[P8] Research on Interacting Particle Systems Motivated by Microbial Division of Labor

Jin-Hyeon Kim, Korea University

Division of labor is believed to underlie many important evolutionary transitions including the evolution and proliferation of multicellularity. In this research, we formulate interacting particle system model for the emergence of multicellular organisms from unicellular cells cooperating through division of labor. First, we present the mean-field analysis of the model to explain the basic effect of division of labor. From the linear stability analysis, we construct the phase diagram showing the conditions that co-existence of species doing division of labor is predominant and maintained. Further, we perform the extensive stochastic simulation of the lattice version of the model in 1D to examine the effect of dimensionality and stochasticity. Depending on the effective cooperation rate, the model exhibits two different “phases.” When the cooperation effect is weak, the system is dominated by the segregated single-species domains, in each of which each species is living separated from the other by a well-defined boundary. On the other hand, when the cooperation effect is strong enough, the mixed-species domain emerges, within which both species live and mingle together. Within such domain, different species cells tend to locate adjacent to each other and effectively behave like bi-cellular organisms. We characterize this “phase transition” and critical phenomena from the perspective of nonequilibrium phase transition.