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FINAL PROGRAM  
for  
THE Fourth IMACS INTERNATIONAL CONFERENCE ON  
NONLINEAR EVOLUTION EQUATIONS AND WAVE PHENOMENA:  
COMPUTATION AND THEORY  
ATHENS, GA  
APRIL 11 - 14, 2005

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**SUNDAY, APRIL 10, 2005**

5:00 – 6:00 REGISTRATION  
6:00 – 8:00 RECEPTION

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**MONDAY, APRIL 11, 2005**

7:00 – 9:00 REGISTRATION  
8:00 – 8:20 WELCOME, Masters Hall  
Thiab R. Taha/Program Chair and Conference Coordinator  
Garnett S. Stokes/ Dean, Franklin College of Arts and Sciences, UGA  
8:20 - 9:20 KEYNOTE LECTURE: Frederic Dias , Masters Hall  
Title: Nonlinear Water Waves  
Chair: Jerry Bona

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9:20 - 10:20 SESSION 6, Masters Hall  
Chairs: John Carter and Constance Schober  
Title: Recent Developments in Water Waves  
9:20 - 09:50 Speaker: Harvey Segur  
Title: Stable, three-dimensional wave patterns in deep water  
9:50 - 10:20 Speaker: Vladimir Zakharov  
Title: What Mathematics is behind the Freak Wave?  
9:20 - 10:20 CONTRIBUTED PAPERS, Room R  
Chair: Andrus Salupere  
9:20 - 9:50 Speaker: Andrus Salupere  
Title: On Solitary Waves and Solitons in Hierarchical Systems  
9:50 - 10:20 Speaker: Olari Ilison  
Title: On the Propagation of Solitary Pulses in Microstructured Media

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9:20 - 10:20 CONTRIBUTED PAPERS, Room Q  
Chair: Otis Wright  
9:20 - 9:50 Speaker: Otis Wright  
Title: Instabilities and Oscillations in a modified nonlinear Schrödinger equation  
9:50 - 10:20 Speaker: Vadim Zharnitsky  
Title: Ground states in the higher order averaged DM NLS in the absence of residual dispersion

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10:20 - 10:40 COFFEE BREAK

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10:40 - 12:10 SESSION 11, Masters Hall  
Chairs: Andrei Ludu  
Title: Solitary Waves and Nonlinear Patterns on Compact Spaces

10:40 - 11:10 Speaker: Roy Choudhury  
Title: Traveling Wavetrains in the Complex Cubic-Quintic Ginzburg-landau Equation (CGLE)

11:10 - 11:40 Speaker: Andrei Ludu  
Title: Solitons on the Surface of Neutron Stars

11:40 - 12:10 Speaker: Thomas Powers  
Title: Protofilament Model for Polymorphism of Bacterial Flagella

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10:40 - 12:10 SESSION 7, Room R  
Chairs: Bernard Deconinck  
Title: Symbolical and numerical Computation for Differential Equations

10:40 - 11:10 Speaker: Edgardo S. Cheb-Terrab  
Title: Abel, Hypergeometric, Heun and Painleve Equations:  
New Developments in their Relation and their Solutions

11:10 - 11:40 Speaker: Elizabeth L. Mansfield  
Title: Moving Frames and Integrating  $SL(2)$  Invariant ODEs

11:40 - 12:10 Speaker: Matt Patterson  
Title: Computing the Abel Map

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10:40 - 11:40 CONTRIBUTED PAPERS, Room Q  
Chair: Thierry Colin

10:40 - 11:10 Speaker: Géraldine Ebrard  
Title: Numerical modelling of crossing laser-beams in a plasma

11:10 - 11:40 Speaker: Yair Zarmi  
Title: Wave Interactions in the Unperturbed and Perturbed Burgers Equation

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12:10 - 1:20 LUNCH

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1:20 - 3:20 SESSION 1, Masters Hall  
Chair: Nail Akhmediev

1:20 - 1:50 Speaker: Mark Saffman  
Title: Collective Atom Optical Solitons in Incoherent Matter

1:50 - 2:20 Speaker: Alexander Nepomnyashchy  
Title: Feedback Control of Morphological Instabilities in Directional Solidification

2:20 - 2:50 Speaker: Alexander Golovin  
Title: Self-assembly of Quantum Dots in Thin Solid Films

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1:20 - 3:20 SESSION 4, Room R  
Chairs: Jerry Bona, Min Chen, Vassilios Dougalis, Gerard Iooss  
Title: Modeling and Analysis of Nonlinear Waves

1:20 - 1:50 Speaker: Dmitri Agueev  
Title: Modeling of low-contrast Photonic Crystals with Coupled-mode Equations

1:50 - 2:20 Speaker: M. Colin  
Title: Zakharov System and Laser-Plasma Interactions

2:20 – 2:50	Speaker: Thierry Colin Title: A Model for Landau Damping in Plasma Physics
2:50 – 3:20	Speaker: Vladimir Varlamov Title: Nonlinear Wave Generation by Moving Boundaries
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1:20 – 3:20	SESSION 12, Room Q Chairs: David Nicholls Title: Novel Computational Methods for Nonlinear Dispersive Wave Equations
1:20 – 1:50	Speaker: Philippe Guyenne Title: Water waves over bottom topography
1:50 – 2:20	Speaker: Chi-Wang Shu Title: Local Discontinuous Galerkin Methods for the Two-dimensional Kadomtsev-Petviashvili and Zakharov-Kuznetsov Equations
2:20 – 2:50	Speaker: Jue Yan Title: Discontinuous Galerkin Methods for Nonlinear Dispersive Equations
2:50 – 3:20	Speaker: David Nicholls Title: Robust Computation of Dirichlet-Neumann Operators with Application to Dynamical Water Wave Simulations
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3:20 – 3:45	COFFEE BREAK
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3:45 – 5:45	SESSION 6, Masters Hall Chairs: John Carter and Constance Schober Title: Recent Developments in Water Waves
3:45 – 4:15	Speaker: Bernard Deconinck Title: Waves in shallow water: Riemann surfaces and all that
4:15 – 4:45	Speaker: Paul H. Taylor Title: Freak Waves and Wave Focusing - Non-Linear Group Dynamics on Deep Water?
4:45 – 5:15	Speaker: John Carter Title: Stability of Stokes' Wave Solutions of Higher-Order Generalizations of the Nonlinear Schrödinger Equation Including Dissipation
5:15 – 5:45	Speaker: Constance Schober Title: Predicting Rogue Waves in Random Oceanic Sea States
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3:45 – 5:45	SESSION 7, Room R Chairs: Bernard Deconinck Title: Symbolical and Numerical Computation for Differential Equations
3:45 – 4:15	Speaker: Willy Hereman Title: Continuous and Discrete Homotopy Operators: A Theoretical Approach Made Concrete
4:15 – 4:45	Speaker: Irina Kogan Title: Group Invariant Moving Frames: Symbolic Computation and Applications
4:45 – 5:15	Speaker: Mark van Hoeij Title: Solving Linear ODEs in Terms of Solutions of Linear ODEs of Lower Order
5:15 – 5:45	Speaker: Peter A. Clarkson Title: Rational Solutions of the Soliton Equations
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3:45 – 5:45	SESSION 8, Room Q Chairs: Roy H. Goodman and Jianke Yang Title: Mathematical Techniques for Non-integrable Systems
3:45 – 4:15	Speaker: D.J. Kaup Title: Variational Methods in Nonlinear Waves

4:15 – 4:45 Speaker: Richard Haberman  
Title: Vector-soliton Collision Dynamics in Nonlinear Optical Fibers

4:45 – 5:15 Speaker: Roy H. Goodman  
Title: The Two-Bounce Resonance in Solitary Wave Collisions

5:15 – 5:45 Speaker: Stefan Mancas  
Title: Bifurcations and Competing Coherent Structures in the Cubic-Quintic Ginzburg-Landau Equation (CGLE)

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## TUESDAY, APRIL 12, 2005

8:00 - 9:00 KEYNOTE LECTURE: Demetrios Christodoulides, Masters Hall  
Title: Discrete Solitons in Waveguide Arrays and Optical Lattices  
Chair: David Kaup

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9:00 - 10:00 CONTRIBUTED PAPERS, Masters Hall  
Chairs: Gulcin Muslu

9:00 - 09:30 Speaker: Gulcin Muslu  
Title: A Numerical Study of the Long Wave-Short Wave Interaction Equations

9:30 - 10:00 Speaker: Khaled El Dika  
Title: Asymptotic Stability of Solitary Waves for The Benjamin-Bona-Mahony Equation

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9:00 - 10:00 SESSION 1, Room R  
Chairs: Nail Akhmediev  
Title: Dissipative Solitons

9:00 - 09:30 Speaker: Majid Taki  
Title: Walk-off stabilizes optical dissipative solitons

9:30 - 10:00 Speaker: Hidetsugu Sakaguchi  
Title: Motion of Dissipative Solitons in the Quintic Complex Ginzberg-Landau Equation without Viscosity

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9:00 - 10:00 **TUTORIAL, Room Q**  
**Gino Biondini and William L. Kath**  
**Title: An Introduction to Optical Fiber Communications(1)**

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10:00 - 10:20 COFFEE BREAK

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10:20 - 12:20 SESSION 10, Masters Hall  
Chairs: Pedro Jordan  
Title: Nonlinear Problems in the Physical Sciences

10:20 - 11:20 Speaker: Christo Christov  
Title: On the Elastodynamics of Moving Patterns Solitons

11:20 - 11:50 Speaker: S. A. Chin-Bing  
Title: Nonlinear Fourier Analysis of Solitons to Predict Their Effects on Ocean Acoustics

11:50 - 12:20 Speaker: Pratap Puri  
Title: Eigenvalue Bounds in the Stability Analysis of the Flow of a Dipolar Fluid Between Two Parallel Plates

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10:20 - 12:20 SESSION 9, Room R  
Chairs: Philippe Guyenne and Henrik Kalisch  
Title: Internal Waves

10:20 - 10:50 Speaker: Henrik Kalisch  
Title: Model Equations for Internal Waves in Two-Fluid Systems

10:50 - 11:20 Speaker: Dorian Fructus  
Title: A New Rapid Fully Nonlinear Method for Water Waves in 3D with Variable Bottom in Space and Time

11:20 - 11:50 Speaker: John Grue  
Title: Velocity Profiles and Breaking of Internal Solitary Waves

11:50 - 12:20 Speaker: O. Kristiansen  
Title: Simulations of Stokes Wave Instabilities on Finite Depth

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10:20 – 12:20 **TUTORIAL (Continued), Room Q**  
**Speaker: Gino Biondini and William L. Kath**  
**Title: An Introduction to Optical Fiber Communications(2)**

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12:20 – 1:20 LUNCH

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1:20 – 3:20 SESSION 1 , Masters Hall  
Chair: Nail Akhmediev  
Title: Dissipative Solitons

1:20 – 1:50 Speaker: Nail Akhmediev  
Title: Pulsating solitons in dissipative systems

1:50 – 2:20 Speaker: Sonia Boscolo  
Title: Dissipative Localized Structures in Nonlinear Fiber Optics

2:20 – 2:50 Speaker: Matthias Pesch  
Title: Dissipative Optical Solitons in the Presence of a Symmetry-breaking Bifurcation: Experimental Investigations in a Single-mirror Feedback System

2:50 – 3:20 Speaker: Mustapha Tlidi  
Title: Dissipative Hyperbolic Transverse Pattern Formation in Nonlinear Optics

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1:20 – 3:20 SESSION 5, Room R  
Chairs: R. Carretero-Gonzalez, P.G. Kevrekidis and B.A. Malomed  
Title: Nonlinear Waves in Bose-Einstein Condensates

1:20 – 1:50 Speaker: Chandra Raman  
Title: Superfluid Flows in a Gaseous Bose-Einstein condensate

1:50 – 2:20 Speaker: Masahito Ueda  
Title: Coherent Nonlinear Dynamics of Collapsing and Exploding Bose-Einstein

2:20 – 2:50 Speaker: Lincoln Carr  
Title: Atomic soliton lasers, nonlinear band structure, ring solitons, and attractive vortices in Bose-Einstein condensates

2:50 – 3:20 Speaker: Roger Thelwell  
Title: The stability of 1-D nontrivial-phase solutions of the 2-D NLS equation

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1:20 – 3:20 SESSION 8, Room Q  
Chairs: Roy H. Goodman and Jianke Yang  
Title: Mathematical Techniques for Non-integrable Systems

1:20 – 1:50 Speaker: T. R. Akylas  
Title: Gravity–Capillary Lumps

1:50 – 2:20 Speaker: John P. Boyd  
Title: When Dispersion is Weak: Corner Waves, Sub-corner Breaking, and Quasi-Periodic Waves

2:20 – 2:50 Speaker: Xing-Biao Hu  
Title: Integrable Semi-discretizations of Two Model Equations for Shallow Water Waves

2:50 – 3:20 Speaker: D.F. Parker  
Title: Accelerating Solitons – Self-similarity and Stability

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1:20 – 3:45 POSTER SESSION, First Floor

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Paper 1: Computing spectra of linear operators

Authors: Bernard Deconinck and Firat Kiyak

Paper 2: A better symbolic integrator using homotopy methods

Authors: Bernard Deconinck and Michael A. Nivala

Paper 3: Mathematica Program for Calculating the Stability of Solutions to Nonlinear Partial Differential Equations

Author: William W. Whitwel and John D. Carter

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3:20 – 3:45 COFFEE BREAK

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3:45 – 5:45 SESSION 4, Master Hall

Chairs: Jerry Bona, Min Chen, Vassilios Dougalis, Gerard Iooss

Title: Modeling and Analysis of Nonlinear Waves

3:45 – 4:15 Speaker: Gérard Iooss

Title: Existence of Standing Gravity Waves in Deep Water

4:15 – 4:45 Speaker: Shu-Ming Sun

Title: Exact Linear Stability of Solitary Waves

4:45 – 5:15 Speaker: Hongqiu Chen

Title: Travelling Waves with Small Propagation Velocity for Boussinesq-type Systems of Equations

5:15 – 5:45 Speaker: Bing-Yu Zhang

Title: Global Stabilization of the Korteweg-de Vries Equation Posed on a Finite Domain

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3:45 – 5:45 SESSION 1, Room R

Chair: Nail Akhmediev

Title: Dissipative Solitons

03:45 – 04:15 Speaker: Jorge Tredicce

Title: Properties of Cavity Solitons in Semiconductors

04:15 – 04:45 Speaker: Frank Wise

Title: Period-doubling Route to a Non-Chaotic State in a Soliton Laser

04:45 – 05:15 Speaker: Jin Kang

Title: Spatial Solitons in AlGaAs near Third of Bandgap

05:15 – 05:45 Speaker: Nathan Kutz

Title: Mode-Locking of Fiber Lasers via Nonlinear Mode-Coupling

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3:45 – 5:15 SESSION 11, Room Q

Chair: Andrei Ludu

Title: Solitary Waves and Patterns on Compact Manifolds

3:45 – 4:15 Speaker: Hongqiu Chen

Title: Periodic Traveling Waves of Nonlinear Dispersive Wave Equations

4:15 – 4:45 Speaker: Scott H. Hawley

Title: A Review of General Relativistic Solitons

4:45 – 5:15 Speaker: Raymond E. Goldstein

Title: The Platonic Ideal of Speleothem Growth

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6:30 - 8:30 **BANQUET**

**Speaker: Robert Vichnevetsky/President of IMACS**

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## WEDNESDAY, APRIL 13, 2005

- 8:00 – 9:00 KEYNOTE LECTURE: Peter D. Miller, Masters Hall  
Title: Asymptotic Methods for Integrable Systems in Nonlinear Wave Theory  
Chair: William Kath
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- 9:00 – 10:00 CONTRIBUTED PAPERS, Masters Hall  
Chair: Willy Malfliet
- 9:00 – 9:30 Speaker: Willy Malfliet  
Title: Approximate Solutions to the Boussinesq Equations
- 9:30 – 10:00 Speaker: Joshua L. Proctor  
Title: Q-Switching in Actively Mode-locked Lasers
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- 9:00 – 10:00 CONTRIBUTED PAPERS, Room R  
Chair: Christo Christov
- 9:00 – 09:30 Speaker: Harish S. Bhat  
Title: Theory and Numerics for a Family of Non-local, Nonlinear Evolution Equations
- 9:30 – 10:00 Speaker: Jun-Xiao Zhao  
Title: Commutativity of Pfaffianization and Bäcklund Transformations: the KP Equation
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- 9:00 – 10:00 SESSION 2, Room Q  
Chairs: Gino Biondini and Sarbarish Chakravarty  
Title: Soliton Resonance and Web Structure in (2+1)-dimensional Integrable Systems
- 9:00 – 09:30 Speaker: Gino Biondini  
Title: Soliton Resonance and Web structure in (2+1)-dimensional Integrable Systems: An Introduction
- 9:30 – 10:00 Speaker: Kenichi Maruno  
Title: Web Structure of Discrete 2-dimensional Integrable Systems
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- 10:00 – 10:20 COFFEE BREAK
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- 10:20 – 12:20 SESSION 1 , Masters Hall  
Chairs: Nail Akhmediev and G. Kovacic  
Title: Dissipative Solitons
- 10:20 – 10:50 Speaker: Vladimir Konotop  
Title: On collapse in the nonlinear Shroedinger equation with periodically varying nonlinearity
- 10:50 – 11:20 Speaker: Gregor Kovacic  
Title: Stochastic dynamics of light solitons in a lambda-configuration nonlinear resonant medium
- 11:20 – 11:50 Speaker: Wieslaw Krolikowski  
Title: Ring Vortex Solitons in Self-focusing Nonlocal Media
- 11:50 – 12:20 Speaker: Vladimir Skarka  
Title: Generation and dynamics of dissipative spatial solitons
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- 10:20 – 12:20 SESSION 9, Room R  
Chairs: Philippe Guyenne and Henrik Kalisch  
Title: Internal Waves
- 10:20 – 10:50 Speaker: Kevin Lamb  
Title: Extreme Internal Solitary Waves in the Ocean: Theory and computation
- 10:50 – 11:20 Speaker: Frederic Dias  
Title: Nonlinear Interfacial Flows due to Moving Disturbances

- 11:20 – 11:50 Speaker: Thomas Peacock  
Title: Rotating and Reflecting Internal Wave Beams
- 11:50 – 12:20 Speaker: Emilian Parau  
Title: Three-dimensional Gravity and Gravity-capillary Interfacial Flows
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- 10:20 – 11:50 SESSION 8, Room Q  
Chairs: Roy H. Goodman and Jianke Yang  
Title: Mathematical Techniques for Non-integrable Systems
- 10:20 – 10:50 Speaker: Boris A. Malomed  
Title: Dynamics of Solitons in Couple-Mode-Systems for Saturable Media with Photonic Lattices
- 10:50 – 11:20 Speaker: Brian Marks  
Title: Analysis of Interchannel Crosstalk in an Analog Optical Fiber Transmission Link
- 11:20 – 11:50 Speaker: Bao-Feng Feng  
Title: A Reduced Three Particle Model for the Study of Intrinsic Localized Modes in Fermi-Pasta-Ulam Chain
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- 12:20 – 1:20 LUNCH
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- 1:20 – 2:50 SESSION 1, Masters Hall  
Chairs: Nail Akhmediev  
Title: Dissipative Solitons
- 1:20 – 1:50 Speaker: Alexandre Shcherbakov  
Title: Dissipative Optical Solitons in Erbium Doped Fiber Amplifiers
- 1:50 – 2:20 Speaker: Paolo di Trapani  
Title: Conical wave bullets
- 2:20 – 2:50 Speaker: Roberto Morandotti  
Title: Discrete Optical Solitons in Ultrafast Kerr Media
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- 1:20 – 3:20 SESSION 10, Room R  
Chairs: Pedro Jordan  
Title: Nonlinear Problems in the Physical Sciences
- 1:20 – 2:20 Speaker: Ronald Mickens  
Title: Nonstandard finite difference schemes for systems of PDEs having cross-diffusion
- 2:20 – 2:50 Speaker: J. K. Fulford  
Title: Acoustic wave splitting due to inertial effects in Biot poro-elastic model
- 2:50 – 3:20 Speaker: Marios Christou  
Title: Fourier–Galerkin method for 2D solitons of generalized wave equations
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- 1:20 – 2:20 SESSION 2, Room Q  
Chairs: Gino Biondini and Sarbarish Chakravarty  
Title: Soliton Resonance and Web Structure in  $(2+1)$ -dimensional Integrable Systems
- 1:20 – 1:50 Speaker: Sarbarish Chakravarty  
Title: Elastic  $N$ -soliton solutions of the Kadomtsev-Petviashvili II equation
- 1:50 – 2:20 Speaker: Meltem Yerbag Francisco  
Title: Dissipative AKNS Hierarchy and Resonance Solitons for KP-II
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- 2:20 – 3:20 SESSION 8, Room Q  
Chair: Roy H. Goodman and Jianke Yang  
Title: Mathematical Techniques for Non-integrable Systems

2:20 – 2:50	Speaker: P.G. Kevrekidis Title: Discrete Solitary Waves in Optics and BEC: Some Old Aspects, Some Recent Findings and Some Future Perspectives
2:50 – 3:20	Speaker: William L. Kath Title: Extracting Solitons Out of Noise
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3:20 – 3:45	COFFEE BREAK
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3:45 – 5:45	SESSION 4, Masters Hall Chairs: Jerry Bona, Min Chen, Vassilios Dougalis, Gerard Iooss Title: Modeling and Analysis of Nonlinear Waves
3:45 – 4:15	Speaker: D. E. Mitsotakis and V. A. Dougalis Title: Generalized solitary waves of the coupled KdV system of Boussinesq equations
4:15 – 4:45	Speaker: Min Chen Title: Numerical Simulations of two-dimensional Boussinesq systems for three-dimensional water waves
4:45 – 5:15	Speaker: David P. Nicholls Title: High-Order Simulation and Dynamic Stability of Three-Dimensional Traveling Water Waves
5:15 – 5:45	Speaker: Jerry Bona Title: Recent results on nonlinear wave equations
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3:45 – 5:45	SESSION 5, Room R Chairs: R. Carretero-Gonzalez, P.G. Kevrekidis and B.A. Malomed Title: Nonlinear Waves in Bose-Einstein Condensates
3:45 – 4:15	Speaker: Boris A. Malomed Title: Higher-order Vortex Solitons, Multipoles, and Supervortices on a Square Optical Lattice
4:15 – 4:45	Speaker: Karl Frinkle Title: A Galérkin Projection and Multiple Scales approach to Feshbach Resonance
4:45 – 5:15	Speaker: Vladimir V. Konotop Title: Interaction of Matter Solitons with defects in Optical Lattices
5:15 – 5:45	Speaker: Joachim Brand Title: BEC solitons under the influence of transverse confinement and strong interactions
5:45 – 6:15	Speaker: Brian Seaman Title: Period doubling and the growth of swallowtails in Bose-Einstein condensates trapped in a lattice potential
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3:45 – 5:45	SESSION 3, Room Q Chair: Gino Biondini, William L. Kath and John Zweck Title: Nonlinear and Stochastic Effects in Optical Fibers and Short Pulse Lasers
3:45 – 4:15	Speaker: John Zweck Title: Deterministic and Stochastic Methods for Computing the Bit Error Ratio in an Optical Fiber Communication System
4:15 – 4:45	Speaker: Peter Winzer Title: How Static Fiber Complicates PMD Outage Specifications
4:45 – 5:15	Speaker: Nail Akhmediev Title: Group Soliton Interactions in a Fiber Laser
5:15 – 5:45	Speaker: Qudsia Quraishi Title: Theoretical and Experimental Dynamics of an Ultrashort Pulsed Laser
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## THURSDAY, APRIL 14, 2005

- 9:00 – 10:00 SESSION 3, Masters Hall  
Chair: Gino Biondini, William L. Kath and John Zweck  
Title: Nonlinear and Stochastic Effects in Optical Fibers and Short Pulse Lasers
- 9:00 – 9:30 Speaker: Michael Chertkov  
Title: Effects of Noise and Disorder in Fiber Optics
- 9:30 – 10:00 Speaker: E.T. Spiller  
Title: Modeling and Computation of Error Rates in Lightwave Systems due to Nonlinear Phase Noise
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- 9:00 – 10:30 SESSION 10, R  
Chairs: Pedro Jordan  
Title: Nonlinear Problems in the Physical Sciences
- 9:00 – 9:30 Speaker: C.I. Christov  
Title: Solitons and Wave-Particle Syncretism: a New Perspective on Unification
- 9:30 – 10:00 Speaker: X. H. Tang  
Title: Numerical Investigation of Two-dimensional Nonlinear Convective Waves in a Vertical Slot With Differentially Heated Walls
- 10:00 – 10:30 Speaker: P. M. Jordan  
Title: Nonlinear Acoustic Propagation in Fluid-saturated Porous Media: Traveling Wave Solutions
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10:30 - 10:50 COFFEE BREAK

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11:30 – 12:30 LUNCH

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**THE END OF THE PROGRAM**

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