Non-linear Metamaterials from Rods and Hinges

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Abstract:

A complete characterization is given of the possible macroscopic deformations of periodic nonlinear affine unimode metamaterials constructed from rigid bars and pivots. The materials are affine in the sense that their macroscopic deformations can only be affine deformations: on a local level the deformation may vary from cell to cell. Unimode means that macroscopically the material can only deform along a one dimensional trajectory in the six dimensional space of invariants describing the deformation (excluding translations and rotations). We show by explicit construction that any continuous trajectory is realizable to an arbitrarily high degree of approximation provided at all points along the trajectory the geometry does not collapse to a lower dimensional one. In particular, we present two and three dimensional dilational materials having an arbitrarily large flexibility window. These are perfect auxetic materials for which a dilation is the only easy mode of deformation. They are free to dilate to arbitrarily large strain with zero bulk modulus.

About the speaker:

Prof Graeme Milton received his PhD degree in Physics from Cornell University in 1985, and a DSc from Sydney University in 2003 based on his book “The Theory of Composites” published by Cambridge University Press. He is currently a distinguished professor of mathematics at the University of Utah, where he served as department chairman from 2002 to 2005. He has been awarded Sloan and Packard Fellowships, the 2003 SIAM Ralph Kleinman Prize for research bridging the gap between mathematics and applications, the 2007 Society for Engineering Science Prager Medal for contributions to theoretical mechanics, and the 2012 Landauer Medal of the ETOPIM association for seminal contributions to the field of composite material science. He is a fellow of Society for Industrial and Applied Mathematics. His main interests are in the fields of composite materials, inverse problems, cloaking theory, discrete networks, electromagnetism and elasticity theory, with over 130 published papers.

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