Durham University

Mechanics Research Seminar

E240, Higginson Building, School of Engineering and Computing Sciences
Wednesday April 5th 13:00

EMERGING DEFORMATION PATTERNS IN ELASTICITY: FOLDING OF A CONTINUUM, DRIPPING AND SNAKING OF AN ELASTIC ROD AND SELF-OSCILLATING STRUCTURES

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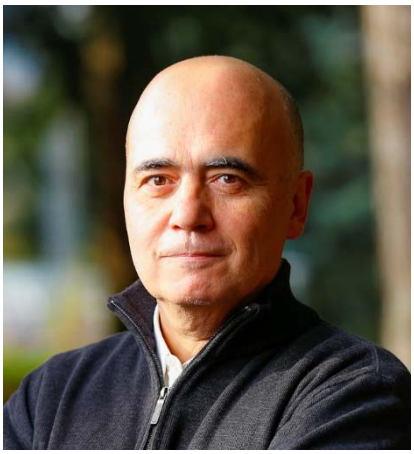
How deformation patterns emerge during extreme loading of an elastic solid or an elastic structure? Buckling and instability has been advocated as a possible explanation of morphogenesis, describing the emergence of brain convolutions of geological structures, and of the undulations of sea shells. Folding is a process in which bending localizes into sharp corners separated by almost undeformed elements. This process is rarely encountered in nature and is difficult to be described within the realm of the Cauchy theory of elasticity. On the other hand, it is shown that folding can be understood as a constitutive instability of a constrained-Cosserat elastic material occurring at the elliptic boundary. The nonlinear theory of elastic rods is a framework for describing bifurcation and instabilities of a number of interesting structures, showing for instance configurational forces analogous to those acting on dislocations in solids. We address the self-encapsulation problem, namely, how the rod can be loaded to assume the shape of a drop, which is suggested by the fact that elastica governs not only bifurcation of rods, but also the oscillating pendulum and the shape of a pendant drop. Self-oscillating mechanical systems reach a limit-cycle oscillation when subject to steady input of energy. An example of this behaviour will be presented as related to the flutter instability of an elastic structure loaded by a force generated through dry friction.



BIOGRAPHY Professor Davide Bigoni is a mechanician working in material modelling (nonlinear elasticity, damage, elastoplasticity, visco- and thermo- plasticity, with applications to ceramic materials, granular media, composites, metals, and biomaterials), wave propagation in solids (with applications to metamaterials), fracture mechanics (with applications to porous media, and rock–like materials) and structural mechanics (with an emphasis on bifurcation and instability). His approach to research is the employment of a broad vision of mechanics, with a combination of mathematical modelling, numerical simulation, and experimental validation. His research activity is addressed to Solid and Structural Mechanics; examples of his results are the perturbative approach to material instability, the folding of an elastic continuum, buckling in tension, flutter induced by friction, the elastica arm scale and the torsional locomotion. He has been awarded an ERC advanced grant in 2013, the maximum recognition for excellence in research in Europe, awarded by the European Research Council. From 2001 Davide Bigoni holds a full professor position at the University of Trento (Italy), where he is leading a very active group in the field of Solid and Structural Mechanics. He has authored or co-authored more than 100 journal papers and has published a book on nonlinear Solid Mechanics. He was elected in 2009 Euromech Fellow (of the European Mechanics Society), has received in 2012 the Ceramic Technology Transfer Day Award (of the ACIMAC and ISTEC-CNR), and in 2014 he has received the Doctor Honoris Causa degree at the Ovidius University of Constanta. He is co-editor of the Journal of Mechanics of Materials and Structures, is associate Editor of Mechanics Research Communications. He was vice chair of the panel PE8 for the European Research Council Starting Grants, panel member: for the Swiss National Science Foundation Starting Grants, for the Excellence Initiative funded by the Government of Spain, and for the Romanian National Council for Development and Innovation. He is reviewer for the Deutsche Forschungsgemeinschaft, for the EPSRC Research Grants (UK), for the Irish Research Council, for the Research Council of Norway, for the Technology Foundation STW of Netherlands, and for the Israel Science Foundation.