

## TIME TABLE

(Registration on Monday at 8.30)

TIME	Monday September 26	Tuesday September 27	Wednesday September 28	Thursday September 29	Friday September 30
9.00 - 9.45	Ravi-Chandrar	Leblond	Leblond	Needleman	Barthelat
9.45 - 10.30	Ravi-Chandrar	Leblond	Leblond	Needleman	Barthelat
11.00 - 11.45	Leblond	Ponson	Ravi-Chandrar	Barthelat	Fineberg
11.45 - 12.30	Leblond	Ponson	Ravi-Chandrar	Barthelat	Fineberg
14.00 - 14.45	Ravi-Chandrar	Fineberg	Barthelat	Ponson	
14.45 - 15.30	Ravi-Chandrar	Fineberg	Barthelat	Ponson	
16.00 - 16.45	Fineberg	Ponson	Needleman	Needleman	
16.45 - 17.30	Fineberg	Ponson	Needleman	Needleman	

## ADMISSION AND ACCOMMODATION

The registration fee is of 575,00 Euro + VAT taxes\*, where applicable (bank charges are not included).

The registration fee includes a complimentary bag, four fixed menu buffet lunches (Friday subject to numbers), 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 our web site: <http://www.cism.it> or by post.

A message of confirmation will be sent to accepted participants. If you need assistance for registration please contact our secretariat.

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

If cancellation occurs less than two weeks prior to the start of the course, a Euro 50,00 handling fee will be charged. Incorrect payments are subject to Euro 50,00 handling fee.

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

Requests should be sent to CISM Secretariat by **July 26, 2016** 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 our web site, or can be mailed upon request.

Please note that the Centre will be closed for summer vacation the first three weeks in August.

\* Italian VAT is 22%.

*For further information please contact:*

CISM  
Palazzo del Torso  
Piazza Garibaldi 18  
33100 Udine (Italy)  
tel. +39 0432 248511 (6 lines)  
fax +39 0432 248550  
e-mail: [cism@cism.it](mailto:cism@cism.it)



# MECHANICS AND PHYSICS OF FRACTURE: MULTI-SCALE MODELING OF THE FAILURE BEHAVIOUR OF SOLIDS

Advanced School  
coordinated by

**Laurent Ponson**  
Université Pierre et Marie Curie  
Paris, France

Udine September 26 - 30 2016

# MECHANICS AND PHYSICS OF FRACTURE: MULTI-SCALE MODELING OF THE FAILURE BEHAVIOUR OF SOLIDS

The objective of this school is to provide an overview of the recent progresses in the mechanics and physics of fracture in solids. The six courses will provide a comprehensive understanding of the macroscopic failure behavior of solids from the description of the microscopic failure processes and their coupling with the microstructure.

Fracture of materials is a multi-scale process that couples the continuum scale from which elastic energy is released to the microstructure scale where this energy is dissipated through damage mechanisms at the crack tip vicinity. For that reason, the microstructural features of materials greatly influences their failure behavior. Powerful approaches have been recently developed to bridge length scales in

fracture phenomena and this school will provide a pedagogical overview of the concepts and tools that allow to go from the small to the large scale and, vice & versa, the basic rules for the design of tough solids.

Three fundamental questions will be addressed during the school:

(i) The relation between the microstructural

features of materials and their effective fracture properties,

(ii) the role of damage mechanisms and non-linear deformations near the crack tip on the failure behavior of solids and

(iii) the role of dynamic inertial effects during fast fracture.

## PRELIMINARY SUGGESTED READING

Some of the suggested readings are available for registered participants in the download area of <http://www.cism.it/courses/C1611>

B. Lawn, Fracture of brittle solids, Cambridge Univ. Press (1993).

I. Svetlizky and J. Fineberg, Classical shear cracks drive the onset of dry frictional motion, Nature 509, p. 205 (2014).

U. Wegst, H. Bai, E. Saiz, A. Tomsia and R. Ritchie, Nature Materials 14, p. 25, Bioinspired structural materials (2015).

S. Xia, L. Ponson, G. Ravichandran and K. Bhattachary, Toughening and asymmetry in peeling of heterogeneous adhesives, Physical Review Letters 108, 196101 (2012).

F. Barthelat and R. Rabiei, Toughness amplification in natural composites, Journal of the Mechanics and Physics of Solids, 509, p. 829 (2011).

Review articles to be published soon in International Journal of Fracture:

J. Fineberg and E. Bouchbinder, Recent developments in dynamic fracture: some perspectives.

L. Ponson, Statistical aspects in crack growth phenomena.

## 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

**K. Ravi-Chandar** - The University of Texas at Austin, TX, USA

*6 lectures on:* Introduction to fracture mechanics  
I. Introduction to quasi-static fracture mechanics  
II. Dynamic fracture and instabilities  
III. Fracture path and instabilities during slow fracture

**Jean-Baptiste Leblond** - UPMC, Paris, France

*6 lectures on:* Perturbations of cracks  
I. Crack perturbations under mixed-mode I+II  
II. Coplanar crack perturbations under pure mode I  
III. Non-coplanar crack perturbations under mixed mode I+III

**Jay Fineberg** - Jerusalem University, Israël

*6 lectures on:* Non-linear fracture mechanics and friction  
I. Fast fracture in slow motion: Dynamic fracture in brittle gels and the structure of the near-tip region - experiment and theory  
II. Ever more singular: Instability in Dynamic Fracture  
III. Friction is fracture

**Laurent Ponson** - UPMC, Paris, France

*6 lectures on:* Fracture mechanics of heterogeneous materials  
I. Effective toughness of heterogeneous brittle solids  
II. Failure of disordered materials: Intermittent crack dynamics and depinning transition  
III. Roughening mechanisms and application in quantitative fractography

**Alan Needleman** - Texas A&M, TX, USA

*6 lectures on:* Ductile crack growth  
I. Mechanisms of ductile failure and theoretical modeling  
II. Computational fracture mechanics and application to ductile failure  
III. From microstructure to ductile crack growth resistance and vice & versa

**Francois Barthelat** - McGill University, Montreal, Quebec, Canada

*6 lectures on:* Toughening mechanisms in biological materials: Experiments, modeling and bio-inspiration  
I. Experimental tools for fracture mechanics and application to biological materials  
II. Why biological materials are so tough  
III. Toughness of bio-inspired materials

**MECHANICS AND PHYSICS OF FRACTURE: MULTI-SCALE  
MODELING OF THE FAILURE BEHAVIOUR OF SOLIDS**

**Udine, September 26 - 30, 2016**

**Application Form**

(Please print or type)

Surname \_\_\_\_\_

Name \_\_\_\_\_

Affiliation \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

E-mail \_\_\_\_\_

Phone \_\_\_\_\_ Fax \_\_\_\_\_

**Method of payment upon receipt of confirmation (Please check the box)**

*The fee is 575,00 Euro + 22% Italian VAT taxes, where applicable (bank charges are not included).*

I shall send a check of Euro \_\_\_\_\_

Payment will be made to CISM - Bank Account No. 094570210900,  
VENETO BANCA - Udine (CAB 12300 - ABI 05035 - SWIFT/BIC  
VEBHIT2M - IBAN CODE IT46 N 05035 12300 09457 0210900).  
*Copy of the receipt should be sent to the secretariat*

I shall pay at the registration counter with check or VISA Credit Card  
(Mastercard/Eurocard, Visa, CartaSi)

**IMPORTANT: CISM is obliged to present an invoice for the above sum.  
Please indicate to whom the invoice should be addressed.**

Name \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

C.F.\* \_\_\_\_\_

VAT/IVA\* No \_\_\_\_\_

(\* Only for EU residents or foreigners with a permanent business activity in Italy.

**Only for Italian Public Companies**

I ask for IVA exemption (ex law n. 537/1993 - art. 14 comma 10).

**Privacy policy:** I understand that data received via this form will be used only to provide information about CISM and its activities, within the limits set by the Italian legislative decree no. 196/2003 and subsequent amendments.

Complete information on CISM's privacy policy is available at [www.cism.it](http://www.cism.it).

I have read the "Admission and Accommodation" terms and conditions and agree.

Date \_\_\_\_\_ Signature \_\_\_\_\_