



III Potsdam-V Kiev International Workshop on Nonlinear Processes in Physics

Organizing Committee:

A.S. Fokas, D.J. Kaup, A.C. Newell, and V.E. Zakharov

Department of Mathematics and Computer Science

Clarkson University

Potsdam, New York 13699-5815, U.S.A.

August 1-11, 1991

OTIC
S-1000
C

The III Potsdam-V Kiev Workshop on Nonlinear Processes in Physics was held at Clarkson University, Potsdam, NY from August 1-11, 1991. It was sponsored by the Clarkson School of Science and was funded by the National Science Foundation, the Department of Energy, the US Air Force of Scientific Research, the US Office of Naval Research, the Sloan Foundation and the School of Science of Clarkson University. The organizing committee was A.S. Fokas, D.J. Kaup, A.C. Newell and V.E. Zakharov.

This was the first major scientific workshop in the USA where the Soviet scientists formed a major contingent of the participants. There were 31 USSR participants out of a total of 106 participants. The emphasis of the workshop was on the interaction between mathematical techniques and problems of physical interest. It was particularly successful in mixing plasma physicists, fluid physicists and soliton theorists. The exchanges between these groups, particularly with the participation of the Soviet delegation, were quite stimulating.

The most difficult part of the organization of this conference was the travel arrangements of the Soviet participants. We appreciate the efforts of Ildar Gabitov in this direction. However, in spite of our efforts several invited Soviet scientists were not able to attend, mainly because of difficulties in arranging their travel to the USA. ✓

For many of the Soviet participants, this was their first visit to the USA. Potsdam, being a small village in the foothills of the Adirondack Mountains, was a particularly pleasing location for their introduction to the Western style of life. There were the occasional luncheons and dinners with local residents as well as interviews with local news reporters. Quite a bit of color was added to the local scene by newspapers using headlines like "The Russians are coming!", "Take a Russian to lunch", etc. There were many other lighter moments during this workshop such as the birthday party for Zakharov and the "Pepsi can accident"..

Turning to the more serious side, there were up to 11 lectures per day with one and a half days off for excursions. Still there was time in the afternoon for private discussions or a walk



downtown. The lectures ranged from algebraic features of integrable systems and vortex dynamics to applications in plasma physics, ionospheric physics, nonlinear optics, oceanic studies and solid state. It is not possible to give full justice to all the excellent lectures here, but we shall mention some results. Lax presented a survey of the work on the zero dispersion limit for several types of dispersive systems and Levermore, Tian, and Venakides presented new important developments and applications of the Lax-Levermore theory and the associated Whitham's equation. Explicit solutions of this equation, using algebraic-geometric techniques, were presented by Krichever and Dubrovin. Krichever, also reviewed the recent appearance of Whitham's equation in the minimal models of 2D quantum gravity. Another connection between soliton theory and 2D quantum gravity was presented by Its who discussed the role of discrete Painlevé equations and gave a rigorous description of their continuous limit. Deift described a rigorous methodology for studying the long time behavior of the Riemann-Hilbert problems arising in the inverse spectral theory. Santini discussed the possibility of solving purely algebraic equations by the algebraic-geometric techniques developed in soliton theory. New results in the inverse spectral theory of evolution equations in two spatial dimensions was described by Boiti (dromions for DSI), Zhou (KPI), Sung (DSII), and Pogrebkov (KPI). McKean described the spectral theory associated with bi-Hamiltonian structures in classical mechanics, and Dorfman reviewed Hamiltonian and symplectic structures for evolution equations in one and two spatial variables. McLaughlin described algebraic-geometric aspects of the perturbation theory of certain soliton equations. Applications of the dressing method to nonlocal nonlinear evolution equations and to nonlinear evolution equations in multidimensions were discussed by Degasperis and Sabatier respectively. Takhtajan introduced a reversible soliton cellular automaton. Korepin derived and analyzed the integrable PDE's satisfied by quantum correlation functions. Beals described the action angle formulation of the Gel'fand-Dikii hierarchies. Shulman talked about new results regarding degenerate dispersion law. Alber analyzed certain complicated but integrable Hamiltonian systems. Bogoyanlenskij analyzed a certain $2 + 1$ version of the KdV and showed that it exhibits the phenomena of breaking of solitons. Conte and Fordy explained how to implement the Painlevé test in the presence of negative resonances.

Grunbaum discussed a novel inverse problem arising in low energy medical imaging (diffuse tomography) and Monk described analytical and numerical aspects of a certain inverse scattering problem. Hasegawa described some of the technical points involved with using solitons as pulses in the proposed transatlantic optical cable and Rupasov described new rigorous results in the quantum theory of stimulated Raman scattering. Bona showed how a rough wave model could give a respectable explanation of the appearance of underwater sand ridges seen on sloping beaches.

Important new results in vortex dynamics was presented by Zabusky, Majda, Ichikawa, Horton and Petviashvili. Norm showed excellent detailed visual descriptions of the collisions and reconnection of vortex filaments while Majda and Ichikawa each independently described the stretching and kinking of vortex filaments in irrotational fluids. Both Horton and Petviashvili discussed the rotational case and in particular, showed that the strength of the vortex determines whether the vortex behaves as a point vortex or a KdV soliton in collisions. Langmuir turbulence and collapsing cavitons in the ionosphere were discussed by Don DuBois while Rao and Kaup described how the mode conversion into electron Bernstein waves could cause the quenching of the downshifted peaks seen in the Tromsø and Arecibo ionospheric modification experiments. Morales discussed the nonlinear refraction of an rf wave in the ionosphere while Hada and Hamilton both presented studies of nonlinear Alfvén waves in space plasmas. One of the major presentations in collapse physics was made by Malkin who presented new analytical results for the self-focusing problem

of the two-dimensional nonlinear Schrödinger equation. Zakharov and Rubenchik each discussed aspects of weak turbulence.

Of course there well may be others that should be mentioned also, but the above will serve to give a flavor of the quality and quantity of these lectures.

All the lecturers and titles are listed below. The proceedings of the workshop will be published by Springer-Verlag, hopefully by early 1992. Current plans are to continue this series of workshops, with the next one planned to be held in the USSR in mid-August, 1993.

The Organizing Committee is grateful to the International Program Committee (Beals, Bona, Burke, Grundbaum, Hasagawa, Horton, Krichever, Kruskal, Kuznetsov, Lax, McLaughlin, Mikhailov, Rubenchik, Sabatier, Tabor, Zabusky) for their assistance and important suggestions.

Participants and their contributions

Eitan Abraham
Heriot-Watt University, GB

Instabilities in Semiconductor Lasers

Alejandro Aceves
University of New Mexico, USA

Chaotic Dynamics for Longitudinally
Degenerate Modes in a Ring-Cavity Laser

Solomon Alber
University of Nevada, USA

Complex Nonalgebraic Integrable
Hamiltonian Systems

Michele Bartuccelli
Imperial College, GB

Length Scales and the Navier Stokes
Equations

Richard Beals
Yale University, USA

Action-Angle Variables for the Gel'fand-
Dikii Flows

Keith Blow
British Telecom Lab., GB

Quantum Self Phase Modulation in Optical
Fibers

Oleg Bogoyavlenskij
Steklov Mathematical Institute
USSR

Breaking Solitons

Marco Boiti
Universita' Di Lecce, Italy

Real and Virtual Multidimensional
Solitons

Marco Boiti
Universita' Di Lecce, Italy

12 minute movie on Solitons

Jerry Bona
Penn State University, USA

Nonlinear Waves and Sediment Transport

Robin Bullough

Quantum Groups: q -Boson Theories of Integrable

UMIST, GB

William Burke
Geophysics Lab.,
Hanscom AFB, USA

Carson Chow
MIT, USA

Robert Conte
Saclay, FR

Anne DeBouard
Universite Paris-Sud, FR

Antonio Degasperis
Universita Di Roma I, Italy

Percy Deift
Courant Institute, USA

Charles Doering
Clarkson University, USA

Irene Dorfman
Institute of Chemical Physics,
USSR

D.F. DuBois
Los Alamos National Lab., USA

Boris Dubrovin
Moscow State University, USSR

Alexander Dykhne
Kurchatov Institute, USSR

Nikolai Erokhin
Space Research Institute, USSR

A.P. Fordy
Leeds University

Greg Forest

Models and Applications in Nonlinear Optics

Nonlinear Model of Supersonic Equatorial
Bubbles

Spatiotemporal Chaos in the Nonlinear
Three Wave Interaction

The Fuchs-Painleve Test of
Nonlinear PDE

On the Instability of the Static Soliton-
Like "Bubbles"

Combining Dressing and Nonlocality

A Steepest Descent Method for Oscillatory
Riemann-Hilbert Problems

Attractor Dimension Estimates for the
Incompressible 2D Navier-Stokes Equations

Symplectic and Hamiltonian Structure of
Nonlinear Evolution Equations

Physical Realizations of Strong Langmuir
Turbulence in Plasmas

Evolution of multivalued functions
in dispersive hydrodynamics

Low Probability Events, Natural
and Manmade

Self-Similar Models of Unlimited Acceleration
of Charged Particles by Strong Waves
in Inhomogeneous Plasma

Analyzing Negative Resonances in the
Painleve Test

Fully Nonlinear Modulation Equations for Nearly

Ohio State University, USA

G. Fraiman
Institute of Applied Physics,
USSR

Ildar Gabitov
Landau Institute, USSR

Ildar Gabitov
Landau Institute, USSR

J.D. Gibbon
Imperial College, GB

K.A. Gorshkov
Institute of Applied Physics,
USSR

P. Grinevich
Landau Institute, USSR

Alberto Grunbaum
University of Berkeley, USA

E.Z. Gusakov
A.F. Ioffe Physico, USSR

Tohru Hada
Kyushu University, Japan

Robert Hamilton
UCLA, USA

Akira Hasegawa
AT & T Labs, USA

Darryl Holm
Los Alamos National Lab., USA

Wendell Horton
University of Texas, USA

Integrable Equations

On a Relation Within the Theory of
Adiabatic Invariants

One-Dimensional Defects in the
Ginzburg-Landau Equation

Ultra Short Pulse Propagation in Active Fibers

Weak and Strong
Turbulence in the CGL and Navier
Stokes Equations

Chaotic Scattering of Multidimensional
Localized Structures of Nonlinear Fields

The Action of the Viasoro Nonispectral KdV
Symmetries on the Whitham Equations.

Medical Imaging with Low Energy;
A Nonlinear Inverse Problem

Coherent Parametric Phenomena in
Inhomogeneous Plasma

Nonlinear Evolution of Alfvén Waves

Formation of Quasiparallel Alfvén Solitons

Guiding Center Soliton in Optical
Fibers

Chaotic Laser-Matter Interaction

Drift Wave Vortices in Inhomogeneous
Plasmas

Yoshi Ichikawa
National Institute for Fusion
Japan

Michael Isichenko
University of Texas, USA

Alexander Its
Steklov Institute, USSR
Clarkson University, USA

Palaniappan Kaliappan
N.G.M. College, India

Yukio Kaneda
Nagoya University, Japan

Yuji Kodama
Ohio State University, USA

Vladimir Korepin
SUNY at Stony Brook, USA

Igor Krichever
Landau Institute, USSR

Martin Kruskal
Rutgers University, USA

Boris Kupershmidt
Tennessee Space Institute, USA

E.A. Kuznetsov
Institute of Automation, USSR

Peter Lax
Courant Institute, USA

Jyh-Hao Lee
Academia Sinica (Taiwan)

David Levermore
University of Arizona, USA

Solitons on Thin Vortex Filament with
Axial Flow

Statistical Topography: Fractal Orbits
and Turbulent Diffusion

Some Asymptotic Aspects of the Theory
of Integrable Systems and 2D Quantum Gravity

Painleve Analysis and Particular Solutions
of the Coupled Nonlinear Reaction
Diffusion System

Lagrangian Statistics in Two Dimensional
Turbulences

Perturbation Method and Optical Solitons

Differential Equations for Quantum
Correlation Functions

Algebraic Geometrical Perturbation Theory
of Integrable Equations

The Painleve Test and Beyond

Relativistic Analogs of Lax Equations

Weak MHD Turbulence

Dispersive Systems

$n \times n$ Zakharov-Shabat System of the Form
 $\frac{d\psi}{dx} = (z^2 - 1/z^2)J\psi + (zQ + P + R/z)\psi$

Semiclassical Limit for Nonlinear
Schrodinger Equations

Yan Guang Li
Princeton University, USA

A. Mahalov
Cornell University, USA

Andrew Majda
Princeton University, USA

Vladimir Malkin
Institute of Nuclear Physics,
USSR

Dimitrii Manin
Rutgers University, USA

V.A. Marchenko
Ukr. SSR Academy of Sciences

Henry McKean
Courant Institute, USA

David McLaughlin
Princeton University, USA

Alexander Mikhailov
Landau Institute, USSR

Elinar Mjølhus
University of Tromsø, Norway

Semen Moiseev
Space Research Institute, USSR

Peter Monk
University of Delaware, USA

George Morales
UCLA, USA

David Muraki
Princeton University, USA

David Newman

Davey-Stewartson Equation: Curves
and Homoclinic Behavior

Pattern Formation Via Resonant Interactions
in Fluid Flows

Stretching of Vortices in Turbulence and
Novel Singular Perturbations on NLS

The Analytical Theory for Self-Focusing
of Radiation

Length Scale of Vortices and Mode
Competition in Quasi 2D Shear Flows

Closure of Sets of Multisoliton Solutions

Magri's Work on
Two Symplectic Structures

Whiskered Tori for Soliton E4*

Asymptotic Expansions and Integrability

Numerical Test of a Weak Turbulence
for an Electromagnetically Driven
Langmuir Turbulence

Dissipative Mechanisms of Large-Scale
Structures Generation in Fluids

An Inverse Scattering Problem for Time
Harmonic Waves in an Inhomogeneous Medium

Nonlinear Refraction of an HF Wave
in the Ionosphere

NLS Modulation and Optical Shocks

Beam-Driven Langmuir Turbulence in the

University of Colorado, USA	Moderately Magnetized Auroral Ionosphere
David Newman University of Colorado, USA	Ionospheric Langmuir Turbulence Driven by an Electromagnetic Pump Below the Upper-Hybrid Frequency
A.Y. Orlov Shirshov Institute, USSR	Volterra Operator Algebra for Zero Curvature Representation. Universality of KP
Vladimir Petviashvili Kurchatov Institute, USSR	Dynamics of Vortex-Current Filaments in Plasma, Comparison of Experimental Rossby Vortices with the Theory
Len Pismen Technion University, Israel	Interaction of Point Defects in Nonlinear Dissipative Fields
Andre Pogrebkov Steklov Institute, USSR	New Results on $2 + 1$ Integrable Systems
Nagesha Rao Clarkson University, USA	Mode Conversions in Ionospheric Heating Experiments
Pedro Ripa C.I.C.E.S.E., Mexico	Success of Arnold's Method in a Hierarchy of Ocean Models
A.M. Rubenchik Institute of Automation, USSR	Weak and Strong Turbulence Coexistence
Valery Rupasov Institute of Spectroscopy, USSR	Rigorous Results in the Theory of Stimulated Raman Scattering
P.C. Sabatier Universite Montpellier II, FR	Extensions of Dressing
Paolo Santini Universita Di Roma, Italy	On the Solution of Certain Systems of Nonlinear Algebraic Equations
E. Schulman P.P. Shirshov Institute for Oceanology, USSR	Analytic Degenerate Dispersion Laws
Vadim Shvets Auburn University, USA	On Superstrong Wave Collapse
Michael Spector	Local and Nonlocal Transfer of Motion

Tel Aviv University, Israel

Natalia Sternberg
Clark University, USA

Heinz Steudel
Zentralinstitut fur Optik
Germany

Li-Yeng Sung
Clarkson University, USA

Grover Swartzlander
Naval Research Lab., USA

Leon Takhtajan
Steklov Institute, USSR
University of Colorado, USA

Fei Ran Tian
Courant Institute, USA

Ladislav Trlifaj
Institute of Physics
Czechoslovakia

Stephanos Venakides
Duke University, USA

Elena Villalon
Northeastern University, USA

Stefan Wabnitz
Fondazione Ugo Bordoni, Italy

Alexander Wai
University of Maryland, USA

John Weiss
Arlington, Massachusetts,
USA

John Weiss
Arlington, Massachusetts, USA

Integrals in Wave Turbulence

Mathematical Modeling in Plasma Physics

*Backlund Transformations as Physical
Equations*

IST for DS II

*(2+1) D Spatial Dark Solitons in
Nonlinear Optics*

Reversible Cellular Automata

*The Whitham Equations, The Zero
Dispersion Limit of the KdV Equation*

Fluctuating Solitons of the KdV Hierarchy

The Toda Shock Problem

*Interactions of Energetic Electrons and
Protons with Whistler Waves in the
Earth's Radiation Belts*

*Dynamics of Optical Pulses in a Periodically
Twisted Birefringent Fiber Filter*

Soliton Propagation in Random Medium

*Periodic Fixed Points of Bäcklund
Transformations*

Wavelets & Two Dimensional Turbulence

Vladimir Yan'kov
I.V. Kurchatov Institute, USSR

Thermodynamics for Linear and
Nonlinear Waves

Norman Zabusky
Rutgers University, USA

Vortex Scattering Paradigm for Reconnection
and Turbulent Intermittency

V.E. Zakharov
Landau Institute, USSR

Integrable Turbulence

Xin Zhou
Yale University, USA

IST for KPI