INFN Istituto Nazionale di Fisica Nucleare

Bologna Workshop on:

CFT AND INTEGRABLE MODELS

and their applications from gauge/gravity dualities to statistical mechanics and quantum information

Contribution ID: **335** Type: **Poster**

Emergent Hydrodynamics in the Symmetric Dyson Exclusion Process

Friday 5 September 2025 14:00 (30 minutes)

We study the \emph{symmetric Dyson exclusion process} (SDEP)—a lattice gas with exclusion and long-range, Coulomb–type interactions that emerge both as the maximal-activity limit of the symmetric exclusion process and as a discrete version of Dyson's Brownian motion on the unitary group. Exploiting an exact ground-state (Doob) transform, we map the stochastic generator of the SDEP onto the spin-
*tfrac*12 XX quantum chain, which in turn admits a free-fermion representation. This mapping yields closed, finite-size expressions for the time-dependent density and current in terms of modified lattice Bessel functions.
At macroscopic scales we conjecture that the SDEP displays \emph{ballistic}, non-local hydrodynamics governed by the continuity equation
$\partial_t \rho + \partial_x j[\rho] = 0, \qquad j[\rho](x) = \sin\big(\pi\rho(x)\big)\ \sinh\big(\pi\mathcal{H}\rho(x)\big),$
where\(\mathcal{H}\)istheperiodicHilberttransform,makingthecurrentagenuinelynon−localfunctionalofthedensity.T
localone−fielddescriptionisequivalenttoalocaltwo−field"complexHopf"systemandimpliesballisticscaling\(z =
1\).

Closed evolution formulas allow us to solve the melting of single- and double-block initial states, producing limit shapes and arctic curves that agree with large-scale Monte-Carlo simulations. The model thus offers a tractable example of emergent non-local hydrodynamics driven by long-range interactions.

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