

Coexistence and pattern formations in the rock-paper-scissors game on the heterogeneous lattice system

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ABSTRACT

Most existing works for spatial rock-paper-scissors (RPS) game have been studied on the one patch defined by a square lattice with periodic boundaries. In the real world, however, the spatial structure in which individuals actually act is more complex. In order to investigate more realistic behaviors on complex spatial structures, we consider that the spatial domain is defined by the attachment of two square lattices, where two lattices have different sizes and share the interior boundary. Utilizing fundamental rules of the spatial rock-paper-scissors game, we investigate the effect of a heterogeneous structures on biodiversity in the RPS game. By measuring the mean extinction time and the extinction probability for the given evolution time, we found there exists a critical mobility to result in extinction, which arises from small domain sizes. In addition, when all species coexist, we also found that pattern formations can appear in different ways, either spiral-spiral or spiral-layer waves, associated to specific oscillations of species density. Our findings may provide a new perspective on the biodiversity of the cyclic game in more complexly formed spaces.

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