

Department of Mathematical Sciences, School of Physical
Sciences, University of Liverpool
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RESEARCH DAY
ON
MODELLING OF METAMATERIALS AND
WAVES IN MULTI-SCALE SYSTEMS

2ND March, 2015 (10am-4pm)

Venue: University of Liverpool,
Foresight Centre, Thornton Room,
1 Brownlow St, Liverpool L69 3GL

The event will feature a Keynote Lecture of
Professor Graeme Milton (*University of Utah, USA*)
on
ELASTIC METAMATERIALS

The programme of the Day is attached

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PROGRAMME:

RESEARCH DAY ON MODELLING OF METAMATERIALS AND WAVES IN MULTI- SCALE SYSTEMS

- **10.00-10.20** Coffee, Thornton Room, Foresight Centre
- **10.20 -10.30** Introduction: **A. Movchan**
- **10.30- 11.30** Keynote Lecture: **G.W. Milton**

Elastic Metamaterials

Abstract: Composite materials can have properties unlike any found in nature, and in this case they are known as metamaterials. Materials with negative Poisson's ratio or negative refractive index are now classic examples. The effective mass density, which governs the propagation of elastic waves in a metamaterial can be anisotropic, negative, or even complex. Even the eigenvectors of the effective mass density tensor can vary with frequency. We show that metamaterials can exhibit a "Willis type behavior" which generalizes continuum elastodynamics. Non-linear metamaterials are also interesting and a basic question is what non-linear behaviors can one get in periodic materials constructed from rigid bars and pivots? It turns out that the range is enormous. Materials for which the only easy mode of macroscopic deformation is an affine deformation, can be classed as unimode, bimode, trimode,...hexamode, according to the number of easy modes of deformation. We give a complete

characterization of possible behaviors of nonlinear unimode materials.

- **11.30 -12.10 M. Makwana** *General asymptotic theory for periodic structures*
- **12.10-12.50 S. Haslinger**, *Wiener-Hopf model and flexural waves for semi-infinite arrays of rigid pins*
- **12.50-13.50 Lunch**
- **13.50-14.30 J. O'Neill** *Active cloaking of elastic coated inclusions in resonant regimes*
- **14.30 -15.10 G. Mishuris** *Spontaneous fracture waves propagation in lattices*
- **15.10 -15.50 M. Nieves** *Meso-scale models for elastic bodies with heavily perforated regions*
- **15.50 Tea, Coffee, Concluding discussion**