Aperiodic Crystals: atomic structure and dynamics

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For more than a century the understanding of physical and chemical properties of solids has been based on the notion of periodicity in a crystal, associated to long-range order. The discovery, in a wide range of systems, of solids with long-range order yet without translational periodicity at least in one dimension, led to a new definition of crystals. The crystal definition includes now aperiodic crystals that are characterised by a diffraction pattern whose Bragg peak positions require more than three independent integer indices to be indexed. This encompasses incommensurately modulated phases, incommensurate composites and quasicrystals [1].

This opened a completely new field of research where the understanding of the atomic structure and associated physical and chemical properties has to be reconsidered with new perspectives.

This lecture will provide with an introduction to the fascinating field of aperiodic crystals. Their structure is now well understood using the super-space approach, and this will be illustrated on a few examples. Understanding the physical properties of aperiodic crystals is still challenging. There is however a vibrational excitation that is characteristic to the aperiodic long-range order and named phason mode [1]. Phason modes are predicted to be diffusive like excitations in the longwavelength hydrodynamic limit, whereas a damped propagative mode is predicted in specific cases at shorter wavelength. I will review results obtained for the measurement of phason modes in the three classes of aperiodic crystals illustrating the common behaviour of this excitation [1].

[1] T. Janssen, G. Chapuis, and M. de Boissieu, *Aperiodic Crystals. From modulated phases to quasicrystals (second edition)* (Oxford University Press, Oxford, 2018), Vol. 20, IUCr Monographs on Crystallography.