Epidemic percolation among motility-induced clusters of active particles

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In this work, we study the spread of susceptible-infected-recovered (SIR) epidemics—or other sorts of information exchange by contact—in two-dimensional spatially structured systems. We employ a model of self-propelled particles which spontaneously form multiple clusters. Particles are embedded in a square lattice and each site has at most one particle. Each particle has a self-propulsion velocity of constant magnitude and reorientation rate. We show that, even for global concentrations below the site percolation threshold, there is a critical infection rate above which motion is capable of effectively inducing an *epidemic percolation* by bridging clusters together over time. This phase transition survives in the thermodynamic limit, which is not true in the one-dimensional case [1]. The final fraction of ever-infected individuals peaks at intermediate reorientation rate. This can be explained either via the fraction of mobile particles or via the network of unique contacts integrated over a characteristic time window. We hope that our results can provide useful insights into active matter with transmission of internal states by contact, in particular toward the context phage therapy where viruses are used to kill bacterial colonies.

References

[1] P. de Castro, F. Urbina, A. Norambuena, and F. Guzmán-Lastra, Physical Review E 108, 044104 (2023

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ORAL