

**02-5 IUTAM Symposium on Complementary-Dual Variational Principles in Nonlinear Mechanics, Shanghai, China, August 13-16, 2002**

**a) Scientific Committee**

D.Y. Gao (USA, Co-Chair), K. Hackl (Germany), G. Maier (Italy), N.Q. Son (France), R.W. Ogden (UK), N. Olhoff (Denmark, IUTAM Representative), D.J. Steigmann (USA), C.-C. Wu (China), W. Zhong (China, Chair)

**b) Short summary of scientific progress achieved**

The concepts of duality, complementarity and symmetry play more and more important roles in modern mechanics, theoretical physics, engineering optimization, control theory and computational methods.

Much research has been devoted to the developments of complementary and dual variational principles in the last forty years. The theory is well developed in several directions, for example in linear/nonlinear optimization and variational problems, finite deformation theory, quantum mechanics, elasto-plastic fracture mechanics, penetration mechanics, shear bands, phase transitions and shape memory alloys, and finite element methods, etc., the complementary-dual variational methods have made substantial contributions.

Apart from providing a more complete picture of variational methods, complementary-dual formulations often provide useful bounds on some important parameters of interest. Recently, the complementary-dual variational methodology and associated computational methods have been found more and more important in theoretical physics, nonsmooth/nonconvex mechanics and large-scale structural analysis and design.

The IUTAM symposium was held jointly with the Fourth International Conference on Nonlinear Mechanics in Baolong Hotel, Shanghai from August 13-16. This symposium brought together, for the first time, engineers, physicists and

mathematicians from a variety of scientific disciplines who are working on duality, complementarity and symmetry in nonlinear science and computational methods.

The speakers in this symposium presented progress made in their respective areas of study with theory, methods, algorithms and applications in general nonlinear mechanics, including the following areas:

- nonsmooth & nonconvex mechanics: bifurcation and buckling problems, chaotic systems, phase transitions and hysteresis, super-conductivity and shape memory alloys, contact and fractural mechanics, stress concentrations, penetration and shear bands, composite materials,
- finite deformation field theory,
- nonconvex and non-conservative Hamilton systems,
- engineering optimization and control,
- plastic limit analysis, design and shakedown theory,
- analytic solutions for general nonlinear partial differential equations,
- computational mechanics, numerical models and algorithms,
- nonlinear mathematical programming,
- adaptive systems and “smart” structures.

#### **c) Countries represented and number of participants**

Australia (1), Austria (1), Belgium (1), China (4), Czech (1), France (6), Germany (1), Greece (1), Hong Kong (1), Italy (1), Japan (2), Netherlands (1), Portugal (1), Russia (1), Singapore (1), Switzerland (2), UK (3), USA (7).

Total number of registered attendee: more than 300 (for the joined meetings with ICNM- IV)

#### **d) Publication of Proceedings of the Symposium**

- The Proceedings of refereed four-page extended abstracts was published by Shanghai University.
- The Proceedings of IUTAM Symposium on Duality, Complementarity and Symmetry in Nonlinear Mechanics, edited by David Gao, will be published by Kluwer Academic Publishers in late 2003.

### **e) Financial supports**

- International Union of Theoretical and Applied Mechanics
- National Science Foundation, USA
- Shanghai University
- National Natural Science Foundation of China

### **f) Scientific program**

#### **Keynote Lectures, August 13**

D.H. van Campen, *Some aspects of nonlinear dynamics of discontinuous mechanical systems*

K.P. Chong, *Mechanics and materials research and challenges in the twenty-first century*

I. Ekeland, *The least action principle and its duals*

#### **Technical sessions**

X. Li and S. Pan, *Duality for Entropy Optimization and Its Applications*

D.Y. Gao, *Duality, Complementarity and Triality: Unifying Mechanics, Scientific Computations and Human Understanding*

H. Yoshimura, *On the duality principle for dynamics of constrained mechanical systems*

Q.S. Nguyen, *On shakedown theorems in hardening plasticity*

H. Nguyen-Dang and D.K. Vu, *Mathematical Duality in Kinematical Shakedown Analysis of*

Q. C. He, *Polar Duality and Limit Analysis in Micromechanics*

#### **Technical sessions, August 14**

Q.-P. Sun, *Deformation Instability during Phase Transformation in Shape Memory Alloys: Experiment and Simulation*

D. Gao, J.-F. Li and D. Viehland, *Tri-duality Solutions to Landau-Ginzburg Equation for Imperfect Ferroelectrics*

W. Dai and R. Nassar, *A Linear Finite Difference Scheme for Solving a Nonlinear Micro Heat Transport Equation in Symmetric Thin Film*

M. Thera, *Well-positioned closed convex sets and well-positioned closed convex functions*  
 C-S. Man, *Flow Stress Anisotropy in Textured Sheet Metals*  
 C. Vallee, M. Hjiiaj, D. Fortune, G. de Saxce, *Duality Extended By Generalising the Legendre-Fenchel-Moreau Transformation*  
 F.Y.M. Wan, *Bifurcation Analysis of Spherical Shells*  
 K.A. Lazopoulos, *Beam bending and buckling for materials with non-local spatial dependence*  
 T.C. Gasser and G.A. Holzapfel, *On the mathematical modeling of three-dimensional delamination processes of laminated composites*  
 R.J. Greechie, *The Models for the Logical Foundations of Quantum Mechanics: Effect Algebras*  
 G.H.M. Van der Heijden, *Constrained rods: from drill strings to DNA supercoils*  
 V. S. Zarubin and E.E. Krasnovski, *Application of the dual variational statements for error estimation of approximate solutions of thermomechanics problems*

### **Technical sessions, August 15**

C.-C. Wu, *Finite Element Dual Analysis in Piezoelectric Crack Estimation*  
 P. Vsnini and R. Nascimbene, *Computing FEM solutions of plasticity problems via nonlinear mixed variational inequalities.*  
 D. Gao and P. Lin, *Primal-Dual Finite Element Analysis for Ginzburg-Landau Superconductivity*  
 T.S. Ratiu, *Averaged Euler equations and second grade fluids with free slip Navier boundary*  
 D. Motreanu, *Minimax theory, duality and applications*  
 M. Tajiri, *Periodic Soliton Resonances*  
 C. Glocker, *Newton's and poisson's impact law for the non-convex case of re-entrant*  
 R. Nassar and W. Dai, *Numerical Modeling and Optimization for Depositing Symmetric 3-D Microstructures by Laser-induced Chemical Vapor Deposition*  
 M. Hjiiaj and S.W. Sloan, *Extension of limit analysis theorems to incompressible material with a non-associated flow rule*  
 J. Haslinger, *Duality in Optimal Shape Design*

R. Ogden, *Generating exact solutions in compressible nonlinear*

**Plenary Sessions, August 16**

A. Jeffrey, *Hyper-elastic media, acceleration waves and a latered half-space*

G.A. Maugin, *Essential concepts and applications of eshlbian nonlinear material mechanics*

**Report Composed by David Y. Gao**