Spontaneous Chiral Symmetry Breaking in 2D Aggregation

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Abstract Recent experiments [1] using ionized-cluster-beam (ICB) deposition have revealed unusual "seahorse"-like growth patterns. These patterns possess a spontaneously broken chiral (left/right) symmetry, despite the fact that the particles constituting the aggregate are symmetric. We develop a continuum quasi-equilibrium growth model, assuming that the growing aggregate is charged, and that the incoming particles are polarizable, and hence attracted to regions of strong electric field. This model is used both for theoretical analysis and numerical simulation of the growth process. We find that our model possesses a *chiral instability.* That is, during the growth, the system amplifies enormously even tiny left-right asymmetry (which may arise due to noise). This instability leads to the formation of S-like patterns like those seen experimentally. The origin of this instability is the long-range interaction (competition and repulsion) among growing branches of the aggregate, such that a right or left side consistently dominates the growth process. We also show that the electrostatic interaction can account for the principal geometrical properties of the aggregates, such as the existence of only 2 main arms, and the "finned" external edge of the main arms.

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