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Foreword

On behalf of the International Scientific Committee of the IUTAM Symposium on Complexity of Nonlinear Waves we have the pleasure of introducing this special issue of the *Proceedings of the Estonian Academy of Sciences*. The selected papers presented at the symposium are published in two parts (Vol. 64 No. 3 and No. 3S) and are ordered alphabetically by first author. The symposium was held in Tallinn, Estonia, on 8–12 September 2014. The main organizer of the symposium was the Centre of Nonlinear Studies (CENS) at the Institute of Cybernetics at Tallinn University of Technology.

At the CENS the complexity of wave fields in solids and fluids has been one of the focal issues for a long time. The IUTAM Symposium on Complexity of Nonlinear Waves was a logical continuation of a series of international conferences dedicated to nonlinear wave phenomena and organized by the Institute of Cybernetics at Tallinn University of Technology. The series started in 1973 and it includes an IUTAM symposium and four Euromech colloquia. The previous three conferences were held in 2002, 2006, and 2009.

The focus of the 2014 symposium was on nonlinear problems of wave propagation characterized by complicated original mathematical models, innovative ideas for computing, and novel applications in various areas. The interaction of nonlinearity with accompanying effects such as changing properties of the medium sheds further light on the nature and forecasts of physical phenomena. The symposium provided a forum for the presentation and discussion of innovative complex models and methods including computer-based simulation of dynamical processes in mechanics.

Wave motion is the key mechanism of interest in many fields of science, such as solid mechanics, acoustics, seismology, oceanography, coastal and offshore engineering, electromagnetism, etc. Despite the extreme variety of physical appearances of wave phenomena, different disciplines share many mathematical models and numerical methods. The conceptual similarity of mathematical models for wave motion in solids and fluids leads to similar formalism in analysis. Our purpose was to foster research into different aspects of nonlinear wave phenomena – the theoretical, the computational and the applied – through promoting the transfer of competence over the existing borders of classical research disciplines. The synergy of many fields and directions was the main goal of the symposium. The high quality of the presentations and the fruitful discussions, which took place in a friendly and inspiring atmosphere, allow us to conclude that the goals of the symposium were achieved. As evidenced by excellent feedback from the participants, there was a good balance between different generations of scientists at the symposium.

During the symposium 47 oral and 12 seminar presentations were given in 16 sessions. The presenting authors were from 18 countries: Bulgaria, the Czech Republic, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Japan, Norway, Russia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the USA. However, if all co-authors of the accepted papers are considered, Australia, Austria, China, India, the Republic of Korea, and Ukraine should be added to the list and therefore the number of countries will rise by six.

This special issue of the *Proceedings of the Estonian Academy of Sciences* contains 31 papers selected from those presented at the symposium. Wave phenomena in fluids are treated in 14 papers and 17 papers are dedicated to these in solids.

Waves in fluids

Oleg Didenkulov et al. study the run-up of solitary waves of different bell-like shapes in a linearly inclined bay of parabolic cross-section.

Lev Shemer examines the limitations of the nonlinear Schrödinger equation in the description of the evolution of nonlinear water–wave groups by carrying out a comparison between the numerical simulations and the results of measurements in laboratory wave tanks.

Bruno Lombard et al. examine some properties of acoustic solitons such as the low-frequency regime, balance of energy, and stability. They present results of numerical experiments demonstrating in which case solitary waves behave like classical solitons.

Georg Lindgren illustrates by examples some statistical characteristics of the Lagrange wave model and investigates some differences between the Gauss model and the Lagrange model.

Motonori Hirata et al. simulate numerically the behaviour of capillary gravity waves excited by an obstacle in shallow water making use of the Euler equations. They demonstrate in which cases the results agree with the weakly nonlinear theory.

The mathematical analysis and wave kinematics calculations presented in the paper by John Grue are motivated by a set of ocean wave measurements in which the elevation was obtained and there was a need to calculate the kinematics, which was not measured.

Naoto Yokoyama and Masanori Takaoka found that the representation of nonlinear energy in a wave turbulence system is not necessarily unique. They consider in their paper the Majda–McLaughlin–Tabak model as an example.

Takao Yoshinaga and Takasumi Iwai investigate breakup phenomena of a viscous liquid column jet closely placed in a concentric sheath on which a static electric field is imposed. They demonstrate under what conditions different types of breakup modes realize.

Shanshan Xu and Frédéric Dias discuss the run-up of waves in an arbitrary water depth and compare four solutions of standing waves.

The papers by Bert Viikmäe et al. and Nicole Delpeche-Ellmann et al. are dedicated to pollution control in the Gulf of Finland.

Katri Pindsoo and Tarmo Soomere consider the formation of extreme water levels at the waterfront of the Tallinn area and Maris Eelsalu et al. study coastal processes in Tallinn Bay.

Ship wake transformation in the coastal zone is analysed by Tomas Torsvik et al. by using time–frequency methods.

Waves in solids

Arkadi Berezovski studies wave propagation in microstructural solids and demonstrates how the nonlinear behaviour of internal variables may lead at the macroscale to evolution equations of different types, e.g. the Benjamin–Bona–Mahoney equation or the Camassa–Holm equation.

Tanel Peets and Kert Tamm present results of numerical experiments on nerve pulse propagation, modelled by a Boussinesq-type wave equation.

An overview of interdisciplinary studies into the complexity of wave processes with the main attention paid to wave–wave, field–field, wave–internal structure, and other interactions is presented by Jüri Engelbrecht.

Manuel G. Velarde et al. consider the wave dynamics of a one-dimensional lattice where both on-site and intersite vibrations are governed by Morse interactions. Their attention is focused on the onset of lattice solitons and discrete breathers.

In one of their two articles Hüsnü Ata Erbay et al. examine the stability and instability properties of solitary waves for the double dispersion equation. In their other article they consider unidirectional wave propagation in a nonlocally and nonlinearly elastic medium and compare exact and asymptotic models making use of numerical experiments.

Michail D. Todorov et al. study soliton interactions in the Manakov system under composite external potentials and demonstrate that the potentials can change the asymptotic regimes of the soliton trains.

Alexey V. Porubov et al. consider transverse instability of nonlinear longitudinal waves in hexagonal lattices and show that one long wavelength continuum limit gives rise to the Kadomtsev–Petviashvili equation, while another continuum limit results in obtaining two-dimensional generalization of the nonlinear Schrödinger equation.

Anatoli Stulov and Vladimir Erofeev examine the formation and propagation of shock waves in nonlinear microstructured wool felt. They show that the front velocity of the shock wave is greater than the velocity of sound in a linear medium.

Jaan Kalda and Mihkel Kree demonstrate how the theory of turbulent mixing can be applied for modelling wave propagation in media with a fluctuating coefficient of refraction.

Yosuke Watanabe et al. study numerically localized oscillations in finite mass–spring chains driven sinusoidally at one end with the other end fixed. They show that when the amplitude exceeds the threshold, localized oscillations are excited intermittently at the driving end and propagated down the chain at a constant speed.

Angela Madeo et al. consider a 2D pantographic structure composed of two orthogonal families of Euler beams, present a set of results of numerical simulations of wave propagation, and demonstrate that in some cases soliton-like behaviour was detected.

Francesco dell'Isola et al. study elastic pantographic 2D lattices and analyse wave propagation in the considered structure and the static response of the structure.

The paper by Peter Ván et al. demonstrates that the application of the theory of internal variables in non-equilibrium thermodynamics results in hierarchical evolution equations.

Martin Lints et al. simulate numerically solitary wave propagation in carbon fibre reinforced polymer and demonstrate how the material properties influence the character of wave propagation.

Sanichiro Yoshida derives field equations that govern the dynamics of all stages of deformation on the same theoretical basis and discusses the existence of solitary waves in different deformation regimes.

Ivan C. Christov proposes a hierarchy of nonlinearly dispersive generalized Korteweg–de Vries evolution equations. He demonstrates that the equations from the proposed hierarchy possess a Hamiltonian structure and the solutions to these equations can be compact and, in addition, peaked.

Last but not least, we would like to thank all authors, reviewers, and the editorial staff of the journal for excellent cooperation.

Andrus Salupere and Gérard A. Maugin
Guest Editors