MM 40: Quasicrystals I

Time: Thursday 10:15–11:30 Location: IFW D

MM 40.1 Thu 10:15 IFW D

The hydrodynamic structure factor of quasicrystals — •Andreas Chatzopoulos and Hans-Rainer Trebin — Institut für Theoretische und Angewandte Physik, Universiät Stuttgart, Germany

A theory of the hydrodynamic structure factor of quasicrystals is developed and exploited. Based on the hydrodynamic equations for icosahedral quasicrystals we introduce the terms of dynamic correlation and response. For a better understanding of phonon and phason dynamics in reciprocal space we determine in a first step the hydrodynamic structure factor in one dimension.
In three dimensions the anisotropic phasonic peak shapes of the static structure factor are reproduced depending only on the ratio of the two phason elastic constants[1].
Then we show the dynamic extension and illustrate the effect of frequency and kinetic coefficient.

[1] M. de Boissieu et al. *Physical Review Letters*, 75(1): 89-92, 1995.

MM 40.2 Thu 10:30 IFW D

Can Kinematic Diffraction Distinguish Order from Disorder? — Michael Baake[1] and •Uwe Grimm[2] — [1]Fakultät für Mathematik, Universität Bielefeld, Postfach 100131, 33501 Bielefeld, Germany — [2]Department of Mathematics and Statistics, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK

Diffraction methods are at the heart of structure determination of solids. While Bragg-like scattering (pure point diffraction) is a characteristic feature of crystals and quasicrystals, it is not straightforward to interpret continuous diffraction intensities, which are generally linked to the presence of disorder. However, based on simple model systems, we demonstrate that it may be impossible to draw conclusions on the degree of order in the system from its diffraction image. In particular, we construct a family of one-dimensional binary systems which cover the entire entropy range but still share the same purely diffuse diffraction spectrum.

MM 40.3 Thu 10:45 IFW D

In search of multipolar order on the Penrose tiling — •Elena Y. Vedmedenko[1], Ron Lifshitz[2], and S. Even-Dar Mandel[2] — [1]University of Hamburg, Jungiusstr. 11, 20355 Hamburg — [2]Tel Aviv University, 69978 Tel Aviv, Israel

We use Monte Carlo calculations to analyse multipolar ordering on the Penrose tiling, relevant for two-dimensional molecular adsorbates on quasicrystalline surfaces and for nanomagnetic arrays. Our initial investigations are restricted to multipolar rotors of rank one through four positioned on the vertices of the rhombic Penrose tiling. At first sight, the ground states of odd-parity multipoles seem to exhibit long-range order, in agreement with previous investigations of dipolar systems. Yet, careful analysis performed here establishes that long-range order is absent for all types of rotors, and only short-range order exists. Nevertheless, we show here that short-range order suffices to yield a superstructure in the form of the decagonal Hexagon-Boat-Star tiling.
[1] E. Y. Vedmedenko, S. Even-Dar Mandelb and R. Lifshitz, Phil. Mag. 88, 2197 (2008).

MM 40.4 Thu 11:00 IFW D

Scaling Behavior of the Participation Ratio in d-dimensional Quasiperiodic Models based on the Octonacci Sequence — •Stefanie Thiem and Michael Schreiber — Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz, Germany

The characteristics of quasicrystals are determined by the nature of their eigenstates. Studying the scaling behavior of the participation ratio p is a practicable way to obtain the localization properties of these wave functions. We investigate d-dimensional quasiperiodic models based on the octonacci sequence and prove that the scaling exponent is independent of the dimension for these models.

The eigenstates of the octonacci chain are obtained by numerical calculations for a tight-binding model. Higher dimensional eigenstates of the associated labyrinth tiling are constructed then by a product approach from the one-dimensional results, allowing the numerical consideration of large systems up to 10^{11} sites. We give explicit construction rules for the energies E and wave functions $\Phi_{\mathbf{r}}$ in d dimensions.

The participation ratio $p = \frac{1}{V}\left[\sum_{\mathbf{r}} |\Phi_{\mathbf{r}}|^4\right]^{-1}$ is studied in one, two, and three dimensions. It is a known result that p scales for fractal states with $p \sim V^{-\gamma}$ $(0 < \gamma < 1)$ in the number of sites V. We calculated the scaling exponent γ of the average participation ratio $\langle p \rangle$ over all eigenstates for different dimensions and various strengths of the coupling parameter v $(0 < v < 1)$. These results suggest that $\gamma(v)$ is independent of the dimension d. We also give a mathematical proof for the dimension independence of this scaling exponent using the product structure of the labyrinth tiling.

MM 40.5 Thu 11:15 IFW D

Structures of Colloidal Quasicrystals — •Johannes Roth — ITAP, Universiät Stuttgart, Germany

Quasicrystals and archimedean-like tilings formed by strips of squares and triangles have recently been observed in experiments of colloidal particles on laser-generated quasicrystalline substrate potentials (Nature **454**, 501 (2008)). Restricted square-triangle tilings are also present in a model of binary dipolar colloids. We will present several classes of restricted square-triangle tilings and will study their properties by Monte-Carlo simulations.

In a second part we will discuss the properties of quasicrystalline laser potentials with respect to the number of beams. We find that there are significant differences between the five-fold case generated by linearly polarized light on the one hand and other polarizations or seven-fold symmetry on the other hand. In the first case the trapping sites form a structure close to a quasiperiodic tiling while in the second case there are low lying saddle points and far fewer deep minima.