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Periodic Minimizers of A Ternary Nonlocal Isoperimetric Problem

We study a two-dimensional ternary inhibitory system. The free energy functional combines an interface energy favoring micro-domain growth with a Coulomb-type long range interaction energy which prevents micro-domains from unlimited spreading. Here we consider a limit in which two species are vanishingly small, but interactions are correspondingly large to maintain a nontrivial limit. In this limit two energy levels are distinguished: the highest order limit encodes information on the geometry of local structures as a two-component isoperimetric problem, while the second level describes the spatial distribution of components in global minimizers. We provide a sharp rigorous derivation of the asymptotic limit, both for minimizers and in the context of Gamma-convergence. Geometrical descriptions of limit configurations are derived. The main difficulties are hidden in the optimal solution of two-component isoperimetric problem: compared to binary systems, not only it lacks an explicit formula, but, more crucially, it can be neither concave nor convex on parts of its domain.