Frustrated crystalline order in confined long-range interacting particles

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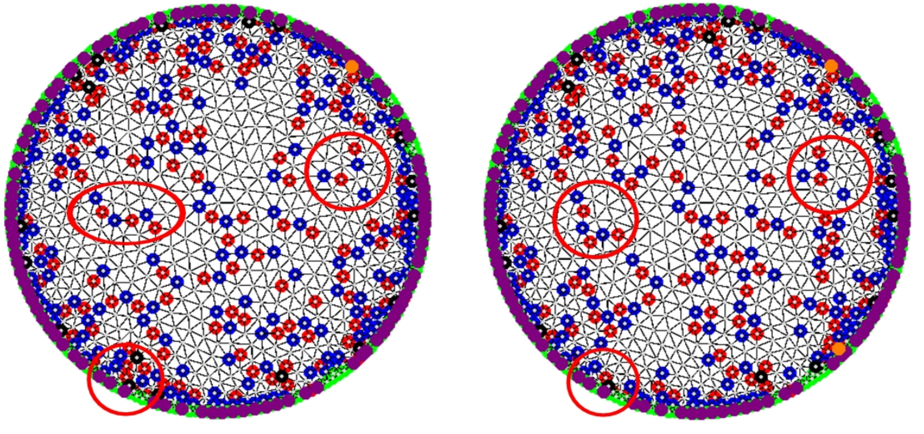
Packing of interacting particles has been a fruitful model to understand a wide variety of systems from the assembly of viruses to the melting of crystals. It has been well established that for short-ranged potential, Nature's algorithm will guide the particles to be evenly distributed, developing an ordered crystalline structure. However, our recent simulation study on the evolution of a collection of electrically charged particles confined in a planar disk, discloses a fundamentally distinct scenario. We find that when particles can communicate with each other remotely via a long-range potential, more and more particles are squeezed towards the boundary. As a result, the crystalline order is observed to be frustrated by proliferating topological defects, as if the particles are living on a saddle-like surface where the formation of topological defects has been well understood. These peculiar behaviors can ultimately be traced back to the modification of the local particle-particle distance by the long-range potential. The disclosed frustration of crystalline order by long-range potential in this work gives us new thinking on crystallization, in particular, in general long-range interacting systems.



(a) (b)

The evolution of topological defects in the relaxation process of a two-dimensional Coulomb cluster. During this process, the total interior topological charge converges to a negative constant.

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