Degenerate Quasicrystal of Hard Triangular Bipyramids Stabilized by Entropic Forces

AMIR HAJI-AKBARI, MICHAEL ENGEL, SHARON GLOTZER, University of Michigan — The assembly of hard polyhedra into novel ordered structures has recently received much attention. Here we focus on triangular bipyramids (TBPs)- i.e. dimers of hard tetrahedra- which pack densely in a simple triclinic crystal with two particles per unit cell [1]. This packing is referred to as the TBP crystal. We show that hard TBPs do not form this densest packing in simulation. Instead, they assemble into a different, far more complicated structure, a dodecagonal quasicrystal, which, in the level of monomers, is identical to the quasicrystal recently discovered in the hard tetrahedron system [2], but the way that tetrahedra pair into TBPs in the nearest neighbor network is random, making it the first degenerate quasicrystal reported in the literature [3]. This notion of degeneracy is in the level of decorating individual tiles and is different from the degeneracy of a quasiperiodic random tiling arising from phason flips [4]. The (3.4.3^2.4) approximant of the quasicrystal is shown to be more stable than the TBP crystal at densities below 79.7%.