Phasons modes and dynamics of aperiodic crystals.

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The notion of crystal has, for long time, been associated with periodicity and believed to be the only possible form of long-range order in matter. The understanding of physical and chemical properties of solids has been also largely based on the notion of periodicity in a crystal. There is however a large class of materials, named aperiodic crystals, which are long range ordered, yet without lattice translation at least in one dimension. Aperiodic crystals fall in three classes [1]: incommensurately modulated phases, incommensurate composites and quasicrystals and are found almost 'everywhere': in minerals, single element under pression, organic compounds, intermetallic, oxydes, ferrolectrics… and even proteins. The lack of periodicity in aperiodic crystals, yet with long range order, opened a completely new and fascinating field of research where the understanding of the atomic structure and associated physical and chemical properties had to be reconsidered with new perspectives.

In this talk I will illustrate how the theory developed over the years together with recent advances in diffraction experiments has allowed a precise understanding of the atomic structure and crystal chemistry of such complex phases. The physical properties of aperiodic crystals is a very active field with open questions due to the lack of periodicity. There is however a property unique to all aperiodic crystals and named phason modes, which I will introduce. Experimental results in the three classes of materials and the link with dynamics will be then presented.

[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, 532 pages.