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Intermediate quasiperiodic-periodic structures

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Since the recognition of quasicrystals for what they are a plethora of pentagonal, octagonal, decagonal and dodecagonal structures have been observed in several alloy systems. These structures are quasiperiodic in a plane and periodic in its perpendicular direction. Incommensurate crystals, aperiodic in one direction have, of course, been known for decades. At the same time, the mathematical aspects of tilings with the mentioned symmetries and aperiodic chains have been intensively studied as well. It is therefore interesting to study intermediate structures in which the periodic and quasiperiodic directions are intrinsically connected. One way to do so is by cutting and projecting a periodic structure in $D(>3)$ dimensions into three-dimensional space in such a way that the second cut-and-projection be quasiperiodic in a plane. We have achieved this earlier in the octagonal case [1] and partly in the dodecagonal case [2]. Here we briefly review these and present an improved dodecagonal version. We also present a new look at the pentagonal, or rather decagonal, case. In the octagonal case we cut and project first the four-dimensional simple cubic lattice $\mathbf{Z}^4$ into $\mathbf{R}^3$ and then into a suitable irrational $\mathbf{R}^2$. In the dodecagonal case we start with the root lattice D_4 (in the earlier version it was $\mathbf{Z}^6$). For the pentagonal/decagonal case we have two variants: (1) In the "straightforward" version we start with the five-dimensional simple cubic lattice $\mathbf{Z}^5$, project it into an irrational $\mathbf{R}^3$ and then onto an $\mathbf{R}^2$. (2) In the "minimal" version we project the root lattice A_4 into an irrational $\mathbf{R}^3$ and then into an $\mathbf{R}^2$.

[1] S.I. Ben-Abraham, *Ferroelectrics,* 305 (2004) 29-32.
[2] S.I. Ben-Abraham, Y. Lerer, Y. Snapir, *J. Non-Cryst. Solids,* 334&335 (2004) 71-76.

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Polydisperse TiO_2 particles with metal-modified surface: XRD and AFM studies

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Polydisperse titanium dioxide (TiO_2) is now one of the most popular investigated object among metal oxides due to its wide applications in modern technologies.
TiO_2 materials of a high chemical purity, as-prepared and modified by metal cations (Fe^{3+}, Co^{2+}, Cu^{2+}), have been investigated by the X-ray diffraction, X-ray fluorescence and AFM methods. All TiO_2 powders have a fine-dispersated anatase structure and consist of grown together nanocrystallites of ~ 8 - 17 nm. TiO_2 particles, usually ranging from 100 to 600 nm, show the ability to form large agglomerates, up to 2 (m in size. Contrary to pure anatase, metal-modified TiO_2 particles possess a positive charge on their surface and can be lifted away by the AFM tip from the substrate surface during the scanning. The possible interaction mechanisms between different TiO_2 particles and a silicon tip are discussed. The electrostatic force has been found to play an essential role in the sample - tip interaction processes, and its value depends on the type of metal cation used.