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Explicit formulas for the transition probabilities of the multispecies asymmetric simple exclusion process (ASEP)

The multispecies ASEP is a stochastic particle model on $\mathbb{Z}$, where particles may belong to different species, labelled $1, \cdots, M$. For a N-particle system, a state is represented by a pair (X, π) where $X = (x_1, \cdots, x_N)$ with $x_1 < \cdots < x_N, x_i \in \mathbb{Z}$ and π is a *word*, represented by $\pi_1 \pi_2 \cdots \pi_M$ where $\pi_i \in \{1, 2, \cdots, M\}$. The state (X, π) implies the ith particle from the left is located at x_i and it belongs to species π_i. The rule of the multispecies ASEP is as follows: each particle waits an exponential time. Then, the particle tries to jump one step to the right with probability p and one step to the left with probability q. If a particle of species l tries to jump to a site occupied by a particle of species l' with $l \leq l'$, the move is prohibited. If a particle of species l tries to jump to a site occupied by a particle of species l' with $l > l'$, the particles interchange positions.

Let $P_{(Y,\nu)}(X, \pi; t)$ be the transition probability from state (Y, ν) to state (X, π) after time t. Tracy and Widom established a formula for $P_{(Y,\nu)}(X, \pi; t)$ but the formula was not completely explicit as noted in their paper [Tracy-Widom,2013]. In this talk, we provide an explicit formula of $P_{(Y,\nu)}(X, \pi; t)$ and some further results from the explicit formula. It is expected that our algorithm to find the explicit formula can be used in studying the generalization of any other exactly solvable models to their multispecies versions.