The investigation of the lateral interaction in cellular automaton traffic flow model with open boundaries

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Abstract

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Traffic flow models based on periodic boundaries have been intensively studied before. However, the traffic behavior under open boundaries has played an important role in statistical mechanics. Indeed, traffic flow shows phase transition which is induced by the boundaries. Such transitions have no counterpart in the one dimensional equilibrium systems. This fact has led many physicists to address open systems using different strategies of injections. The extension of the different traffic phases for open boundaries depends on the adopted injection strategy of vehicles [1-3]. In this context, we proposed a new injection strategy in which a reentrance phenomenon appears with an extension of the low density phase [3]. In the deterministic case, the reentrance is exhibited for high injection rate. However, for the non-deterministic case, the reentrance shifts to higher values of extraction rate. The main mechanism that induces that phenomenon is the inflow function. Indeed, by adopting our injection rule, the injection rate and the inflow are not equal. Furthermore, an injection rate exists, above which the in-flow begins to decrease by increasing the injection rate.

In the previous work [3], only longitudinal interactions between vehicles are taken into account. In fact, vehicles may interact laterally in many situations. This kind of interaction is noticeable in real traffic flow and was studied by using the periodic boundaries [4]. However, the traffic behavior with an open system is not taken into account. This fact have led us to investigate analytically and by numerical simulations the effect of defects on the phase diagram by using our new injection strategy [3]. Indeed, we have found that the presence of defects induces a lateral interaction between the defects and vehicles [4]. In this work, we have found that with the presence of defects (impurities), the inflow function depends on the defects permeability (the probability of lateral deceleration [4]) and their distribution on the lattice. In that respect, two cases were studied: the random distribution of defects and the compact distribution of defects. It is found that the random distribution of defects reduces the inflow. Subsequently, the low density phase region expands. However, for a compact distribution of defects, the inflow keeps unchanged which induces an expansion of the high-density phase with a maximum current phase appearance. In this context, the maximum current phase is studied in sufficient detail to explain his apparition by considering the lattice inflow and the defects region inflow.

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