WORKSHOP 2017

MODELLING, THEORY AND NUMERICAL APPROXIMATION OF NONLINEAR WAVE PROBLEMS

ORGANIZERS: Department of Applied Mathematics, University of Valladolid

DATE. OCTOBER 23-24, 2017

LOCATION: Faculty of Science, University of Valladolid

TOPICS: The workshop is devoted to the physical and mathematical treatment of models for Nonlinear Waves.

SPEAKERS:

1. *Ricardo Barros (Loughborough University). (mimaet@gmail.com)*
2. *Vassilios Dougalis (University of Athens). (doug@math.uoa.gr)*
3. *Dimitrios Mitsotakis (Victoria University of Wellington). (dmitsot@gmail.com)*
4. *Manuel G. Velarde (Instituto Pluridisciplinar, UCM, Madrid). (mgvelarde@pluri.ucm.es)*

WORKSHOP SUPPORTED BY:

1. PROJECTS:
   - *Análisis numérico de problemas de evolución no lineales y no locales (ANPENLNL): MTM2014-54710-P. (IP: César Palencia, Ángel Durán)*
2. RESEARCH GROUPS:
   - Análisis Numérico de Problemas de Evolución. (Grupo de Investigación Reconocido, Universidad de Valladolid. Coordinador: César Palencia)
   - Unidad de Investigación Consolidada de Castilla y León UIC 033. (Director: Miguel Ángel López Marcos)
3. DEPARTMENT OF APPLIED MATHEMATICS, UNIVERSITY OF VALLADOLID, SPAIN
4. INSTITUTE OF MATHEMATICS, UNIVERSITY OF VALLADOLID, SPAIN (IMUVA)

PRELIMINARY PROGRAM:

- *Monday, October 23.*

  16:00-16:45

  ***Speaker**:* Manuel G. Velarde (Instituto Pluridisciplinar, UCM, Madrid).
  ***Title**: Soliton surfing transport and the nanomechanical control of electrons in anharmonic crystals.*
  ***Abstract**:* The Toda lattice is a soliton-bearing an-harmonic lattice whose analytical solutions are explicitly known. Indeed, it is an integrable Hamiltonian system, perhaps the first many-body problem solved by hand. Its "interatomic" potential is, however, not quite acceptable as the attractive component is unphysical. If the Toda potential is replaced by the quantum-based Morse potential then the system in no longer integrable. Yet its numerical solution is fairly well approximated, within about ten percent, by the solution of the Toda lattice. I shall present soliton-assisted electron transport (electron surfing) on a Morse lattice by treating the electron in the "tight-binding" approximation. It appears that when adding an excess electron there is electron trapping by the supersonically moving lattice soliton. This dynamic bound state has been called a solectron which, depending on parameter values, provides (sub- or supersonic) electron surfing. The solectron is a natural extension to an-harmonic lattices of the Landau-Pekar polaron for harmonic lattices. Based on this process a novel field effect transistor –offering extremely low heat dissipation- has been invented and it is now patent pending in the UK. I shall also present work on (nano-) mechanical control of electron transport from say a source to a drain along "natural channels" (crystallographic axes) in e.g. triangular lattices, like in a transistor though with no electric field involved. Finally, I shall comment on the relationship between lattice solitons and discrete breathers (DB, kind of unification with differences) and the related problem of charge or energy storage and transport.

  17:00-17:45

  Speaker: Ricardo Barros (Loughborough University)
  Title: *Large amplitude internal waves in two- and three-layer flows.*
  Abstract: We revisit the strongly nonlinear long wave model for large amplitude internal waves in two-layer flows with a free surface proposed by Choi & Camassa (1996) and Barros, Gavrilyuk & Teshukov (2007). Its solitary-wave solutions are governed by a Hamiltonian system with two degrees of freedom, whose critical points are examined in detail leading to some new results. It will be shown how similar techniques can be used to study nonlinear internal waves in a three-layer flow confined between two rigid walls. Some results on mode-2 waves will be presented.

- *Tuesday, October 24.*

  16:00-16:45

  Speaker: Vassilios Dougalis (University of Athens).
  Title: *Galerkin methods for the Serre and the Camassa-Holm equations*.
  Abstract: We will present some recent joint work with D. Antonopoulos and D. Mitsotakis on error estimates for Galerkin finite element methods for two related strongly nonlinear dispersive models of water- wave propagation, namely the system of Serre equations and the Camassa-Holm equation. The results of numerical experiments illustrating properties of solitary-wave solutions of both models will also be presented.

  17:00-17-45

  ***Speaker**:* Dimitrios Mitsotakis (Victoria University of Wellington).
  ***Title**: On nonlinear and dispersive water waves in the presence of surface tension*.
  ***Abstract**:* The generalised Serre (gSerre) system is a coupled, fully nonlinear system of dispersive evolution equations which approximates the full water wave problem with surface tension effects. The system is known to describe accurately the wave motion at the surface of an incompressible inviscid fluid in the case when the fluid flow is irrotational and two-dimensional, and is an extension of the well known shallow-water system to the situation where the waves are long, but not so long that dispersive effects can be neglected. We solve numerically the gSerre system using a stable, accurate and efficient fully-discrete numerical scheme based on Galerkin/finite element methods. After reviewing the properties of the proposed numerical scheme, a detailed study of the dynamics of the solitary waves of the gSerre system along with a new type of singular traveling waves in the critical regime. We also discuss various wave breaking regimes in the presence of surface tension.