Laboratoire de Mécanique des Solides
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Parrainé par la Chaire André Citroën

Symposium Jean Mandel

Experimental Methods in Mechanics

Méthodes expérimentales en mécanique

Tuesday, June 26th, 2018

Becquerel Amphitheatre
École Polytechnique

Inscription gratuite à symposium-mandel@meslistes.polytechnique.fr avant le 10 juin 2018
Free registration by email at symposium-mandel@meslistes.polytechnique.fr by June, 10th 2018
Contact : daniel.weisz-patrault@polytechnique.edu

Plenary Lecture

by Guruswami Ravichandran

Biological Cell-Matrix Interactions in Three-Dimensions

Biological cells are complex living systems that can be viewed as micromachines, which derive many of their mechanical functions from the molecular machinery within the cell. The force cells apply to their surrounding extracellular matrix through focal adhesions influence processes such as growth, adhesion, development and migration. A new experimental approach to quantify three dimensional full-field displacements and tractions due to cells embedded in a fibrous matrix is presented. Cells and their surrounding matrix are imaged in three dimensions using laser scanning confocal microscopy. Cell-induced matrix displacements are computed using digital volume correlation. The full-field tractions are computed directly from the displacement data. The simultaneous imaging of the cell and the labeled matrix enables the study of cell-matrix interactions and the consequences of matrix remodeling due to cell-induced forces. The three dimensional traction force microscopy technique is used to investigate how cells employ physical forces during cell division, spreading and sensing. In a three-dimensional fibrous matrix, dividing cells apply tensile force to the matrix through thin, persistent extensions that in turn direct the orientation and location of the daughter cells. During spreading, cells extend thin protrusions into the matrix and apply forces using these protrusions. These forces lead to the formation of localized intercellular bands of tensile deformations. A constitutive model for a fibrous material to simulate deformations induced by cells is presented. It is shown that cells in a fibrous matrix induce deformation fields that propagate over a longer range than predicted by linear elasticity. The model captures measured cell induced matrix displacements from experiments and identifies loss of compression stiffness due to microbuckling of fibers as an important mechanism for long-range cell mechanosensing.

Guruswami Ravichandran

Professor
Aerospace and Mechanical Engineering
California Institute of Technology

Guruswami (Ravi) Ravichandran is the John E. Goode, Jr. Professor of Aerospace and Mechanical Engineering and Otis Booth Leadership Chair of the Division of Engineering and Applied Science at the California Institute of Technology. He received his B.E. (Honors) in Mechanical Engineering from the University of Madras, Sc.M. in Engineering and Applied Mathematics, and Ph.D. in Engineering (Solid Mechanics and Structures) from Brown University. He has held visiting scholar appointments at Ecole Polytechnique (CNRS Visiting Senior Scientist), Indian Institute of Science (Aditya Birla Chair), and Tokyo Institute of Technology (Chair in International Cooperation). He is a member of the National Academy of Engineering, International Academy of Engineering, Academy of Europe, and European Academy of Sciences and Arts. He is a Fellow of the American Society of Mechanical Engineers (ASME), Society for Experimental Mechanics (SEM), and American Academy of Mechanics (AAM). He was named Chevalier de l'ordre des Palmes Academiques by the Republic of France. His awards include A.C. Eringen Medal from the Society of Engineering Science, Warner T. Koiter Medal from ASME, and William M. Murray Lecture Award from SEM. His research interests are in mechanics of materials including deformation, damage and failure, dynamic behavior, wave propagation, micro/nano mechanics, composites, active materials, biomaterials, cell mechanics, and experimental methods.

Tuesday, June 26th, 2018 Program

Becquerel Amphitheater

08:30 - 09:00 am *Registration and Welcome Coffee*

09:00 - 09:10 am **Welcome Address** by **Patrick Le Tallec**, LMS director

09:10 - 10:10 am **Plenary Lecture** by **Guruswami Ravichandran**
Biological Cell-Matrix Interactions in Three-Dimensions.

10:10 - 10:40 am *Coffee Break*

10:40 - 11:00 am **Anchal Goyal and Li Meng**
Ultrafine versus coarse-grained Al alloy: from low-cycle to giga-cycle fatigue.

11:00 - 11:20 am **Thomas Bonniot**
Experimental investigation of fatigue crack growth in a rail steel under non-proportional mixed-mode I + II loading.

11:20 - 11:40 am **Stephane Zanella**
Creep Fatigue Interaction in Solder Joint Alloys of Electronic Packages.

11:40 - 12:00 pm **Anthony Janin**
Characterization of adhesive joints under dynamic multiaxial loadings: experiments and modeling.

12:00 - 12:20 pm **David Roucou**
Mode I fracture of elastomers: SENT vs. PS tests.

12:20 - 14:00 pm *Lunch*

14:00 - 14:20 pm **Alexandre El Sabbagh**
Hot deformation of aluminum: experimental investigation of viscoplastic micro-mechanisms.

14:20 - 14:40 pm **Charles Francart**
Identification of uncertainties in Hopkinson Bars tests and probabilistic data processing.

14:40 - 15:00 pm **Yanis Balit**
Metallic lattice structures manufactured by Direct Energy Deposition.

15:00 - 15:20 pm **Othmane Zerhouni**
A combined numerical and experimental study of random isotropic material using 3D printed numerically-generated microstructures.

15:20 - 15:40 pm **Jean-Pierre Voropaieff**
MRE Elastomers: Experiments, theory and modeling.

15:40 - 16:00 pm **Laurent Guin**
Experimental study of strain effects on solar cells.

16:00 - 16:10 pm **Closing Address** by **Patrick Le Tallec**

Jean Mandel

Founder of the Laboratoire de Mécanique des Solides

After brilliant secondary studies, Jean Mandel went on to École Polytechnique in 1927 and later to École des Mines. In 1932 he became a professor at École des Mines de Saint-Étienne and in 1948 at École des Mines de Paris. From 1951 to 1973 he was professor of mechanics at École Polytechnique.

Jean Mandel's research career was devoted mainly to the mechanics of solids and the strength of materials. In 1961 he created the Laboratoire de Mécanique des Solides, a laboratory common to École Polytechnique, École des Mines de Paris, École des Ponts et Chaussées and associated to the Centre National de la Recherche Scientifique. In October 1964 he founded and became the first president of the Groupe Français de Rhéologie. In 1980 he became "honorary member" of this group.

The scientific work of Jean Mandel covers a very wide field with a bibliography listing more than 150 articles and 5 books. He presented original ideas on the buckling of beams and shells, the finite deformations of solids, laminar flow in porous media, the bearing capacity of shallow foundations, the punch resistance of a two-layer medium, the stability of underground cavities, the plastic flow of metals, and the effect of cyclic loading on structures, as well as contributions to the fields of thermodynamics, rolling friction and homogenization.

But Jean Mandel's influence extended far beyond the field of his personal research. A good many students were trained, under his direction, in the Laboratoire de Mécanique des Solides. A fine teacher and a constant stimulus to his research group, he gave his time generously to study the details of manuscripts that were sent to him and to suggest the minor modifications he deemed necessary. Those who had the privilege of working with him were left with an impression of palpable scientific passion and moral rigor that will continue to be an example for generations to come.

Jean Mandel passed away on the 19th of July 1982, the victim of a tragic accident at the very height of his intellectual prime.

Text by Pierre Habib

The Jean Mandel Symposium is open to all students, researchers and scientists interested in the proposed topic. It combines, in an informal setting, a keynote presentation by an internationally renowned scientist and talks given by young researchers associated with the laboratory. A large amount of time is dedicated to scientific discussions.