TIME TABLE

Registration on Monday at 8.30

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	July 9	**July 10**	**July 11**	**July 12**	**July 13**
9.00 - 9.45	Ganghoffer	Ganghoffer	Ganghoffer	Mazza	Mazza
9.45 - 10.30	Ganghoffer	Ganghoffer	Ganghoffer	Mazza	Mazza
11.00 - 11.45	Dell'Isola	Dell'Isola	Dell'Isola	Mofrad	Mofrad
11.45 - 12.30	Dell'Isola	Dell'Isola	Dell'Isola	Mofrad	Mofrad
14.00 - 14.45	Boisse	Boisse	Picu	Mazza	
14.45 - 15.30	Boisse	Boisse	Picu	Mazza	
16.00 - 16.45	Picu	Picu	Mazza	Mofrad	
16.45 - 17.30	Picu	Picu	Mazza	Mofrad	
18.00	Welcome Aperitif				

ADMISSION AND ACCOMMODATION

The registration fee is 600.00 Euro + VAT*, where applicable (bank charges are not included). The registration fee includes a complimentary bag, four fixed menu buffet lunches (on Friday upon request), hot beverages, downloadable lecture notes and wi-fi internet access.

Applicants must apply at least one month before the beginning of the course. Application forms should be sent on-line through the following web site: http://www.cism.it. A message of confirmation will be sent to accepted participants. Applicants requiring assistance with the registration should contact the secretariat at the following email address cism@cism.it.

Applicants may cancel their course registration and receive a full refund by notifying CISM Secretariat in writing (by email to cism@cism.it) no later than two weeks prior to the start of the course.

Cancellation requests received during the two weeks prior to the start of the course will be charged a 50.00 Euro handling fee. Incorrect payments are also subject to a 50.00 Euro handling fee.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered lodging and/or board, if available, in a reasonably priced hotel or student guest house.

Requests should be sent to CISM Secretariat by **May 9**, **2018** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on the web site www.cism.it, or can be mailed upon request.

* Italian VAT is 22%..

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ACADEMIC YEAR 2018
The Cowin Session
Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

MECHANICS OF FIBROUS MATERIALS AND APPLICATIONS: PHYSICAL AND MODELLING ASPECTS

Advanced School
coordinated by

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Udine ***July 9 - 13*** 2018

MECHANICS OF FIBROUS MATERIALS AND APPLICATIONS: PHYSICAL AND MODELLING ASPECTS

Fibrous media are present in a large variety of systems and applications due to their high mechanical performances at low weight. Such systems include complex yarns used as reinforcement for rubber tires, 3D woven structures used in cutting-edge areas such as aeronautics, composite engineering for transportation (aerospace, maritime, automotive industry), biological tissues, scaffolds for tissue growth and some biomaterials, such as ligament biosubstitutes or vascular endoprostheses. Some man-made fibrous structures have a regular, periodic architecture, e.g. woven networks for composite applications, while others have random microstructure, such as in paper and various types of insulation materials. Rubber and gels are random molecular networks. Many biological materials have a random complex fibrilar structure which plays the central role in their mechanics. Examples include soft connective tissue, such as tendons and ligaments, the arterial walls, and the cellular cytoskeleton. Damage accumulation, fracture and the related non-linear behavior under large deformations are important considerations in all these materials.

The scientific problems raised by the complexity of fibrous media include the following aspects:
- The development of methods to characterize the multiscale structure, including imaging techniques and image-to-model conversion;
- The identification of the relation between the fiber properties and network architecture, and the overall mechanical behavior of the fibrous assembly;
- The description and prediction of the onset of damage and overall structural failure, including occurrence of global scale instabilities;
- Accounting for time-dependent behavior under small and large deformations, including the rheology of wet fibrilar structures and fibrilar structures embedded in matrix;
- Understanding the mechanical behavior of active networks such as the cellular cytoskeleton;
- The development of homogenization methods for constructing an equivalent homogeneous medium;
- The consideration of scale effects, which may require the consideration of generalized continua (Cosserat, second gradient, microstretch or micromorphic media);
- The design of experimental procedures for identifying specific mechanical properties and in particular non-conventional properties of networks;
- The design of metamaterials with a fibrous architecture for acoustic or other applications;
- The development of efficient numerical methods to handle fibrous microstructures incorporating multiscale aspects (discrete elements, multi-domain approaches, finite element techniques).

The aim of the course is to bring together researchers in the field of fibrous media, to foster interactions between experts with different background and to educate the next generation of researchers. The course is mostly intended for Master students, PHD students, post-doctoral researchers, industrial researchers and engineers and scientists interested in the more practical use of such materials. More established researchers interested in an overview of the field are also welcome.

PRELIMINARY SUGGESTED READINGS

F. Dos Reis, J.F. Ganghoffer. 'Construction of micropolar models from lattice homogenization'. Computers Struct. 2012, 112-113, 354-363.

I. Goda, M. Assidi, J.F. Ganghoffer. 'Equivalent mechanical properties of textile monolayers from discrete asymptotic homogenization. J. Mech. Phys. Solids, 61, 12, 2013, 2537–2565.

Y Rahali and I Goda and JF Ganghoffer. 'Numerical identification of classical and nonclassical moduli of 3D woven textiles and analysis of scale effects', 2016. Composite Structures, 135, 122-139.

A. Charmettant, P. Boisse, E. Vidal-Sallé. 'Hyperelastic modelling for mesoscopic analyses of composite reinforcements'. Composites Science and Technology, Elsevier, 2011, 71, 1623-1631.

P. Boisse, N. Hamila, E. Vidal-Sallé, F. Dumont. 'Simulation of wrinkling during textile composite reinforcement forming. Influence of tensile, in-plane shear and bending stiffnesses'. Composites Science and Technology 71 (5), 683-692.

A. Shahsavari, R. C. Picu. 'Size effects on mechanical behavior of random fiber networks'. Int. J. Solids Structures 50 (20-21), 2013, 3332-3338. doi:10.1016/j.ijsolstr.2013.06.004.

R. C. Picu. 'Mechanics of random fiber networks: a review'. Soft Matter 7 (15) (2012) 6768{6785. doi:10.1039/C1SM05022B.

Mauri A., Hopf R., Ehret A.E., Picu C.R., Mazza, E., 2015, A discrete model to represent the deformation behavior uf human amnion, Journal of the Mechanical Behavior of Biomedical Materials, 58, 45-56. DOI: 10.1016/j.jmbbm.2015.11.009.

Mauri A., Ehret A.E., De Focatiis D.S.A., Mazza, E., 2015, A model for the compressible, viscoelastic behavior of human amnion addressing tissue variability through a single parameter, Biomechanics and Modeling in Mechanobiology, S.1-13. DOI: 10.1007/s10237-015-0739-0.

Mofrad MRK and Kamm RD Eds. Cellular Mechanotransduction: Diverse Perspectives from Molecules to Tissues, Cambridge University Press, 2014.

Mofrad MRK and Kamm RD Eds. Cytoskeletal Mechanics: Models and Measurements, Cambridge University Press, 2011.

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from the CISM web site. Instructions will be sent to accepted participants.

INVITED LECTURERS

Philippe Boisse - LaMCoS, INSA de Lyon, France
6 lectures on: Continuous fibre composite reinforcement forming. Composite structures are constructed using continuous fibre preforms. These preforms are obtained by forming textile reinforcements. The objective of this contribution is to analyse the specific behaviour of these fibrous reinforcements and to propose simulation approaches of their forming process.

Francesco dell'Isola - University of Rome "La Sapienza, Italy
6 lectures on: Discrete and continuous models for pantographic metamaterials and applications.
The recent demand of novel technological solutions in material science urged for the design of complex metamaterials exhibiting tailored behavior. The specification of the demanded behavior is obtained by fixing the evolution equation. Also strictly related to the concept of the design of tailored metamaterials is the problem of the determination of the microstructure of the various kinds of generalized continua which have been studied in the literature. A particular attention will be paid to pantographic microstructures and to the mechanical systems endowed with such a microstructure.

Jean-François Ganghoffer - LEMTA, Université de Lorraine, Vandoeuvre, France
6 lectures on: Homogenization methods for fibrous materials - static and dynamic aspects.

Edoardo Mazza - ETH Zurich, Switzerland
6 lectures on: Mechanics of soft connective tissue. Characteristic features of soft biological tissues include large strain viscoelasticity, anisotropy, and chemomechanical coupling. Experimental observations under uniaxial and multiaxial loading states and their analysis using advanced continuum models as well as discrete fiber network models. Biological membranes and thin planar tissues represent soft mechanical structures with important physiological functions.

Mohammad Mofrad - Molecular Cell Biomechanics Laboratory, University of California at Berkeley, USA
6 lectures on: Molecular biomechanics and mechanobiology of the cell. Mechanical phenomena affect nearly every aspect of cellular biology and function, yet the underlying mechanisms of how mechanical forces and biochemical signals interact is not clearly understood. We are interested in understanding the molecular basis of cell mechanics and mechanotransduction and shedding light on the role of these processes in human disease. Our specific attention is on the role of two macromolecular systems in cellular function, namely the integrin-mediated focal adhesions at the interface between the cell and extracellular matrix (ECM) and the nuclear pore complex (NPC).

Catalin Picu- Rensselaer Polytechnic Institute, Troy, USA
6 lectures on: Mechanics of random fibrous media.