critically in terms of the scaling of the sizes of the largest clusters in the box: incipient „infinite" clusters which give rise to the infinite cluster. Within the scaling window, we show that the size of the largest cluster behaves like n^{d_f}, where d_f is the fractal dimension of the incipient cluster, and that there are typically many clusters of this scale. Above the window, we show that the size of the largest cluster scales like $P_\infty n^d$, where $P_\infty = P_\infty(p(n))$ is the infinite cluster density, and that there is only one cluster of this scale. Below the window, we show that the largest cluster is only of scale $\xi^{d_f} \log(n/\xi)$, where $\xi = \xi(p(n))$ is the correlation length. We establish these results axiomatically and explicitly verify the axioms in dimension $d = 2$. Our results are two–dimensional analogues of recent results on the dominant and giant component of the Erdös–Rény, random graph model.

We also comment on the postmodernist percolation model in which the densities of occupied and vacant bonds sum to a number exceeding 1. This model was inspired by recent work of the famous French philosopher Jean Bricmont.

J.–P. Eckmann
Universitè de Genève

Approach to Equilibrium

In my talk I tried to describe the interesting papers of Jaksic and Pillet on return to equilibrium in classical dynamical systems coupled to an infinite heat bath.

A. Joye
Centre de Physique Théorique, Marseille and
Université de Toulon

Upper Bounds on Expectation Values of Observables in Time–dependent Quantum Mechanics

Consider a time dependent family of self adjoint operators $H(t)$ on some Hilbert space $\mathbb{H}$ generating a two–parameter evolution operator $U(t,s)$. The expectation value of a positive operator A is defined by $< A >_\varphi (t) \ = < U(t,o)\varphi | A\ U(t,o)\varphi >$ with $\varphi \in \mathbb{H}$. This is a quantity of interest in the study of „Quantum Stability“ initiated by Bellissard, as well as in the study of „Transport“ . In case $A = \sum_{j\in\mathbb{N}} \lambda_j P_j$ where $\{P_j\}_{j\in\mathbb{N}}$ is a complete set of orthogonal projectors and $0 < \lambda_j \simeq j^\mu$ as $j \to \infty$, for some $\mu > 0$, we show, that provided $\|P_j H(t) P_k\| \leq \frac{\text{const}}{|j-h|^p}$, for p large enough, $< A >_\varphi (t) = O(t^\delta)$ where the exponent $\delta = \mu(1 + O(\frac{1}{p}))$, as $t \to \infty$ (and $O(\frac{1}{p})$ is uniform in μ). These results have been obtained in collaboration with J. M. Barbaroux.

A. Knauf
Technische Universität Berlin

Classical and Quantum Motion in Periodic Potentials

This is an overview and also a report on work done partly in collaboration with J. Asch, T. Hudetz and F. Benatti.
We consider the form of the motion of a classical and a quantum particle in a periodic potential. Classically this motion need not be ballistic but may be diffusive or even bounded above the maximum of the potential.

It is never Anosov if the potential is C^2. On the other hand, the quantal motion is ballistic, and the distribution of group velocity approaches the classical distribution in the semiclassical limit.
We also consider the classical and quantum dynamical entropies. An appropriately rescaled entropy of the gas is **lowered** if the classical entropy is enhanced by stochastic motion.

R. Kotecky
Charles University, Prague

Metastability and approach to equilibrium for lattice models

This is an overview of work done in collaboration with E. Olivieri and a work in preparation with F. Martinelli.
For the 2–dimensional case with small external field the non–Wulff behaviour of growing nucleus is exposed in different anisotropic situations. The underlying mechanism is explained microscopically in the limit of vanishing temperatures.
The proof of decay rate (Arrhemius law) for 3–dimensional case with vanishing external field and at fixed low temperatures is briefly discussed.

A. Kupiainen
Helsinki University

Universality in turbulence - the case of Passive scalar

We show that a scalar field passively advected by a rough random velocity field exhibits anomolous scaling exponents in the structure functions. This establishes breaking of Kolmogorrov scaling theory in a nontrivial turbulence model.

P. Levay
Technical University of Budapest

Landau Hamiltonians on Riemann surfaces. Some results and open problems

Parametrized families of Landau Hamiltonians on Riemann surfaces of genus $g > 1$ are considered. The parameters are describing deformations of such surfaces. The adiabatic curvature for the ground state is calculated by using Quillen's local index theorem. It is shown that the adiabatic curvature is the sum of two terms. The first is $\frac{1}{11}\left(B - B^2 - \frac{1}{6}\right)$ times the Weil–Pettersson two form living on the „space of shapes“ (i.e. Teichmüller space), the second term is a one describing fluctuations.

The meaning of the fluctuating term is clarified, and its relation to quantum chaos is pointed out.
The components of the adiabatic curvature are also related to the viscosity tensor of quantum Hall fluids.

C. D. Levermore
University of Arizona

Macroscopic Dynamics without Dissipation

The continuum limit of a conservative dynamical system over a one–dimensional lattice is shown to exhibit three different macroscopic phases; these are characterized by smooth, oscillatory, and chaotic, microscopic structures. This is contrast with the (completely integrable) Toda lattice, which exhibits an infinity of phases chracterized by modulated quasiperiodic structures. Similar phenomena is discussed in the context of the semiclassical (zero–dispersion) limit of various integrable partial differential equations, including the nonlinear Schrödinger, Korteweg–de Vries, and modified Korteweg–de Vries. The macroscopic dynamics is the continuum limit of a „soliton gas".

P. Markowich
Technische Universität Berlin

Homogenization Limit and Wigner Transforms

We consider antiselfadjoint pseudodifferential initial value problems with a small parameter (just as the Planck constant in the Schrödinger equation) and analyze the weak limit of quadratic functions of the solution by means of the Wigner transform. In the limit we obtain transport equations for the semiclassical measures of which we can deduce the weak limits of the observables by calculating moments.

B. Perthame
Frankreich

On the motion of a delute phase in a potential flow

Following P. Scherekow and G. Rasso's work we consider the motion of balls in a flow described by a potential flow in the dipole approximation. We make precise the Hamiltonian structure of the system, and study the limit as the number of balls tends to ∞, and Na^3 is constant ($a =$

radius of balls), obtaining a kinetic equation of Vlasov type with a very strong non-linearity. The control of kinetic energy is proved for this kinetic equation.

Itamar Procaccia
Weizmann Institute

Theory of Hydrodynamics Turbulence

The Kolmogorvo theory exponents in turbulence gives scaling exponents that are correct at third order structure function and systematically deviate from experimental for higher order. These experimental results were reviewed. Field theortic methods were used to show that perturbative theories fail to capture these deviations. Non-perturbative methods are needed; the fusion rules that control the asymptotic properties of the correlation fucntions were introuduced, and it was shown that multi-time many point correlation functions are not scale invariant in their time arguments. Some building blocks of the non-peruturbative theory are at hand, but the calculation of the scaling exponents from first principles is not achieved yet.

F. Rezakhanlou
UC Berkeley, Dept. of Math.

Kinetic limit for point particles with random collisions

We study the kinetic behaviour of a class of particle systems in which particles travel according to their velocity between random collisions. There are finitely many possible velocities and the macroscopic particle densities satisfy a discrete Boltzmann equation. This was established in dimension one in a joint work with James Tarrer. The equilibrium fluctuation for the model was established in any dimension. The probability of having the microscopic density is close to a given function g is exponentially small if g is not the unique solution of the macroscopic equation. This exponential rate can be calculated in certain cases and in general is given by a variational formula.

R. Seiler
Technische Universität Berlin

Transport, Indices and Adiabatic Curvature

In quantum Hall systems, transport of electric charge can be related to topological concepts. Conductivity, given by Kubo's formula, is equal to a Chern number plus fluctuations or an index of a pair of projections. The main tool in the analysis is the adiabatic theorem. It describes dynamics of the quantum system in the limit of very slow change of magnetic flux, i.e. in the limit where Ohms law for the Hall conductivity holds.

H. Spohn
LMU München

Transport Coefficients in Models of Statistical Mechanics

Slow modes arise either from conservation laws or from broken symmetry. The minimal model for the first case is a stochastic lattice gas. We discuss the notion of conductivity via the Green–Kubo formula, variational formulas, linear response and boundary fluxes. The minimal model for the second case is the stochastic Ising model below its critical temperature. We discuss the mobility and its relation to the Gaussian fluctuation theory.

G. Toscani
Universita di Pavia

Diffusive scaling of finite velocity models

We show that many equations of continuum theory (heat equation, porous medium equation, Burgers equation) can be obtained from the mesoscopic scale of kinetic theory from finite velocity discrete Boltzmann equation.

B. Wennberg
Göteborg

Kinetic Scaling of an Absorbing Lorentz Gas

By the absorbing Lorentz gas, we mean the free flow of a point particle in a domain Z_ε. When the particle hits the boundary it is absorbed. Here $Z_\varepsilon = \mathbb{R}^d \setminus \bigcup_{z \in \varepsilon \mathbb{Z}^d} \overline{B}_{z,r}$, i.e. at each point of the lattice $\varepsilon\, \mathbb{Z}^d$ a ball of radius r is removed. The main result is an estimate of the distribution of free path lengths, $\tau_\varepsilon\,(x,w) = \inf\,\{t > 0 \mid x + wt \in \partial Z_\varepsilon\}$. With $r = \varepsilon^{\frac{d}{d-1}}$, $\limsup_{t\to\infty} t\mu_\varepsilon(\{(x,w) \mid \tau_\varepsilon(x,w) > t\}) < \infty$ and $\liminf_{t\to\infty} t^{d-1}\, \mu_\varepsilon(\{(x,w) \mid \tau_\varepsilon(x,w) > t\}) > 0$, where μ_ε is a normalized measure on a periodic cell in Z_ε. An implication of this is that in the limit as $\varepsilon \to 0$, the flow cannot be described by a Boltzmann equation. This report is a joint work with J. Bourgain and F. Golse.

List of participants with e-mail adresses:

Michael Aizenman	aizenman@princeton.edu
Anton Arnold	arnold@math.tu-berlin.de
Joachim Asch	asch@cptsu5.univ-mrs.fr
Yosi Avron	avron@phys1.technion.ac.il
Jean Bellissard	jeanbel@irsamc2.ups-tlse.fr
Christian Borgs	borgs@physik.uni-leipzig.de
Jean Bricmont	bricmont@fyma.ucl.ac.be
Leonid Bunimovich	bunimovh@math.gatech.edu
Maria Carvalho	carlen@math.gatech.edu (Carvalho)
Eric Carlen	carlen@math.gatech.edu
Jennifer Chayes	jchayes@ias.edu
Jean–Pierre Eckmann	eckmann@mykonos.unige.ch
Ester Gabetta	gabetta@dragon.ian.pv.cnr.it
Ingenuin Gasser	gasser@math.tu-berlin.de
Frank Hövermann	franky@stat.physik.uni-muenchen.de
Alain Joye	Alain.Joye@cptsu5.univ-mrs.fr
Andreas Knauf	knauf@math.tu-berlin.de
Roman Kotecky	kotecky@cucc.ruk.cuni.cz
Antti Kupianen	ajkupiai@cc.helsinki.fi
Peter Levay	levay@phy.bme.hu
C. D. Levermore	lvrmr@math.arizona.edu
Peter Markowich	markowic@math.tu-berlin.de
Francis Nier	nier@orphee.polytechnique.fr
Lorenzo Pareschi	toscani@dragon.ian.pv.cnr.it (Pareschi)
B. Perthame	perthame@ann.jussieu.fr
Itamar Procaccia	cfprocac@weizmann.weizmann.ac.il
Fraydoun Rezakhanlou	rezakhan@math.berkeley.edu
Luc Rey–Bellet	rey@divsun.unige.ch
Thomas Richter	thor@math.tu-berlin.de
Ruedi Seiler	seiler@math.tu-berlin.de
Herbert Spohn	spohn@stat.physik.uni-muenchen.d400.de
Giuseppe Toscani	toscani@dragon.ian.pv.cnr.it
Bernd Wennberg	wennberg@math.chalmers.se

Tagungsteilnehmer

Prof.Dr. Michael Aizenman
Princeton University
P.O. Box 708
Jadwin Hall

Princeton , NJ 08544-0708
USA

Dr. Anton Arnold
Fachbereich Mathematik
Technische Universität Berlin
Straße des 17. Juni 136

10623 Berlin

Dr. Joachim Asch
CNRS - CPT
Luminy Case 907

F-13288 Marseille Cedex 9

Prof.Dr. Josi Avron
Dept. of Physics
TECHNION
Israel Institute of Technology

Haifa 32 000
ISRAEL

Prof.Dr. Jean V. Bellissard
IRSAMC
Universite Paul Sabatier
118, Route de Narbonne

F-31062 Toulouse Cedex

Prof.Dr. Christian Borgs
Microsoft Research
1 Microsoft Way

Redmond , WA 98052
USA

Prof.Dr. Jean Bricmont
Institut de Physique Theorique
Universite Catholique de Louvain
Chemin du Cyclotron, 2

B-1348 Louvain-la-Neuve

Prof.Dr. Leonid A. Bunimovich
Georgia Technical Institute
School of Mathematics

Atlanta , GA 30332-0160
USA

Prof.Dr. Eric Carlen
School of Mathematics
Georgia Institute of Technology

Atlanta , GA 30332-0160
USA

Prof.Dr. Maria C. Carvalho
School of Mathematics
Georgia Inst. of Technology

Atlanta , GA 30332
USA

Frank Hoevermann
Fachbereich Physik
Universität München
Theresienstraße 37

80333 München

Prof.Dr. Jennifer Chayes
Microsoft Research
1 Microsoft Way

Redmond , WA 98052
USA

Prof.Dr. Alain Joye
Centre de Physique Theorique
CNRS
Luminy - Case 907

F-13288 Marseille Cedex 09

Prof.Dr. Jean-Pierre Eckmann
Physique Theorique
Universite de Geneve
Case Postale 240

CH-1211 Geneve 4

Dr. Andreas Knauf
Fachbereich Mathematik
Technische Universität Berlin
Straße des 17. Juni 136

10623 Berlin

Prof.Dr. Ester Gabetta
Dipartimento di Matematica
Universita di Pavia
Via Abbiategrasso 209

I-27100 Pavia

Prof.Dr. Roman Kotecky
Center of Theoretical Study
Charles University
Jilska 1

13000 Praha 1
CZECH REPUBLIC

Ingenuin Gasser
Lehrstuhl Prof. Markowich
Fachbereich Mathematik
Techn. Universität Berlin
Straße des 17. Juni 136

10623 Berlin

Prof.Dr. Antti Kupiainen
Dept. of Mathematics
University of Helsinki
P.O. Box 4

SF-00014 Helsinki 10

Prof.Dr. Peter Levay
Institute of Physics
Technical University of Budapest
Budafoki u. 8

H-1521 Budapest

Prof.Dr. C. David Levermore
Dept. of Mathematics
University of Arizona

Tucson , AZ 85721
USA

Prof.Dr. Peter A. Markowich
Fachbereich Mathematik
Technische Universität Berlin
Straße des 17. Juni 136

10623 Berlin

Francis Nier
Centre de Mathematiques Appliquees
Ecole Polytechnique
U. R. A. - C. N. R. S. 169

F-91128 Palaiseau Cedex

Dr. Lorenzo Pareschi
Dipartimento di Matematica
Universita di Ferrari
Via Savonarola 9

I-44100 Ferrara

Prof.Dr. Benoit Perthame
Laboratoire d'Analyse Numerique,
Tour 55-65
Universite P. et M. Curie(Paris VI)
4, Place Jussieu

F-75252 Paris Cedex 05

Prof.Dr. Itamar Procaccia
Computational and Applied
Math Program
Dept. of Mathematics
University of Chicago

Chicago , IL 60637
USA

Dr. Luc Rey-Bellet
Departement de Mathematique
Universite de Geneve
Case Postale 240
2-4 rue du Lievre

CH-1211 Geneve 24

Prof.Dr. Fraydoun Rezakhanlou
Department of Mathematics
University of California
at Berkeley
815 Evans Hall

Berkeley , CA 94720-3840
USA

Thomas Richter
Fachbereich Mathematik
Sekr. MA 7-2
Technische Universität Berlin
Straße des 17. Juni 136

10623 Berlin

Prof.Dr. Hermann Schulz-Baldes
Laboratoire de Physique Quantique
Universite Paul Sabatier
118 route de Narbonne

F-31062 Toulouse Cedex

Prof.Dr. Ruedi Seiler
Fachbereich Mathematik
Technische Universität Berlin
Straße des 17. Juni 136

10623 Berlin

Prof.Dr. Herbert Spohn
Fachbereich Physik
Universität München
Theresienstraße 37

80333 München

Prof.Dr. Giuseppe Toscani
Dipartimento di Matematica
Universita di Pavia
Via Abbiategrasso 209

I-27100 Pavia

Dr. Bernt Wennberg
Department of Mathematics
Chalmers University of Technology
and University of Göteborg

S-412 96 Göteborg

Gefördert durch
DFG Deutsche Forschungsgemeinschaft