Spatial coagulation processes: large deviations and phase transitions.

We consider a spatial Markovian particle system with pairwise coagulation: after independent exponential random times, particle pairs merge into a single particle, and their masses are summed. We derive an explicit formula for the joint distribution of the particle configuration at a given fixed time, which involves the binary trees describing the history of how each of the particles has been formed via coagulations. While usually these processes are studied with the help of PDE (generalisation of the well-known Smoluchowski equation), our approach comes from statistical mechanics. The description is indeed in terms of a reference process, a Poisson point process of point group distributions, where each of the histories is an independent tree, and the non-coagulation between any two of them induces an exponential pair-interaction. Based on this formula, we give a large-deviation principle for the joint distribution of the particle histories in the limit of many particles with explicit identification of the rate function. We characterise its minimizer (the limit of the configuration) and give criteria for the occurrence of a gelation phase transition, i.e., a loss of mass in the limiting configuration.

This talk is based on an ongoing joint work with W. König, H. Langhammer and R.I.A. Patterson (WIAS Berlin).