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Theoretical investigation of interactions in multi-channel transport processes

Stimulated by the evidence of interactions in the collective dynamics of molecular motors and vehicular traffic in several lanes, we propose and discuss an open two-lane symmetrically coupled interactive totally asymmetric simple exclusion process (TASEP) model that incorporates interaction in the thermodynamically consistent fashion. We study the effect of both repulsive and attractive interaction on the system's dynamical properties using 1- vertical cluster mean-field analysis, 2- vertical cluster mean-field analysis and extensive Monte Carlo simulations. We found that the interactions induce correlations into the system that decreases due to the lane changing of particles. We produce the steady-state phase diagrams for symmetrically split interaction strength. We also analyze the behavior of the maximal particle current concerning the interaction energy E for different coupling rates and interaction splittings. The results suggest that for strong coupling and large splittings, the flow of the motors is maximum at a weak attractive interaction strength known experimentally to exist among kinesin motor protein.