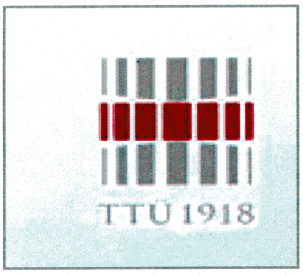

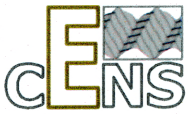



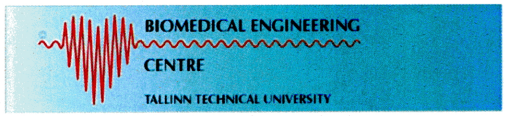

Institute of Cybernetics at Tallinn University of Technology
Chair of Geometry, University of Tartu
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CENS

Centre for Nonlinear Studies

Estonian Centre of Excellence in Research

Annual Report

2006

Tallinn, Estonia

Contents

Abstract

The Report includes a brief overview on all the activities of CENS in 2006. Described are studies and results on: (i) dynamics of microstructured materials and solitons; (ii) water waves; (iii) optical waves and software development; (iv) biomechanics and biophysics; (v) fractality and econophysics; (vi) general nonlinear wave theory; (vii) optical nonlinearity and photoelasticity; (viii) geometric approach to nonlinear problems; (ix) EEG analysis and spectrophotometric signals. The international programmes and projects are described. The full records of published papers, reports, abstracts, conferences, etc are presented. Teaching activities are described and the list of theses given. The foresight on complexity describes the further activities.

Keywords: nonlinear dynamics, soft matter physics, microstructured solids, solitons, interaction solitons, acoustodiagnostics, photoelasticity, cardiac contraction, cell energetics, signal processing, water waves, extreme waves, differential equations.

See also: Centres of Excellence of Estonian Science, Tallinn, 2004.

Sisukord

Lühikokkuvõte

Käesolev aruanne on ülevaade Mittelineaarsete Protsesside Analüüsi Keskuse (CENS) tegevusest 2006.a. Kirjeldatud on tulemused järgmistes suundades: (i) lainelevi mikrostruktuursetes materjalides ja solitonid; (ii) lained veepinnal; (iii) optilised lained ja tarkvara arendus; (iv) biomehaanika ja biofüüsika; (v) fraktaalsus ja ökonofüüsika; (vi) mittelineaarne laineleviteooria; (vii) optiline mittelineaarsus ja fotoelastsus; (viii) diferentsiaalvõrrandite geomeetriline teooria; (ix) EEG analüüs ja biosignaalid. On antud ülevaade CENSi osalusega rahvusvahelistest programmidest ja projektidest. Esitatud on publikatsioonide, aruannete, konverentside, külaliste jm nimekirjad, sh. ka õppetegevus ning kraadiõppe tulemused. Ettevaade komplekssüsteemide arengust kirjeldab tulevikuplaane.

Võtmesõnad:
mittelineaarne dünaamika, pehmisefüüsika, mikrostruktuuriga materjalid, solitonid, interaktsioonisolitonid, akustodiagnostika, fotoelastsus, südamelihase kontraktsioon ja rakuenergeetika, signaalitöötlus, pinnalained, ekstreemlained, diferentsiaalvõrrandid.

Vaata: Eesti teaduse tippkeskused, Tallinn, 2004.
Keeruka maailma ilu, Tallinn, 2006.

1. Introduction

This report is the eighth Annual Report of CENS, following the previous Reports 1999 – 2005. The present CENS is one of the Estonian Centres of Excellence in Research (the whole number of such Centres is 10). The period of holding this title with additional funding was 2003 – 2006 and has been extended to 2007. In addition, the Centres of Excellence in Research could apply for grants from the European Structural Funds through an open competion. CENS got an additional award for renewing the computer cluster (arrival in 2007) and to obtain a device for the analysis of physiological signals.

An overview on activities of CENS "The Beauty of a Complex World" (in Estonian) was published for a wider public.

The present report includes a short summary of research fields (Section 2), an overview on current research in 2006 and research cooperations (Section 3), an overview on funding (Section 4) and publication records, lists of conferences, seminars, public lectures, etc. (Section 5). Conclusions and foresight ideas are presented in Section 6.

2. Overview on CENS

The present research of CENS involves as before:

- Nonlinear waves: complexity of wave motion in solids, coherent wave fields, solitonics and surface waves, phase-transformation fronts, acoustodiagnostics of material properties, microstructured materials, impact;
- Fractality and biophysics: complexity in biophysics, *in silico* modelling of cardiac mechanics and cell energetics, heart rate variability, turbulent diffusion, statistical topography and flooding, econophysics;
- Nonlinear integrated photoelasticity: stress field tomography (tensor tomography), complexity of interference fringes;
- Water waves: marine physics, multimodal waves, wind wave forecast, anomalies of wave fields, extreme waves;
- Geometric approach: Lie-Cartan methods, flows of vector fields on tensor fields;
- Nonlinear signal processing: analysis of physiological signals (EKG, EEG), and applications in cardiology and brain research (hypoxic states of the brain).

In summary, these fields are closely related to the "Complexity–NET" which started in 2006. The Estonian Academy of Sciences is a partner in this ERA–NET with CENS as a focal point.

The International Advisory Board consists of:

Prof. R. Grimshaw, Loughborough University; Prof. G.A. Maugin, University of Paris 6; Prof. H.K. Moffat, Cambridge University; Prof. G. Nicolis, University of Brussels; Prof. F. Pastrone, University of Turin; Prof. G. Stepan, Budapest University of Technology and Economics; Prof. V. Saks, University of Grenoble; Prof. Dick van Campen, Eindhoven University of Technology.

3. Current results 2006

3.1 Institute of Cybernetics, Tallinn University of Technology

3.1.1 Dynamics of microstructured materials and solitons

In order to analyse the propagation and interaction of solitary deformation waves in microstructured solids two types of model equations are applied – the Mindlin–Engelbrecht–Pastrone (MEP) type and the Korteweg–de Vries (KdV) type.

MEP models include Mindlin theory and the concept of wave hierarchies and they are able to take into account nonlinear and dispersive effects on the micro- as well as on the macrolevel. Corresponding model equations — derived by Jüri Engelbrecht and Franco Pastrone — are so called two-wave equations and therefore they can be used for simulation of head-on interaction of solitary waves. In 2006 the main attention was paid to numerical simulation of propagation and interaction of localised initial pulses by employing the pseudospectral method. The results are analysed in terms of space-time variables as well as spectral densities. Special attention is paid to the solitonic character of the solution (A.Salupere, K.Tamm).
The KdV type model equation under consideration is an evolution equation (one wave equation) that includes higher order dispersive and nonlinear terms. In 2006 results of previous studies were generalised and new numerical experiments were carried out in order to simulate interaction of different solitonic structures (A.Salupere, O.Ilison).

Solitary waves in granular materials. Propagation of solitary waves in dilatant granular materials is studied by making use of the hierarchical Korteweg-de Vries type evolution equation. The model equation is solved numerically under localised initial conditions making use of the pseudospectral method. The behaviour of the solution is described and analysed over a wide range of material parameters (two dispersion parameters and one microstructure parameter).
The results are analysed in terms of space-time variables as well as spectral densities. Special attention is paid to the solitonic character of the solution. Five solution types are introduced (A.Salupere, L.Ilison).

Wave hierarchies
The model hierarchical wave equations are two-wave equations (see above) with complicated dispersive terms. It is of interest to understand how these dispersion effects are modelled by evolution equations.

The corresponding evolution equations are derived and the comparative analysis of dispersion relations is carried out (J.Engelbrecht, M.Randrüüt, T.Peets). Two MSc theses on this topic were completed.

3.1.2 Water waves

Surface Waves
An efficient and accurate solver for 2D free surface problems using a half analytical/half numerical approach based on the conformal mapping technique, with extensions to a nonstationary bottom is being developed. The corresponding evolution equations in conformal variables have been derived (P.Peterson).

A novel method based on the conformal mapping technique was considered for solving the free surface problem of ideal incompressible irrotational flow. As a result an original method for solving the corresponding evolution equations in conformal variables using perturbation theory with practical applications was developed. P.Simson suc-

cessfully defended a BSc thesis on the above subject (P.Simson, M.Sepp, P.Peterson).

Weakly two-dimensional interaction of solitons
Several features of nonlinear interactions of long–crested solitonic waves travelling in different directions in shallow water are analysed in the framework of the Kadomtsev–Petviashvili (KP) equation. Exact expressions for the maximum slope in the case of interactions of unequal amplitude solitons are derived. The slope amplification for a certain class of interactions is twice as intense as the amplitude amplification. In the limiting case of exact resonance the interaction pattern is a new KdV soliton as in the case of the Mach stem. This feature allows to directly establish the extreme properties of the humps excited by nonlinear coupling. Evidence of such interactions and their possible consequences in realistic conditions are discussed (T.Soomere, J.Engelbrecht).

Implications of nonlinear ship wake waves
A substantial part of the energy of wake waves from high–speed ships is concentrated in nonlinear components which at times have a solitonic nature. Recent results of investigations into solitonic wave interactions within the framework of the KP equation and their implications for the rogue wave theory are reviewed in a systematic manner (T.Soomere). The most important feature is the possibility of a drastic amplification of wave amplitudes and slopes when the properties of the interacting waves are specifically balanced. The resulting structure may persist for a long time. Nonlinear wake components may exert a considerable influence on the marine ecosystem in coastal areas. In situ measurements in Tallinn Bay confirm that they bring about significant changes in the optical parameters of sea water in the ca. 1 m thick near-bottom layer. The greatest changes occur at relatively small depths, but the duration of the influence increases with increasing depth. The overall influence of fast ferry traffic in Tallinn Bay may result in an annual loss of the order of several hundred litres of fine sediments from each metre of the coastline (T.Soomere, in cooperation with A.Erm from the Marine Systems Institute).

Trends and extremes of wave conditions in the Baltic Sea
One of the longest time series of contemporary wave measurements in the northern Baltic Sea (Almagrundet 1978 – 2003) contains the roughest instrumentally measured wave conditions (significant wave height 7.8 m) in the northern Baltic Proper until December 2004. The data for the years 1979 – 95, the period for which the data are most reliable, show a linear rising trend of 1.8% per annum in the average wave height. The seasonal variation in wave activity follows the variation in wind speed. The monthly mean significant wave height varies from 0.5 m in May – July to 1.3 – 1.4 m in December – January (K.Rannat, T.Soomere; in cooperation with SMHI-Norrköping experts).

Runup of nonlinear waves
The classical studies of runup of long nonbreaking waves on a plane slope in the framework of nonlinear shallow water equations assume that the leading and trailing slopes of the incident wave have equal steepness. The runup and rundown properties of asymmetric long waves with notable steepness of the leading front in shallow water are considered. It is shown that a wave with increased steepness of the leading front penetrates inland over considerably longer distances than a wave with a symmetric profile. The runup height strongly depends on the wave steepness and tends to infinity for a shock wave (bore). The drawdown depth only slightly depends on the

wave steepness (I.Didenkulova, T.Soomere in cooperation with N.Zahibo, A.A.Kurkin, B.V.Levin, E.N.Pelinovsky).

Coastal environment & other preliminary results

The analysis of the practice of the Environmental impact assessment (EIA) performed for developmental works in the Estonian coastal sea during 2001 – 2004/2005 allowed mapping the quality of the analysis of potential impacts and identifying positive experiences and main shortcomings.

The EIAs of planned offshore sand mining operations, potential environmental consequences and possibilities of their mitigation were considered in detail (T.Lapimaa, A.Kask, T.Soomere, in cooperation with experts from the Marine Systems Institute and City of Tallinn). A qualitative analysis of the potential influence of the nonlinear shape of these waves on some features of coastal processes has been performed (R.Põder). A preliminary analysis of wave conditions during the windstorm Gudrun in January 2005 showed that the largest wave heights occurred at a substantial distance from the waveriders. The maximum recorded significant wave height in the central part of the northern Baltic Proper was 7.2 m, wave models indicate that the highest waves occurred off the coasts of Saaremaa and Latvia, where the modelled significant wave height was close to 10 m (T.Soomere, in cooperation with A.Behrens, Germany, L.Tuomi, Finland, and J.W.Nielsen, Denmark). Numerical analysis of sand transport patterns in the area of Pirita beach net loss of sand is about 1000–1500 m^3/year. Beach nourishment in the form of an artificial dune of moderate height along the waterline is suggested as the optimum protection technique for the area in question (T.Soomere, A.Kask, in cooperation with J.Kask, Marine Systems Institute). A model is proposed allowing to calculate the total impact of fast ferries' wakes on the bottom sediments from the results of underwater optical monitoring on the per-wake-basis approach. The effect of each single wake is detected from simultaneous measurements of waves and changes of optical properties of sea water in the near-bottom layer (in cooperation with A.Erm, Marine Systems Institute).

3.1.3 Optical waves and software development

Stability analysis of nonlinear periodic structures

The nonstationary propagation of coherent light through a nonlinear periodic medium has been studied. The structure under investigation was a photopolymer hologram doped with *CdSe* nanoparticles. Four different sets of parameters were studied. It was found that the input-output power transmission exhibits multistable behavior for these structures. Stable solutions can be found on only the first multistable branch, for which the transmitted intensities fall out of the range detectable in experiments. Since the stable transmission cannot be achieved for given structures then the nonstationary solutions are investigated by numerically integrating the coupled-mode system (M.Sepp, L.Rebane, P.Peterson).

M.Sepp successfully defended an MSc thesis on the above subject.

Digital spiral imagining
The imaging applications of the orbital angular momentum of light have been studied. The orbital angular momentum of a light beam, encoded to its spiral spectrum, is directly related to topological properties of the wave–front (intensity and phase distribution) and can thus provide information that is inaccessible by other methods. Two different imaging techniques have been considered. First, digital spiral imaging is based on analyzing the image carrying wave with the information encoded into its spiral spectrum. An experimental study of the spiral spectrum of the light wave has been presented and it was shown how the step-height of a phase jump can be estimated by analyzing the weights of different spiral modes. Second, spiral phase contrast imaging is related to holographic Fourier plane filtering, using a spiral phase element as a filter. How spatial filtering of the object field with a spiral phase element in a Fourier plane of the optical path results in a strong and isotropic edge enhancement at the output image was demonstrated experimentally. Numerical simulations predicted that phase jumps as small as 1% of the optical wavelength could be detected (M.Sepp, L.Rebane, P.Peterson).
L.Rebane successfully defended an MSc thesis on the above subject.

Software development
The program "F2PY – Fortran to Python Interface Generator" (http://cens.ioc.ee/projects/f2py2e/) is being developed. The aim of F2PY is to provide an automatic connection between the high-level Python scripting language and high-performance Fortran/C libraries and programs (P.Peterson).

The Third Generation F2PY project has been created. The aim is to extend F2PY with Fortran 90 specific features such as Fortran 90 type support. The G3 F2PY program has been implemented that can be used to wrap scalar F90 types to Python. The Fortran 2003 parser has been implemented (P.Peterson). See Annex 1 for the list of software.

The SciPy package (http://www.scipy.org/) that gathers a variety of high level science and engineering modules for Python is developed (P.Peterson).

3.1.4 Biomechanics and biophysics

Cell energetics
We developed a novel method to analyse quantitatively mitochondrial positioning in three dimensions. Using this method, we compared the relative positioning of mitochondria in adult rat and rainbow trout (*Oncorhynchus mykiss*) ventricular myocytes. Energetic data suggest that trout, in contrast to rat, have two sub-populations of mitochondria in their cardiomyocytes. Therefore, we speculated whether trout cardiomyocytes exhibit two types of mitochondrial patterns. Stacks of confocal images of mitochondria were acquired in live cardiomyocytes. The images were processed and mitochondrial centers were detected automatically. The mitochondrial arrangement was analyzed by calculating the 3D probability density and distribution functions describing the distances between neighboring mitochondrial centers. In rat (8 cells with a total of 7546 mitochondrial centers), intermyofibrillar mitochondria are highly ordered and arranged in parallel strands. These strands are separated by $\sim$1.8 μm and can be found in any transversal direction relative to each other. Neighboring strands exhibit the same mitochondrial periodicity. In contrast to rat, trout ventricular myocytes (22 cells; 5528 mitochondrial centers) exhibit a relatively chaotic mitochondrial pattern. Neighboring mitochondria can be found in any direction relative to each other. Thus,

two potential sub-populations of mitochondria in trout are not distinguishable by their pattern. The developed method required minor interaction in the filtering of the mitochondrial centers. It is therefore a practical approach to describe intracellular organization, and may also be used for analysis of time-dependent organizational changes. The obtained quantitative description of mitochondrial organization is a requisite for accurate mathematical analysis of mitochondrial systems biology (M.Vendelin).

Functional interaction between mitochondria and surrounding ATPases has been found from the experiments on permeabilized heart muscle fibers. According to our earlier analysis of the acquired kinetic data, such interaction can be induced by relatively local diffusion restrictions in cardiac muscle cells. The specific causes of these restrictions are not known but intracellular structures are speculated to act as diffusion barriers. Based on the proximity of sarcoplasmic reticulum to mitochondria, we hypothesize that SR not only utilizes ATP but may also act as a diffusion barrier for adenosine phosphates leading to functional coupling of ATPases and mitochondria observed in permeabilized fiber preparation. The structural proximity is evident from electron microscope images where thin SR tubules form loose network around and between consecutive mitochondria. With a three dimensional finite-element model, we attempted to explore, SR as the first candidate for diffusion barrier. The geometry for the model was constructed using representative mitochondrial and SR structural organization from confocal microscope images. The reaction-diffusion model was included to track changes for [ADP], [ATP] and [Pi] in myoplasm, myofibrils, mitochondrial intermembrane space and in the vicinity of mitochondria and SR. To analyze if SR alone could account for diffusion restriction, we compared the model simulation results with the following set of experimental data:
1. Mitochondrial respiration rate dependence on exogenous ADP and ATP;
2. Effects of pyruvate kinase (PK) and phosphoenolpyruvate (PEP) additions on respiration;
3. Stabilization of respiration rate after addition of 2 mM ATP or ADP
(Hena R. Ramay).

Non-linear time-series analysis
The multiscaling analysis of low-variability periods has been applied to magnetically confined plasma current and voltage signals. While the multiscaling behaviour was observed for all the data series, the probe positioned at the middle of the apparatus yielded the widest scaling range (J.Kalda, M.Säkki).

3.1.5 Fractality and econophysics

Statistical topography
The statistical topography of passive scalar fields in turbulent flows has been studied. We have established a possible link between the isodensity lines of a turbulently mixed passive scalar (experiments report fractal dimension 1.30), and the fluid lines, transported by a turbulent velocity field (our numerical results yield $D = 1.30 \pm 0.03$). We hypothesize that these two sets belong to the same universality class. A novel simple one-dimensional model has been constructed, aimed to mimic the formation of discontinuity fronts in turbulent fluids (J.Kalda, M.Kree).

Turbulent diffusion
The aggregation of sticky passive tracer particles in rough compressible velocity fields (which can be realized on the free-slip surface of a turbulent fluid) has been studied. The scaling exponents describing the aggregation are expressed via the compressibility, and the exponent of the turbulent spectrum. A novel description of the passive scalar distribution in chaotic smooth velocity fields has been formulated, which takes into account both the multifractality of the dissipation field, and the power-law size-distribution of the scalar blobs. A new definition of the compressibility of turbulent flows has been devised, based of the dispersion statistics of a pair of passive particles (J.Kalda).

Econophysics
A super-universal law derived in the context of low-variability period analysis was addressed. Previously, it was shown that just the very presence of a power-law of the length-distribution of low-variability periods leads to a super-universal law that the probability of observing a large movement is inversely proportional to the length of the ongoing low-variability period. We have successfully tested this relationship in a number of financial time series. Given the fact that the low-variability periods are closely related to the volatility, we have proposed this analysis as a complementary part of risk and volatility analysis. Since econophysics is a very young interdisciplinary field, the main research topics were presented to various audiences in Estonia (R.Kitt).

3.1.6 General nonlinear wave theory

Acoustodiagnostics of inhomogeneous and prestressed solids
The theoretical research to elaborate nondestructive methods for evaluation of strongly variable properties of nonlinear elastic material was carried on. The theoretical basis of nonlinear propagation and interaction of deformation waves (ultrasound) in the material was improved. As the hyperbolic second order nonlinear equation of motion of the material with smoothly variable coefficients has no explicit analytical solution, the main attention was paid to the numerical simulation of the problem making use of the programme package Maple 9. Wave interaction in the material with polynomial variation of properties was studied in detail. The implemented numerical experiments clarified the influence of linear, quadratic and cubic variation of material properties on wave interaction. Numerous experiments verified the fact that variation in material density and linear elastic properties has a larger affect on the distortion of the wave profile than nonlinear effects of wave propagation and variation in nonlinear elastic properties of material. The possibility to distinguish the affect of variable density and variable linear elasticity on the wave interaction is the next challenge.

The universality of the resonance method elaborated for nondestructive evaluation of the properties of a weakly inhomogeneous nonlinear elastic material was checked. The results of numerous numerical experiments with the data of different materials (duralumin, aluminium AA7475, etc.) confirm the conclusion that this method has ample opportunities in acoustodiagnostics of the properties of different materials.

Interaction of longitudinal waves (ultrasound) was studied in nonlinear elastic materials undergoing two-parametric prestress. The aim was to verify applicability of formerly elaborated qualitative and quantitative methods for nondestructive characterization of inhomogeneous prestress in different materials (steel, aluminium, etc.). It was concluded that despite different sensitivity of wave interaction to the values of

prestress parameters in different materials both methods are relevant for the practical problem of nondestructive characterization of inhomogeneous prestress in a wide range of elastic materials (A.Ravasoo, A.Braunbrück).

Wave propagation in materials with internal interfaces
Numerical simulations of the adiabatic phase transition front propagation in a one-dimensional bar under impact loading were performed to explain the influence of thermal effects on the martensitic phase transformation for Ni-Ti shape-memory alloy. The presentation "Impact-induced phase transition front propagation in a bar" by A.Berezovski and G.A.Maugin was made at the 4th World Conference on Structural Control and Monitoring (July 11–13, 2006, San Diego, USA).

The concept of compound deficiency is investigated in the case of a non-equilibrium contact between two discrete systems. It is shown that the local equilibrium approximation of a non-equilibrium state of a discrete system may be true if, and only if, the local equilibrium values are identical to the values of the corresponding contact quantities. In any other case we need to take into account the excess quantities. The results were presented at the EUROMECH Colloquium 478 "Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids" (June 13–16, 2006, Tallinn, Estonia) by W.Muschik and A.Berezovski.

The results of theoretical developments and numerical simulations in the front dynamics in inhomogeneous solids were summarized and presented at the EUROMECH Colloquium 478 "Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids" (June 13–16, 2006, Tallinn, Estonia) by A.Berezovski, J.Engelbrecht and G.A.Maugin.

Piano hammers - theoretical and experimental studies
A special sample of Parlour Grand Piano Estonia L190 was fabricated for experimental studies. Using the B&K impact hammer and accelerometers attached to the bridge as a tool, the frequency response functions and the two dimensional motion of the piano treble bridge were examined in cooperation with IRCAM. The influence of the bridge impedance and duplex scale tuning on the string vibrations was considered. It was shown that inharmonicity of the vibrating string appears not due to string stiffness, but due to the bridge impedance and the presence of a duplex scale. The mathematical models of the string-bridge interaction were also discussed. These results should prove extremely useful in developing an accurate model of the real string vibration excited by a piano hammer.

This study is realized in the framework of the French-Estonian programme PARROT in collaboration with the Institut de Recherche et Coordination Acoustique Musique (IRCAM, France), Ecole Nationale Superieure des Techniques Avancees (ENSTA, France), and Tallinn Piano Factory (A.Stulov).

Inverse problems
Harmonic waves for a coupled system of macrodisplacement and microdeformation were studied. It was proved that 4 of 5 coefficients of this system can be recovered from phase velocities of 4 harmonic waves with different frequencies.

Sets of solutions of nonlinear singular integro-differential equations containing autoconvolution terms were established. These equations generalize a certain equation in Burger's theory of turbulence.

An inverse problem to determine relaxation kernels of heat flux in a discontinuous medium was studied in case the measurements of heat flux on the boundary are given. Existence, uniqueness and stability for the inverse problem were proved under the

assumption that all continuous parts of the medium are accessible from the boundary (J.Janno, J.Engelbrecht).

3.1.7 Optical nonlinearity and photoelasticity

Non-linear integrated photoelasticity
An algorithm of non-linear photoelastic tomography for the measurement of axisymmetric stress fields is described, which is free from the restrictions of the linear approximation.

Photoelastic measurements are carried out in two parallel sections close to each other, perpendicular to the axis of the test object. On many light rays the characteristic directions and phase retardation are measured. Stress components are described in the form of power series along the radial coordinate. Part of the coefficients of these power series are eliminated using equations of equilibrium. The set of coefficients of the power series is named stress vector. The initial set (population) of possible stress vectors is generated from the solution of the linear approximation by addition of small random perturbations. For every stress vector "theoretical"characteristic parameters are calculated by solving the direct problem of photoelastic tomography. Using the real (measured) characteristic parameters and the calculated ones on many light rays, a penalty function F is calculated, which characterizes the difference between the real and calculated data. Applying the differential evolution algorithm, such a stress vector is found for which F has minimum value. As an example, residual stress in a rim-tempered drinking glass has been measured (L.Ainola, H.Aben, J.Anton, A.Errapart).

3.2 Chair of Geometry, University of Tartu

Geometric approach to nonlinear problems
The geometrical approach to the theory of differential prolongations in jet spaces (total differential operators, contact forms, their symmetries and invariants) has been developed, using global analysis and Lie-Cartan methods. The text is prepared for a monograph (contract with publishing house KomKniga, Moscow, 27.06.05) (M.Rahula).

We introduce the notion of a Z_N-connection, where N is any integer satisfying $N > 1$, within the framework of an algebraic approach to the theory of connections. The first component of our construction is a Z_N-graded q-differential algebra where q is a primitive Nth root of unity, denoted by B, and this algebra plays the role of an analog of an algebra of differential forms. It should be mentioned that a differential d satisfies $d^N = 0$. The second component is a Z_N-graded left module E over the subalgebra A of the elements of grading zero of B. From a geometric point of view a module E can be considered as an analog of the space of sections of a Z_N-graded vector bundle. Taking the tensor product of B and E which can be viewed as an analog of a space of Z_N-graded vector bundle valued differentials forms and defining the Z_N -graded structure on this product we give the definition of a Z_N-connection $\mathcal{D}$ in the spirit of D. Quillen and V.Mathai. We prove that the Nth power of a Z_N-connection is the grading zero endomorphism of the tensor product of B and E, and then we define the curvature F_D of a Z_N-connection by $F_D = D^N$. It is proved that the curvature of a Z_N-connection satisfies the Bianchi identity (V.Abramov).

3.3 Biomedical Engineering Centre, Tallinn University of Technology

3.3.1. EEG analysis for detection of nonspecific microwave effects

3.3.1a. Methods for EEG analysis

The EEG signal has a stochastic character and its high fluctuations make it difficult to detect small changes in the signal - these are masked by natural variability. Our aim was to develop methods sensitive to small hidden changes in time variability and energy of the EEG signal. Two new methods for EEG analysis were developed and evaluated in the same database. A nonlinear method of scaling analysis of the EEG signal based on the length distribution of low variability periods (LDLVP) was adapted for EEG analysis. The method of modulation with further integration of differences in energy from EEG segments with and without microwave exposure (IDE) was developed and applied for EEG signals. The database for the evaluation of methods consists of resting EEG recordings of 15 subjects without and with low-level microwave exposure (450 MHz, 0.16 mw/cm^2, modulation 40 Hz). Analysis of the recorded signals by traditional methods (PSD, coherence, bispectral, fractal dimension) did not reveal significant changes between signals with and without exposure for any subject. Significant differences between recordings with and without exposure were detected by the LDLVP method for 3 subjects and IDE method for 2 subjects within the group. The results show that small changes in the EEG signals hidden in visual inspections can be detected by the LDLVP and IDE methods.

3.3.1b. Individual sensitivity to microwaves

Individual sensitivity to modulated low-level microwave exposure effects on human EEG theta, alpha and beta rhythms was evaluated. Results of experiments on four different groups of healthy volunteers exposed to an identical 450 MHz EMF modulated at frequencies 7, 14, 21, 40, 70, 217 and 1000 Hz were analysed. The field power density at the scalp was always 0.16 mW/cm^2. The experimental protocol consists of 10 cycles of repetitive EMF exposure (1 min on and 1 min off) and reference (sham) recordings. The EEG was continuously recorded during all experimental sessions. The EEG analysis was performed using three different methods: integration of differences in energy (IDE) between segments with and without exposure, length distribution of low variability periods (LDLVP) or power of spectral density (PSD). The microwave-induced changes in EEG were detected as an increase in the EEG energy and decrease in the low-variability periods. The changes were stronger in temporal and parietal channels and for EEG beta rhythms (15–20 Hz and 22–40 Hz). The rate of individuals with statistically significant changes in EEG varied from 12,5% to 30% for different modulation frequencies and groups. This rate is higher than the rate of multiple chemical sensitivity estimated to be between 2 and 10% in the general population (H.Hinrikus, M.Bachmann, J.Lass, R.Tomson, V.Tuulik, J.Kalda, M.Säkki).

3.3.2. EEG in anesthesia

Our interest has been to compare the behavior of the various entropy/complexity measures at different levels of sedation in the intensive care unit (ICU). Entropy and complexity of the electroencephalogram (EEG) have recently been proposed as measures of depth of anesthesia and sedation. Using surrogate data of predefined spectrum and probability distribution we show that the various algorithms used for the calculation of entropy and complexity actually measure different properties of the signal. The tested methods, Shannon entropy (ShEn), spectral entropy, approximate entropy (ApEn), Lempel-Ziv complexity (LZC), and Higuchi fractal dimension (HFD) are then applied to the EEG signal recorded during sedation in the intensive care unit (ICU).

It is shown that the applied measures behave in a different manner when compared to the clinical depth of sedation score–the Ramsay score. ShEn tends to increase while the other tested measures decrease with deepening sedation. ApEn, LZC, and HFD are highly sensitive to the presence of high-frequency components in the EEG signal (R.Ferenets, A.Anier).

3.3.3. Analysis of the spectrophotometrical signal in hemodialysis

An on-line monitoring system for dialysis dose calculations could make it possible to provide an adequate dialysis dose that is consistently given to haemodialysis (HD) patients. Our study was aimed to compare the dialysis dose (Kt/V) using four different methods and their sensitiveness to a reduction in clearance. Six patients were monitored on-line with ultraviolet (UV)-absorbance at a wavelength of 297 nm in three consecutive dialysis sessions during 1 week. During the last treatment, the clearance was reduced by approximately 25% by decreasing the blood flow. For the determination of UV-absorbance, a spectrophotometer was connected to the fluid outlet of the dialysis machine with all spent dialysate passing through a flow cuvette. The equilibrated Kt/V (eKt/V) estimated by UV-absorbance was compared with eKt/V from the ionic dialysance method using the on-line clearance monitor (OCM) and the appurtenant software dose-calculation tool DCTool (Fresenius Medical Care, Germany), eKt/V calculated from the dialysate-urea slope and with eKt/V from pre- and post-dialysis blood-urea samples as reference. The study demonstrates that the sensitivity to clearance reduction is similar in the four methods compared for eKt/V. When the different methods were compared, the mean eKt/V of UV-absorbance was 1.21 +/- 0.20, blood 1.30 +/- 0.21, dialysate 1.32 +/- 0.21 and OCM (using the DCTool) 1.31 +/- 0.21. The standard deviation was of the same magnitude. As a result we can conclude that the UV-method gives a similar response to clearance reduction compared with the other methods when comparing the dialysis dose. The high sampling rate by continuous monitoring of UV-absorbance allows evaluation of the clearance process during dialysis and gives immediate feedback to on-line adjustments (I.Fridolin, K.Lauri, M.Luman, J.Jerotskaja).

3.4 Research within international programmes

3.4.1 CENS - CMA

Co-operation of Estonian and Norwegian Scientific Centres within Mathematics and its Applications

The following researchers have used this project: :
Dr. Ewald Quak (Oslo) – senior researcher at CENS;
Dr. Peter Van (Budapest) – senior researcher at CENS;
Dr. Heiko Hermann (Berlin) – post-doc at CENS;
Dr. Jaan Kalda (Tallinn) – senior researcher at CMA;
Prof. Tarmo Soomere (Tallinn) – senior researcher at CMA.

The research results are described in other Sections. The 3rd CENS-CMA Annual Seminar was organized in Tallinn, May 10–11, 2006.

3.4.2 FP-6, Wide-range Non-intrusive Devices toward Conservation of Historical Monuments in the Mediterranean Area (WIND-CHIME). Contract: INCO-CT-2004-509805

Workpackage progress:

WP1 Ni-Ti alloys

Objectives: Identification and characterization of a Ni-Ti SMA alloy with optimal properties toward cultural heritage retrofitting

WP2 Alternative Shape Memory Alloys

Objectives: (A.Berezovski). The influence of temperature variation on the propagation of the martensitic phase-transition front was studied on the example of the one-dimensional impact problem for a Ni-Ti bar. The adiabatic approximation was chosen since the heat conduction is insignificant because of the rapid loading. The presented theory complements the isothermal description. In the considered adiabatic formulation, the contact stresses needed for numerical calculations were determined in the same way as in the isothermal case. At the same time, the determination of contact temperatures in the bulk differs from that at the phase boundary.

The non-equilibrium jump relations provided the possibility to establish a kinetic relation taking into account the temperature variation. The corresponding initiation criterion of phase transformation is also more general than that in the isothermal case. Both the kinetic relation and the initiation criterion were derived under assumption of the continuity of contact quantities at the phase boundary. This assumption can be a subject of generalization.

Numerical simulations of the phase-transition front propagation in a Ni-Ti bar show that the entropy production at the moving phase boundary and latent heat release provide two different contributions in the temperature variation. The latter leads to distinct kinetic behaviors of the phase boundary depending on latent heat release.

3.4.3 FP-6, Complexity - NET.

Within the ERA-NET scheme, after the successful SSA on Complexity, the EC agreed on "Complexity-NET", contract N 036195, signed on 28.07.2006, starting date 01.09. 2006, duration - 3.5 years. CENS is represented by the Estonian Academy of Sciences (on the behalf of the Ministry of Education and Research) as a supervisor for complexity subprogrammes of the Programme of Centres of Excellence in Research). 11 countries participate in the Complexity-NET: United Kingdom (coordinator), Belgium, Denmark, Estonia, Greece, Hungary, Ireland, Italy, the Netherlands, Portugal, and Spain. 2 countries - France and Germany – are the observers. Subprogrammes for CENS are: fractality in nature, complexity in nonlinear wave motion, complexity in biophysics; for CDC - complexity in soft-ware intensive systems, software complexity.

The Steering Commitee had its first meeting on 26–27 Oct. 2006 in London, the next meeting is scheduled for 19 Jan. 2007 in the Hague.

3.4.4 Marie-Curie reintegration grant ERG 6, N14826, "Cardiac energetics"

The research results are described in other sections. The group under the supervision of Dr. M.Vendelin involved : Dr. H.Ramay – post-doc fellow;
A.Illaste – MSc student; M.Berezovski – PhD student.
The cooperation with the Universities of Grenoble (Prof. V.Saks) and Manchester (Dr. H.Shiels) as well as the bioenergetics group of the NICPB (Tallinn) has been supported by the grant.

3.4.5 FP-6, EU IST Network of Excellence AIM@SHAPE on shape modelling. Contract IST-506766

Dr. E.Quak, Senior Fellow of the CENS-CMA project, is the Technical Manager of this Network of Excellence.

The summer school on Applications of 3D Shapes: Ontologies, Software Tools and Industrial Case Studies Tallinn, July 19–25, had 48 participants representing institutions from 11 different countries; 12 invited lectures on shape research, industrial applications and dissemination of scientific results to the public; 10 training sessions on ontologies and software tools; 6 PhD student presentations,
see www.aimatshape.net/event/tallinn06-ss. Contact person: Dr. E.Quak.

3.4.6 PARROT

French-Estonian science and technology collaboration program PARROT

"Experimental and Theoretical Study of Sound Generation Mechanisms in Grand Piano — 2005 – 2006"

In the framework of the program PARROT Anatoli Stulov visited twice the Institute de Recherche et Coordination Acoustique Musique, Equipe Acoustique instrumentale and the Ecole Nationale Superieure des Techniques Avancees, Paris (23.05 and 27.11) and presented two talks in seminars: "Piano duplex scale "and "The influence of the bridge impedance on the piano string vibration".

Antoine Chaigne (ENSTA) and Rene Causse (Institute de Recherche et Coordination Acoustique Musique, Equipe Acoustique instrumentale and Ecole Nationale Superieure des Techniques) took part in the experiments and measurements on the experimental piano in the Institute of Cybernetics and delivered talks in seminars.

3.4.7 Marie Curie Research and Training Network SEAMOCS. Contract MRTN-CT-2005 – 019374.

Applied stochastic models for ocean engineering, climate and safe transportation (2005 – 2009; lead by Lund University. The group of water waves (Prof. T.Soomere) is the leader of the work package 3 "Models on local scale").
The partners are: The University of Sheffield (UK), Université Paul Sabatier (Toulouse), Katholieke Universiteit Leuven, Chalmers Technical University (Göteborg), Royal Netherlands Meteorological Institute (De Bilt), Swedish Meteorological and Hydrological Institute (Norrköping), Det Norske Veritas (Norway, Oslo).

4. Funding

4.1 Target funding through the Ministry of Education and Research

1. Long-term block grant "Nonlinear dynamics and stress analysis", supervisor J.Engelbrecht.
2. Long-term block grant "Bioelectrical signal interpretation", supervisor H.Hinrikus.

4.2 Estonian grants (Estonian Science Foundation)

1. A.Berezovski, J.Engelbrecht, M.Berezovski, T.Peets, ETF grant 5765, "Numerical simulation of wave propagation in materials with internal interfaces", (2004–2006).
2. A.Stulov, ETF grant 5566, "Sound generation mechanisms in grand pianos", (2003–2006).
3. P.Peterson, ETF grant 5767, "Extreme waves: analysis of free surface models", (2004–2007).
4. A.Salupere, ETF grant 5565, "Wave dynamics and wave hierarchy in microstructured materials", (2003–2006).
5. J.Kalda, ETF grant 6121, "Scale-invariant geometrical properties of turbulent diffusion", (2005–2008).
6. T.Soomere, ETF grant 5762, "Wind wave climate of the Baltic Sea and its dependence on nonlinear effects", (2004–2007).
7. J.Janno, A.Ravasoo, ETF grant 6018, "Inverse problems for inhomogeneous and microstructured material identification", (2005–2008).
8. H.Hinrikus, ETF grant 6632, "Effect of electromagnetic radiation on brain oscillations", (2006–2009).
9. I.Fridolin, ETF grant 5871, "Novel optical technique for monitoring and evaluation of quality of hemodialysis", (2004–2006).
10. K.Meigas, ETF grant 5888, "Application of coherent photodetection in cardiovascular diagnostics: noninvasive monitoring of blood pressure and arterial elasticity", (2004–2007).
11. J.Lass, ETF grant 6173, "Microwave effects on cognitive functions", (2005–2008).

4.3 International grants (see also 3.4)

1. Dr. A.Berezovski. FP-6 "Wide-range Non-intrusive devices toward Conservation of Historical Monuments in the Mediterranean Area"(WIND-CHIME) – see 3.5.3.
2. Prof. J.Engelbrecht. Co-operation of Estonian and Norwegian Scientific Centres within Mathematics and its Applications "CENS CMA"– see 3.4.1.
3. Dr. M.Vendelin. Marie-Curie reintegration grant ERG 6, N14826, "Cardiac energetics"– see 3.4.4.

4. Prof. T.Soomere. Marie Curie Research and Training Network SEAMOCS – see 3.4.7.

5. Dr. E.Quak. EU IST Network of Excellence AIM@SHAPE – see 3.4.5.

4.4 Additional funding

1. Estonian Programme for Centre of Excellence in Research - block grant.

2. Institute of Cybernetics at TTU – infrastructure.

3. Estonian Programme for Centres of Excellence in Research - infrastructure support (from the EU Structural funds).

5. Publicity of Results

5.1 Research Reports

1.	Mech 283/06	A.Stulov. The influence of the bridge impedance on the piano string vibrations.
2.	Mech 284/06	A.Ravasoo. Ultrasonic wave interaction for nondestructive evaluation of inhomogeneous plane strain.
3.	Mech 285/06	A.Ravasoo. Application of counterpropagating nonlinear waves to inhomogeneous presters characterization.
4.	Mech 286/06	A.Braunbrück, A.Ravasoo. Resonance phenomenon of wave interaction in inhomogeneous solids.
5.	(no number)	A.Kask, T.Liiv, U.Liiv, A.-M.Uustalu, T.Lapimaa. Environmental Impact Assessment of the reconstruction works of Kelnase harbour. Altakon Grupp.
6.	(no number)	A.Kask, T.Liiv, U.Liiv, A.-M.Uustalu, T.Lapimaa. Environmental Impact Assessment of the reconstruction works of Leppneeme harbour. Altakon Grupp.
7.	(no number)	T.Soomere, A.Kask, J.Kask. On the state and coastal processes along the peninsula of Kakumäe. Description of necessary studies. Research report to City of Tallinn.
8.	(no number)	T.Soomere. On the necessities and possibilities of reducing the speed of fast ferries on Tallinn Bay. Research report to the Department of Transport, City of Tallinn.
9.	(no number)	T.Soomere. Comparison of the influence of natural and wind waves on Tallinn Bay. Formulation of principles and scope of necessary studies. Research report to Municipal Engineering Services Department, City of Tallinn.
10.	(no number)	A.Kask, A.Järvik, I.Jüssi, E.Mägi, T.Lapimaa. Environmental Impact Assessment of the underwater sand mining from the Hiiu Bank.

5.1.1 Lecture Notes

1. Seminar on "Statistical Thermodynamics of Nonequilibrium Processes". `http://cens.ioc.ee/cens/Members/pearu/thermodynamics`.

5.2 Publications

Books, proceedings and theses

1. Keeruka maailma ilu. T.Kändler (koost.). Toim. J.Engelbrecht, M.Kutser. TTÜ Küberneetika Instituut, CENS, 2006. — The Beauty of the Complex World. T.Kändler (comp.), J. Engelbrecht, M.Kutser (eds), Institute of Cybernetics at TUT, CENS, 2006 (in Estonian).

2. Teaduse uued suunad: komplekssüsteemid. Toim. J.Engelbrecht, L.Mõtus. Eesti Teaduste Akadeemia seminari materjalid, Tallinn, 2006, ISSN 1406–9148 — New trends in science: complexity. Ed. by J.Engelbrecht, L.Mõtus. Materials of the seminar in the Estonian. Acad. Sci., Tallinn, 2006, ISSN 1406–9148 (in Estonian).

3. Special issue on Systems Biology of Mitochondrian. Guest editors: D.Beard, M.Vendelin. Am. J. Physiol. Cell Physiol. 2006, 291.

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1. J.Janno, J.Engelbrecht. Üksiklained mittelineaarsetes mikrostruktuuriga tahkises ja nendega seotud pöördülesanne. EMS aastaraamat 2005, Eesti Matemaatika Selts, Tallinn, 2006, 12–29, (Solitary waves in nonlinear microstructured solids and inverse problems - in Estonian - Yearbook of the Estonian Math. Soc.).

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17. T.Soomere, A.Behrens, L.Tuomi, J.W.Nielsen. Unusual wave conditions in the northern Baltic Sea during windstorm Gudrun in January 2005. Geophysical Research Abstracts, 8, Paper 02851, 2006 (Proc. European Geosciences Union (EGU) General Assamblee, Vienna, 4–8 April 2006, CD, 3 pp, SRef-ID: 1607-7962/gra/EGU06-A-02851).

18. T.Soomere, E.Quak. On the possibilities of reducing coastal pollution by a proper choice of the fairway. In: International congress on coastal operational oceanography, Brest, 16–17 Oct 2006, Abstracts, Brest, IFREMER, 2006.

19. T.Soomere. Fast ferry traffic as a new forcing factor of environmental processes in semi-enclosed sea areas. In: Nordic Marine Science Conference, Oslo, 1–3 November 2006, Holmen Fjord Hotel: From the Arctic to the Baltic, Mid-ocean to microbiota, Nordic Marine Academy, SHF, NHF, 2006, 31.

20. A.Valdmann, A.Kask, J.Kask, K.Rannat. Sustainable planning of underwater sand mining and beach protection in vulnerable semi-enclosed sea areas under heavy anthropogenic pressure. Geophysical Research Abstracts, 05578, 2006, 8, (CD, 4 pp., SRef-ID: 1607-7962/gra/EGU06-A-05578).

21. A.Stulov. A mathematical models of sound generation mechanisms in grand piano. In: XXXIV Summer School - Conference "Advanced Problems in Mechanics", June 25 – July 1, 2006, Book of Abstracts, http://www.apm.ruweb.net, St. Petersburg (Repino), Russia, p. 77.

22. A.Stulov. Piano string-bridge interaction and role of duplex scale. In: Acoustics 2006, Programme Book, 33rd International Acoustical Conference – EAA Symposium, High Tatras, Slovakia, October 2006, p. 32.

23. A.Braunbrück, A.Ravasoo. Resonance phenomenon of wave interaction in inhomogeneous solids. Book of Abstracts. EUROMECH Colloquium 478, Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids, June 13–16, 2006, Tallinn, Estonia. Book of Abstracts, 12.

24. A.Ravasoo. Application of counterpropagating nonlinear waves to inhomogeneous prestress characterization. Programme, Book of Abstracts. Thirteenth International Congress on Sound and Vibration (ICSV13), July 2–6, 2006, Vienna, Austria, 122.

25. A.Braunbrück, A.Ravasoo. Resonance of counterpropagating waves in weakly inhomogeneous material. CD-ROM Proc. of the 6th European Solid Mechanics Conference ESMC2006. 28 August – 1 September 2006, Budapest, Hungary, 2 p.

26. R.Kitt, J.Kalda. Probability of large movements in financial markets. Abstracts of APFA5. 29 June – 01 July, 2006, Torino, Italy.

27. H.Hinrikus, M.Bachmann, M.Säkki, J.Lass, J.Kalda. R.Tomson, V.Tuulik. Individual sensitivity to low-level radio-frequency exposure. International Conference on Environmental Epidemiology and Exposure, Sept. 2–6, Paris, p. 421.

28. H.Hinrikus. Studies relevant to neuronal oscillations and cognition in Estonia, COST B27 Meeting May 12–13, Skopje, Macedonia.

29. H.Hinrikus, M.Bachmann, J.Kalda, M.Sakki, J.Lass, R.Tomson. Methods for detection of hidden changes in EEG. Proceedings of Worksop, COST B27 and Society of Applied Neuroscience, September 14–19 2006, Swansea, p.38.

30. M.Rahula. Floors of manifolds and jets of mappings. Abstracts of International Conference on Geometry in Odessa–2006, 23–28 May, Odessa, Ukraine.

31. V.Retšnoi. Geometry of group space GL(n,R). Abstracts of International Conference on Geometry in Odessa–2006, 23–28 May, Odessa, Ukraine.

Popular Science / Science policy

1. J.Engelbrecht. Quo vadis, teadus Eestis? Eesti Aastaraamat 2006–2007. Euroinformer, Tallinn, 2006, 165–173, (in Estonian).

2. J.Engelbrecht. Teaduse tippkeskused Eestis (Estonian centres of excellence in research). Eesti Teadusliku Seltsi Rootsis Aastaraamat/ Annales Societatis Litterarum Estonicae in Svecia, XIII, 2006, Stockholm, 165–171, (in Estonian, abstracts in English and Swedish).

3. J.Engelbrecht. Teadmistepõhise ühiskonna võimalustest - Chancen einer wissenbasierten Gesellschaft. In: Academica I-X (1997–2006), Eesti Keele Sihtasutus, Tartu, 157–165, (in German); 371–377, (in Estonian).

4. J.Engelbrecht, sõnavõtt Akadeemia Presidendi ametiketi üleandmisel. Eesti TA aastaraamat XI(38), 2005. TA, 2006, 54–55, (in Estonian).

5. J.Engelbrecht, lühiessee rubriigis Arvamused akadeemikutelt. Ibid, 179–181, (in Estonian).

6. J.Engelbrecht. Keerukus, terviklus ja füüsika. N.Alumäe medali loengu lühikokkuvõte. Complexity and Physics. Ibid, 219–221, (in Estonian).

7. J.Engelbrecht, G.A.Maugin. Euromech Colloquium 478 "Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids". Euromech Newsletter 30, 2006, 48–49.

8. J.Engelbrecht, T.Soomere. Furious sea III: Monster waves. Horisont, 2006, 1, 28–33 (the leading popular science journal in Estonia, bi-monthly), (in Estonian).

9. T.Soomere. The University of Technology invests into teaching of coastal engineering. Äripäev, 3 April 2006, p. 23 (daily business newspaper), (in Estonian).

10. T.Soomere. The need in experts in coastal processes in Estonia. Äripäev / Tööstus, 3 May 2006, p. 59 (special issue of the daily business newspaper), (in Estonian).

11. T.Soomere. Right fairway may reduce coastal pollution. The Scandinavian Shipping Gazette, June 2006, 14–16 (international industrial journal).

12. T.Lapimaa. A dream of an Estonian: villa at the sea coast. Linnaleht, 7 June 2006, p. 20 (daily newspaper of City of Tallinn, in Estonian).

13. T.Lapimaa, A.Kask. Oceanography, contribution to DVD "Pähklipurejad"(The Nutcrackers, Short stories of young and successful Estonian scientists). DVD2, Archimedes Foundation, Haridus- ja Teadusministeerium, ISBN 9985-9613-9-0, (in Estonian).

14. T.Soomere. Ship on our sea: blessing or curse. Eesti Loodus, 2006, 6, 286–291 (the leading popular journal on nature, monthly, in Estonian).

15. T.Soomere. Wind is not able to compete with fast ferries. Eesti Loodus, 2006, 7, 348–353, (in Estonian).

16. T.Soomere. Teaching of port and coastal engineering. TUT, 2005, TUT, 2006, 32–37, (in Estonian).

17. T.Soomere. Wakes from fast ferries encroach the coastal slope. Eesti Loodus 2006, 12, 634–639, (in Estonian).

18. T.Soomere. Coastal protection starts from the correct choice of the fairway. Meremees, 2006, 4, 18–19, (in Estonian).

19. J.Kalda, R.Mankin, R.Tammelo. On the possibility of life in the non-linear and non-equilibrium intermittent world. I.Koppel, P.Saari. Scientific Thinking in Estonia: Exact Sciences, Tallinn, 2006, 53–62, (in Estonian).

20. M.Kree. A manly contest: Physics olympiad. Horisont, 2006, 3, (in Estonian).

21. J.Kalda. Enduring mind-sharpening: 4th Academic Physics Olympiad for the physics students of the University of Tartu. Horisont, 2006, 3, 45–45, (in Estonian).

22. J.Kalda. Vying against the neighbours: Estonian–Finnish Olympiad. Horisont, 2006, 4, 47–47, (in Estonian).

23. J.Kalda. Estonia will host 100 Olympic teams: International Physics Olympiad. Horisont, 2006, 6, 44–45, (in Estonian).

Submitted papers

1. A.Salupere, K.Tamm, J.Engelbrecht. Numerical simulation of interaction of solitary deformation waves in microstructured solids. Int. J. Non-Linear Mech., (submitted).

2. J.Engelbrecht, A.Salupere, A.Berezovski. Nonlinear deformation waves in solids and dispersion. Wave Motion, (accepted).

3. A.Salupere, K.Tamm, J.Engelbrecht. Interaction of deformation waves in microstructured solids. Proc. Estonian Acad. Sci. Phys. Math., (submitted).

4. L.Ilison, A.Salupere, P.Peterson. On the propagation of localized perturbations in continua with microstructure. Proc. Estonian Acad. Sci. Phys. Math., (submitted).

5. A.Berezovski, J.Engelbrecht, G.A.Maugin. Front dynamics in inhomogeneous solids. Proc. Estonian Acad. Sci. Phys. Math., (submitted).

6. V.Saks, M.Vendelin, M.K.Aliev, T.Kekelidze, J.Engelbrecht. Mechanisms and modeling of energy transfer between and among intracellular compartments. In: Handbook of Neurochemistry & Molecular Neurobiology: Neural Energy Utilization. Kluwer, NY, (in press).

7. J.Engelbrecht, J.Janno. Microstructured solids and inverse problems. Rendicorti Sem. Mat. Univ. Pol. Torino, (accepted).

8. P.Van, A.Berezovski, J.Engelbrecht. Internal variables and dynamic degrees of freedom. Arxiv.org - 0612491, (submitted).

9. A.Berezovski, G.A.Maugin. On the propagation velocity of a straight brittle crack. Int. J. Fracture, (accepted).

10. A.Berezovski, G.A.Maugin. Impact-induced phase transition front propagation in a bar. Proc. of 4WCSCM, (accepted).

11. G.A.Maugin, A.Berezovski. Introduction to the thermomechanics of configurational forces. Thermocon'05 Proc., (submitted).

12. A.Berezovski, J.Engelbrecht, G.A.Maugin. Front dynamics in inhomogeneous solids. EUROMECH 478 Proc., (submitted).

13. G.A.Maugin, A.Berezovski. On the exploitation of Eshelby's stress in isothermal and adiabatic conditions. EUROMECH 478 Proc., (submitted).

14. W.Muschik, A.Berezovski. Non-equilibrium contact quantities and compound deficiency at interfaces between discrete systems. EUROMECH 478 Proc., (submitted).

15. N.Zahibo, I.Didenkulova, A.Kurkin, E.Pelinovsky. Steepness and spectrum of nonlinear deformed shallow water wave. Ocean Engineering, (submitted).

16. I.Didenkulova, E.Pelinovsky, T.Soomere, N.Zahibo. Runup of nonlinear asymmetric waves on a plane beach. Chapter in: Tsunami & Nonlinear Waves (Ed: Anjan Kundu), Springer, (accepted).

17. I.Didenkulova, A.Kurkin, E.Pelinovsky. Runup of solitary waves of different shapes on a beach. Izvestiya, Atmospheric and Oceanic Physics, (submitted).

18. I.Didenkulova, E.Pelinovsky, A.Kurkin. Nonlinear shallow wave characteristics: shape, spectrum and steepness. Izvestiya, Russian Academy of Engineering Science, (in Russian, in press).

19. I.Didenkulova, E.Pelinovsky. Comparison of two global tsunami data in the Indian Ocean. Izvestiya, Russian Academy of Engineering Science, (in Russian, in press).

20. I.Didenkulova. Runup of an asymmetric sea wave on a beach. Proceedings of the Fifth scientific workshop "Young people in science", Sarov, Proc. of the Conference, Sarov, Russia, in November 1–3, 2006, (in Russian, in press).

21. J.Laanearu, T.Koppel, T.Soomere, P.A.Davies. Joint influence of river stream, water level and wind waves on the height of sand bar in a river mouth. Nordic Hydrology, (submitted).

22. T.Soomere, A.Behrens, L.Tuomi, J.W.Nielsen. Wave conditions in the Baltic Proper and in the Gulf of Finland during windstorm Erwin/Gudrun. Boreal Environment Research, (submitted).

23. T.Soomere. Nonlinear components of ship wake waves. Applied Mechanics Reviews, (accepted).

24. T.Soomere. Fast ferries as wavemakers in a natural laboratory of rogue waves. Rendiconti del Seminario Matematico Università Politecnico di Torino, (submitted).

25. T.Soomere, I.Zaitseva. Estimates of wave climate in the northern Baltic Proper derived from visual wave observations at Vilsandi. Proc. of Estonian Academy of Sciences, Engineering, (submitted).

26. S.Keevallik, T.Soomere, R.Pärg, V.Žukova. Outlook for Wind Measurement at Automatic Weather Stations. Proc. of Estonian Academy of Sciences, Engineering, (submitted).

27. J.Janno, A.Lorenzi. Recovering memory kernels in parabolic transmission problems. Zeitschrift für Analysis und ihre Anwendungen, (submitted).

28. J.Janno, L.v.Wolfersdorf. Integro-differential equations of first order with autoconvolution integral. Journal of Integral Equations and Applications, (submitted).

29. A.Ravasoo. Ultrasonic wave interaction for nondestructive evaluation of inhomogeneous plane strain. Acta Mechanica, (submitted).

30. A.Braunbrück and A.Ravasoo. Resonance phenomenon of wave interaction in inhomogeneous solids. Proc. Estonian Acad. Sci. Phys. Math., (submitted).

31. J.Kalda. Sticky particles in compressible flows: aggregation and Richardson's law. Phys. Rev. Lett., (accepted).

32. J.Kalda. Turbulent diffusion in smooth flows: beyond multifractality. Fractals, (submitted).

33. J.Kalda. Non-universal behaviour of passive scalars in real compressible flows. Phys. Rev. E., (submitted).

34. H.Aben, A.Errapart. A non-linear algorithm of photoelastic tomography for the axisymmetric problem. Exp. Mech. (USA), (submitted).

35. L.Ainola, H.Aben. Approximate solution of the inverse problem of axisymmetric thermoelasticity for residual stress measurement in glass. ZAMM, (submitted).

36. H.Hinrikus, M.Bachmann, J.Lass, R.Tomson and V.Tuulik. Effect of 7 Hz, 14 Hz and 21 Hz modulated 450 MHz microwave radiation on human electroencephalographic rhythms. International Journal of Radiation Biology, (submitted).

37. H.Hinrikus, M.Bachmann, J.Kalda, M.Säkki, J.Lass, R.Tomson. Methods of electroencephalographic signal analysis for detection of small hidden changes. Nonlinear Biomedical Physics, (submitted).

38. T.S.Bíró, J.Zimányi, P.Lévai, P.Ván. Equation of state for distributed mass quark matter. Journal of Nuclear Physics G., (submitted).

39. T.S.Bíró, P.Lévai, P.Ván, and J.Zimányi. The mass distribution of quark matter. Physical Review Letters, (submitted).

5.3 Conferences

1. International Workshop on Complex Structures, Generalized Continua and Nonlinear Waves, 4–5 April, Nancy.
   J.Engelbrecht. Internal variables in biomechanics.
   J.Engelbrecht. Origin of dispersion in microstructured solids and corresponding mathematical models.
   T.Soomere. Applications of shallow-water soliton interactions in extreme wave theory.
   T.Soomere. Modelling of unusual wave and water level conditions in the Baltic Sea.

2. International Symposium on Mechanical Waves in Solids, 14–20 May, Hangzhou, China.
   J.Engelbrecht. Nonlinear Deformation Waves in Solids.

3. US National Congress of Theoretical and Applied Mechanics, 26–30 June, Boulder, Colorado
   J.Engelbrecht. Mechanics of biological tissues and internal variables.

4. 6th European Solid Mechanics Conference, chairman of a Minisymposium,
   26 Aug. – 1 Sept., Budapest.
   A.Salupere, K.Tamm, and J.Engelbrecht. Propagation of solitary pulses in microstructured solids.

5. XI IWNEM: 11th International Workshop on Nonlinear Elasticity in Materials, June 4–10, Sorrento, Italy.
   A.Salupere, J.Engelbrecht. Solitary deformation waves in microstructured solids.

6. 77th GAMM Annual Meeting March 27–31, 2006, Berlin, Germany.
   A.Berezovski, G.A.Maugin. Velocity of moving phase-transition front in solids.

7. EUROMECH Colloquium 478 Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids June 13–16, Tallinn, Estonia.
   A.Berezovski, J.Engelbrecht, G.A.Maugin. Waves and fronts motion in inhomogeneous solids.
   G.A.Maugin, A.Berezovski. On the exploitation of Eshelby's stress isothermal and adiabatic conditions.
   W.Muschik, A.Berezovski. Non-equilibrium contact quantities and compound deficiency at interfaces between discrete systems.
   A.Braunbrück and A.Ravasoo. Resonance phenomenon of wave interaction in inhomogeneous solids.
   L.Ilison, A.Salupere. On the propagation of localized perturbances in continua with microstructure.
   A.Salupere, K.Tamm, J.Engelbrecht. Interaction of deformation waves in microstructured solids.

8. 4th World Conference on Structural Control and Monitoring, July 11–13, San Diego, USA.
   A.Berezovski, G.A.Maugin. Impact-induced phase transition front propagation in a bar.

9. International Conference on Full-field Measurement Techniques and their Applications in Experimental Solid Mechanics. Clermont-Ferrand, 10–12 July, 2006, France.
   H.Aben, A.Errapart, J.Sanko, J.Anton. A non-linear algorithm of photoelastic tomography for the axisymmetric problem.

10. Scientific Workshop of the SEAMOCS network, 16–17 Febr., Toulouse, France.
    T.Soomere. Extreme slopes in interactions of long shallow water waves.
    K.Rannat. Wave profile measurements in Tallinn Bay.
    A.Braunbrück. Nonlinearity and inhomogeneity versus wave interaction in solids.

11. Scientific Workshop of the Eco-Net network "Wave Current Interaction in Coastal Environment", 24–27 March, Brest.
    T.Soomere. Wakes from fast ferries in non-tidal areas + Extreme wave conditions in the Baltic Sea and their modelling + Soliton interactions as a model of long-living freak waves in shallow areas.

12. European Geosciences Union (EGU) General Assamblee, Vienna, 4–8 April.
    T.Soomere, A.Behrens, L.Tuomi and J.W. Nielsen. Unusual wave conditions n the northern Baltic Sea during windstorm Gudrun in January 2005;
    I.Didenkulova, A.Kurkin, E.Pelinovsky, T.Soomere, N.Zahibo. Runup of nonlinear deformed waves on a beach.
    A.Valdmann, A.Kask, J.Kask, K.Rannat. Sustainable planning of underwater sand mining and beach protection in vulnerable semi-enclosed sea areas under heavy anthropogenic pressure.

13. US/Baltic International Symposium, 23–25 May, Klaipeda, Lithuania.
    T.Soomere. Wave Models for the Baltic Sea – a Multi-Model Validation Study. Presented by V.Huess. Danish Meteorological Institute, other co-authors L.Tuomi. Finnish Marine Research Institute, J.Woge Nielsen, Danish Meteorological Institute.

14. 5th International Conference on Optimal Research "Simulation and Optimization in Business and Industry", 17–20 May, Tallinn.
    T.Soomere. Unusual wave and water level conditions in the Baltic Sea during windstorm Gudrun in January 2005 and their modelling.

15. International marine conference "Is Estonia a marine country?"Tallinn/Helsingi, 24 May.
    T.Soomere. Estonia in the power of sea and waves.

16. Summer School of young physicists, Arbavere, Estonia, 16–18 June.
    T.Soomere. Waves in the Baltic Sea.

17. International Summer School "Applications of 3D Shapes: Ontologies, Software Tools and Industrial Case Studies", 19–25 July, Tallinn.
    T.Soomere. The needs for geometric modelling in the research of water wave.

18. International Summer School on Air-sea Interaction, 28 Aug. – 1 Sept., Helsinki, Finland.
    I.Didenkulova. Runup of asymmetric waves on a sloping beach.
    T.Soomere: Heterogeneity and uniformity.
    Shallow coastal waters.
    Climatology of extremes.

19. Ninth Marine Geological Conference 27 Aug. – 3 Sept., Jurmala, Latvia.
    T.Soomere. Optical detection of sediment resuspension by wakes from fast ferries. Presented by Ants Erm. Another scheduled presentation "Modelling of sand transport at Pirita beach and formulation of principles of beach nourishment"by T.Soomere, A.Kask and J.Kask was cancelled because of overlapping of several events.

20. Workshop of the EcoNet network meeting, 28–31 Aug., St. Petersburg.
    T.Soomere. Trends and extremes of wave conditions in the northern Baltic Sea.

21. International Conference Coastal Environment, Processes and Evolution: Eurocoast - Littoral 2006, 18–20 Sept., Gdansk.
    A.Erm, A.Kask, T.Soomere. Optical model for monitoring resuspension of the bottom sediments.

22. Humboldt-Colloquium, 22–24 Sept., Helsinki.
    T.Soomere. Unusual wave and water level conditions in the Baltic Sea in Jan. 2005.
    T.Soomere. Lessons from the forecast of an exceptional storm in the Baltic Sea in January 2005.
    E.Quak. The Digital Shape Workbench.
    E.Quak. Panelist in the discussion "Innovation Systems in Global Competition – European Models and Reflections".

23. International Congress on coastal operational oceanography, 16–17 Oct., Brest.
T.Soomere, E.Quak. On the possibilities of reducing coastal pollution by a proper choice of the fairway.
Participated in the discussion of the international conference "Search and rescue on sea"18–19 Oct., both in the framework of International SeaTechWeek, 16–19 Oct., Brest, le Quartz.

24. Nordic Marine Science Conference, From the Arctic to the Baltic, Mid-ocean to microbiota, 1–3 Nov., Oslo, Holmen.
T.Soomere. Fast ferry traffic as a new forcing factor of environmental processes in semi-enclosed sea areas.

25. Scientific seminar of the trilateral Estonian-Finnish-Russian co-operation on the protection of environment of the Gulf of Finland "Support to the Management of Gulf of Finland Ecosystem - Key Topics of Scientific Research", 22–23 Nov., Tallinn.
T.Soomere. The impact of fast ferry traffic to the underwater light field and resuspension of bottom sediments (presented by A.Erm, in cooperation with A.Kask, MSI).

26. 5th Junior European Meeting on Control and Information Technology (JEM'05), 20–22 Sept., Tallinn.
T.Soomere. Ship waves as a simple model of tsunamis and monster waves.

27. Annual meeting and scientific workshop SEAMOCS, 26–28 October, Leuven (Belgium).
T.Soomere. Trends and extremes of wave conditions in the northern Baltic Sea.

28. Laser Diagnostics Institute annual seminar, 1–3 December, Pärnu.
T.Soomere. Some possibilities of reducing coastal pollution by a proper choice of the fairway.

29. XXXIV Summer School – Conference "Advanced Problems in Mechanics", June 25 – July 1, St. Petersburg (Repino), Russia.
A.Stulov. A mathematical model of sound generation mechanisms in grand piano.

30. Acoustics 2006 – 33rd International Acoustical Conference - EAA Symposium, 4–6 Oct., High Tatras, Slovakia.
A.Stulov. Piano string-bridge interaction and role of duplex scale.

31. Thirteenth International Congress on Sound and Vibration (ICSV13), July 2–6, Vienna, Austria.
A.Ravasoo. Application of counterpropagating nonlinear waves to inhomogeneous prestress characterization.

32. 6th European Solid Mechanics Conference ESMC 2006, 28 Aug. – 1 Sept., Budapest, Hungary.
A.Braunbrück and A.Ravasoo. Resonance of counterpropagating waves in weakly inhomogeneous material.

33. Estonian Days of Physics, 21–22 March, Tartu.
J.Kalda, R.Kitt. How much physics is in econophysics?

34. Applications of Physics in Financial Analysis 5(APFA5), 29 June – 1 July, Torino, Italy.
R.Kitt, J.Kalda. Probability of Large Movements in Financial Markets.

35. Conference "20 Years of Nonlinear Dynamics in Geosciences", 11–16 June, Rhodos, Greece.
J.Kalda. Sticky and non-sticky passive particles in compressible turbulent flows.

36. Annual Meeting of Biophysical Society, 18–22 Febr., Salt Lake City, USA.
M.Vendelin. Modulation of energy transfer between mitochondria and myofibrils by changes of the cardiac load.

37. BioThermoKinetics, 14–17 Sept., Trakai, Lithuania.
M.Vendelin. BioThermoKinetics: Frank-Starling law and regulation of oxidative phosphorylation in cardiac muscle.
H.Ramay. A computational model for the role of calcium release site arrangement on calcium dynamics in rat cardiac myocytes.

38. European Muscle Conference, 9–12 Sept., Heidelberg, Germany.
M.Vendelin. Three-dimensional mitochondrial arrangement in ventricular myocytes: from chaos to order.
H.Ramay. A computational model for the role of calcium release site microstructure on calcium spark sprend of rat ventricular myocytes.

39. Gordon Research Conference on Cardiac Regulatory Mechanisms, 16–21 July, New London, NH, USA.
M.Vendelin. Three-dimensional mitochondrial arrangement in ventricular myocytes: from chaos to order.

40. First Cost B27 Action Seminar, 12–13 May, Skopje, Macedonia.
H.Hinrikus. Studies relevant to neuronal oscillations and cognition in Estonia.

41. 28th IEEE EMBS Annual International Conference, New York City, USA, Aug. 30 – Sept. 3.
J.Lass, K.Lauri. Optical dialysis adequacy sensor: contribution of chromophores to the ultra violet absorbance in the spent dialysate.

42. ISEE/ISEA International Conference on Environmental Epidemiology and Exposure, 2–6 Sept., Paris.
H.Hinrikus. Individual Sensitivity to Low-level Radio-frequency Exposure.

43. COST B27 Seminar and SAN Meeting, 14–19 Sept., Swansea.
H.Hinrikus, M.Bachmann. J.Kalda, M.Säkki. Methods for detection of hidden changes in EEG.

44. 4th International Workshop Biological Effects of EMFs, Crete, Greece, 16–20 Oct.
H.Hinrikus, R.Tomson. Individual changes in human EEG caused by modulated 450 MHz microwave.

45. International Conference "Geometry in Odessa–2006", 23–28 May, Odessa, Ukraine.
M.Rahula. Floors of Manifolds and Jets of Mappings.
V.Retchnoi. Geometry of Group Space GL(n,R).

46. 26th International Colloquium on Group Theoretical Methods in Physics, the Graduate Center of the City University of New York, June 26–30, 2006.
V.Abramov. ZN-generalization of superconnection.

47. Algebra, Geometry, and Mathematical Physics, Baltic-Nordic Workshop, 12–14 Oct., 2006, Lund, Sweden.
V.Abramov. Q-generalization of connection and superconnection.

48. Nuclear Physics Meeting'06, Jávorkút, 5–7 May 2006, Hungary.
T.S.Bíró, P.Lévai, P.Ván, J.Zimányi. Mesoscopic thermodynamics: distribution variables.

49. Eurock'06, Multiphysics Coupling and Long Term Behaviour in Rock Mechanics, 9–12 May 2006, Liege, Belgium.
P.Ván and B.Vásárhelyi. Analyzing the influence of the moisture content for the strength of the rock.
P.Ván and Z.Szarka. Rock rheology — time dependence of dilation and stress around a tunnel.

50. EU IST EVENT 2006, "Strategies for Leadership", Europe–Canada Networking Session, 21–23 Nov., Helsinki, Finland.
E.Quak. The Digital Shape Workbench.

5.4 Meetings organized by CENS

1. EUROMECH Colloquium 478 "Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids", June 13–16, Tallinn.

2. Summer School on Applications of 3D Shapes: Ontologies, Software Tools and Industrial Case Studies, July 19–25, Tallinn.

3. The 6th Glass Stress Summer School, June 1–2, Tallinn.

4. Seminar on Complexity, Estonian Acad. Sci., 1 Nov., Tallinn.

5. French–Estonian–Russian ECO–NET Seminar: Wave Current Interaction in Coastal Environment, 7–8 Dec., Tallinn.

6. Mini–symposium "Wave Propagation in Solids"at 6 ESMC, Aug. 28 – Sept. 1, Budapest.

7. 3rd CENS–CMA Seminar, May 10–11, Tallinn.

8. Workshop "Industry Challenges in Geometric Modeling and Simulation", March 9–10, Darmstadt, Germany.

9. Mini–symposium "Industrial Applications of Geometric Modelling and CAD" European Conference on Mathematics for Industry, July 10–14, Madrid, Spain.

5.4.1 Tallinn Seminars on Mechanics (CENS)

1. 16.01. Dr. Robert Kitt: "Risks of financial markets". (CENS).
2. 23.01. Prof. Jüri Engelbrecht, Prof. Enn Tõugu, Prof. Leo Mõtus: "Complex systems (ERA-NET Complexity)".
3. 06.02. Dr. Marko Vendelin: "Cardiac cell energetics".
4. 08.02. Prof. Peter A. Davies (Dundee University): "Internal solitary waves".
5. 20.02. Taivo Lints: "Science of complexity – what, why, how?"
6. 27.02. Dr. Ewald Quak: "An introduction to industrial curve design".
7. 13.03. Dr. Ewald Quak: "An introduction to industrial surface design".
8. 17.04. Prof. Terry Healy (New-Zealand, Waikato University): "Review of littoral drift sediment dynamics for the bay of plenty littoral system".
9. 24.04. Dr. Tarmo Uustalu: "Complexity of computation and description".
10. 05.05. Dr. Pekka Huntala (Satakunta University of Applied Sciences, Finland): "Acoustic wave propagation in bone"(never again!).
11. 11.05 CENS–CMA Annual Seminar:
    Prof. Geir Kleivstul Pedersen (University of Oslo): "Models and theory for water waves with emphasis on application to tsunamis".
    Prof. Tarmo Soomere (Centre for Nonlinear Studies, Tallinn) "On theory and practice of ship waves".
    Dr. Ewald Quak (Centre of Mathematics for Applications, Oslo & Centre for Nonlinear Studies, Tallinn): "Some things that went wrong due to bad numerical computing".
12. 22.05. Ruth Tomson: "Influence of modulated microwave to the EEG". Prof. H.Hinrikus "Skopje COST B27 meeting".
13. 29.05. Dr. Peter Van (Department of Theoretical Physics, KFKI Research Institute for Particle and Nuclear Physics, Budapest):
    Part I. "What is thermodynamics and what is it for?".
    16.06. Dr. Peter Van. Part II. "What is thermodynamics and what is it for?".
14. 09.08. Dr. Tiina Roose (Oxford University): "Tissue mechanics of tumor growth and frog development".
15. 14.09. Dr. Igor Didenkulov (RAS, Institute of Applied Physics): "The use of nonlinear acoustic methods for diagnostics".
16. 18.09. Dr. Arkadi Berezovski: "Waves in microstructured solids".
17. 19.09. Dr. John Mc'Loone (Wolfram Research): "A New Era of Mathematica: A preview of new technologies".
18. 25.09. Dr. Irina Didenkulova (RAS, Institute of Applied Physics): "Runup of asymmetric waves on a beach".

19. 09.10. Prof. Gerhard Holzapfel (KTH, Stockholm): “Structural quantification of collagen and related continuum modeling”.

20. 16.10 Prof. Helge Andersson (Division of Applied Mechanics, Norwegian Universty of Science & Technology, Trondheim): “Computational turbulence”.

21. 23.10. Dr. Arkadi Berezovski: “Internal variables and scale separation in microstructured solids”.

22. 30.10. Prof. Hiie Hinrikus: “The influence of modulated microwaves on depression”.

23. 13.11. Dr. Heiko Herrmann (Postdoc Research Fellow CENS-CMA): Modern constitutive theory: “Introduction and application to heat conduction”.

24. 20.11. Prof. Hans Petter Langtangen (Simula Research Laboratory, Lysaker, Norway): “Simulation of Tsunamis Generated by Earth–Asteroid Collisions”.

25. 22.11. Prof. Bogumil B.J. Linde (The Head of the Institute, University of Gdansk, Institute of Experimental Physics): “Acoustical investigations at the Institute of Experimental Physics”.

26. 27.11. Dr. Arkadi Berezovski: “Macroscopic dynamics of straight brittle crack”.

27. 07.12. Dr. Marc LeBoulluec (IFREMER, Brest, Prantsusmaa): “Some observations on non-linear effects in hydrodynamics”.

28. 11.12. Prof. Serge dos Santos (LUSSI, Université Franeois–Rabelais de Tours): “Symmetry Analysis and its Applications for Imaging the Elastic Nonlinear Behavior of Complex Materials”.
    Dr. Rene Causse (Institut de Recherche et Coordination Acoustique Musique (Ircam–CNRS), Paris): “Three–dimensional elastic coupling between strings, bridge and soundboard in modern piano’s treble register”.
    Prof. Antoine Chaigne (Mecanique Ecole Nationale Superieure des Techniques Avancees (ENSTA), Unite d’Enseignement et de Recherche en Mecanique (UME), Palaiseau): “Boundary conditions in piano strings”.

5.5 Seminars outside the home Institute

1. K.Rannat. On the measurements of wave profiles in Tallinn Bay. Estonia, Institute of Environmental Physics, University of Tartu, 26 April 2006.

2. K.Rannat. Long nonlinear waves in layered medium. Estonia, Institute of Environmental Physics, University of Tartu, 10 May 2006.

3. I.Didenkulova. Runup of nonlinear asymmetric waves on a plane beach. University of Oslo, Department of Mathematics, Mechanics Division, 22 Aug., 2006.

4. I.Didenkulova. Runup of nonlinear deformed waves on a beach. Det Norske Veritas, DNV Research, 25 Aug., 2006.

5. A.Stulov. Piano duplex scale. Institut de Recherche et Coordination Acoustique Musique, Equipe Acoustique instrumentale, Paris, France, 23 May, 2006.

6. A.Stulov. Piano string-bridge interaction and role of duplex scale. Music Faculty of the Academy of Performing Arts, Prague, Czech Republic, 02 Oct., 2006.

7. A.Stulov. The influence of the bridge impedance on the piano string vibrations. Institut de Recherche et Coordination Acoustique Musique, Equipe Acoustique instrumentale, Paris, France, 27 Nov., 2006.

8. A.Braunbrück. Nonlinearity and inhomogeneity versus wave interaction in solids. Scientific kickoff meeting of the project SEAMOCS in Toulouse, Universite Paul Sabatier, France, 16–17 Febr., 2006.

9. J.Kalda. Geometrical complexity of passive scalar turbulence. University of Oslo, 7 March.

10. J.Janno. Determination of properties of microstructured materials by means of Gaussian wave packets and solitary waves. University of Milan, 22 Sept., 2006.

11. P.Peterson. The future of F2PY in NumPy universe. Simula Reseach Lab, Oslo, Norway, 2006.

12. K.Veski. The effect of changes in parameters for forming the action potential. Patras University, Greece, Sept., 2006.

5.6. Science and Society

1. T.Soomere, a two-hour 'live on air' interview in Radio Kuku 29.01.2006.

2. T.Soomere, popular science lecture "Unique wave conditions in the Baltic Sea during the January 2005 storm"at the Estonian National Library, Tallinn 20.03.2006.

3. T.Soomere, Interview to Linnaleht (daily newspaper of City of Tallinn) about teaching of coastal engineering in the Tallinn University of Technology; printed under the title "Art and science meeting at the coasts"27.03.2006.

4. T.Soomere, Interview to Radio Kuku Marine Hour about potential dangers of fast ferry traffic and possibilities of their reduction (broadcast 27.04.2006).

5. T.Soomere, Interview to Eesti Päevaleht (the other leading daily newspaper in Estonia) about dangers of fast ferry traffic, printed 05.05.2006.

6. T.Soomere, Comments in the state TV channel Eesti Televisioon to the documentary "The day the Big Easy drowned"(about consequences of the hurricane Katrina in New Orleans), broadcast 08.05.2006.

7. T.Soomere, Interview to Postimees (the leading daily newspaper) about possibilities of reducing the risks of coastal pollution by means of reasonable choice of the fairway (a cover story on 25.05.2006).

8. T.Soomere, Interview to Radio Kuku Marine Hour about possibilities of reducing the risks of coastal pollution by means of reasonable choice of the fairway, broadcasted 27.05.2006.

9. T.Soomere, Interview to Postimees in the case of unusually strong upwelling events along the northern coast of Estonia, printed 10.08.2006.

10. Overview of the main outcomes of the research by the IoC team into necessities and possibilities of reducing the speed of fast ferries on Tallinn Bay, by S.Kalberg in Eesti Päevaleht, printed 23.10.2006.

5.7 Supportive grants (travel, etc.)

1. A.Stulov, French-Estonian science and technology collaboration program PARROT "Experimental and theoretical study of sound generation mechanisms in grand piano"grant for research visit the Institut de Recherche et Coordination Acoustique Musique, Equipe Acoustique instrumentale and Ecole Nationale Superieure des Techniques Avancees, Paris, May 22–27, and Nov. 27 – Dec. 3, 2006.

2. R.Ferenets, Estonian Ministry of Education and Research; Kristjan Jaak grant for doctoral study and research at Tampere University of Technology, Jan. – April.

3. A.Rodina, State Scholarships Foundation, Greece, grant for PhD study at University of Patras.

4. K.Veski, Erasmus Programme for the MSc Course in the University of Patras.

5. A.Salupere and J.Engelbrecht, Exchange scheme of Hungarian and Estonian Acad. Sci. – grants to attend the GESMC in Budapest, Aug. 26 – Sept. 01, 2006.

6. J.Engelbrecht, grant from the LOC to attend the International Symposium on Mechanical Waves in Solids. Hangzhow, China, May 14–20, 2006.

7. J.Engelbrecht, grant from the Dept. of Mathematics of the University of Turin, for a short stay in, April 18–23, 2006.

8. Prof. M.Rahula. Grant within the Exchange Scheme between French and Estonian Academies of Sciences, Oct. 22 – Nov. 05, 2006, University of Marie and Pierre Curie, Paris.

5.8 International cooperation

Within collaborative agreements:

Institute of Cybernetics:
- Laboratory for Mechanics of Materials of Helsinki University of Technology.
- Laboratory of Theoretical and Applied Mechanics of Helsinki University of Technology.
- Department of Mathematics of City University, Hong Kong.
- HAS-TUB Research Group for Continuum Mechanics, Hungarian Academy of Sciences.
- Stevin Centre for Computational and Experimental Engineering Science, Eindhoven, University of Technology, The Netherlands.
- Department of Mathematics, University of Turin, Italy.
- Laboratoire de Modelisation en Mecanique, Universite Pierre at Marie Curie, Paris, France.

- Department of Mathematical Sciences, Loughborough University, England.
- Fraunhofer Institute for Nondestructive Testing, Saarbrücken, Germany.
- Research and Development Department, Instrumental acoustics laboratory, IRCAM, Paris, France.
- Institut de Recherche et Coordination Acoustique Musique, Equipe Acoustique instrumentale, France.
- Ecole Nationale Superieure des Techniques Avancees, France.
- Finnish Marine Research Institute, Helsinki, Finland.
- GKSS Geesthacht, Germany
- Division of Atmospheric Sciences, Department of Physical Sciences, University of Helsinki, Finland.

Centre of Biomedical Engineering:
- COST 281 Potential Health Implications from Mobile Communication Systems.
- COST B27 Electric neuronal oscillations and cognition (ENOC).
- NATO grant: Optical methods for diagnosis and monitoring of clinical parameters, I.Fridolin.

5.9 Research programmes (national)

1. Estonian Programme on Mechanics.

2. Estonian Programme on Biomedical Engineering.

5.10 Teaching activities
5.10.1 CENS Seminars for graduate students

Statistical thermodynamics	– supervisors:	Dr. M.Vendelin,
of non-equilibrium process		Dr. P.Peterson;
Bioenergetics	– supervisor:	Dr. M.Vendelin;
Waves in microstructured solids	– supervisor:	Prof. A.Salupere.

5.10.2 Courses:

1. A.Salupere – courses in TUT:
   - Dynamics
   - Statics
   - Continuum Mechanics
   - Theory of Elasticity
   - Special Topics in Mechanics
   - Special Course of Mechanics for PhD Students
   - Seminars and Special Seminars for BSc, MSc and PhD students

2. J.Engelbrecht – courses in TUT:
   - Mathematical modelling
   - Nonlinear Dynamics

3. A.Braunbrück – courses in TUT:
   - Technical Mechanics

4. M.Randrüüt – courses in TUT:
   - Technical Mechanics

5. P.Peterson – courses in TUT:
   - Water Waves
   - Statistical Thermodynamics of Nonequilibrium Processes (together with M.Vendelin)
   - Seminars and Special Seminars for BSc, MSc and PhD students

6. J.Kalda :
   - Training of the Estonian and Finnish teams for 37. International Physics Olympiad July 8–17, Singapore. Estonian students won five honourable mentions.
   - Participation in the organization of 4th Estonian-Finnish Olympiad 3–5 May 2006, Tallinn.
   - 4th Academic Olympiad in Physics 20 April 2006, University of Tartu.
   - 53rd Estonian Physics Olympiad 9 April 2006.

7. R.Kitt – courses in TUT:
   - Financial Analysis
   - Security Analysis

8. T.Soomere – courses in TUT:
   - Coastal processes
   - Wave dynamics

9. J.Lass, R.Ferenets – courses in TUT:
   - Signal processing
   - Physiological signal processing

10. H.Hinrikus, M.Bachmann – courses in TUT:
    - Biological effects of electromagnetic field

11. I.Fridolin, H.Hinrikus – courses in TUT:
    - Electromagnetic fields and waves

Participation in schools:

1. M.Berezovski: CISM Advanced School "Waves in Nonlinear Pre-Stressed Materials", Udine, Italy: 4–8 Sept., 2006.

2. L.Rebane: The institute of Photonic Sciences, Technical University of Catalunya, Barcelona: 1 Febr. – 4 May, 2006.

3. L.Rebane, M.Sepp: Quantum & Nonlinear Optics - Ph.D. Summer School, Krogerup Hujskole, Humlebęk, Denmark: 20–26 Aug., 2006.

4. L.Rebane: CERN summer student program, Genf: 4 July – 12 Aug., 2006.

5.11 Visiting fellows (longer periods)

1. Dr. Peter Ván, (Research Fellow CENS-CMA, 3 months).
2. Dr. Heiko Herrmann (postdoc Research Fellow CENS-CMA).
3. Dr. Hene Ramay (postdoc Research Fellow, M.C. reintegration grant).
4. Dr. Rikke Birkendal (Manchester).
5. Dr. Irina Didenkulova (Nijni-Novgorod, Early Stage Researcher, SEAMOCS, 5 months).
6. Prof. Terry Healy (New Zealand).
7. Prof. Peter Davies (Aberdeen).

5.12 Theses

Institute of Cybernetics:
Promoted:

1. BSc:
   - I.Zaitseva: On wave statistics in Estonian coastal waters based on visual observations (supervisor T.Soomere).
   - A.Illaste: Mathematical modeling of mitochondrial respiration (supervisor M.Vendelin).
   - P.Simson: Solving nonstationary freesurface problem with conformal mapping technique (supervisor P.Peterson).
2. MSc:
   - M.Randrüüt: Modelling of deformation waves in microstructured solids (supervisor J.Engelbrecht).
   - T.Peets: Dispersion in microstructured solids (supervisor J.Engelbrecht).
   - M.Berezovski: Numerical simulation of elastic wave propagation in layered nonlinear media (supervisor J.Engelbrecht).
   - K.Tamm: Interaction of deformation waves in microstructured solids (supervisor A.Salupere).
   - L.Rebane: Applications of the orbital angular momentum of light for imaging (supervisor P.Peterson).
   - M.Sepp: Propagation characteristics of nonstationary coherent optical waves in a startified medium with Kerr nonlinearity (supervisor P.Peterson).
3. PhD:
   - I.I.Didenkulova: Runup of long waves on the sloping beach and analysis of real events (supervisor E.Pelinovsky).

In progress:

1. PhD:

A.Kask.	Natural and anthropogenic morphodynamics caused by litohydrodynamical processes in the Estonian coastal sea (supervisor T.Soomere).
K.Rannat.	Long weakly nonlinear waves in geophysical applications (supervisors H.Ohvril, University of Tartu, and T.Soomere).
K.Tamm.	Deformation waves in microstructured solids (supervisor A.Salupere).
L.Ilison.	Solitons and solitary waves in KdV-type hierarchical systems (supervisor A.Salupere).
M.Randrüüt:	Evolution and existence of nonlinear waves in microstructured solids (supervisor J.Engelbrecht).
T.Peets:	Dispersion in microstructured solids (supervisor J.Engelbrecht).
M.Berezovski:	Numerical simulation of elastic wave propagation in layered nonlinear media (supervisor J.Engelbrecht).
M.Sepp	Analysis of surface wave models under extreme waves (supervisor P.Peterson).

2. MSc:

T.Lapimaa.	Methodology of monitoring of development activities in coastal waters and its implementation in Estonia (supervisor T.Soomere).
M.Kalda:	Interaction of waves in strongly inhomogeneous materials (supervisor A.Ravasoo).
P.Simson:	Solving nonstationary freesurface problem with conformal mapping technique (supervisor P.Peterson).
K.Veski:	On modelling of excitation of heart (supervisor J.Engelbrecht).
A.Illaste:	Mathematical modeling of mitochondrial respiration (supervisor M.Vendelin).

Chair of Geometry, University of Tartu:

In progress:

1. PhD:

V.Retšnoi	Vector fields and infinite jets (supervisor M.Rahula).

1. MSc:

O.Liivapuu:	Superconnection in calibration field theory (supervisor V.Abramov).

Centre of Biomedical Engineering:
Promoted:

1. MSc:
   R.Tomson — Modulated microwave effect on EEG (supervisor H.Hinrikus).
   K.Lauri — Optical method for monitoring of dialysis (supervisor I.Fridolin).
2. BSc: E.Kukka, I.Mazurkevitch.

In progress:

1. MSc:
   A.Suhhova (supervisor M.Bachmann).
   J.Rubljova (supervisor M.Bachmann).
   J.Jerotskaja (supervisor I.Fridolin).
   L.Berkis (supervisor K.Meigas).
   A.Štšerbakov (supervisor I.Fridolin).
   G.Vaik (supervisor I.Fridolin).
   A.Kaasik (supervisor J.Lass).
   K.Temitski (supervisor J.Lass).
   A.Suik (supervisor K.Meigas).
   I.Krotova (supervisor V.Tuulik).
2. PhD:
   M.Bachmann (supervisor H.Hinrikus).
   R.Ferenets (supervisor T.Lipping).
   A.Anier (supervisor T.Lipping).
   I.Hlimonenko (supervisor K.Meigas).
   M.Luman (supervisor I.Fridolin).
   K.Lauri (supervisor I.Fridolin).

5.13 Distinctions
Fellows:

1. I.Didenkulova: state medal "For the best student scientific work"for her MSc thesis "Reconstruction of the wave source"(defended in 2003, honoured in 2006) by Ministry of Education and Science of the Russian Federation (15 such medals for all Russia).
2. M.Randrüüt: student award of the Estonian Acad. Sci.
3. K.Tamm: student award of the Estonian Acad. Sci.
4. L.Rebane: student award of the Estonian Acad. Sci.

6. Summary

6.1. Current year 2006

It has been a good working year. CENS organized several scientific meetings, a new programme "Complexity-NETY"started, the collaboration CENS-CMA is going on well. We had 1 PhD and 8 MSc theses promoted, according to 4 + 2 schemes, i.e. real research included. All those promoted as MSc-s continue as PhD students, although one joined another group in physics.

We published a popular overview on our research in order to reach wider publicity.

The number of refereed papers in 2006 is a little bit smaller than in 2005 but the numbers of submitted papers and conference talks are at the same level as in 2005.

We should clearly work harder for gaining more visibility as an international node of research.

6.2. Coming year 2007

The coming year will be quite important while CENS has to submit two new applications. One is for the block grant and another is for the next call of the Centres of Excellence in Research. That is why we added to this Report the Section 6.3: Foresight on Complexity.

6.3. Foresight on "Complexity"

In 2006, the ERA–NET "Complexity"started with 11 participants. Estonia is represented in this ERA–NET by the Estonian Academy of Sciences, authorized by the Ministry of Education and Research. The nodal point for complexity studies in Estonia has been CENS but bearing in mind the former SSA and present actions, the Centre for Dependable Computing (CDC) has been invited to join the ERA–NET studies. Both performing organizations, CENS and CDC, are operating through the subprogrammes of the Estonian Programme for Centres of Excellence in Research (2002 – 2006, prolonged to 2007).

The recent EC report on ERA–NETs (ERA–NET Review 2006) has clearly revealed the need for the Member States to initiate strategic reviews of their own needs and priorities vis-à-vis trans-national R&D activities. In Estonia, complexity studies have been carried out by the bottom-up initiative of CENS and CDC, following their programmes. In 2006, the Estonian Academy of Sciences organized a special seminar "Complexity"(within the Academy seminars "New trends of science") in order to give an overview on the present ERA–NET and possible topics in physics, biophysics, computer sciences and econophysics. In 2007, a new call for the next round of Centres of Excellence in Research will be launched by the Ministry of Education and Research. Therefore, CENS would like to initiate discussions on developing programmes on complexity.

The Estonian programme for the ERA–NET Complexity has the following subthemes:

- fractality in nature (statistical topography, heart rate variability, turbulent diffusion, econophysics) – CENS;
- complexity in nonlinear wave motion (solitonics and coherent wave fields; phase - transformation fronts, thermodynamical constraints' anomalies of water waves, extreme waves) – CENS;
- complexity in biophysics (*in silico* modelling of cardiac contraction and cell energetics, internal variables) – CENS;
- software complexity (structured and computational complexity in distributed computing and web-based applications) – CDC;
- complexity in software-intensive systems (time-aware interaction-centred models of computation, time-counting systems with multiple metric times and simultaneous use of three time concepts, holistic self - organizing systems) – CDC.

Beyond these targeted studies, CENS has continuously supported the general studies in Complexity. In the recent publication "The Beauty of the Complex World"(in Estonian) meant for the wider public the ideas of complexity are explained: complex systems are composed of many parts, they may exhibit a layered hierarchy and possess coherent and/or chaotic behaviours. So CENS has kept the view that nonlinear and complex dynamics is a unifying discipline across traditional boundaries and is a cornerstone in interdisciplinary studies in mathematics, physics, chemistry, biology, computer science, social sciences, medicine, etc. The following set of keywords is characteristic to many studies of CENS: conservative and dissipative systems/structures, coupling effects, emergence of structures, length and/or time scaling, nonlinear time series, controlling complexity. This list is by no means exhaustive.

The main problems ahead are related to the critical mass. The staff of CENS and those of CDC related to complexity studies is around 30 on the PhD (and/or DSc) level and about 20 students. The question locally is to involve more groups, maybe on the level of association (nonlinear control theory, systems biology) and internationally – to enhance collaboration on all levels. For this, the following instruments are planned:

- ERA–NET Complexity activities;
- CENS–CMA and SEAMOCS joint activities;
- Network of Excellence "Non-Linear Dynamics of Advanced Materials"(in preparation);
- CENS–CMA open positions;
- traditional Summer schools and intensive weeks.

CENS is going to enhance the number of publications and certainly will welcome all proposals of co-operation and joint studies.

Annexes:

1. List of software developed in CENS (P.Peterson);
2. Report on Euromech Colloquium 478;
3. List of papers of the Euromech 478 to be published in Proc. Estonian Acad. Sci. Phys. Math. 2007, vol. 56, N 1;
4. Programme of the Minisymposium on Wave Propagation in Solids at 6 ESMC, Budapest. Aug. 28 – Sept. 1, 2006;
5. First Announcement to the Advanced Study School in Waves and Coastal Processes. Aug. 25 – Sept. 9, 2007, Tallinn, Estonia;
6. Proposal for the Network of Excellence "Non-Linear Dynamics of Advanced Materials".

Annex 1

List of software developed in CENS (P.Peterson)

F2PY Fortran to Python Interface Generator, an automatic tool to connect the high-level Python scripting language and high-performance Fortran/C libraries and programs. F2PY is now a part of NumPy package, see http://www.scipy.org for more information. The original F2PY site is http://cens.ioc.ee/projects/f2py2e/.

SciPy Scientific Python, a collection of a variety of high level science and engineering modules for Python. See http://www.scipy.org for more information.

NumPy N-dimensional array manipulations in Python. Together with T. Oliphant and other SciPy developers. See http://www.scipy.org for more information.

fdfpack Finite Differences Formula packages, a set of high-performance functions for finding numerical derivatives of periodic functions using FDF in Python. Fdfpack is available in SciPy sandbox via SVN checkout.

riigihange A web based program for finding the optimal configuration of a computational cluster with fixed financial resources and variable set of CPU, MB, etc details. Together with M.Vendelin. Please contact pearu@cens.ioc.ee or markov@cens.ioc.ee for availability.

G3 F2PY The Third Generation of F2PY, a complete rewrite of F2PY to support Fortran 90 specific language constructs. Includes a Fortran 2003 parser in Python. G3 F2PY is part of NumPy package (see numpy/f2py/lib/ directory under Numpy source or installation tree).

pyvtk Tools for manipulating VTK files in Python. See http://cens.ioc.ee/projects/pyvtk/ for more information.

polyhedron A Python wrapper to CDDLIB, a C library for computing convex polyhedron vertix data. See http://cens.ioc.ee/projects/polyhedron/ for more information.

mgppp Preprocessor for MagicPoint presentation files for inclusion of LaTeX text. See http://cens.ioc.ee/projects/mgppp/ for more information.

symbolic Collection of tools for performing symbolic calculations in Python.

All software can be downloaded at

http://cens.ioc.ee/cens/Members/pearu/software/

Annex 2

Euromech Colloquium No 478 Scientific Report

Dynamic problems in the general area of deformation, damage initiation and growth, and failure of materials and structures require the effective prediction of material's properties and performance. Few materials are used solely in their ideal equilibrium state. Non-equilibrium phases can be associated with inherent abilities to undergo structural changes, which are manifested in rearrangement of particles, crack propagation, phase transformation, and inhomogeneities of various kinds.

The objective of the Colloquium was to present and critically discuss the state of the art, various mathematical formulations, constitutive modeling, and numerical simulations in the prediction of the response of such materials to various types of dynamic loading.

The goal of the Colloquium was to promote advances in the formulation and solution of real-life problems, with an emphasis on dynamical aspects, and with a multidisciplinary vision accounting for all the complex dynamics involved in the physical description.

There were altogether 40 participants from 16 countries and 32 presentations (list of participants and full programme attached).

Recurring issues addressed in the talks and discussed were:

- Material forces:
  Material description of continuum mechanics delivers real tools to analyze and describe various phenomena in inhomogeneous materials. Different aspects of the role of configurational forces in dynamics and electrodynamics of solids were discussed. Material description of continuum mechanics was used as a background in many presentations during the Colloquium.

- Thermodynamics:
  Thermodynamic considerations and constraints give another general approach to analyze the thermomechanical behavior of materials. It was emphasized that thermodynamical description of non-equilibrium states and irreversible processes is highly important in the understanding of phenomena, development of new models, and even in the construction of algorithms for numerical simulations.

- Martensitic transformations
  Materials capable to phase transformations under applied thermal or mechanical loading provide many examples of complex material behavior. Experimental results, theoretical models, and numerical simulations of martensitic transformations in solids and the corresponding microstructure formation were discussed intensively. The complexity of involved phenomena, the development of new models and experimental techniques show clearly that the understanding of the phenomena on the basis of a sound theoretical background is still needed. Applications of shape memory alloys to retrofitting of constructions and buildings were also considered.

- Phenomenology and various applications
  Applications of thermomechanical methods to crack and damage problems, hole growth, transforming nanoparticles, growing of biological materials, etc. show the power of the phenomenological description and its applicability in distinct areas.

- Wave propagation in inhomogeneous solids
  Different aspects of linear and non-linear wave propagation in microstructured solids were presented and discussed. Both theoretical considerations and numerical simulations demonstrated the richness of dynamic phenomena in materials behaviour.

From the above given list it should be clear that many questions are still far from being solved. The attending community proposed to establish a Network of Excellence to keep up and develop further the level of mutual understanding reached at the Colloquium.

We would like to thank the Centre for Nonlinear Studies and EUROMECH for making the Colloquium possible, in particular through their financial and organizational support.

Annex 3

Euromech 478 Proceedings

Nonlinear waves

1. Alesia CASASSO, Franco PASTRONE and Alexander M. SAMSONOV
   Nonlinear waves in dissipative microstructured 2-D solids
2. Lauri ILISON, Andrus SALUPERE and Pearu PETERSON
   On the propagation of localized perturbations in continua with microstructure
3. Andrus SALUPERE, Kert TAMM and Jüri ENGELBRECHT
   Interaction of deformation waves in microstructured solids
4. Patrizia TROVALUSCI and Giuseppe REGA
   Elastic waves in heterogeneous materials as multiscale-multifield continua
5. Andres BRAUNBRÜCK and Arvi RAVASOO
   Resonance phenomenon of wave interaction in inhomogeneous solids

Continuum mechanics and thermodynamics

6. Carmine TRIMARCO
   Configurational forces in dynamics and electrodynamics
7. Gérard A. MAUGIN and Arkadi BEREZOVSKI
   On the exploitation of Eshelby's stress in isothermal and adiabatic conditions
8. Wolfgang MUSCHIK and Arkadi BEREZOVSKI
   Non-equilibrium contact quantities and compound deficiency at interfaces between discrete systems
9. Tomáš ROUBÍČEK, Martin KRUČK and Jan KOUTNÝ
   A mesoscopical model of shape-memory alloys
10. Arkadi BEREZOVSKI, Jüri ENGELBRECHT and Gérard A. MAUGIN
    Front dynamics in inhomogeneous solids
11. Natalya N. KIZILOVA
    Load transfer from growing fibres into the multilayered plate from a biological material

Applications and experiments

12. J. Pablo CASAS-RODRIGUEZ, Ian A. ASHCROFT and Vadim V. SILBERSCHMIDT
Propagation of delamination zones in bonded joints

13. Vicenç TORRA, Antonio ISALGUÉ, Francisco C. LOVEY and Ferran MARTORELL
Phase metastability in shape memory alloys. Target: dampers in engineering via SMA

14. Casper van der EIJK, Jim Stian OLSEN and Zhiliang Z. L. ZHANG
Investigation of the pseudo-elastic behaviour in two commercial NiTi alloys: experiments and modelling

15. Fabio CASCIATI, Sara CASCIATI and Lucia FARAVELLI
Fatigue characterization of a Cu-based shape memory alloy

16. Hanuš SEINER, Michal LANDA and Petr SEDLÁK Propagation of an austenite-martensite interface in a thermal gradient

Annex 4

6 th European Solid Mechanics Conference, Budapest
Aug. 28 – Sept. 1, 2006

Minisymposium 11: Wave propagation in Solids

Organisers and chairmen: J.Engelbrecht, P.L.Christiansen

1. P.L.Christiansen, A.R.Rasmussen, M.P.Sorensen, Yu.B.Gaididei. Travelling wave fronts in thermoviscous fluids.
2. A.I.Potapov. Nonlinear waves in molecular chain with dipole-dipole interactions.
3. G.A.Maugin. Nonlinear kinematic wave mechanics of solids.
4. A.Salupere, K.Tamm, J.Engelbrecht. Propagation of solitary pulses in microstructured solids.
5. M.Okrouhlik, S.Ptak, B.Lundberg. Wave energy transfer in percussive drilling.
6. F.Pastrone. Nonlinear waves and solitons in plane microstructured solids.

Annex 5

Advanced study school in waves and coastal processes
Aug. 25 – Sept. 9, 2007, Tallinn, Estonia

The joint influence of sea level rise and increasing storminess are creating an ever escalating pressure on the ocean coasts. Reducing the consequences of its impact is a major challenge of the coastal management during the new century and presumes a comprehensive knowledge of both the coastal processes and their forcing factors.

The main objective of the school is to provide a systematic overview of contemporary ideas and methods in the research and applications of the coastal processes and their basic forcing factor - surface waves. The synchronized presentation of both the aspects by leading scientists will be particularly beneficial for people specializing in coastal management.

From a wide variety of issues of both theoretical and practical interest, the school concentrates on

(i) dynamical coastal geomorphology, coastal management, sediment transport processes in the coastal zone, coastal hazards, and forcing factors of the coastal processes;

(ii) description and modelling of wave properties and wave-induced effects in shallow areas, particularly emphasizing the dynamics of nonlinear waves and its potential consequences.

Overview lectures will cover closely related topics such as water level in semi-enclosed basins, storm surges, ice dynamics, elements of marine meteorology and atmospheric boundary layers, analysis and forecast of extreme events, freak wave studies, environmental aspects of coastal engineering, analysis of major failures of coastal structures, etc.

The course in coastal processes is mostly designed for well-prepared MSc students and for PhD students in their early phase, and includes a two-day field trip. The basic course in wave dynamics contains introduction into the classical linear wave theory and its applications in coastal engineering. A large part of the topics in surface waves are more advanced and extend to contemporary nonlinear wave dynamics.

The school might be of interest for young researchers and marine and coastal engineers who wish to get an overview of the state-of-the-art of coastal processes and surface wave matters, and their interrelations. The expertise from the school may be used in different areas of marine and environmental sciences including, yet not limited with meteorology, oceanography, geophysical hydrodynamics, ocean and coastal engineering, pollution control.

The school is co-organised by Tallinn University of Technology (TUT), Dept. of Civil Engineering (in the framework of launching teaching of port and coastal engineering at the TUT, supported by the EU & INNOVE), Estonian Academy of Sciences, Institute of Cybernetics at TUT, Centre of Excellence for Nonlinear Studies (CENS), Estonian Marine Academy, Marie Curie RTN network SEAMOCS, and Marie Curie Transfer of Knowledge network CENS-CMA.

Organizing Committee:

Chairman:	Prof. Tarmo Soomere (Tallinn University of Technology);
Co-Chairmen:	Prof. Jüri Engelbrecht (Institute of Cybernetics, CENS, Tallinn)
	Prof. Terry Healy (Waikato University, NZ);
	Prof. Tiit Koppel (Tallinn University of Technology);
	Dr. Miguel Onorato (University of Torino).

Annex 6

Network of Excellence "Non-Linear Dynamics of Advanced Materials"

Objectives

The Network of Excellence 'Non-Linear Dynamics of Advanced Materials' (NoLDAM) aims to create a coherent pan-European structure of key academic and research institutions in the development of fundamental knowledge of dynamic materials phenomena and the structure-property relationships at different scales for prediction of dynamic materials behavior in highly demanding loading and environmental conditions. The Network has assembled a critical mass of high level expertise gathered from 15 partners across 9 European countries.

List of participants:

1. Centre for Nonlinear Studies, Institute of Cybernetics at Tallinn University of Technology, ESTONIA (Prof. J.Engelbrecht);
2. Laboratoire de Modélisation en Mécanique, Université Pierre at Marie Curie, Paris, FRANCE (Prof. G.A.Maugin);
3. Institut für Theoretische Physik, TU Berlin, GERMANY (Prof. W.Muschik);
4. Dipartimento di Matematica, Università di Torino, ITALY (Prof. F.Pastrone);
5. Laboratoire de Mechanique des Solides, Ecole Polytechnique, Palaiseau, FRANCE (Prof. L.Truskinovsky);
6. Department of Impact and Waves in Solids, The Institute of Thermomechanics, Prague, CZECH REPUBLIC (Dr. M.Landa);
7. Laboratoire Mécanique Appliquée, Raymond CHALEAT, Université de Frache-Comté, Besançon, FRANCE (Prof. C.Lexcellent);
8. Laboratoire de Physique et Mécanique des Matériaux, Institut Supérieur de Génie Mécanique et Productique, Université de Metz, FRANCE (Prof. M.Berveiller)
9. Wolfson School of Mechanical and Manufacturing Engineering, Loughborough University, UK (Prof. V.Silberschmidt)
10. Research Institute of Particle and Nuclear Physics, Budapest, HUNGARY (Dr. P.Van)
11. Department of Mathematics and Research Center of Applied Mathematics (C.I.R.A.M.), University of Bologna, ITALY (Prof. T.Ruggeri)
12. Departament de Física Aplicada, Polytechnical University of Catalonia, Barcelona, SPAIN (Prof. V.Torra)
13. Department of Production Engineering, University of Bremen, GERMANY (Prof. R.Kinzler)
14. Department of Applied Mathematics, University of Pisa, ITALY (Prof. C.Trimarco)
15. Universität Linz, Institut für Technische Mechanik, Linz, AUSTRIA (Prof. H.Irschik)

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