Introduction to aperiodic crystals and hypermaterials.

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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 atomic structure is described as a periodic arrangement of a 'decorated' unit cell. The discovery, in a wide range of systems, of solids with long-range order, characterized by Bragg peaks in their diffraction pattern, yet without translational periodicity at least in one dimension has 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 new class of materials is named aperiodic crystals and they are classified in three families:
(i) Incommensurately modulated phases, (ii) incommensurate composites and (iii) quasicrystals. Their atomic structure is best described using superspace crystallography as invented by P. de Wolf, A. Janner and T. Janssen (3-4).
In this lecture, after a brief reminder of 3D periodic crystallography and diffraction (1, 2), I will introduce the different classes of aperiodic crystals and hypermaterials on a few examples (3-4). A brief introduction to the super-space crystallography will also be given (3-4).

References:

[1] The Basics of Crystallography and Diffraction, C. Hammond, Oxford University press, 2016
[2] A series of applet introducing crystallography is available at the EPFL, Lausanne web site: https://www.epfl.ch/schools/sb/research/iphys/teaching/crystallography/
[3] Aperiodic crystals: from modulated phases to quasicrystals, T. Janssen, G. Chapuis, M. de Boissieu, Oxford University Press 2018 (second edition)
[4] Janssen, T. & Janner, A. Aperiodic crystals and superspace concepts. Acta Cryst. B 70, 617-651 (2014)