**Mosaic Two-lengthscale Quasicrystals**

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Over the past decade quasicrystalline order was reported in many soft-matter systems including dendrimers, star terpolymers, and diblock copolymer micelles, establishing soft quasicrystals (QCs) as an integral part of the field. The existence of QCs in solutions of fuzzy macromolecular micelles suggests that they must be induced by a generic mechanism rather by specific chemistry. The most evident common feature of micelles stemming from their open architecture is softness but so far no direct link to quasicrystallinity has been established. We explore a model which captures certain aspects of the soft micelle-micelle interaction, showing that it leads to a hierarchy of novel random QCs. Using numerical simulations, we study two-dimensional hard disks decorated with square-shoulder repulsion to find a coherent sequence of QCs with 10-, 12-, 18-, and 24-fold bond-orientational order. These QCs originate from mosaics of tiles based on local arrangements of the particles which can be regarded as generalizations of the hexagonal lattice. The two-lengthscale pair potential responsible for the novel phases is much more transparent than the quantum-mechanical interatomic forces in metallic-alloy QCs, and it suggests that quasicrystallinity can be related to universal packing principles which may well apply to a range of objects from atoms to macromolecular assemblies