

## EUROMECH Colloquium 580

### “Wind Farms in Complex Terrains”

11 – 13 July, 2016, Grenoble, France

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EUROMECH Colloquium 580 focused on the nonlinear dynamics of granular media (disordered packings or ordered granular metamaterials) and mechanical metamaterials from a broad perspective. This covered experiments, physical modelling, numerical and analytical methods, applications and connection with industrial problems such as modelling of ballasted railway tracks, silo honking and vibration absorbers in vehicles. The colloquium brought together 54 participants from 11 countries, mixing researchers from the applied mathematics, engineering, nonlinear physics and mechanics communities. The programme comprised 38 talks and 11 poster presentations, leading to many stimulating discussions and exchanges of ideas among participants.

It was extremely useful for the metamaterials community to learn about continuum models and numerical methods developed in the context of disordered granular media or more general systems of interacting particles, and to be aware of up-to-date experimental approaches such as network-based characterisation of force chains. In addition, some nonlinear phenomena which have been discussed in the framework of disordered granular materials may lead to future design principles for metamaterials. Conversely, granular metamaterials provide a simplified framework for investigation of grain- or meso-scale processes in disordered granular media, with the goal of understanding larger-scale phenomena. In this way, some topics which have been discussed in the context of ordered metamaterials and nonlinear mechanical networks could provide interesting new theoretical approaches to achieve deeper insight into the physics of granular matter. For example, theoretical and numerical methods for prediction of nonlinear energy transfer between vibrational modes could find application in analysis of vibration in disordered granular media near the onset of jamming.

The interaction between groups working on mechanical metamaterials on the experimental side and nonlinear lattices on the theoretical side was also extremely fruitful. This connection arises naturally because different types of nonlinear lattices, such as the Fermi-Pasta-Ulam and discrete Klein-Gordon models or mass-in-mass chains, can be realised through various types of mechanical metamaterials reviewed during the conference: granular chains, woodpile phononic crystals, networks of snapping structures, magnets or Helmholtz resonators. As a consequence, different nonlinear wave phenomena investigated theoretically can now be realised experimentally. Colloquium 580 provided a forum to review useful theoretical concepts, suggest design principles inspired by theory and unveil interesting new theoretical problems. As described in several talks, the high tunability of certain metamaterials can lead to new dynamical effects and raise interesting theoretical questions.

Challenging new directions reviewed in the colloquium include the analysis of adhesion effects in microscale or magnetic granular crystals, nonlinear wave phenomena involving rotations of grains, two and three-dimensional wave propagation in granular crystals, interaction of continuous elastic media with nonlinear oscillators and breaking of time-reversal symmetry. Another important concept reviewed during the colloquium is the notion of topologically protected modes, preserved under smooth deformations or imperfections of a metamaterial. Applications of concepts discussed during the colloquium concerned shock mitigation, vibration isolation, wave guiding, nonlinear diodes, mechanical logic gates and detection of cracks.

The colloquium organising committee received highly positive feedback from many participants. EUROMECH Colloquium 580 is expected to foster new collaborations between researchers with different areas of expertise and generate notable contributions to the field. The organisers are grateful to all contributors for the quality of their presentations and active participation, and to EUROMECH and INRIA for essential support.