Preface
Rigidity of periodic and symmetric structures in nature and engineering

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This issue contains papers presented at the Theo Murphy Discussion Meeting *Rigidity of periodic and symmetric structures in nature and engineering*, held at the Kavli Royal Society International Centre, Chicheley Hall, 23–24 February, 2012.

In 1864 James Clerk Maxwell identified a simple counting condition that must hold if an idealised bar-joint structure is to be rigid to first order. Together with Laman's sufficiency condition, revealed only in 1970, this provided the seeds for modern combinatorial rigidity theory, with its matroidal, algebraic and algorithmic tools and perspectives. Symmetry-based methods for finite systems gave added understanding and useful tools and methods. Not surprisingly, in view of its economy and universality, rigidity theory has been taken up in very diverse areas of application. Ideas of rigidity percolation in physics date to the 1980s; the use of rigidity in understanding crystalline solids in earth sciences dates to the 1990s; and the relevance to micro-architectured materials has emerged over the last decade. There is a striking convergence in research themes originating in these apparently disparate topics, where workers in many of these fields are asking similar questions about the influence of periodicity and symmetry. This meeting brought together researchers from many disciplines, interested both in the mathematical methods, and their physical applications.

The papers contained in this special issue cover many aspects of the rigidity of periodic and symmetric structures, including identification and categorisation of periodic nets, frameworks and materials, methods for determining the implications of symmetry for rigidity, and the development of methodologies for flexibility analysis of periodic structures. They will be of interest to diverse constituencies, including: materials scientists, chemists and physicists working on framework materials, especially zeolites and metal-organic frameworks; earth scientists working on crystalline minerals and phase transitions; industrial chemists working on zeolite design, for use as novel catalysts and filters; engineers involved in micro-architectured materials, in particular new smart 'morphing' materials; engineers and architects interested in large repetitive structures used in the built environment; biophysicists and bioengineers interested in the implications of periodicity on the biomechanics of bones and shells. As the papers show, there is a rich mathematical vein to be worked in this area, both in the setting of proper definitions, and their translation for different areas of application. The beautiful microgeometry present in nature, as illustrated by the cover image[1] may also inspire new pure mathematics.

We would like to thank all those who participated in and contributed to the meeting, and the Kavli Royal Society International Centre for their support in hosting this event.

[1] View along the [100] direction of the cubic-symmetry Tschörtnerite zeolite structure. It is a corner-sharing tetrahedral framework that contains open channels. This crystal fragment is six unit cells in length. Courtesy of Mike Treacy, Arizona State University