



International Round Table Italy - Russia@Dubna
Efforts in Fundamental Research and Perspectives
for Applied S&T and Business Development

Integrable systems in Pure and Applied Mathematics

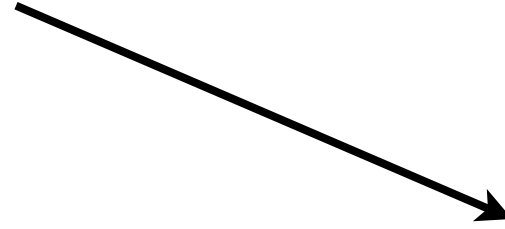
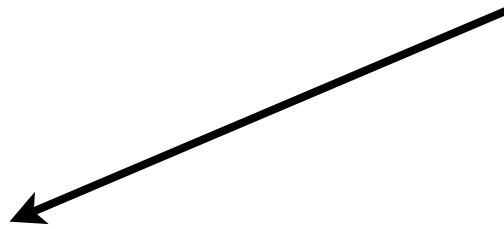
Boris DUBROVIN
SISSA, Trieste

- Something personal
- Italian - Russian collaboration and grant system
- Impact of integrable systems on Pure and Applied Math.
- Concluding remarks

My first contacts with Italian researchers:

- INFN
- Scuola Normale Superiore
- La Sapienza
- SISSA

Grants



Italian

European

Cofin/PRIN

Marie Curie

Italy - Russia

ESF

ERC

More flexibility to support Russian scientists is needed

Integrable systems

In classical mechanics:

regular (as the opposite to chaotic) behaviour.

Stimulated by the early days quantum mechanics

In 50s-60s discovery of integrability in systems

with large (even infinite) number of degrees of freedom

FPU, Korteweg - de Vries equation, Calogero - Moser system

Impact on Pure Mathematics

- Applied aspects of algebraic geometry
- Quantum groups

Beginning of 90s: integrable systems and strings

Classical integrable systems describe

the renormalization group flow

in certain quantum systems

New life for topology and algebraic geometry

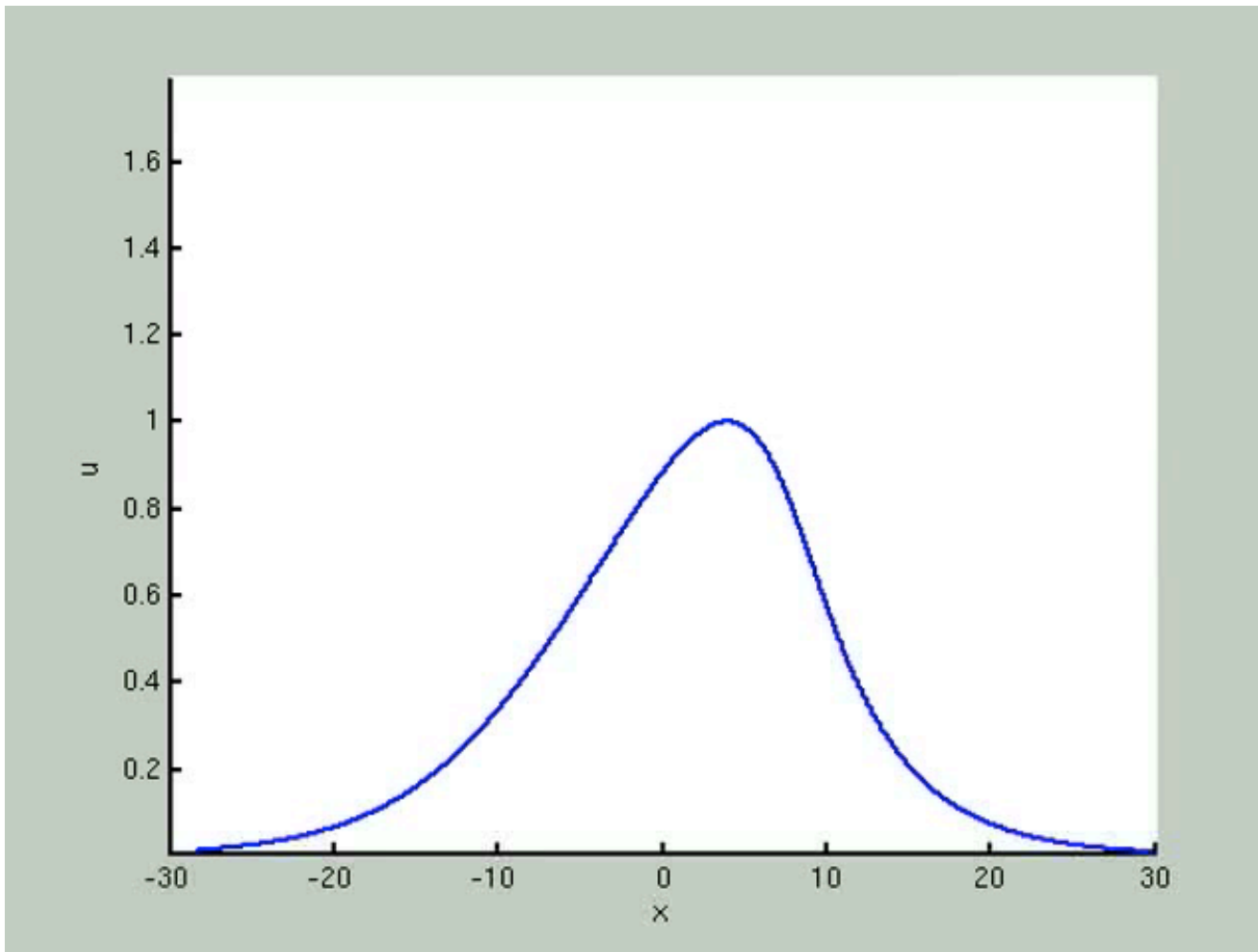
- Moduli spaces of Riemann surfaces and KdV (Kontsevich - Witten theorem)
- Mirror symmetry

Towards Applied Mathematics

Problem of oscillatory behaviour in conservative systems

KdV equation

$$u_t + u u_x + u_{xxx} = 0$$



Integrability at the point of phase transition

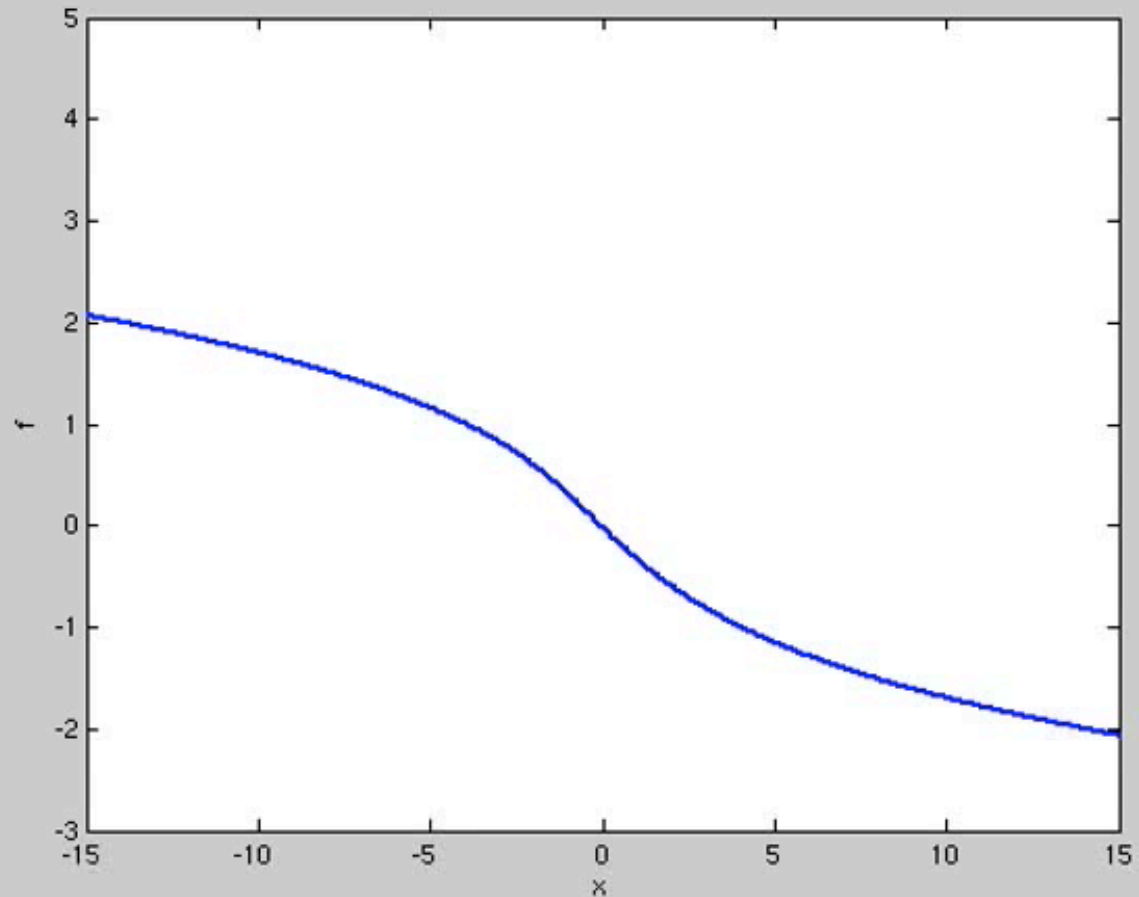
from regular to oscillatory behaviour

Universality: just one special function works

for a large class of systems at the point of phase transition

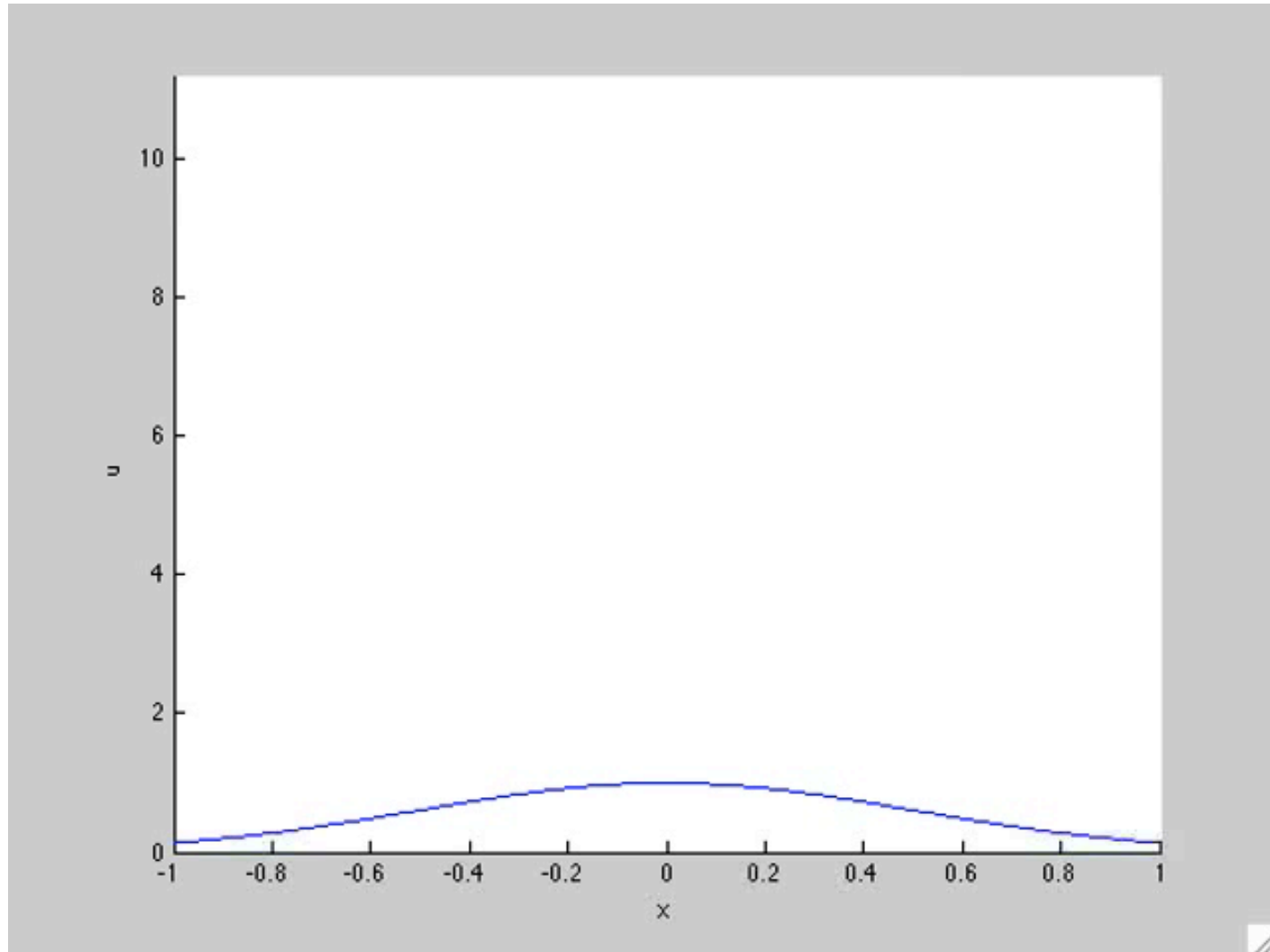
Smooth solution $U(X, T)$ to P_I^2

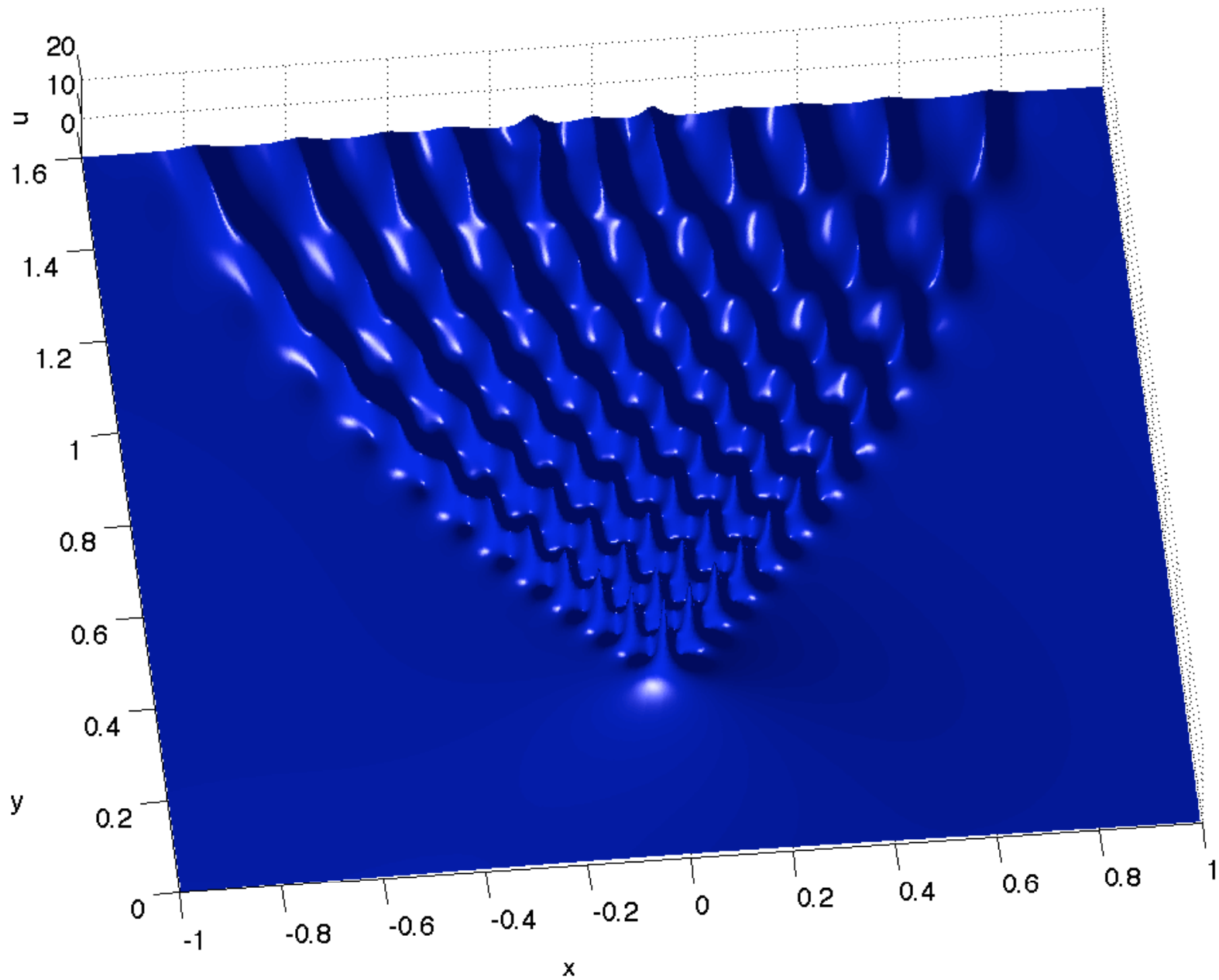
$$X = TU - \left[\frac{1}{6}U^3 + \frac{1}{24}(U'^2 + 2UU'') + \frac{1}{240}U^{IV} \right]$$



Different type of critical behaviour: self-focusing

in the nonlinear Schrödinger equation $i \psi_t + \frac{1}{2} \psi_{xx} + |\psi|^2 \psi = 0$

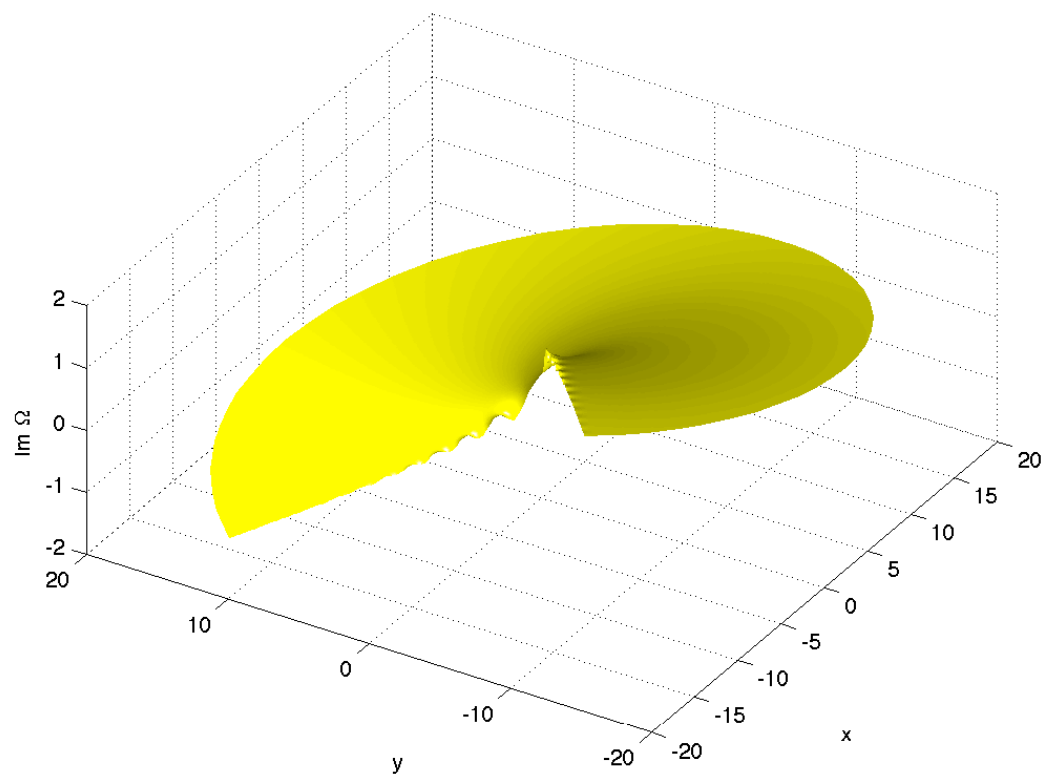
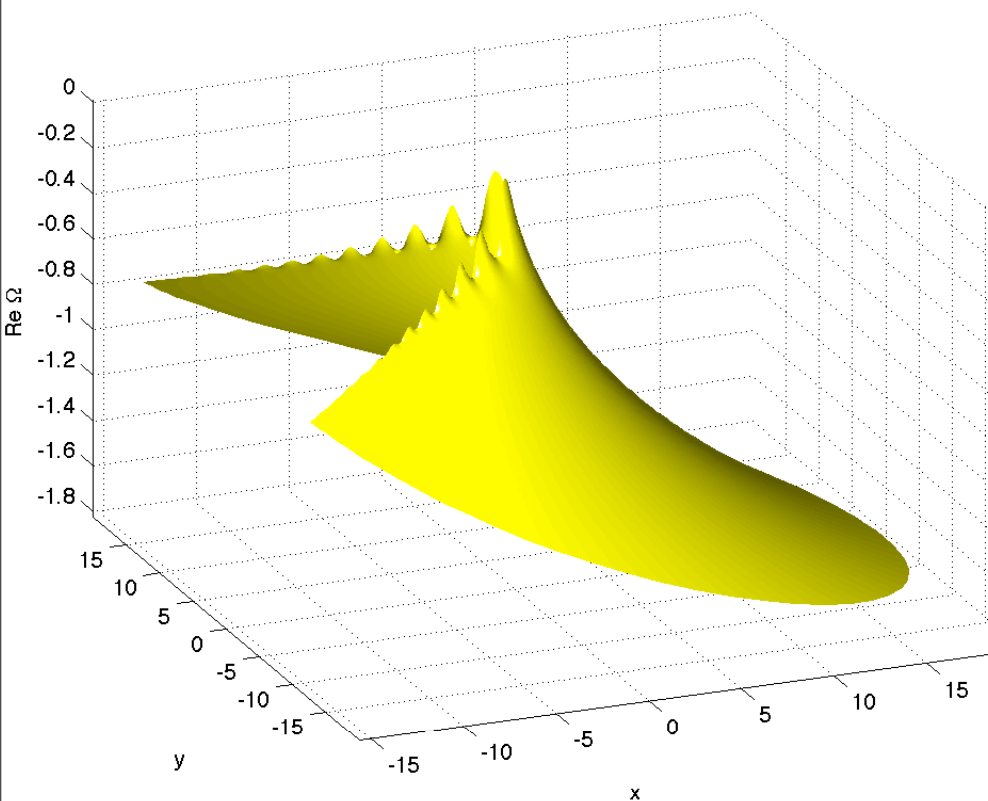




The point of phase transition: a particular solution

to the Painlevé-I equation

$$W'' = 6W^2 - Z$$





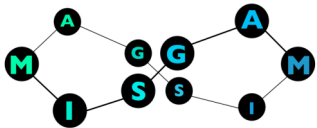
The Abdus Salam
International Centre for Theoretical Physics



CO-SPONSORED SCHOOL AND WORKSHOP ON INTEGRABLE SYSTEMS AND SCIENTIFIC COMPUTING

15 - 20 June 2009

ICTP, Miramare - Trieste, Italy



Directors

- B. Dubrovin (Italy)
- T. Grava (Italy)
- C. Klein (France)
- A. Kuijlaars (Belgium)

Local Organizer

C.E. Chidume
ICTP, Trieste, Italy

Lecturers

The Abdus Salam International Centre for Theoretical Physics (ICTP) is organizing a **Co-sponsored School and Workshop on Integrable Systems and Scientific Computing**, to be held from 15 to 20 June 2009, in Trieste, Italy. The activity will be directed by B. Dubrovin (SISSA/ISAS, Trieste, Italy), T. Grava (SISSA/ISAS, Trieste, Italy), C. Klein (Department of Mathematics, Dijon, France) and A. Kuijlaars (Katholieke Universiteit Leuven, Belgium). The activity is co-sponsored by the European Science Foundation (ESF) grant MISGAM (Method of Integrable Systems, Geometry and Applied Mathematics) and by SISSA.

The aim of this School/Workshop is to bring together mathematicians working in the community of integrable systems and numerical analysts. The School will cover different aspects of applications of integrable systems: theory of nonlinear waves, random matrices and discrete integrable surfaces. The analytical and numerical treatment of highly oscillatory solutions of nonlinear evolution partial differential equations arising in different fields of mathematical physics will be considered. This problem is very closely related to large N limits in random matrix theory and asymptotics for orthogonal polynomials.

Discrete differential geometry is an active mathematical terrain where differential geometry and discrete geometry meet and interact. It provides discrete equivalents of the geometric notions and methods of differential geometry, such as notions of curvature and integrability for polyhedral surfaces. Current progress in this field is to a large extent stimulated by its relevance for computer graphics and mathematical physics.

Nowdays it is not an easy time for young researches
in Italy and Russia

I am confident that the Italian-Russian collaboration
will be mutually beneficial

Thank you!