Poster Sessions

On the basis of careful examinations of diffraction peak appearances, we find a striking feature that the stacking periods are extended into extremely long distances, typically being longer than ~100Å. Furthermore, even though there are many stacking sequences possible for a given periodic length, each of the observed stacking structures can be uniquely determined according to the polytype series generated by a hyperspace crystallography, as combined with an systematic introduction of shear strains for a hyper-cubic crystal. This intriguing fact in turn implies that the occurrence of the present long-period variants is restricted by the hidden order along the hyperspace dimension. For understanding an origin of this restriction in terms of temperature dependence of the length-scale change, we applied axial next-nearest-neighbour ising model to the present polytype structures, by defining the stacking direction parameters with an analogy of up-down spin configurations. According to the Monte Carlo simulations, we are able to reproduce the intense peak shift depending on temperature. This suggests that the second nearest-neighbour interactions play a critical role for realizing the extremely long-period order and perhaps incommensurate aperiodic order.

Keywords: quasicrystal, polytype, incommensurate

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Application of average unit cell concept to 3D Ammann-Kramer tiling

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Ammann-Kramer tiling is a 3D generalization of the Penrose tiling. It consists of two kinds of structure units: prolate and oblate rhombohedra with all edge lengths equal. All faces of the structure units are identical rhombuses. The ratio of the face diagonals is equal to \( \tau \), and the acute angle amounts to \( \arctan(2) = 63.44^\circ \). The volume ratio of the unit tiles as well as the ratio of their frequencies in the tiling also equals \( \tau \). Ammann-Kramer tiling reveals an icosahedral symmetry, thus it can be used as a quasilattice for building a model of an icosahedral quasicrystal.

One can generate the set of points of the Ammann-Kramer tiling by projecting a 6D hypercubic lattice via 3D window – the so called atomic surface. In case of the tiling the atomic surface has the shape of a rhombic triacontahedron (Fig.1).

We present a derivation of the structure factor of the Amman-Kramer tiling by projecting a 6D hypercubic lattice via 3D window – the so called reference atomic surface. In case of the tiling the atomic surface has the shape of a rhombic triacontahedron (Fig.1).

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The position distribution of Amman-Kramer tiling points satisfies the average unit cell concept (Fig.1). Because of the aperiodicity of the tiling the distribution \( P(u,v,w) \) should be related to another one \( P(v,x,y) \), whose lattice constants are elongated by \( \tau \). A 6D distribution \( P(u,v,w,v,v,v) \) is only nonzero along lines: \( v = \pm u \). This is a characteristic feature of quasicrystalline lattices. One can show that there is a linear relation between the shape of the distribution and the shape of the atomic surface. A structure factor for any scattering vector can be calculated as a Fourier transform of this distribution. It is important to see that because of the characteristic relation between \( v \) and \( u \), the Fourier transform actually reduces to a 3D integral.

The comparison between structure factors obtained with three methods (numerical calculations, in the perpendicular space and with average unit cell concept) will be presented to show the perfect agreement. The results of first attempts to fit the Cd-Yb [4] experimental data to our model will be discussed.

Keywords: quasicrystal, polytype, incommensurate

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Multidimensional paperfolding substitution structures

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We succeeded to generalize the substitution for the regular one-dimensional paperfolding sequence to two and more dimensions enabling us to construct multidimensional paperfolding structures. We elaborate the algorithm in detail. Here we explicitly present a two-dimensional example of the structure. We display the successive generations using the alphabet \{+ , \} as well as a “realistic” image of a folded paper sheet. We show the calculated Fourier spectrum which is known to have a dense pure point (Bragg) part. We compute the rectangle complexity which is polynomial and hence the entropy vanishes.

Keywords: paper folding structure, substitution

Figure 1. Atomic surface (left) and the average unit cell (right) for Ammann-Kramer tiling.