

An eight-fold quasiperiodic tiling with cold atoms

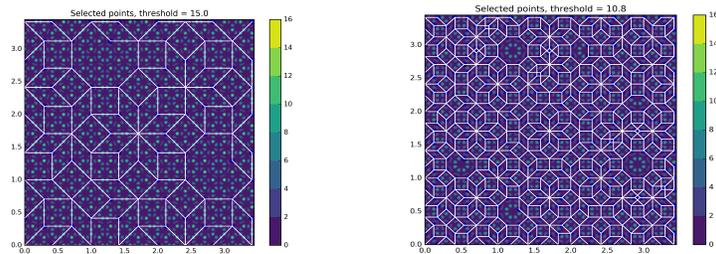
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With the discovery of the first quasicrystals, the quest began for, on the one hand, new quasiperiodic systems with better characterization of structural properties, and on the other hand, for theoretical methods to handle these systems. One of the goals of experiment has been, in particular, obtaining a single component quasicrystal, in the hope of finding direct relationships between its physical and geometrical properties. This may we hope become possible in cold atom systems. Cold atoms in optical lattices have been used to simulate quantum behavior of periodic crystals, but not, thus far, of quasiperiodic tilings. Tilings, of which the best known examples are the Fibonacci chain (in 1 dimension) or Penrose (in 2 dimensions) or the icosahedral tiling are the equivalent of the Bravais lattices for periodic crystals. Thus, tilings are commonly used in theoretical models for quasicrystals, and it is of great interest to devise a quantum simulator for them.

Two examples of optical tilings



We have described a scheme ¹ for realizing a tiling by trapping cold atoms in a laser generated potential having eight-fold symmetry. The optical tiling thus obtained is very similar to the well-known Ammann-Beenker tiling (see figs). The relation between the two tilings can be readily seen by moving to a higher 4-dimensional representation of the laser potential. We will describe the two structures and we will show how, by adding interparticle repulsive interactions, one can obtain the perfect quasiperiodic Ammann-Beenker tiling in the experimental setup.

Such a system, if realized, would make it possible to simulate the Heisenberg model for quantum spins, the Hubbard model for interacting particles and other important theoretical models in a perfect 2D quasicrystal.

1. A.Jagannathan & M.Duneau, *The eight-fold way for optical quasicrystals*, EPJB 87, 149, 2014