Thermodynamic Stability and Dynamical Metastabilty of Soft-Matter Quasicrystals *via* Interactive GPU-Accelerated Simulations using a Stabilized Langevin-Verlet Integrator

Samuel Savitz[1], Ron Lifshitz[2]

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

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

Sam@Savitz.org

We begin by briefly reviewing the Lifshitz-Petrich (LP) model [1, 2], which is based on the Swift-Hohenberg equation [3] and was motivated by the observation of quasicrystalline patterns in Faraday waves [4]. The LP model succeeds in stabilizing decagonal and dodecagonal quasicrystals through the introduction of three-body interactions and a second length scale.

We will proceed to demonstrate interactive, GPU-accelerated simulations of the LP model, which clearly show dynamics of the various phase transitions to and from quasicrystals, periodic crystals, and the uniform liquid state. A screenshot, shown in Fig. 1, demonstrates a thermodynamically stable decagonal domain in the process of overtaking a metastable periodic hexagonal phase. The octic UV divergence in the LP dispersion relation requires us to introduce a novel stabilized Langevin-Verlet integrator which applies both friction and thermal noise and can be adjusted to produce arbitrarily accurate approximations to the Boltzmann ensemble at any given temperature. These simulations are not mere amusement; they also provide a quick means by which to confirm analytic stability and metastability predictions made by the LP model, up to finite-size and non-zero temperature effects.

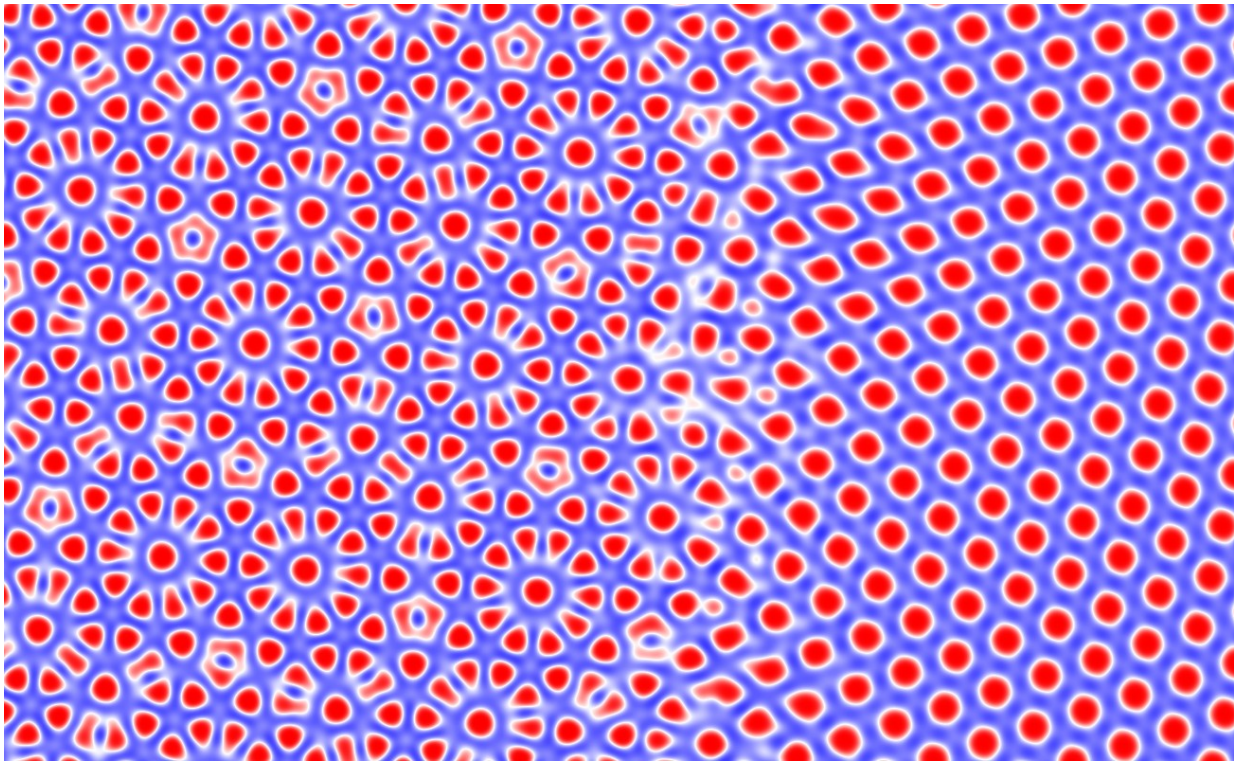

Figure 1. A cropped screenshot of the interactive GPU-accelerated soft quasicrystal simulation. Here, a thermodynamically stable decagonal quasicrystalline phase on the left is shown in the process of overtaking the periodic metastable hexagonal phase on the right.

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