Contribution ID: **146**   Type: **10 min Talk + Poster**

Integrability and exact solution of the multi-species non-equilibrium stirring process

Monday, 4 September 2023 17:20 (10 minutes)

The simple symmetric exclusion process (SSEP) is a well studied interacting particle system that consists of a random walk with an additional exclusion constraint that allows at most one particle per site. The system can be put out of equilibrium via interaction with reservoirs. An interesting question (also for applications like statistical mechanics) is to characterize the non-equilibrium steady state. In this direction much effort has been done and some techniques have been developed, for instance matrix product ansatz (MPA), stochastic duality and quantum inverse scattering method. Stochastic duality is a technique that relates the expectations of two Markov processes (the original and the dual one) via an observable called duality function. This implies a similarity transformation between the original Hamiltonian and the "simpler" dual one.

The aim of this talk is to extend the previous techniques to study a multi-species (multi-colour) version of the SSEP, namely the "stirring process". The idea is to use $gl(N)$ Lie algebra (where N is the number of different species) to construct the Hamiltonian and exploit its symmetries to find a duality relation. This duality relation allows to simplify the non-equilibrium problem and to apply efficiently a multi-variate version of MPA. As a consequence exact formulas for arbitrary point correlations in the non-equilibrium steady state are written. Moreover, we can map the stirring process to a higher rank version of the XXX-Heisemberg spin chain. Therefore, using Yang-Baxter-Equation, we construct a proper non-local similarity transformation that maps the eigenvector of the non-equilibrium Hamiltonian onto the equilibrium ones. This defines a connection between equilibrium and non-equilibrium situation, that also allows to find again the exact non-equilibrium steady state. Although integrability and MPA do not apply to higher spin situations, duality does. Finally, a reaction-diffusion version of the stirring process with the same duality relation can be introduced.

This talk is based on a work in progress that will appear soon on ArXiv.

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Session Classification: Gong Session for Posters