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A statistical model to study stochastic transport systems with finite resources

There are many real-life physical as well as biological phenomena which depend upon the limited availability of resources. For instance, finite medium engrossed in vehicular and pedestrian dynamics and ribosomes involved in translation process during protein synthesis etc. In particular, biological transport involving molecular motors is also far from being infinite. Motor proteins namely kinesin, dynein and myosin, execute active motion along microtubule filaments serving as macromolecular highways to and from within far-away locations. The transit progression of systems entrusting on the availability of resources requires a balance between available amount and requirement. This circumstance results in the competition for finite resources, thereby influencing the system dynamics considerably.

In this presentation, I will talk about a statistical model namely two-lane asymmetrically coupled Totally Asymmetric Simple Exclusion Process with Langmuir Kinetics to study the impact of the limited supply of particles on stochastic transport systems. We propose a generalized mean-field theory to solve the resulting complex system using singular perturbation technique which is able to explain the rich dynamics arose due to the significant effect of limited resources. Moreover, we have shown that extensively performed Monte Carlo simulation results are in good agreement with simulation results validating our theoretical findings.