Multiple-scale structures: from Faraday waves to soft-matter quasicrystals

Samuel Savitz[1], Mehrtash Babadi[2], Ron Lifshitz[3]

[1]*Condensed Matter Physics, California Institute of Technology, Pasadena, CA 91125, USA*

[2]*Broad Institute of MIT and Harvard, Cambridge, MA 02142, USA*

[3]*Raymond and Beverly Sackler School of Physics & Astronomy, Tel Aviv University, Tel Aviv 69978, Israel*

ronlif@tau.ac.il

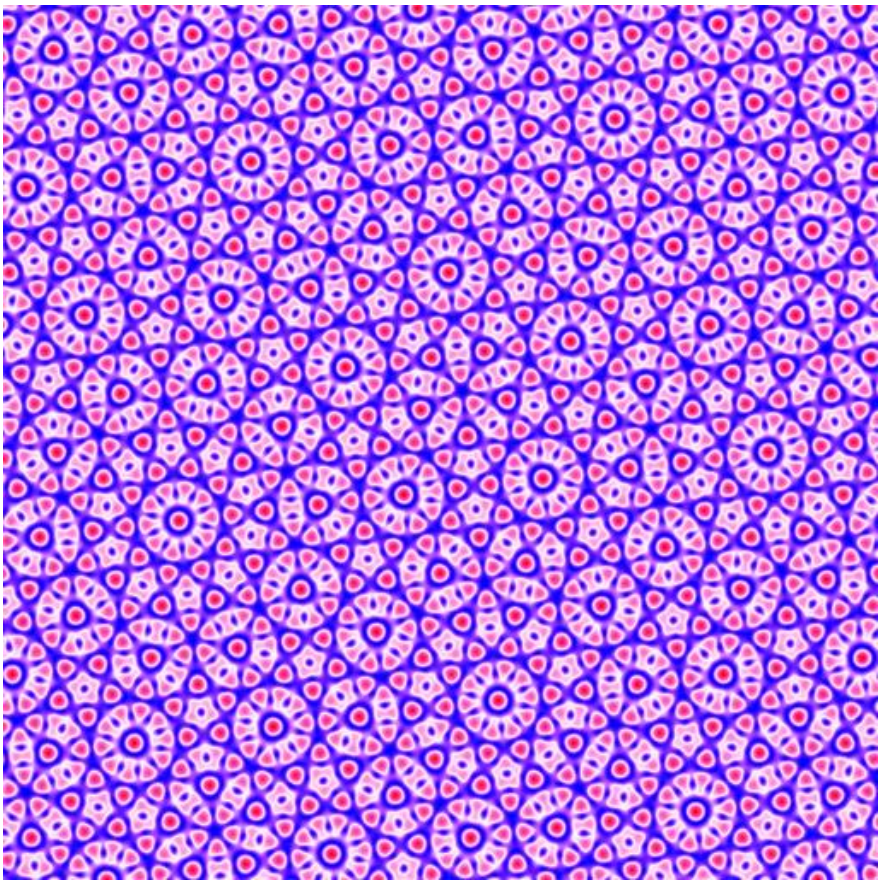

Figure 1. Predicted thermodynamically stable decagonal quasicrystal in the model of Barkan, Diamant, and Lifshitz [1]. Red shades correspond to positive field values and blue shades to negative values. Note the abundance of blue or white areas which are interspersed with bright red spots. This asymmetry between positive and negative values is what makes the structure so stable in this model. Taken from Ref. [2].

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For many years, quasicrystals were observed only as solid-state metallic alloys, yet current research is now actively exploring their formation in a variety of soft materials, including systems of macromolecules, nanoparticles and colloids. Much effort is being invested in understanding the thermodynamic properties of these soft-matter quasicrystals in order to predict and possibly control the structures that form, and hopefully to shed light on the broader yet unresolved general questions of quasicrystal formation and stability. Moreover, the ability to control the self-assembly of soft quasicrystals may contribute to the development of novel photonics or other applications based on self-assembled metamaterials. Here a path is followed, leading to quantitative stability predictions [2], that starts with a model developed two decades ago [3] to treat the formation of multiple-scale quasiperiodic Faraday waves (standing wave patterns in vibrating fluid surfaces) and which was later mapped onto systems of soft particles, interacting *via* multiple-scale pair potentials [1,4]. The presentation reviews, and substantially expands, the quantitative predictions of these models, while correcting a few discrepancies in earlier calculations, and presents new analytical methods for treating the models. In so doing, a number of new stable quasicrystalline structures are found with octagonal, octadecagonal and higher-order symmetries, some of which may, it is hoped, be observed in future experiments.

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