ESF-EMS-ERCOM Conference on Completely Integrable Systems and Applications

Chair: Gerald Teschl
Cochair: Spyros Kamvissis

ESI Vienna
3.–8. July 2011

	Mon 4.7	Tue 5.7	Wed 6.7	Thu 7.7
8:45–9:00	Opening			
	Session 1	Session 5	Session 9	Session 11
	Chair: Spyros Kamvissis	Chair: Helge Holden	Chair: Fritz Gesztesy	Chair: Anne Boutet de Monvel
9:00–9:45	Athanassios S. Fokas	Helge Holden	Anne Boutet de Monvel	Ira Egorova
9:45–10:30	Jonatan Lenells	Adrian Constantin	Dmitry Shepelsky	Spyros Kamvissis
Coffe break				
	Session 2	Session 6	Session 10	Session 12
	Chair: Pierre Van Moerbeke	Chair: Jonatan Lenells	Chair: Jerry Bona	Chair: Gerald Teschl
11:00–11:45	Beatrice Pelloni	Tamara Grava	Arno Kuijlaars	Pierre Van Moerbeke
11:45–12:30	Jerry Bona	Jinho Baik	Ravi Srinivasan	Fritz Gesztesy
Lunch break				
	Session 3	Session 7	Excursion	Session 13
	Chair: Arno Kuijlaars	Chair: Ravi Srinivasan		Chair: Tamara Grava
14:30–14:55	Boris Konopelchenko	Aleksei Rybkin		Dong Wang
14:55–15:20	Mattia Cafasso	Peter D. Miller		Reinout Quispel
15:20–15:45	Hongqiu Chen	Alexander Minakov		Jiuguang Wang
15:45–16:10	Yen Do	Antonio Moro		Viktor Enolski
Coffe break				
	Session 4	Session 8		Session 14
	Chair: Beatrice Pelloni	Chair: Jinho Baik		Chair: Ira Egorova
16:40–17:05	Katrin Grunert	Alexander Soshnikov		Dionyssios Mantzavinos
17:05–17:30	Irina Nenciu	Alexander Sakhnovich		Davide Masoero
17:30–17:50	Iasonas Hitzazis	Johanna Michor		Hans Lundmark
17.50–18.10	Jonathan Eckhardt	Jacek Szmigielski		Alice Mikikits-Leitner
18.10–18.30	TBA	Kavitha Louis		Caroline Kalla
	Forward Look	Dinner		Poster

Detailed Program

All events will take place at the ESI (Boltzmanngasse 9, A-1090 Vienna) unless otherwise indicated.

Sunday, July 3

17.00–19:00	Registration at the ESF desk
17:00 onwards	Welcome Drink and Reception

Monday, July 4

08.45–09.00	Conference Opening	
Session 1	Chair: Spyros Kamvissis, University of Crete	
09.00–09.45	Athanassios S. Fokas, Cambridge A unified and effective method for integrable nonlinear PDEs	p13
09.45–10.30	Jonatan Lenells, Baylor University Boundary value problems for the Ernst equation	p18
10.30–11.00	Coffee break	
Session 2	Chair: Pierre Van Moerbeke, UCL Louvain	
11.00–11.45	Beatrice Pelloni, University of Reading Boundary value problems for a nonlinear elliptic PDE: the elliptic sine-Gordon equation	p27
11.45–12.30	Jerry Bona, University of Illinois at Chicago Systems of nonlinear, dispersive wave equations	p8
12.30–14.00	Lunch break	
Session 3	Chair: Arno Kuijlaars, Katholieke Universiteit Leuven	
14.30–14.55	Boris Konopelchenko, University of Salento Harrison cohomology and integrable systems for the hyperelliptic subsets in Birkhoff strata of the Sato Grassmannian	p17
14.55–15.20	Mattia Cafasso, Centre de Recherches Mathématiques Two transitions between the Pearcey and the Airy process	p9
15.20–15.45	Hongqiu Chen, University of Memphis Long-wave limit of periodic solutions of nonlinear wave equations	p10
15.45–16.10	Yen Do, Georgia Institute of Technology Oscillatory Riemann–Hilbert problems and stationary phase	p11
16.10–16.40	Coffee break	
Session 4	Chair: Beatrice Pelloni, University of Reading	
16:40–17.05	Katrin Grunert, University of Vienna, AT A Lipschitz metric for the Camassa–Holm equation	p15
17:05–17.30	Irina Nenciu, University of Illinois at Chicago The periodic Ablowitz–Ladik equation and Floquet CMV matrices	p26
17.30–17.50	Iasonas Hitzazis, University of Patras Initial-boundary problems for integrable nonlinear PDEs	p15
17.50–18.10	Jonathan Eckhardt, University of Vienna The isospectral problem of the Camassa–Holm equation	p11
18.10–18.30	TBA, TBA TBA	p**??**
19.00–20.00	Forward Look Plenary Discussion	

Tuesday, July 5

Session 5	Chair: Helge Holden, NTNU Trondheim	
09.00–09.45	Helge Holden, NTNU Trondheim On the nonlinear variational wave equation	p16
09.45–10.30	Adrian Constantin, University of Vienna The hydrodynamical relevance of the Camassa–Holm and Degasperis–Procesi equations	p10
10.30–11.00	Coffee break	
Session 6	Chair: Jonatan Lenells, Baylor University	
11.00–11.45	Tamara Grava, SISSA Trieste Universality in Hamiltonian PDEs	p14
11.45–12.30	Jinho Baik, University of Michigan Complete matchings and random matrix theory	p8
12.30–14.00	Lunch break	
Session 7	Chair: Ravi Srinivasan, University of Texas at Austin	
14.30–14.55	Aleksei Rybkin, University of Alaska Fairbanks The KdV equation, the Titchmarsh–Weyl m-function and Hankel operators	p28
14.55–15.20	Peter D. Miller, University of Michigan Fluxon condensates and the semiclassical sine-Gordon equation	p23
15.20–15.45	Alexander Minakov, Institute for Low Temperature Physics Long-time behavior of the solution to the mKdV equation with the step like initial data	p24
15.45–16.10	Antonio Moro, SISSA Thermodynamic phase transitions and shock singularities	p26
16.10–16.40	Coffee break	
Session 8	Chair: Jinho Baik, University of Michigan	
16:40–17.05	Alexander Soshnikov, University of California at Davis Random matrices: finite rank deformations and fluctuations of matrix entries of regular functions	p30
17:05–17.30	Alexander Sakhnovich, University of Vienna Weyl theory, inverse spectral transform, and initial-boundary value problems for integrable equations	p29
17.30–17.50	Johanna Michor, University of Vienna On the spatial asymptotics of solutions of the Ablowitz–Ladik hierarchy	p22
17.50–18.10	Jacek Szmigielski, University of Saskatchewan On an inverse spectral problem associated to a two-potential generalization of the Degasperis–Procesi equation	p31
18.10–18.30	Kavitha Louis, Periyar University The integrability and the magnetization dynam- ics of weak ferro and antiferromagnets	p19
20.00	Evening reception by the mayor of Vienna Heuriger S'Pfiff, Rathstraße 4, 1190 Vienna	

Wednesday, July 6

Session 9	Chair: Fritz Gesztesy, UMC Columbia	
09.00–09.45	Anne Boutet de Monvel, University Paris Diderot Long-time dynamics of step-like data for NLS+	p9
09.45–10.30	Dmitry Shepelsky, Institute for Low Temperature Physics The short-wave model for the Camassa–Holm equation: the Riemann–Hilbert approach	p29
10.30–11.00	Coffee break	
Session 10	Chair: Jerry Bona, University of Illinois at Chicago	
11.00–11.45	Arno Kuijlaars, Katholieke Universiteit Leuven Multiple orthogonal polynomials in the normal matrix model	p18
11.45–12.30	Ravi Srinivasan, University of Texas at Austin Burgers turbulence, kinetic theory of shock clustering, and complete integrability	p30
12.30–14.00	Lunch break	
Excursion	Wachau (http://en.wikipedia.org/wiki/Wachau)	
13:45 (sharp!)	Bus departure at the ESI (in front of Hotel Boltzmann).	
15:00	Arrival in Melk (http://en.wikipedia.org/wiki/Melk). We have decided to get you off the buses at a parking lot from which one has a nice look at the famous baroque Benedictine monastery named Stift Melk, although this requires a few minutes walk afterwards to reach the boarding point of our ship.	
15:30	Departure from Melk on board of the "MS AUSTRIA PRINCESS" under the command of Captain Wolfgang Sehner. The sun deck offers plenty of space; the covered section is equipped with seats and tables. Drinks can be purchased at the bar.	
17:00	Arrival in Krems - after having passed through the Wachau (this is the name of the Danube valley in this pittoresque section). In 2000, the Wachau was declared part of the UNESCO World heritage.	
17:30	Departure from the "Donaustation Krems" to Palt, again riding on our K&K buses.	
17:45	Arrival in Palt at the "Winzerhof [Vintner's estate] Rosenberger". In the Heurigen restaurant of the Winzerhof, Stefan Rosenberger and his team will serve their splendid KREMSTAL DAC Grüner Veltliner 2010 Ried Höhlgraben (as well as non-alcoholic drinks) and a cold dinner presenting typical specialities of this region, quite a number of them homemade at the Winzerhof. - For those interested in visiting the vineyards before the dinner we offer a guided tour of about half an hour duration.	
21:30	Departure from Winzerhof Rosenberger by bus.	
22:45	Arrival in Vienna at the ESI.	

Thursday, July 7

Session 11	Chair: Anne Boutet de Monvel, University Paris Diderot	
09.00–09.45	Ira Egorova, Institute for Low Temperature Physics Inverse scattering transform for the KdV and Toda equations with steplike finite-gap backgrounds	p12
09.45–10.30	Spyros Kamvissis, University of Crete Stability of the periodic Toda lattice	p17
10.30–11.00	Coffee break	
Session 12	Chair: Gerald Teschl, University of Vienna	
11.00–11.45	Pierre Van Moerbeke, Universite de Louvain & Brandeis University From longest increasing sequences of random permutations to the Tacnode Process	p31
11.45–12.30	Fritz Gesztesy, UMC Columbia On a generalization of the spectral problem underlying the Camassa–Holm hierarchy	p14
12.30–14.00	Lunch break	
Session 13	Chair: Tamara Grava, SISSA Trieste	
14.30–14.55	Dong Wang, University of Michigan Hermitian matrix model with spiked external source: universality and new discoveries	p32
14.55–15.20	Reinout Quispel, La Trobe University Discrete Integrable Systems	p27
15.20–15.45	Jiuguang Wang, Carnegie Mellon University Riemann–Hilbert problems in optimal control	p32
15.45–16.10	Viktor Enolski, Institute of Magnetism NASU On the charge three cyclic monopole	p12
16.10–16.40	Coffee break	
Session 14	Chair: Ira Egorova, Institute for Low Temperature Physics	
16:40–17.05	Dionyssios Mantzavinos, University of Cambridge Applications of complex analysis to initial-boundary value problems	p21
17:05–17.30	Davide Masoero, Universidade de Lisboa Some results concerning the semiclassical limit of KdV before the gradient catastrophe	p22
17.30–17.50	Hans Lundmark, Linköping University Orthogonal and biorthogonal polynomials in the theory of peakon equations	p20
17.50–18.10	Alice Mikikits-Leitner, Technical University Munich Long-time asymptotics of perturbed finite-gap Korteweg–de Vries solutions	p23
18.10–18.30	Caroline Kalla, University of Bourgogne Algebro-geometric solutions to the multi-component NLS equation: a theoretical and numerical description	p16
18.30–20.00	Poster Session	
20.00	Get-together	

Abstracts

Complete matchings and random matrix theory

Jinho Baik
University of Michigan

Abstract. Over the last decade or so, it has been found that the distributions that first appeared in random matrix theory describe an increasing number of objects in probability and combinatorics which do not come from matrix at all. We consider one more such an example from the so-called maximal crossing and nesting of random complete matchings. The asymptotic analysis is based on the Riemann-Hilbert problem for a Hankel determinant associated to a discrete measure which is also related to the Schur flow. This is a joint work with Bob Jenkins at the university of Michigan.

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Systems of nonlinear, dispersive wave equations

Jerry Bona
University of Illinois at Chicago

Abstract. Considered here will be coupled systems of nonlinear, dispersive wave equations. Several different aspects of such equations will be discussed, including where they arise, mathematical questions of well-posedness and singularity formation and associated connections to inverse scattering theory and issues of stabilty and instabilty of solitary-wave solutions.

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Long-time dynamics of step-like data for NLS+

Anne Boutet de Monvel
University Paris Diderot

Abstract. We consider the initial-value problem for the focusing nonlinear Schrödinger equation $\mathrm{i}q_t + q_{xx} + 2|q|^2 q = 0$ on the line with "step-like" initial data: $q(x, 0) = 0$ for $x \le 0$ and $q(x, 0) = A \exp(-2\mathrm{i}Bx)$ for $x > 0$, where $A > 0$ and B are real constants.

I will discuss the long-time asymptotic behavior of the solution $q(x, t)$. There are different qualitative asymptotic behaviors, depending on the value of x/t in the half-plane $x \in \mathbb{R}$, $t > 0$.

Our results are obtained by the Riemann-Hilbert approach together with Deift–Zhou's nonlinear steepest descent method.

This is joint work with Vladimir Kotlyarov and Dmitry Shepelsky.

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Two transitions between the Pearcey and the Airy processes

Mattia Cafasso
Centre de Recherches Mathématiques

Abstract. The Pearcey and the Airy processes model the microscopic behaviour of a large number of non-intersecting Dyson brownian motions in two different regimes. In this talk I will show how, under a suitable rescaling of the variables, it is possible to approximate the Pearcey process with one/two Airy processes. This is talk is based on joint works with Mark Adler, Marco Bertola and Pierre van Moerbeke.

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Long-wave limit of periodic solutions of nonlinear wave equations

Hongqiu CHEN
University of Memphis

Abstract. In this lecture, we consider some non-linear, dispersive equations posed on the entire real line and the interest here is the relationship between two different types of solutions. One type is in Sobolev space defined on $\mathbb{R}$ and the other is periodic, say of period $2l$. For the same equation, if two types of solutions are close in some sense at some time as $l \to \infty$, say initially, then we show that as $l \to \infty$, the periodic solutions converge to the solution in the Sobolev space.

Similarly, solitary-wave solution are often approximated by using periodic data. Our theory is a nice justification.

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The hydrodynamical relevance of the Camassa–Holm and Degasperis–Procesi equations

Adrian Constantin
University of Vienna

Abstract. In recent years two nonlinear dispersive PDE's have attracted much attention due to their integrable structure. We describe how both equations arise in the modeling of the propagation of shallow water waves over a flat bed. The equations capture stronger nonlinear effects than the classical KdV equation. In particular, they accomodate wave breaking phenomena.

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Oscillatory Riemann-Hilbert problems and stationary phase

Yen Do
Georgia Tech

Abstract. In this talk, I will describe some progress on asymptotics behaviors of oscillatory Riemann–Hilbert problems with non-analytic data.

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The isospectral problem of the Camassa–Holm equation

Jonathan Eckhardt
University of Vienna

Abstract. The isospectral problem of the dispersionless Camassa–Holm equation is the Sturm–Liouville problem

$$-y''(x) + \frac{1}{4}y(x) = z\omega(x)y(x), \quad x \in \mathsf{R},\ z \in \mathsf{C},$$

with some boundary condition at $\pm\infty$. Here ω is allowed to be some finite signed measure. One may associate with this spectral problem a self-adjoint operator in a Sobolev space or a self-adjoint operator in some Krein space. Analogously to classical Weyl–Titchmarsh theory, we develop a spectral theory of such operators. Finally we give a solution of the inverse spectral problem from the spectral measure. This talk is based on joint work with G. Teschl.

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Inverse scattering transform for the KdV and Toda equations with steplike finite-gap backgrounds

Iryna Egorova
Institute for Low Temperature Physics, Kharkiv, Ukraine

Abstract. We present a rigorous treatment of the inverse scattering transform method (the Marchenko approach) for solving the Cauchy problem for the Korteweg - de Vries equation and for the Toda lattice with initial data, which are asymptotically close to different finite-gap backgrounds as $x \to +\infty$ and $x \to -\infty$ ($n \to \pm\infty$ for the Toda lattice). Using this approach we study the long time asymptotic behavior of the solution in a neighborhood of the leading edge. We show that the solution split into solitons, the number of which grows in time.

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On the charge three cyclic monopole

Victor Enolski
Institute of Magnetism, Kiev

Abstract. We study $SU(2)$ monopoles of the charge 3 in the Bogomolny-Prasad-Sommerfeld (BPS) limit with the spectral curve that respects C_3-symmetry. That is of the genus four curve taken in the form $\eta^3 + a\eta\zeta^2 + \zeta^6 + b\zeta^3 - 1 = 0$ where a and b are two real parameters.

First we are considering the case $a = 0$ and establish that the only curve from this family that yields BPS monopole enjoy the tetrahedrally symmetry. We introduce on this stage several new techniques making use of a factorization theorem of Fay and Accola for theta functions of unramified coverings, together with properties of the Humbert variety. The geometry leads us to a formulation purely in terms of elliptic functions.

Then we are extending this result by continuity and find (numerically) a curve in parameter a, b-plane that produces new monopole solutions. To do that a well adapted homology basis is presented enabling the theta functions and monopole data constructed by initial genus four curve to be given in genus two data. The Richelot correspondence and generalize arithmetic-geometric mean is used to solve this genus two curve.

We also expose the reconstruction of the monopole fields that is based on the Nahm Ansatz and theta-functional solutions to the Nahm equations.

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A unified and effective method for integrable non-linear PDEs

Athanassios S. Fokas **(Talk will be delivered by J. Lenelles)**
Cambridge

Abstract. A new method for analyzing boundary value problems (BVPs) extending ideas of the inverse scattering transform method, was introduced in [1], [2] and further developed by several authors, in particular by G. Biondini, J. Bona, A. Boutet de Monvel, B. Deconinck, A.R. Its, V. Kotlyarov, J. Lenells, D. Mantzavinos, B. Pelloni, D. Shepelsky and L.Y. Sung. Recent unexpected developments regarding the implementation of this method to evolution PDEs in the half-line will be reviewed, which suggest the following: (i) For linearizable BVPs the new method is as effective as the usual inverse scattering transform method; this included PDEs with a third order derivative, for which the alternative approach of extension from the half-line to the full line, fails. (ii) For general (non-linearizable) BVPs, it yields the solution via a matrix Riemann–Hilbert problem, whose jump matrix can be characterized via a well defined nonlinear equation, in terms of the given initial and boundary conditions. (iii) For general BVPs, with either decaying, or t-*periodic* boundary conditions, it yields effective long time asymptotic formulae.

In addition, the x-periodic initial value problem with arbitrary, as opposed to "finite gap", initial conditions can be incorporated in the new method.

References

[1] A.S. Fokas, *A Unified Transform Method for Solving Linear and Certain Nonlinear PDEs*, Proc. R. Soc. Lond. A **453**, 1411–1443 (1997).

[2] A.S. Fokas, *On the Integrability of Linear and Nonlinear PDEs*, J. Math. Phys. **41**, 4188–4237 (2000).

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On a generalization of the spectral problem underlying the Camassa–Holm hierarchy

Fritz Gesztesy
UMC Columbia

Abstract. Using a Birman–Schwinger-type operator approach, we study generalizations of the left-definite spectral problem underlying the Camassa–Holm hierarchy. We re-derive a number of known results, including basic Floquet theoretic facts, considerably relaxing the conditions on the coefficients (permitting certain measures and distributions).

We also illustrate the manner in which the Birman–Schwinger-type approach is most natural in the sense that it yields necessary and sufficient conditions for certain relative boundedness and relative compactness results.

This is based on joint work with Rudi Weikard (UAB, Alabama, USA).

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Universality in Hamiltonian PDEs

Tamara Grava
SISSA Trieste

Abstract. We consider Hamiltonian PDEs and study the behaviour of solutions near critical points. Such behaviour is locally independent from the initial data and it is described by special solutions of a Painleve equations.

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A Lipschitz metric for the Camassa–Holm equation

Katrin Grunert
University of Vienna

Abstract. When studying the Cauchy problem for the Camassa–Holm equation the question of how to continue solutions beyond wave breaking is of special interest. In the case of conservative solutions which preserve the energy for almost all times, we present how to study the stability of such solutions by deriving a Lipschitz metric. This talk is based on joint work with Helge Holden and Xavier Raynaud.

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Initial-boundary problems for integrable nonlinear PDEs

Iasonas Hitzazis
University of Patras

Abstract. We study initial-boundary value problems (IBVPs) for certain nonlinear partial differential equations (PDEs) integrable by the so-called inverse scattering method (ISM). First applied in the middle 60's upon the initial value problem (IVP) for the celebrated Korteweg–de Vries (KdV) equation, the ISM has since been developed into a powerful technique for studying the IVP for nonlinear PDEs that admit a so-called Lax pair formulation (integrable PDEs). A generalization of the ISM, that renders it applicable upon initial-boundary value problems (IBVPs) as well, has recently been developed by A.S.Fokas and his collaborators. First applied upon the Goursat IVP for the Ernst equation, this so-called Unified Transform Method is based on a simultaneous spectral analysis of the Lax pair associated to the given integrable PDE. Alike the classical ISM, this generalized method reduces the IBVP under consideration to a Riemann–Hilbert or a DBAR problem in the spectral plane. This makes it possible to further studying the asymptotic properties of the solutions of the given IBVP by applying an appropriate nonlinear steepest descent method . In this presentation we illustrate the application of the Unified Transform Method upon certain IBVPs. In particular, we mainly address the IBVP for the KdV equation posed on a finite interval of the spatial variable. Other IBVPs will also briefly be addressed, including: (i) Moving IBVPs for integrable two-dimensional PDEs (KdV and mKdV equations), and (ii) IBVPs for multidimensional integrable PDEs, like the Davey–Stewartson equation.

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On the nonlinear variational wave equation

Helge Holden
Norwegian University of Science and Technology

Abstract. We prove existence of a global semigroup of conservative solutions of the nonlinear variational wave equation $u_{tt} - c(u)(c(u)u_x)_x = 0$. This equation shares many of the peculiarities of the Hunter–Saxton and the Camassa–Holm equations. In particular, the equation possesses two distinct classes of solutions denoted conservative and dissipative. In order to solve the Cauchy problem it is necessary to augment the equation properly in order to obtain a unique solution. In this talk we describe how this is done for conservative solutions. The equation was derived by Saxton as a model for liquid crystals. The talk is based on joint work with Xavier Raynaud.

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Algebro-geometric solutions to the multi-component NLS equation: a theoretical and numerical description

Caroline Kalla
University of Bourgogne, France

Abstract. It is well known that almost periodic solutions of certain integrable systems can be given in terms of multi-dimensional theta functions associated to compact Riemann surfaces. We present such solutions for the multi-component nonlinear Schrödinger equation (n-NLS) using a method based on Fay's famous trisecant identity, relating the theta function and its partial derivatives. A degenerated version of the Fay identity leads to algebro-geometric solutions of the n-NLS equation. The underlying Riemann surface has to satisfy reality properties. The solutions are visualized for hyperelliptic and for general Riemann surfaces. Degenerating the Riemann surface into a genus zero surface, we obtain solutions like solitons, breathers and rational breathers, well known in the scalar case.

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Stability of the periodic Toda lattice

Spyros Kamvissis
University of Crete

Abstract. We consider the question of the asymptotic stability of periodic (and slightly more generally of algebro-geometric finite-gap) solutions of the doubly infinite Toda lattice under a short-range perturbation. We prove that the perturbed lattice asymptotically approaches a modulated lattice instead. Our method relies on the equivalence of the inverse spectral problem to a vector Riemann–Hilbert problem defined on the hyperelliptic curve and generalizes the so-called nonlinear stationary phase/steepest descent method for Riemann–Hilbert problem deformations to Riemann surfaces.

This is joint work with Gerald Teschl.

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Harrison cohomology and integrable systems for the hyperelliptic subsets in Birkhoff strata of Sato Grassmannian

Boris Konopelchenko
University of Salento, Lecce, Italy

Abstract. Local properties of the families W of algebraic varieties in Birkhoff strata of the Sato Grassmannian containing hyperelliptic curves of genus g are discussed. It is shown that the tangent spaces T for W are isomorphic to linear spaces of 2-coboundaries. Particular subsets in W are described by the integrable dispersionless coupled KdV hierarchies which provide us with the special class of Harrison's 2-cocycles and 2-coboundaries. In particular, the dispersionless NLS equation describes deformations of an elliptic curves with the fixed point and gives a class of dNLS 2-cocycles and 2-coboundaries. It is shown that the blowups of such 2-cocycles and 2-coboundaries and gradient catastrophes for associated integrable systems are interrelated.

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Multiple orthogonal polynomials in the normal matrix model

Arno Kuijlaars
Katholieke Universiteit Leuven

Abstract. The normal matrix model is a random matrix model defined on complex matrices. The eigenvalues in this model fill a two-dimensional region in the complex plane as the size of the matrices tends to infinity. Orthogonal polynomials with respect to a planar measure are a main tool in the analysis.

In many interesting cases, however, the orthogonality is not well-defined, since the integrals that define the orthogonality are divergent. I will present a way to redefine the orthogonality in terms of a well-defined Hermitian form. This reformulation allows for a Riemann-Hilbert characterization as multiple orthogonal polynomials. For the special case of a cubic potential it is possible to do a complete steepest descent analysis on the Riemann-Hilbert problem, which leads to strong asymptotics of the multiple orthogonal polynomials, and in particular to the two-dimensional domain where the eigenvalues are supposed to accumulate.

This is joint work with Pavel Bleher (Indianapolis).

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Boundary value problems for the Ernst equation

Jonatan Lenells
Baylor University

Abstract. For stationary and axisymmetric spacetimes, the vacuum Einstein equations reduce to a single integrable equation in two dimensions—the celebrated Ernst equation. Using the new method introduced by Fokas, we first recover two of the most famous solutions of this equation, the Kerr black hole and the Neugebauer–Meinel disk, as solutions of linearizable boundary value problems. We then present new exact solutions of a class of boundary value problems corresponding to a disk rotating around a central black hole. The new solutions are given explicitly in terms of theta functions on a family of Riemann surfaces of genus four.

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The integrability and the magnetization dynamics of weak ferro and antiferromagnets

Kavitha Louis
Department of Physics, Periyar University, Salem , India and The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy.

Abstract. Magnetization reversal and electromagnetic soliton propagation in magnetic medium in the frame of Landau-Lifshitz equation is reasonably well understood especially for the magnetic bit recording through flipping of soliton offers the possibility of developing a new novel approach for higher data storage devices and magneto optical recording. The spin dynamics of a Heisenberg helimagnet with antisymmetric spin-orbit induced exchange interaction namely Dzyaloshinskii-Moriya (DM) interaction is governed by a generalized higher order nonlinear Schrodinger equation. We establish the possibility of switching of magnetization through flipping of soliton in the helimagnet medium by solving the coupled evolution equations for the amplitude and velocity of the soliton using the fourth order Runge-Kutta method numerically by controlling the associated DM interaction parameter. In another context, the effect of Dzyaloshinskii-Moriya interaction with single ion anisotropy in a classical Heisenberg antiferromagnet under the influence of electromagnetic field is studied within the context of Maxwell-Landau model by employing the powerful reductive perturbation technique and it is found that the dynamics of the modeled system is governed by derivative nonlinear Schrodinger equation (DNLS). The investigation of the exact solution, in particular solitons, for the nonlinear evolution equations plays an important and interesting role in the study of nonlinear physical phenomenon. Thus an effective algebraic method which is straightforward and systematic to find the exact analytical solution is employed to identify the soliton solution pattern of the derivative nonlinear Schrdinger equation using symbolic computation. Interesting finite energy solutions including multi-solitons have been obtained in these systems only in certain limiting cases.

This work is coauthored with M. Saravanan (Department of Physics, Periyar University, India), A. Prabhu (Department of Physics, Periyar University, India) and D. Gopi (Department of Chemistry, Periyar University, India)

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Orthogonal and biorthogonal polynomials in the theory of peakon equations

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Abstract. The Camassa-Holm shallow water equation is well-known for being an integrable PDE which admits non-smooth soliton solutions, usually called peakons (peaked solitons); these waves have corners where the derivative is undefined. The general n-peakon solution is given by explicit formulas which can be expressed in terms of polynomials orthogonal with respect to the spectral measure of an associated vibrating string problem. More recently, other integrable PDEs with peakon solutions have been discovered, the most widely known of these being the Degasperis–Procesi eqations. Whereas the Camassa–Holm peakons are closely related to very classical mathematics (orthogonal polynomials, Padé approximation, Stieltjes continued fractions, selfadjoint Sturm–Liouville problems), the newer peakon equations have turned out to be a rich source of interesting generalizations of these concepts. For these equations, the n-peakon solution can be expressed in terms of polynomials which are biorthonal with respect to a bilinear form involving the so-called Cauchy kernel and a spectral measure coming from an associated "cubic string" (a certain third-order non-selfadjoint boundary value problem). The talk will give an overview of how all this works, and also touch upon some recent developments.

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Applications of complex analysis to initial-boundary value problems

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Abstract. Perhaps one of the most important developments in the area of PDEs took place back in 1997, when Fokas introduced a new method for the analysis of initial-boundary value (ibv) problems for linear and integrable nonlinear PDEs on the half-line [1]. This new approach was subsequently applied to more complicated domains (see e.g. [2]-[6]), while more recently, it was extended to higher dimensions via the solution of the ibv problem for the Davey-Stewartson equation on the half-plane [7]. In this talk, we present the implementation of the new method in 2+1 dimensions (2 spatial and 1 temporal) in the case of the Kadomtsev-Petviashvili II equation, which is the two dimensional analogue of the celebrated Korteweg-de Vries equation. In particular, through the simultaneous spectral analysis of a suitable Lax pair, we are able to express the corresponding eigenfunctions (i) with respect to the physical variables via a nonlocal RH problem, and (ii) with respect to the spectral variables via a d-bar problem. By comparing the two expressions, we obtain an integral representation for the solution of the ibv problem, involving appropriate transforms of the initial and the boundary values. A so-called global relation is also produced, relating the afforementioned transforms. The elimination of the unknown boundary values from the integral representation remains an open problem.

1. A.S. Fokas, A unified transform method for solving linear and certain nonlinear PDEs, Proc. R. Soc. Lond. Ser. A 453 (1997).
2. A.S. Fokas and B. Pelloni, A Transform Method for Evolution PDEs on the Interval, IMA J. Appl. Maths 75, 564-587 (2005).
3. A.S. Fokas, A.R. Its and L.Y. Sung, The Nonlinear Schroedinger Equation on the Half-Line, Nonlinearity 18, 1771-1822 (2005).
4. A. Boutet de Monvel, A.S. Fokas and D. Shepelsky, Integrable Nonlinear Evolution Equations on the Interval, Comm. Math. Phys. 263, 133 (2006).
5. J.L. Bona and A.S. Fokas, Initial-Boundary-Value Problems for Linear and Integrable Nonlinear Dispersive PDEs, Nonlinearity 21, T195-T203 (2008).
6. J. Lenells and A.S. Fokas, Boundary Value Problems for the Stationary Axisymmetric Einstein Equations: A Rotating Disk, Nonlinearity 24, 177-206 (2011).
7. A.S. Fokas, The Davey-Stewartson equation on the half-plane, Comm. Math. Phys. 289 (2009).

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Some results concerning the semiclassical limit of KdV before the gradient catastrophe

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Abstract. We consider the KdV equation in the semiclassical limit, namely the following Cauchy problem

$$u_t = uu_x + \epsilon u_{xxx}, \qquad u(t=0;\epsilon) = \varphi(x) \in H^s(\mathbb{R}), s \geq 3 \, .$$

If $\epsilon = 0$ the solution of the Cauchy problem develops a singularity at a time $t_c > 0$.

We show that if $T < t_c$ and $s \geq 3N+3$, the solution of the Cauchy problem is continuous and N-times differentiable with respect to ϵ. Moreover, we compute explicitely the first derivatives at $\epsilon = 0$.

We then generalise the result to some deformations of the KdV equation.

This is a joint work with A. Raimondo, SISSA.

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On the spatial asymptotics of solutions of the Ablowitz–Ladik hierarchy

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Abstract. We show that for decaying solutions of the Ablowitz–Ladik system (an integrable discretization of the AKNS-ZS system), the leading asymptotic term is time independent. In addition, two arbitrary bounded solutions of the Ablowitz–Ladik system which are asymptotically close at the initial time stay close. We briefly mention the corresponding results for the associated hierarchy.

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Long-time asymptotics of perturbed finite-gap Korteweg–de Vries solutions

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Abstract. In this talk we will consider one of the most famous examples of a completely integrable nonlinear wave equation, the Korteweg–de Vries (KdV) equation. The goal will be to investigate the long-time asymptotic behavior of solutions of the KdV equation which are short-range perturbations of quasi-periodic finite-gap KdV solutions. It is well-known that in the classical case with constant background in the limit for long times the following picture appears: the perturbed solution splits up into a number of solitons (solitary waves) generated by the eigenvalues of the Lax operator. Apart from that there exists a decaying radiation part corresponding to the continuous spectrum. In other words, the solitons constitute the stable part of the solution. We will investigate the case where the constant background is replaced by a quasi-periodic one. One possibility for rigorously studying this question is provided by applying the method of nonlinear steepest descent for oscillatory Riemann–Hilbert problems.

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Fluxon condensates and the semiclassical sine-Gordon equation

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Abstract. The semiclassically scaled sine-Gordon equation is considered with (relatively) slowly varying initial data. Considered as functions of x, the initial conditions parametrize a curve in the phase portrait of the simple pendulum. We study the solution of the initial-value problem and show that away from certain critical points $x = x_{\mathrm{crit}}$ where the initial data curve crosses the pendulum separatrix the solution is asymptotically described by modulated elliptic functions characterizing superluminal pulse trains of either librational (kink-antikink) type or rotational (kink-kink) type. On the other hand, near critical points x_{crit}, the behavior is far more subtle but universal (independent of details of initial conditions), being described by a specific network of kinks, antikinks, and degenerate grazing collisions of kinks spatiotemporally organized according to an infinite hierarchy of rational solutions of the Painlevé-II system. This is joint work with Robert Buckingham.

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Long/short-time behavior of the solution to the mKdV equation with the step-like initial data

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Abstract. We consider the initial value problem for the modified Korteweg–de Vries equation:

$$\begin{aligned} q_t + 6q^2 q_x + q_{xxx} =& 0, \quad x, t \in \mathbb{R} \\ q(x,0) =& c_l, \quad x < 0, \\ =& c_r, \quad x > 0. \end{aligned}$$

Arbitrary real numbers c_l, c_r are positive and $c_l > c_r$. The goal of this report is to present the asymptotic behavior of the solution of the initial value problem as $t \to \mp\infty$ and $t \to +0$. The case $t \to -\infty$ corresponds to the long-time dynamics of the rarefaction wave.

Theorem 1 [1] *For $t \to -\infty$ the solution of the initial value problem takes the form*

$$q(x,t) = \begin{cases} c_l + O(\mathrm{e}^{-Ct}), & -\infty < x < 6c_l^2 t, \\ \sqrt{\dfrac{x}{6t}} + O(t^{-1/2}), & 6c_l^2 t < x < 6c_r^2 t, \\ c_r + O(t^{-1/2}), & x > 6c_r^2 t. \end{cases}$$

where $C > 0$ is some positive number.

In [2] the second term of the asymptotics is obtained in the form of the self-similar vanishing (as $O(t^{-1/2})$) wave when $x > 6c_r^2 t$ and $t \to -\infty$.

The case $t \to \infty$ corresponds to the long-time dynamics of the compressive wave, which was studied in the case $c = c_l > c_r = 0$.

Theorem 2 [3] *Let $t \to \infty$. Then the solution of initial value problem takes the form of a modulated elliptic wave:*

$$q(x,t) = \begin{cases} c, & -\infty < x < -6c^2 t; \\ (c + d(\xi))\mathrm{dn}\left(U(t,\xi)\middle| m(\xi)\right) + O(t^{-1/2}), & -6c^2 t < x < 4c^2 t; \\ 0, & 4c^2 t < x < \infty, \end{cases}$$

where $m(\xi) = 1 - \dfrac{d(\xi)}{c} \in (0,1)$ is a modulo of Jacobian elliptic function, and function $d = d(\xi)$, being monotone and continuous, satisfies the equation:

$$d^2 = c^2 + 2\xi - \int_0^1 \lambda^2 d^2 \sqrt{\frac{1-\lambda^2}{c^2 - \lambda^2 d^2}} d\lambda \left(\int_0^1 \sqrt{\frac{1-\lambda^2}{c^2 - \lambda^2 d^2}} d\lambda \right)^{-1}, \qquad \xi = x/12t.$$

Function $U(t,\xi)$ has the form $U(t,\xi) = K[m(\xi)]\,(U_0(\xi) + tU_1(\xi))$, where

$$K[m] = \int_0^{\frac{\pi}{2}} \frac{d\theta}{\sqrt{1 - m\sin^2(\theta)}},$$

$U_1(\xi)$, $U_0(\xi)$ are some known functions.

We have also studied the asymptotic behavior of the solution as $t \to 0$:

Theorem 3 [4] *For sufficiently small $t > 0$ and any positive x_0 solution $q(x,t)$ is smooth in x and t and has the following asymptotic behavior (as $t \to +0$):*

$$q(x,t) = \begin{cases} c\int_\tau^\infty \mathrm{Ai}(s)ds + O(t^{1/3}), & \tau = \dfrac{x}{(3t)^{1/3}} > -x_0, \\ c + O(t^{1/3}), & x < -6c^2 t, \end{cases}$$

where $\mathrm{Ai}(s)$ is known Airy function.

This formula and asymptotic formulae for the Airy function as $\tau \to \pm\infty$ ($t \to +0$) show that the Gibbs-type phenomenon occurs at the point $x = 0$.

This is based on joint work with Vladimir Kotlyarov.

References

[1] A.Minakov, Journal of Mathematical Physics, Analysis, Geometry **7/1** (2011), 59-86

[2] A.Minakov, J.Phys.A: Math. Theor **44**, 085206 (2011)

[3] V.Kotlyarov and A.Minakov, JMP **51**, 093506 (2010)

[4] V.Kotlyarov and A.Minakov, Short-time evolution of discontinuous step-like initial data to the mKdV equation: nonlinear Gibbs-type phenomenon, preprint.

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Thermodynamic phase transitions and shock singularities

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Abstract. We show that under rather general assumptions on the functional form of the state functions, the balance equation for a gas in thermodynamic equilibrium is equivalent to a system of nonlinear equations of hydrodynamic type. This set of equations is integrable via the method of the characteristics and provides the equation of state for the gas. The critical point of gradient catastrophe identifies the phase transition.

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The periodic Ablowitz–Ladik equation and Floquet CMV matrices

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Abstract. We consider the periodic defocusing Ablowitz–Ladik equation and show that it can be expressed as an isospectral deformation of Floquet CMV matrices. We then introduce a Poisson Lie group whose underlying group is a loop group and show that the set of Floquet CMV matrices is a Coxeter dressing orbit of this Poisson Lie group. By using the group-theoretic framework, we establish the Liouville integrability of the equation by constructing action-angle variables, we also solve the Hamiltonian equations generated by the commuting flows via Riemann-Hilbert factorization problems. This is joint work with L.-C. Li.

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Boundary value problems for a nonlinear elliptic PDE: the elliptic sine-Gordon equation

Beatrice Pelloni
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Abstract. I will present recent work on the analysis of an elliptic integrable model, the so-called elliptic sine-Gordon equation. The analysis is based on the implementation of the method introduced by Fokas for the study of boundary value problem for integral PDES in two independent variables. Because of the elliptic nature of the problem, this implementation presents several novel features. In particular, I will discuss the Dirichlet to Neumann map for the case of boundary value problems posed in a half plane. I will also present a specific case of linearisable boundary conditions for the problem posed in a semistrip.

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Discrete integrable systems

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Abstract. Integrable ordinary differential equations (ODEs) have been studied intensively since the time of Kepler and Newton, integrable partial differential (PDEs) equations since the discovery of solitons in the Korteweg–de Vries equation by Kruskal and collaborators. Both integrable ODEs as well as PDEs are of great importance in mathematics as well as in applications (e.g. as a starting point for perturbation theory). The question thus arises how to generalize this theory and its applications from the continuous case (integrable differential equations) to the discrete case (integrable difference equations), i.e. when all independent variables are discrete. This question is important both from the point of view of mathematics (where the discrete case may be viewed as a deformation of the continuous case), as well as from the point of view of applications. The history of discrete integrable systems goes back to seminal papers in the 1970s by Ablowitz and Ladik and by Hirota. In the early 1980s, systematic methods for the construction of integrable nonlinear partial difference equations (P∆Es) were found, e.g. through the representation theory of infinite-dimensional Lie algebra, or in the work of Quispel, Nijhoff and co-workers on singular integral equations and connections with Bäcklund transformations. Integrable ordinary difference equations (O∆Es) were first extensively studied by Quispel, Roberts, and Thompson (QRT) in the second-order case, and by Papageorgiou, Nijhoff and Capel, and by Quispel et al. in the higher-order case. As is not uncommon when one studies deformations of a theory, the discrete case exhibits both similarities to, as well as differences from, the continuous case.

Discrete integrable systems may be (in a sense) more fundamental than continuous ones. This is one reason for their significance. Not only does e.g. the continuous KdV equation arise in the continuum limit from the discrete KdV equation, but in fact, the entire infinite hierarchy of continuous KdV equations arises in the limit from the single discrete KdV equation! This was shown in an important, but little-known, paper by Wiersma and Capel using vertex operator methods. (Similarly for other integrable PΔEs.) Related to this is the fact that discrete integrable PΔEs exhibit a much higher symmetry than their continuous counterparts, this symmetry being broken in the continuum limit. While this symmetry of integrable PΔEs and of their Lax pairs under permutation of the (discrete) spatial independent variables has been very explicit since e.g. our early work, a much fuller understanding has been obtained more recently in terms of so-called multi-dimensional consistency.

In this talk, we will present some recent results from this exciting area.

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The KdV equation, the Titchmarsh-Weyl m-function and Hankel operators

Alexei Rybkin
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Abstract. This talk is concerned with linking together the theory of Hankel operators and completely integrable systems. On the prototypical example of the Cauchy problem for the KdV equation we demonstrate the power of the language of Hankel operators which symbols are conveniently represented in terms of the Titchmarsh-Weyl m-functions associated with the initial data. Among others, this approach yields some new wellposedness results for the initial value problem for the KdV equation.

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Weyl theory, inverse spectral transform, and initial-boundary value problems for integrable equations

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Abstract. Inverse spectral transform is a fruitful approach to initial-boundary value problems. We present several examples as well as new results on the Weyl theory and inverse spectral transform for Dirac system with rectangular potential.

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The short-wave model for the Camassa–Holm equation: the Riemann–Hilbert approach

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Abstract. We present the inverse scattering transform approach to the Cauchy problem on the line for the short-wave model for the Camassa–Holm equation

$$u_{txx} - 2u_x + 2u_x u_{xx} + uu_{xxx} = 0$$

in the form of the associated Riemann–Hilbert problem. This approach allows us to give a representation of the classical (smooth) solutions, describe their asymptotics as $t \to \infty$, and describe cuspons — non-smooth soliton solutions with infinite slope at the crest.

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Random matrices: finite rank deformations and fluctuations of matrix entries of regular functions

Alexander Soshnikov
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Abstract. In the first part of the talk I will discuss the results about fluctuation of the outliers in the spectrum of finite rank deformations of Wigner random matrices. This question is related to the limiting distribution of the resolvent entries of standard Wigner matrices. The second part of the talk will be devoted to the results about the fluctuation of the matrix entries of regular functions of Wigner and sample covariance random matrices.

The results are joint with Sean O'Rourke, Alessandro Pizzo, and David Renfrew (preprints arXiv:1103.1170, arXiv:1103.3731, and arXiv:1104.1663).

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Burgers turbulence, kinetic theory of shock clustering, and complete integrability

Ravi Srinivasan
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Abstract. A remarkable stochastic coalescence model arises from considering shock statistics in scalar conservation laws with Markov initial data. While rooted in the study of Burgers turbulence, the model has deep connections to kinetic theory, random matrices, and statistics. The evolution takes the form of a Lax equation, which admits some rather intriguing exact solutions. More recently, it has been shown that this flow on 'Markov groups' is a completely integrable Hamiltonian system and is a natural analogue of the N-wave model from nonlinear optics. We will provide a broad overview of these results and their various connections. This talk consists of joint work with Govind Menon (Brown University, USA).

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On an inverse spectral problem associated to a two-potential generalization of the Degasperis–Procesi equation

Jacek Szmigielski
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Abstract. In this talk I will show a construction of peakon solutions to the integrable system of coupled nonlinear equations depending on two potentials first introduced by X. Geng and B. Xue. This system generalizes in a symmetric way Degasperis–Procesi (DP) and V. Novikov equations (VN). The construction of solutions in this class relies on the use of Cauchy biorthogonal polynomials and inverse spectral methods both of which will be explained during the talk. One of the novel features of our solution is that one uses two distinct Lax pairs to do the construction and to carry out the inverse problem. The direct spectral problem is non-selfadjoint but can be studied using ideas related to the concept of Gantmacher–Krein oscillatory kernels. The inverse spectral problem is solved using certain Hermite–Padé approximations and Cauchy biorthogonal polynomials which were introduced in connection with the inverse problem pertinent to the DP equation. A comparison will be made between this construction and preceding results for DP and VN. This is joint work with H. Lundmark.

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From longest increasing sequences of random permutations to the Tacnode Process

Pierre van Moerbeke
Universite de Louvain & Brandeis University

Abstract. A new process appears, when non-intersecting random walks or Brownian motions meet momentarily; it is decribed by a by a kernel, representable in many different ways.

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Hermitian matrix model with spiked external source: universality and new discoveries

Dong Wang
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Abstract. In this talk I will discuss the limiting distribution of top eigenvalues in the Hermitian matrix model with general potential and spiked external source, i.e., the external source is of finite rank. For a large class of potentials, the phase transition phenomenon that was observed for Gaussian and Laguerre potentials is proved to be universal. However, new types of transitions are discovered for other classes of potentials.

This is joint work with Jinho Baik.

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Riemann–Hilbert problems in optimal control

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Abstract.

We present a Riemann–Hilbert formulation of optimal control theory as applied to problems in robotics. Continuous time optimal control has traditionally been based on resolving necessary and sufficient conditions for optimality, most notably the Hamilton–Jacobi–Bellman (HJB) equation, Pontryagin's minimum principle, and their numerical approximations. It is unusual to derive exact analytical solutions to these problems since it typically involves solving a set of partial differential equations that do not, in general, yield smooth solutions. Instead, numerical tools such as dynamic programming are used to obtain a discretized globally optimal control policy. Other trajectory optimization tools based on nonlinear programming can be used to obtain approximate solutions that can be verified to be locally optimal. While these numerical approximations have been proven to be effective in solving real-world problems, especially given complex physical constraints, they suffer from the *curse of dimensionality* and require extensive computational resources to pre-compute control policies offline. When available, analytical solutions offer significant computational advantages over open-loop trajectory optimizers and can be easily implemented in a closed-loop setting for high-dimensional systems. In this work, we formulate a class of optimal control problems in the complex plane and show that the resulting Riemann–Hilbert problem can be solved with calculus of variations. We show how closed-form, analytical solutions can be obtained from this formulation and the use of these results in robotics applications.

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