

*Quasicrystals. what do we know - what can we know?*

Walter Steurer<sup>1</sup>

<sup>1</sup>Department Of Materials, ETH Zürich, Zürich, Switzerland  
E-mail: steurer@mat.ethz.ch

Formally, the description of periodic and quasiperiodic structures seems to be quite similar. Both can be represented by the contents of their  $nD$  unit cells and  $nD$  space groups, with  $n=3$  in the first case and  $n > 3$  in the second. The fundamental difference between periodic and quasiperiodic structures is in their long-range order (lro). The lro of a 3D periodic crystal can be fully described by one of the fourteen 3D Bravais lattices. In the case of a 3D quasicrystal (QC), there exists an infinite number of different quasiperiodic tilings that can underlie its quasiperiodic structure. Its  $nD$  Bravais lattice ( $n > 3$ ) is not sufficient for fully defining the lro. For that purpose, also the  $(n-3)D$  atomic surfaces (occupation domains) decorating the  $nD$  unit cells have to be known in detail. In other words, both short- and long-range order are coded in the atomic surfaces. There are approximately one hundred stable decagonal and icosahedral QCs known so far in binary and ternary intermetallic systems. While we already know many fascinating details about the yet increasing number of QCs, the big picture shows many white spots. Even some fundamental questions are still open. What do we know about their structures and the ways they can disorder? How far do we understand the principles of their formation and growth? Is the state of the art in quasicrystal research already comparable to that in complex intermetallics? What can we learn from the studies on mesoscopic quasicrystals for the structure formation of intermetallic quasicrystals? A fundamental question is, what exactly do we have to know and to prove experimentally before we can say we fully understand the formation of quasicrystalline order.

In the talk, we will shortly address what has been achieved and what are the future goals and challenges in QC research. For more information see [1-3].

[1] Steurer, W. (2017). J. Phys.: Conf. Series in the press.

[2] Steurer, W. & Deloudi, S. (2014). C. R. Physique 15, 40-47.

[3] Steurer, W. & Deloudi, S. (2009) Crystallography of Quasicrystals. Concepts, Methods and Structures. Springer Series in Materials Science, Vol. 126. XIV, 384 p. Springer, Heidelberg 2009.

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