THERMALIZATION OF THE WIGNER FUNCTION

— a real time, non-perturbative quantum simulation based on the Schwinger Model

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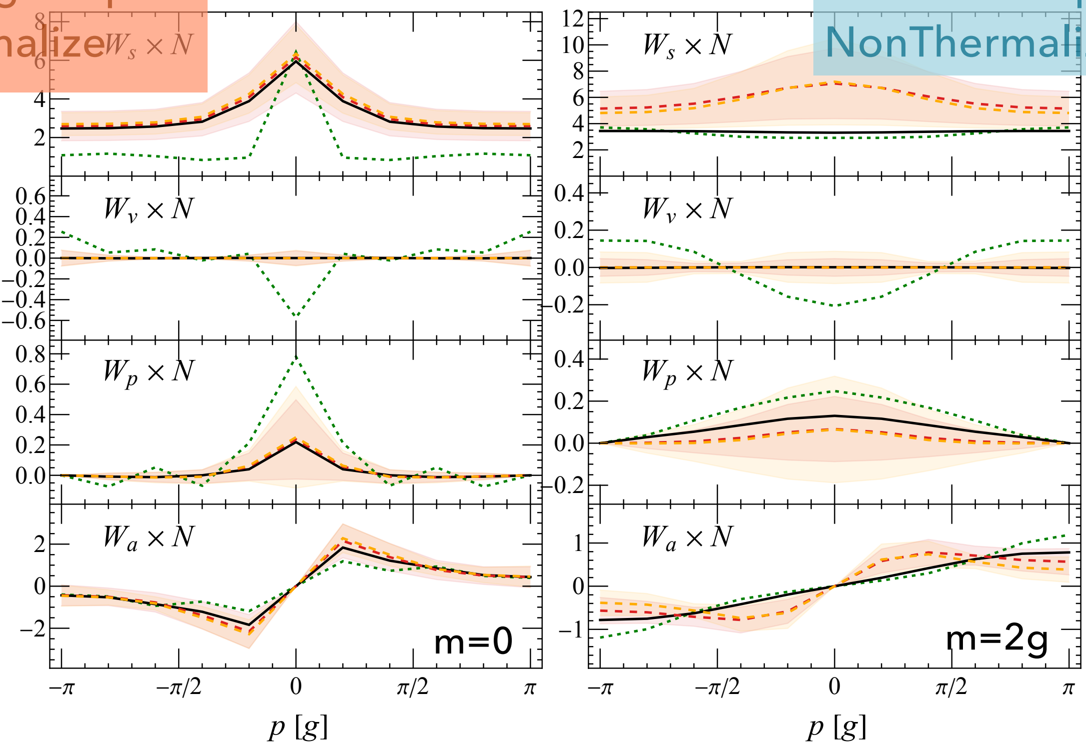
I. Time evolution of Wigner function

$$W = W_s + W_v\,\gamma^0 + W_a\,\gamma^1 - iW_p\,\gamma^5$$

Strong coupl. Thermalize

Weak coupl. NonThermalize



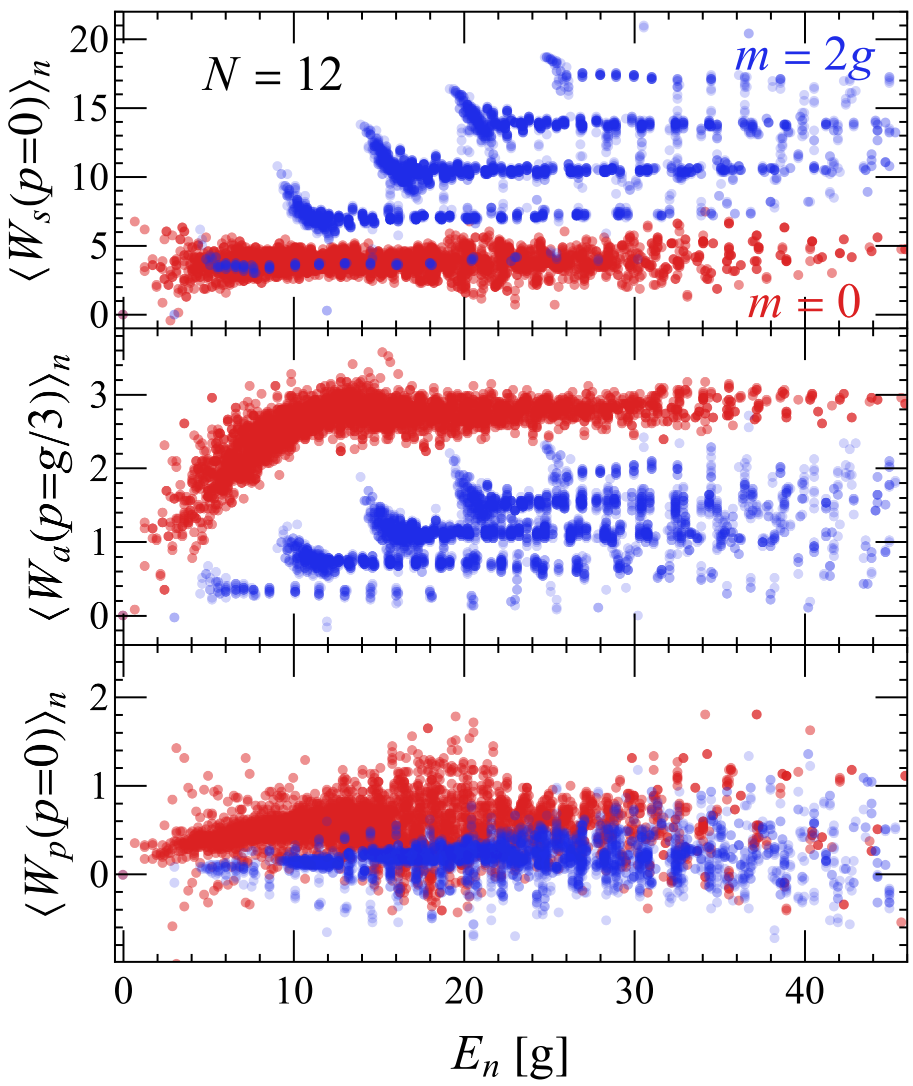
II. Eigenstate Thermalization Hypothesis

$$\langle E_a|\mathcal{O}|E_b\rangle = f_{\mathcal{O}}(E)\delta_{ab} + \Omega^{-1/2}(E)r_{ab}$$

$$E = (E_a + E_b)/2$$

$f_{\mathcal{O}}(E)$ A smooth function of energy

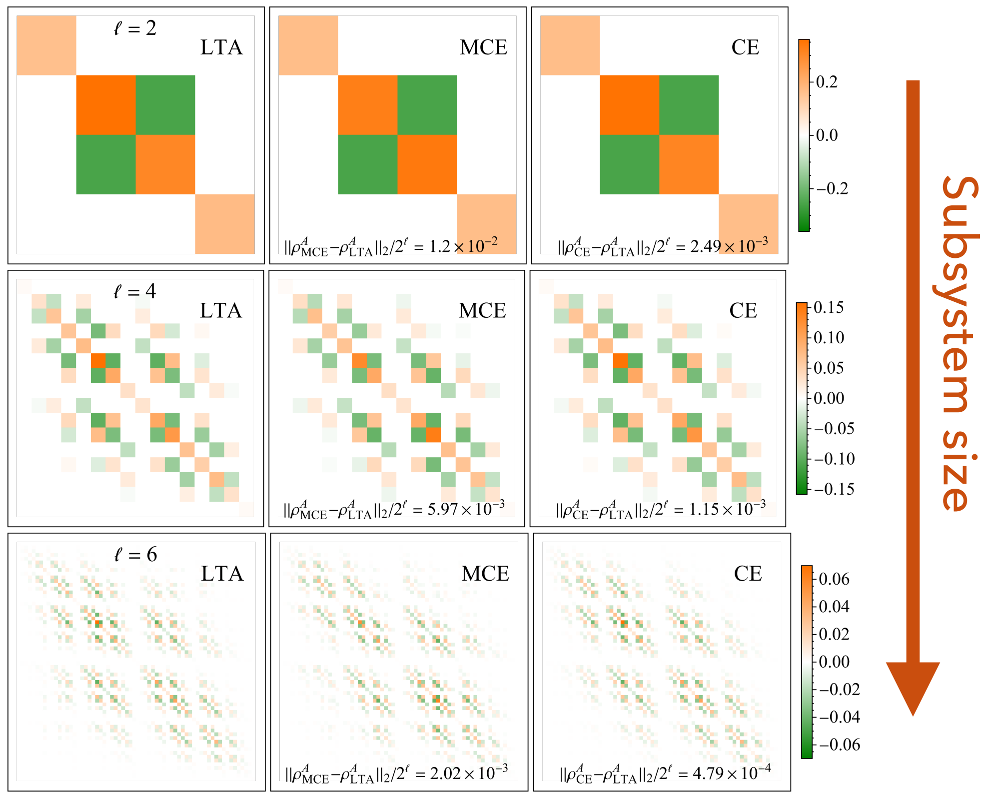
$\Omega(E)$ State Density



III. Subsystem thermalization

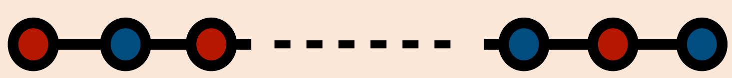
Diagonal $||\rho_a^A - \rho^A(E = E_a)|| \sim O[\Omega^{-1/2}(E_a)]$

Off diagonal $||\rho_{ab}^A|| \sim O[\Omega^{-1/2}(E)]$



Schwinger model

$$H = \int \left(\bar{\psi}\left(\gamma^1(-i\partial_z - g\,A_1) + m\right)\psi + \frac{1}{2}\mathcal{E}^2\right)\mathrm{d}z$$



1+1 D QED Chain

Fermion

Anti-fermion

Discretization field

$$z_n = na \qquad \varepsilon_n = g^{-1}E_{(z_n)} \qquad \phi_n = agA_0(z_n)$$

$$\chi_{2n} = a^{1/2}\psi_\uparrow(z_{2n}) \qquad \chi_{2n+1} = a^{1/2}\psi_\downarrow(z_{2n+1})$$

$$H_{PBC} = \sum_{n=1}^{N}\left(-\frac{i}{2}\frac{1}{a}(\chi_n^\dagger e^{i\phi_n}\chi_{n+1} - \chi_{n+1}^\dagger e^{-i\phi_n}\chi_n) + (-1)^n m_0\chi_n^\dagger\chi_n + \frac{ag^2}{2}\varepsilon_n^2\right)$$

Wigner function

$$W_{ab}(t,z,p) = \int \bar{\psi}_a(z + \frac{y}{2})\psi_b(z - \frac{y}{2})e^{ipy}dy$$

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