MS23 Quasicrystals and complex intermetallic materials

MS23-02

Square-triangle tilings: an infinite playground for soft matter

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Abstract

Regular square and triangle, two very simple geometrical figures, can be used to construct a fascinating variety of tilings which cover the 2D plane without any overlaps or holes. Such tilings are observed in many soft matter systems. We follow a geometrical approach based on the lifting of a tiling in a four-dimensional superspace. A classification of all possible globally uniform square-triangle phases is obtained by taking into account both the overall composition and the orientations of the two kinds of tiles [1]. Special square-triangle phases encountered in soft matter systems are described in this context: The ArchimedeanΣand H phases, the striped phases and the 12-fold maximally symmetric phases. Geometrical constraints on boundary lines and junction points between domains of different compositions are predicted, a situation likely to be encountered in experimental and numerical studies.

Recent numerical simulations evidence new quasicrystal phases with octagonal symmetry [2]. They are observed in the self-assembly on a plane of a binary mixture of small and large hard spheres. Remarkably, the octagonal symmetry results from the association of three type of tiles: isosceles triangle combined with small and large squares. The relative concentration of the three tiles can be continuously varied by tuning the number of smaller spheres present in the system. Such octagonal quasicrystals open the way to a new family of square-triangle tilings.

References

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[2] E. Fayen, M. Impéror-Clerc, L. Filion, G. Foffi and F. Smallenburg, under review, arXiv:2202.12726v1