Distinguishing Integrable and Non-Integrable Systems using Quantum Quenches

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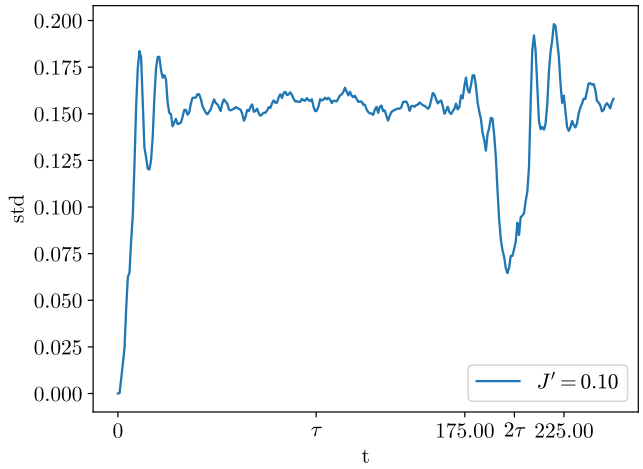
M. Tech. Project of
Abhishek Raj,
IIT(BHU)

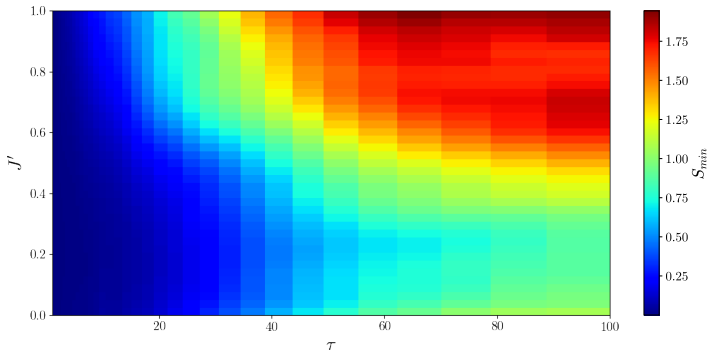
Financial
Support
DST-SERB

5th Indian Statistical Physics Community Meeting 2018

ICTS, Bengaluru
February 18, 2018

Overview





epl A Letters Journal Exploring the Frontiers of Physics

September 2016

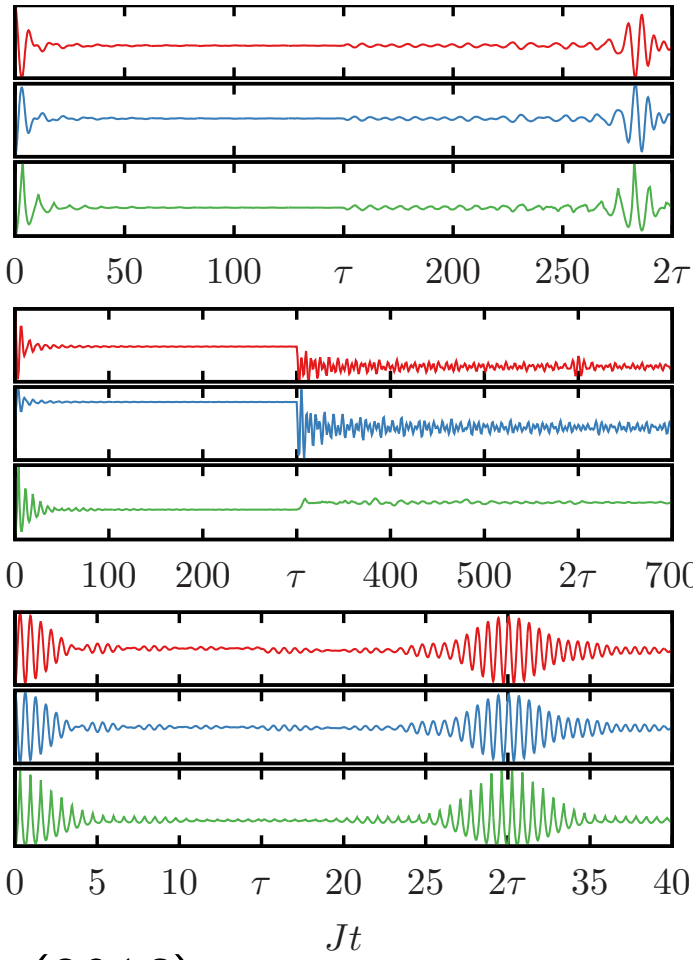
EPL, **115** (2016) 50001
doi: 10.1209/0295-5075/115/50001

www.epljournal.org

Effective time reversal and echo dynamics in the transverse field Ising model

Markus Schmitt and Stefan Kehrein

Institute for Theoretical Physics, Georg-August-Universität Göttingen - Friedrich-Hund-Platz 1, Göttingen 37077, Germany



Schmitt, Kehrein (2016)

System

$$H_{TFIM} = -J \sum_{i=1}^{N} S_i^z S_{i+1}^z + h \sum_{i=1}^{N} S_i^x$$

$$H_{ANNNI} = H_{TFIM} + J' \sum_{i=1}^{N} S_i^z S_{i+2}^z$$

$2S_i^{\{x,y,z\}} = \sigma_i^{\{x,y,z\}}$ (Pauli matrices)

System

Quench Protocol: $H(h) \rightarrow -H(h + \delta h)$

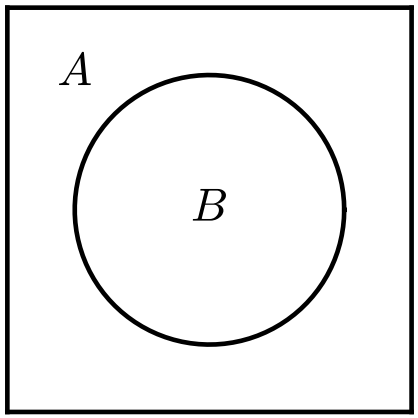
Observables:

$\langle m_z \rangle = \frac{1}{N} \sum_{i=1}^{N} \langle S_i^z \rangle$

$\mathcal{F} = \langle \psi | {S^z_{N/2}}^2 | \psi \rangle - \langle \psi | S^z_{N/2} | \psi \rangle^2$

$\langle s_c \rangle = \langle S_i^z S_{i+2}^z \rangle$

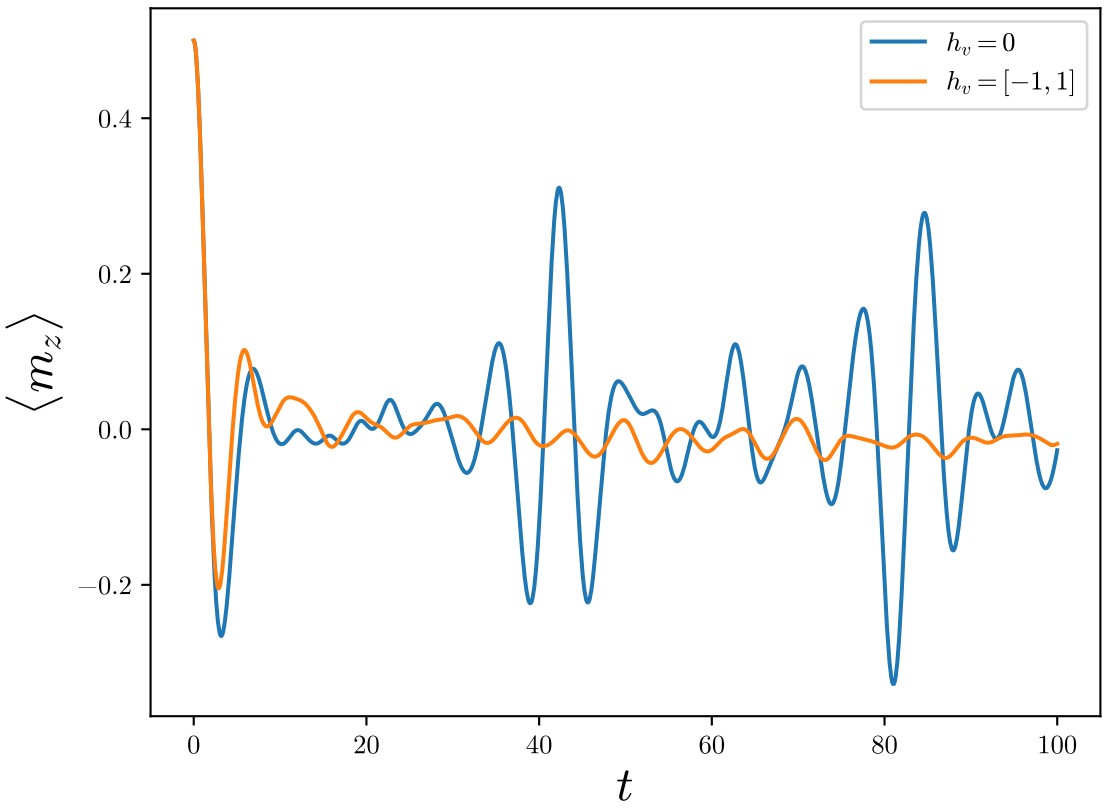
$I = \frac{1}{N} \ln(|\langle \psi_0 | \psi_t \rangle|^2)$



$\rho_B = \mathrm{Tr}_A |\psi\rangle\langle\psi|$

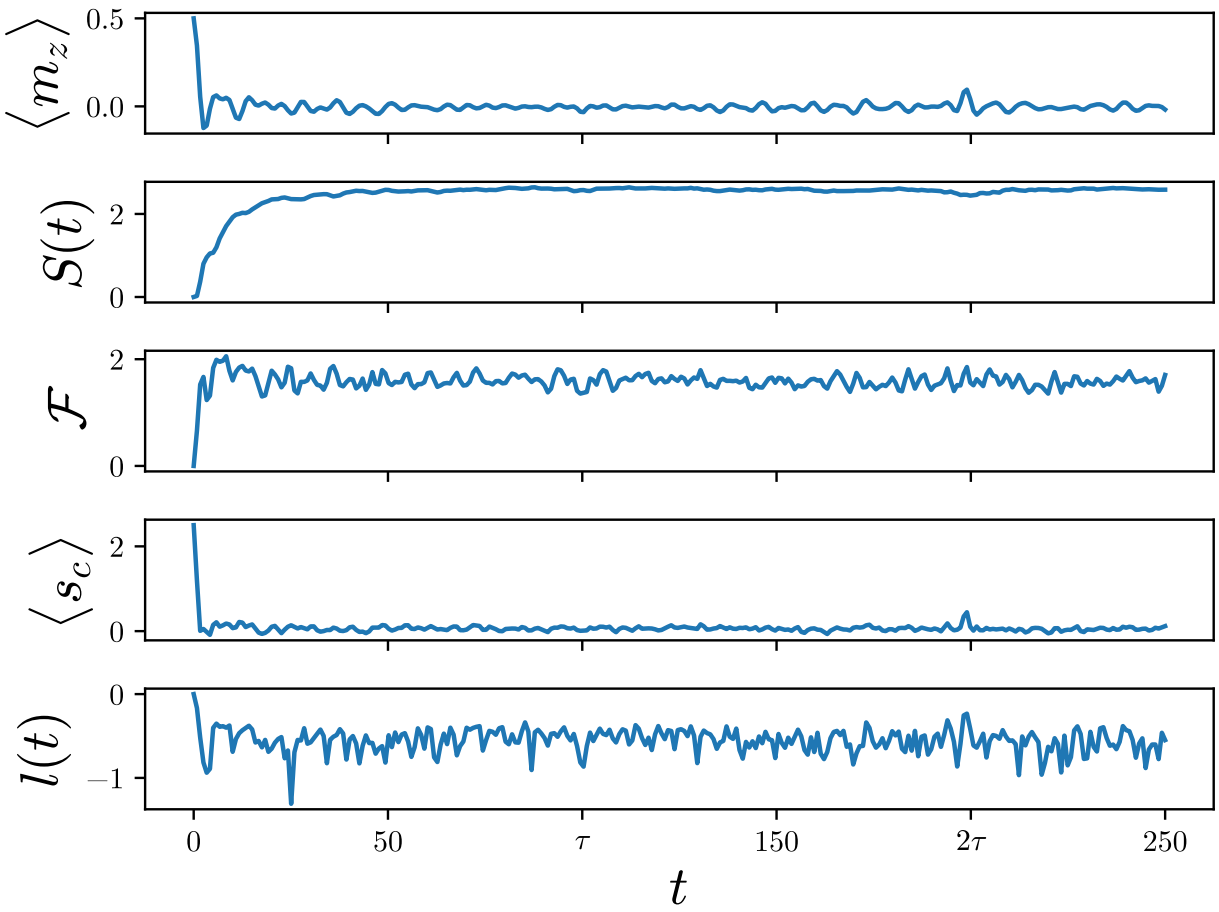
$S = -\mathrm{Tr}_B\ \rho_B \log \rho_B$

System



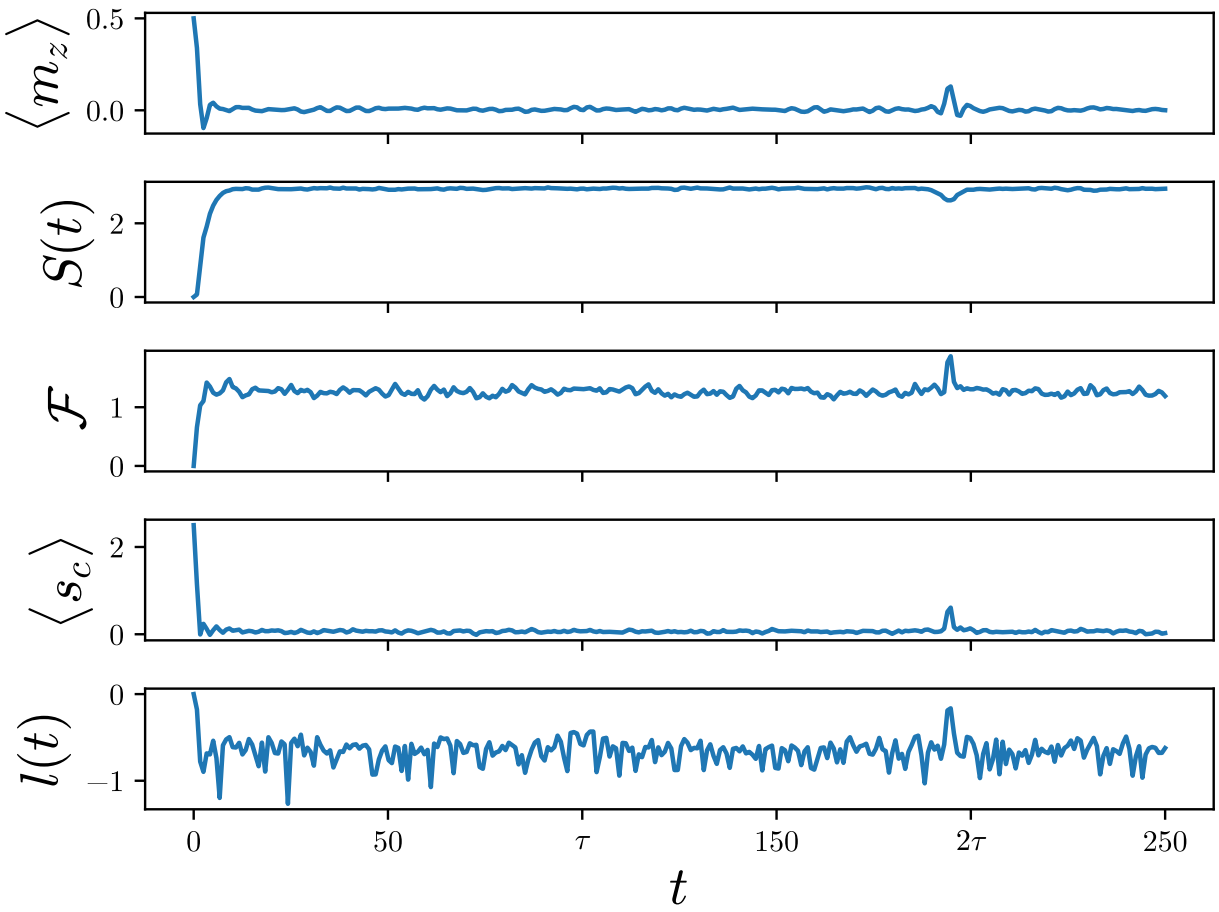
To suppress oscillations: $h_v = \sum_{i=1}^{N} h_i S_i^z$

Time Evolution and Reversal



$N = 10, J = 1, h = 1, \delta h = 0.1, h_v = 1, \tau = 100, J' = 0$
fully polarized i.c., single realization

Time Evolution and Reversal



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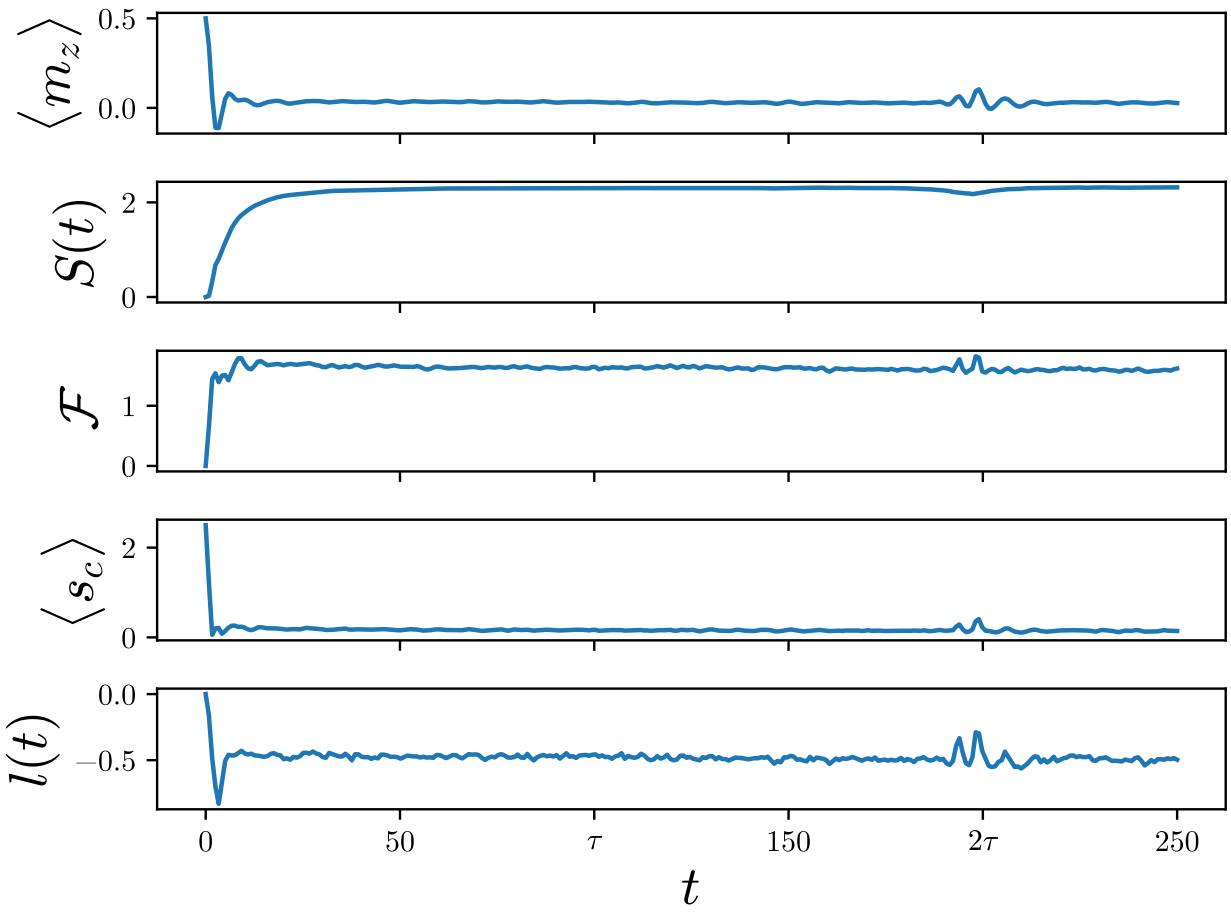
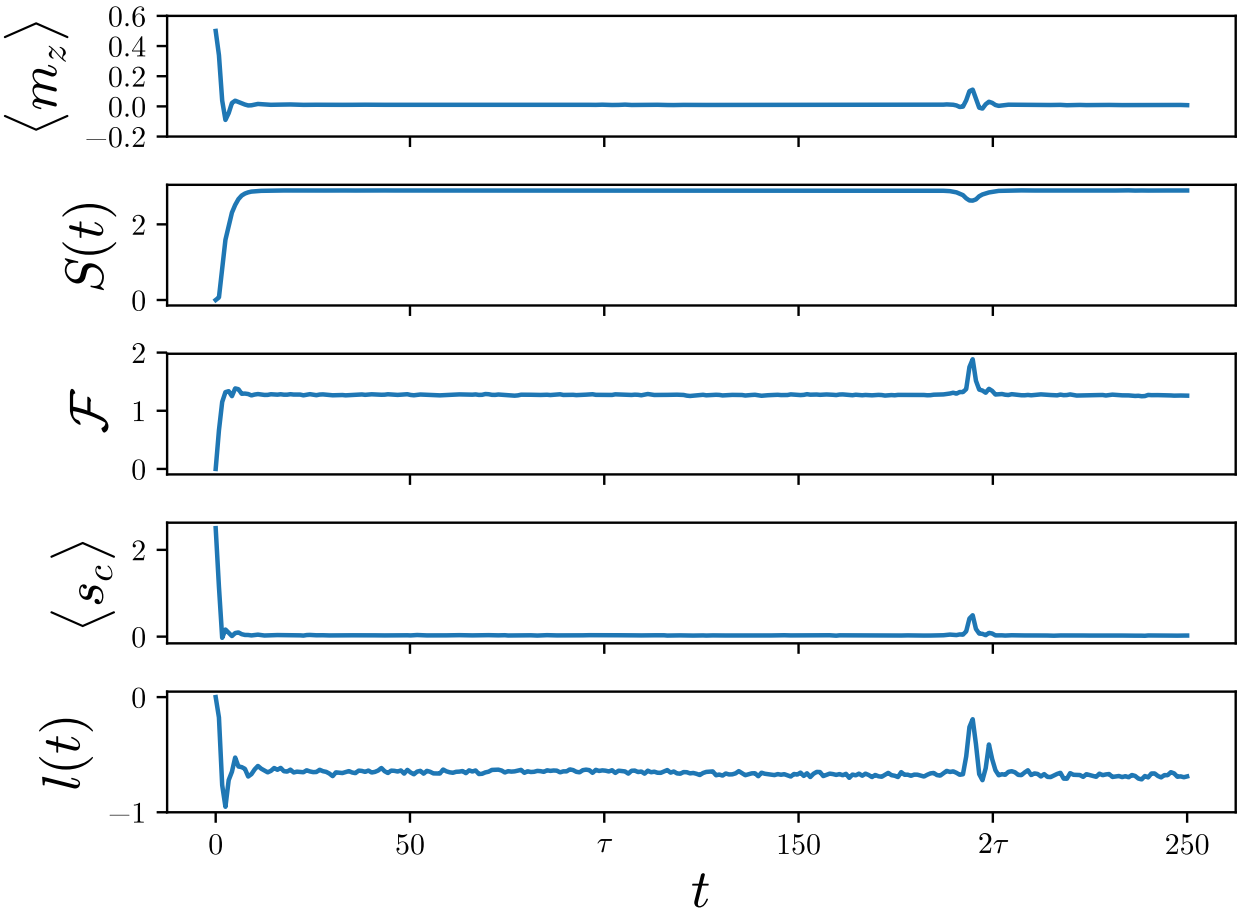
Time Evolution and Reversal



$N = 10, J = 1, h = 1, \delta h = 0.1, h_v = 1, \tau = 100, J' = 0$
fully polarized i.c., disorder averaged

Time Evolution and Reversal



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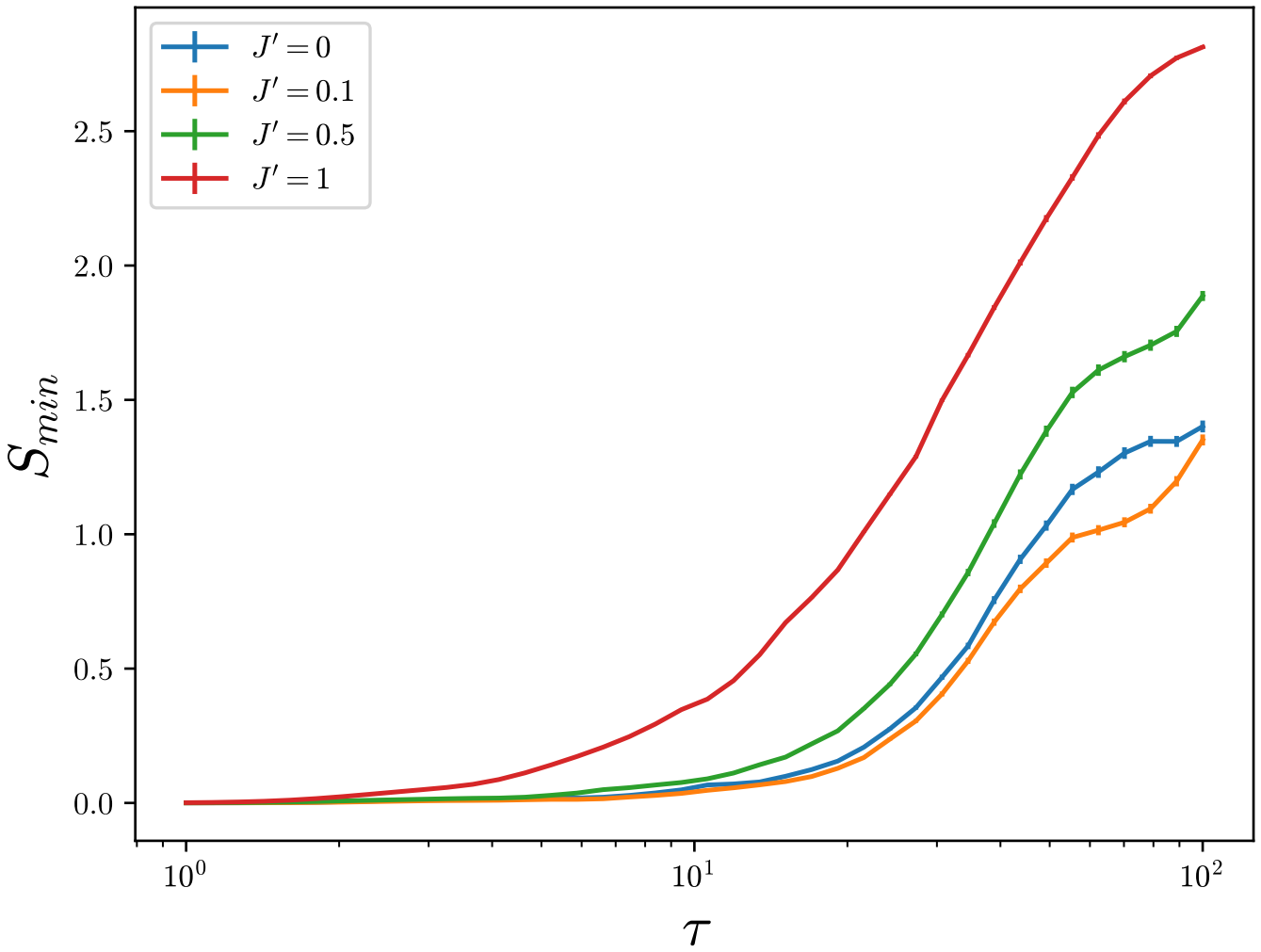
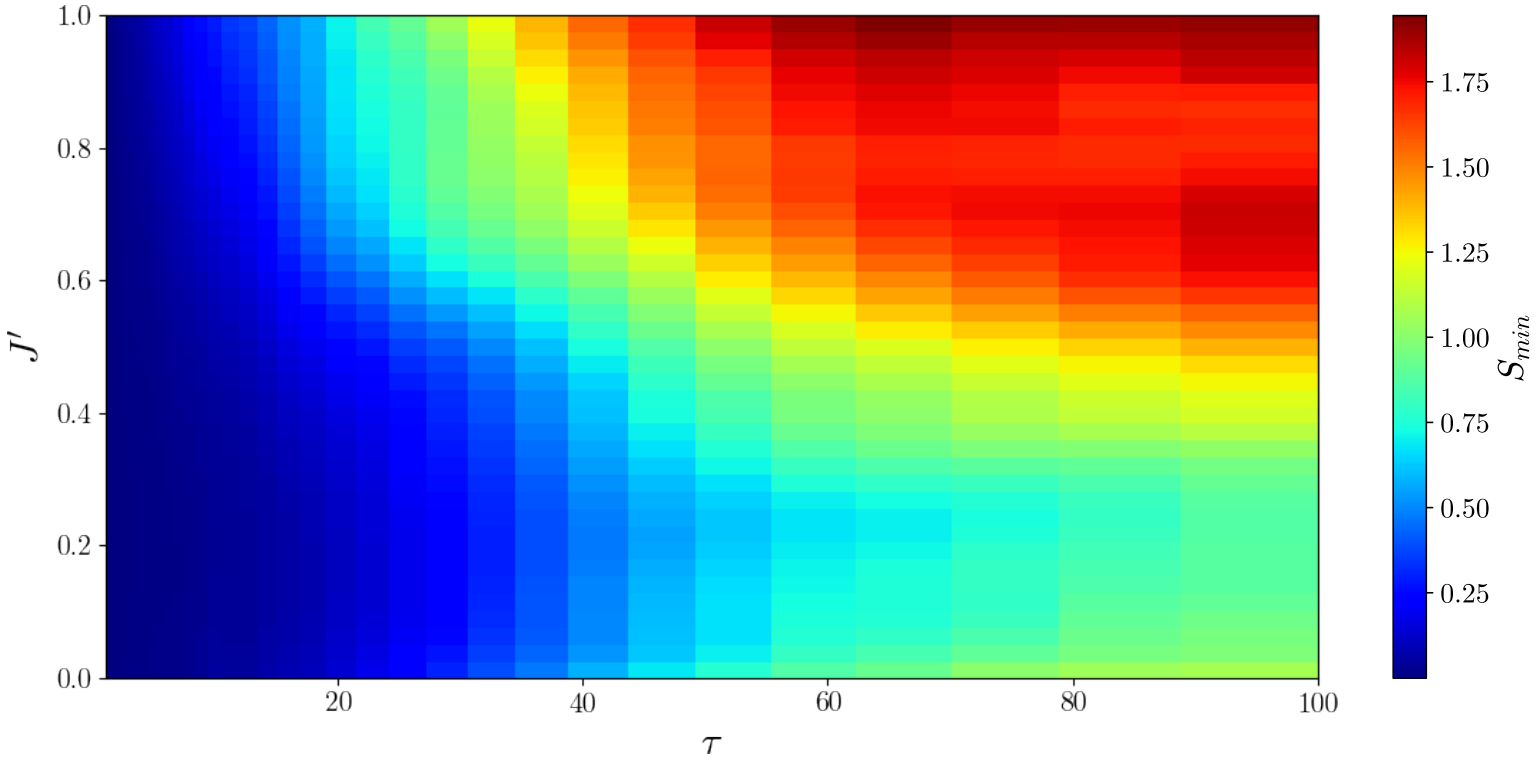
fully polarized i.c., disorder averaged

Entanglement at Echo



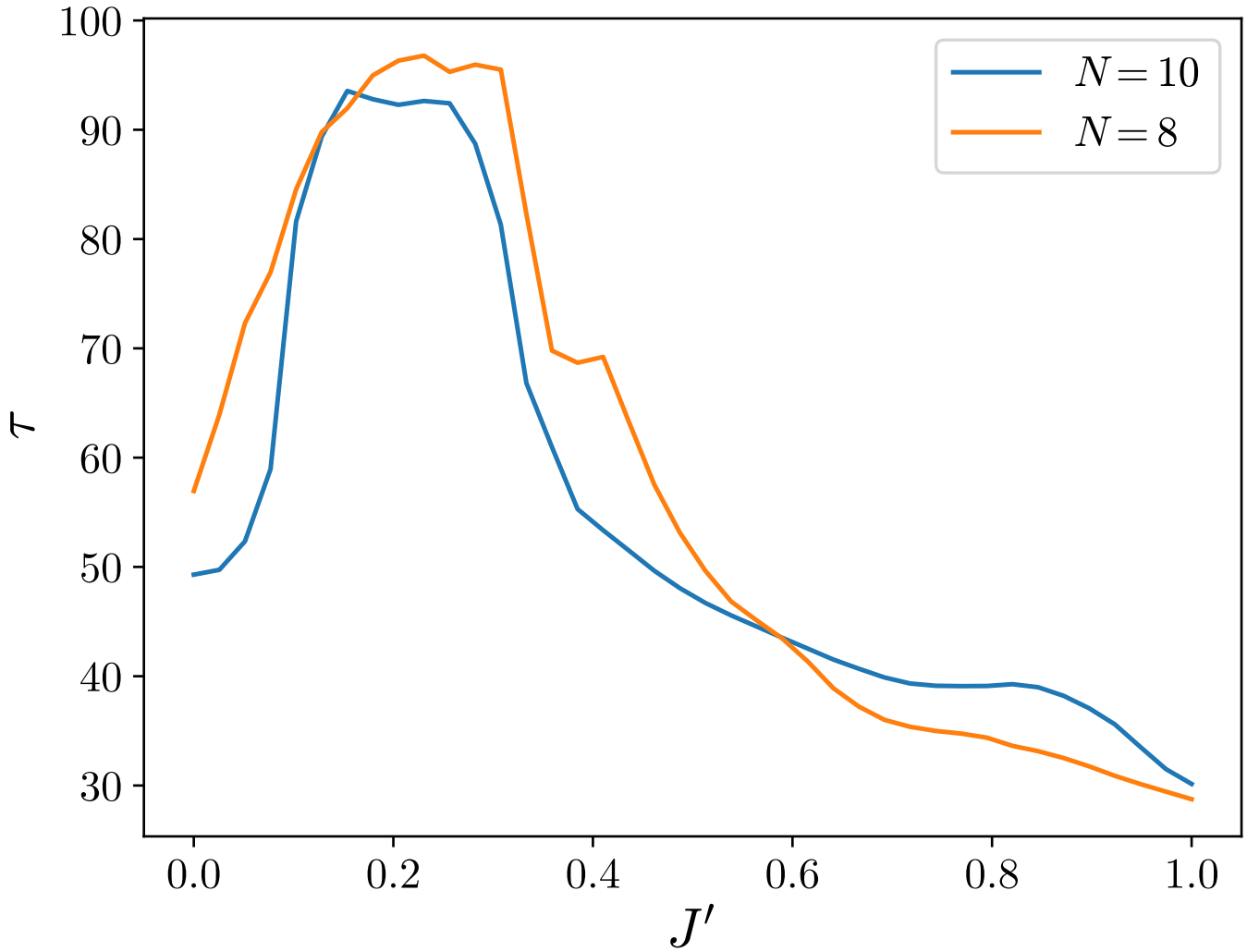
$h = 1, \delta h = 0.1, h_v = 0.1$, $N = 10$

Entanglement at Echo



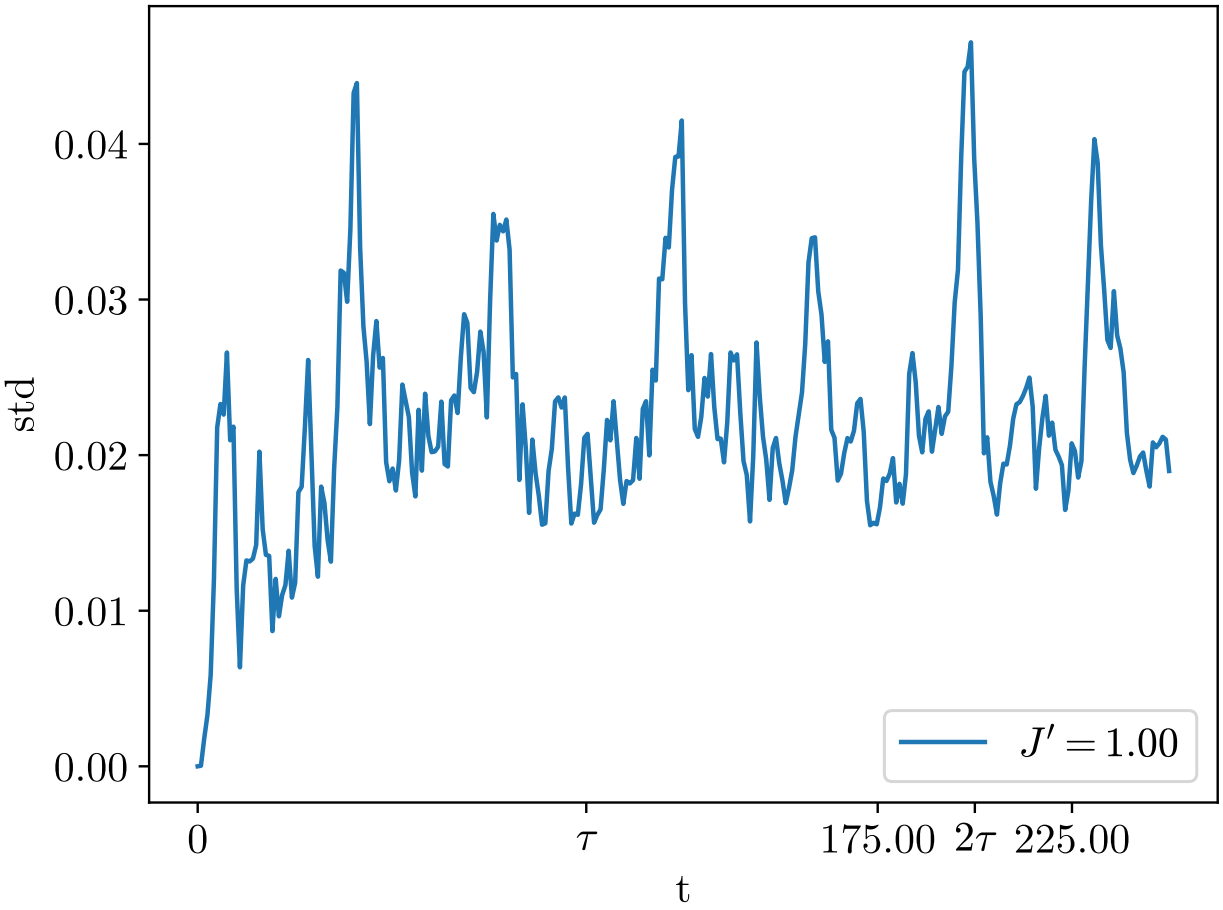
$h = 1, \delta h = 0.1, h_v = 0.1 \quad , N = 8$

Entanglement at Echo



$h = 1, \delta h = 0.1, h_v = 0.1$

Fluctuation in Entanglement



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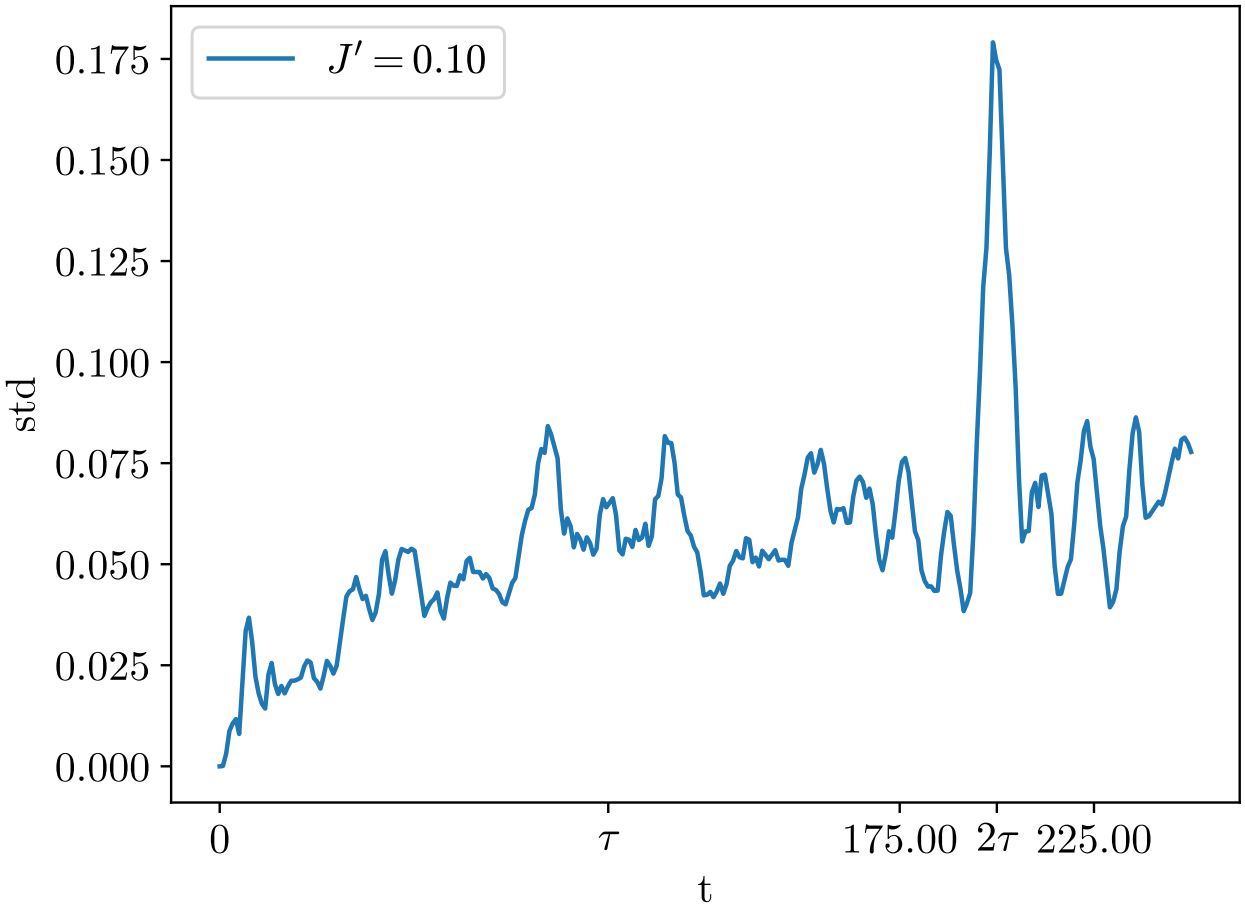
fully polarized i.c. ($h_v = 0.1$)

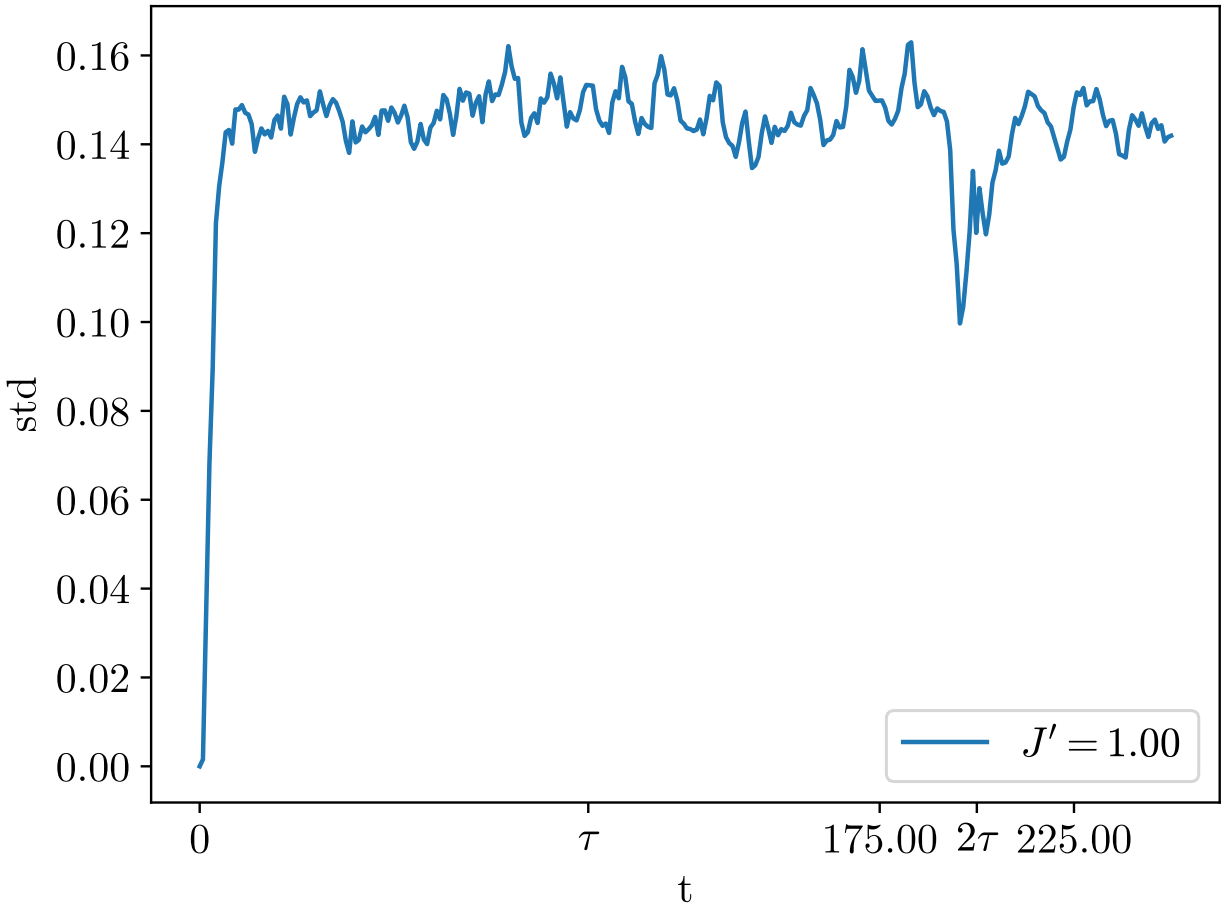
Fluctuation in Entanglement



$N = 10, J = 1, h = 1, \delta h = 0.1, \tau = 100$

fully polarized i.c. $(h_v = 0.1)$

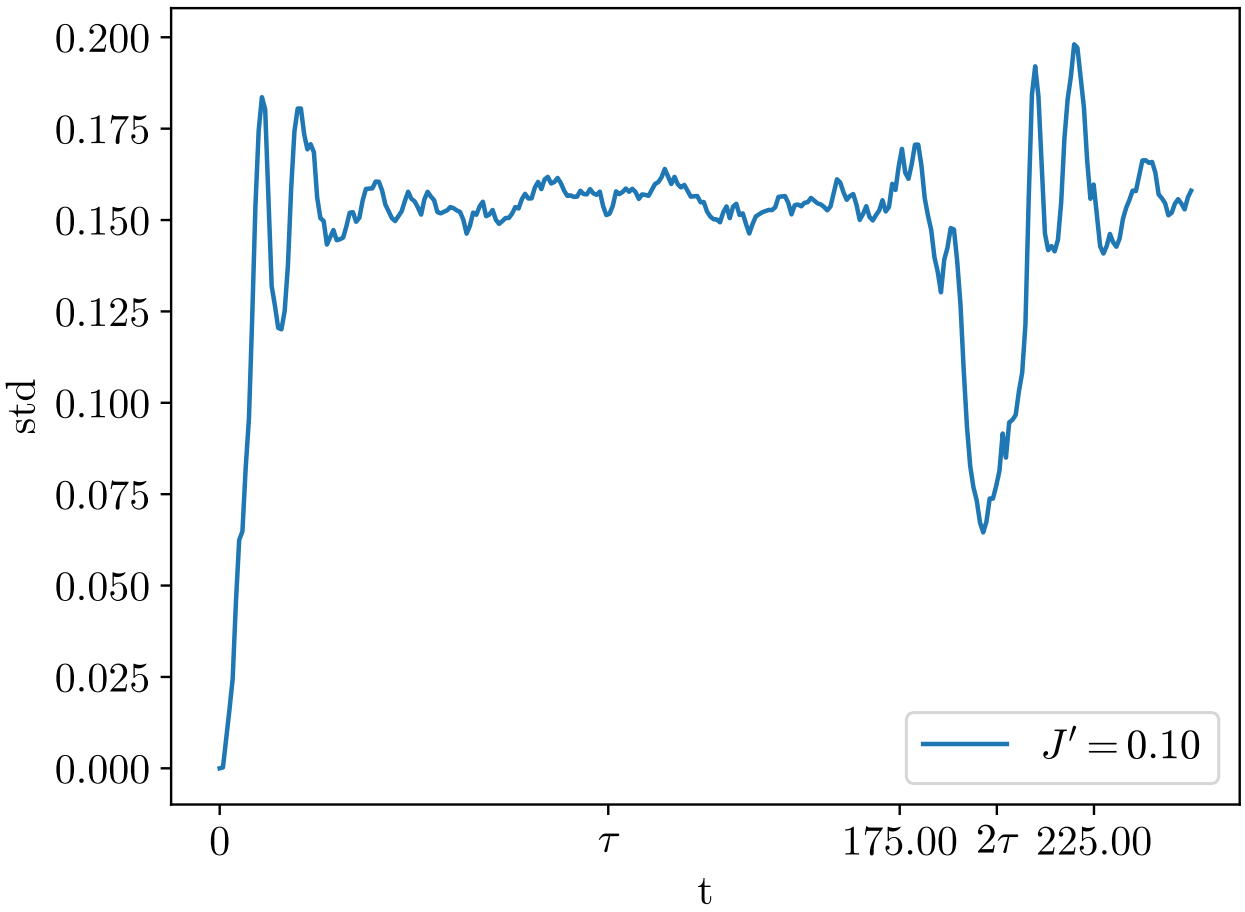
Fluctuation in Entanglement



$N = 10, J = 1, h = 1, \delta h = 0.1, \tau = 100$

random classical i.c. $(h_v = 0)$

Fluctuation in Entanglement



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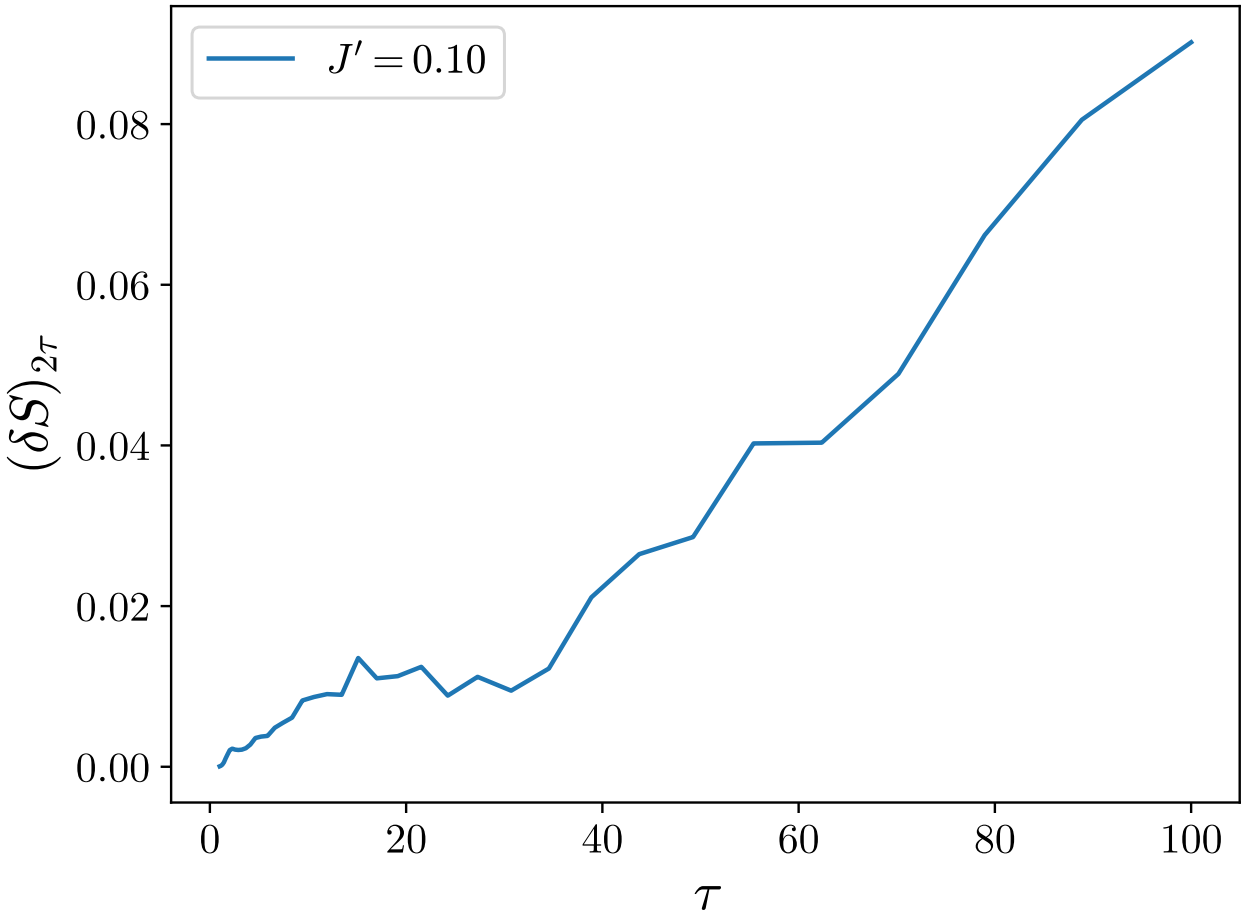
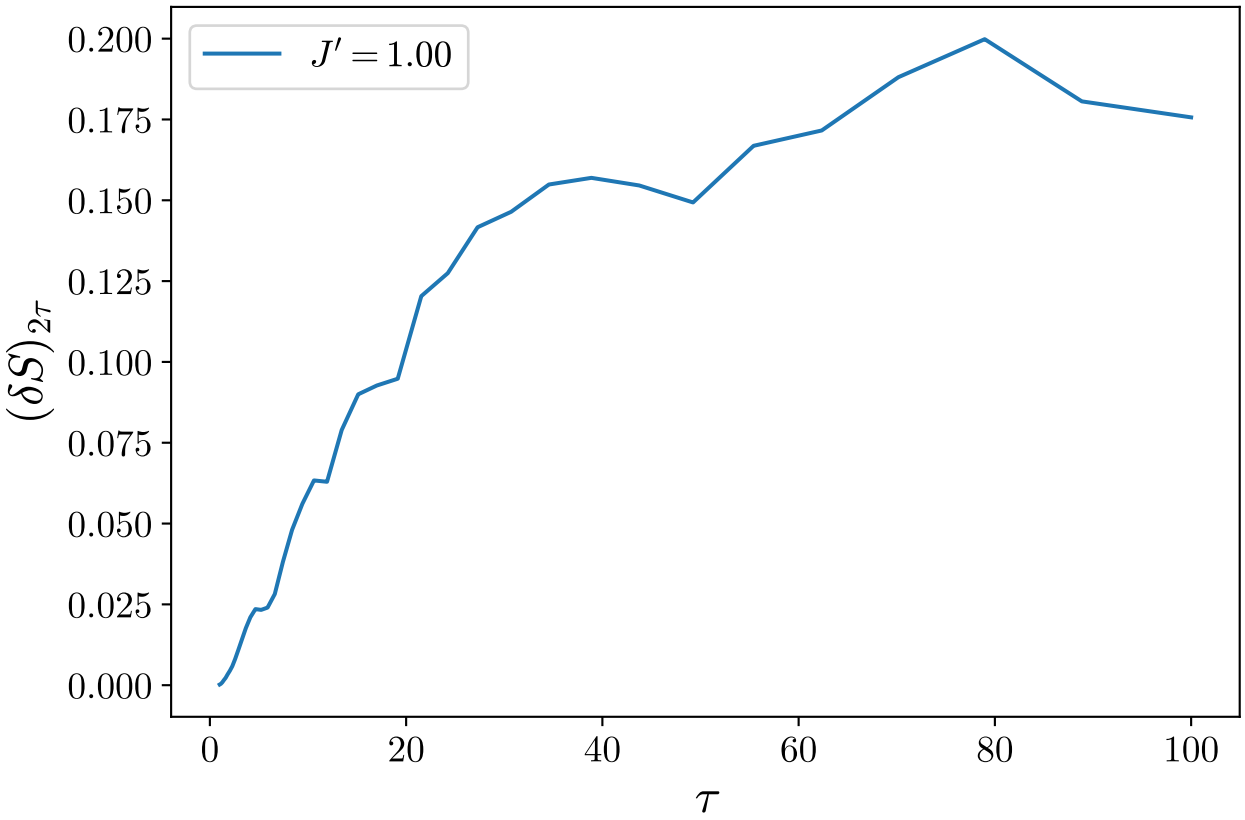
Entanglement Fluctuation at Echo



$N = 8, J = 1, h = 1, \delta h = 0.1$

random classical i.c. $(h_v = 0)$

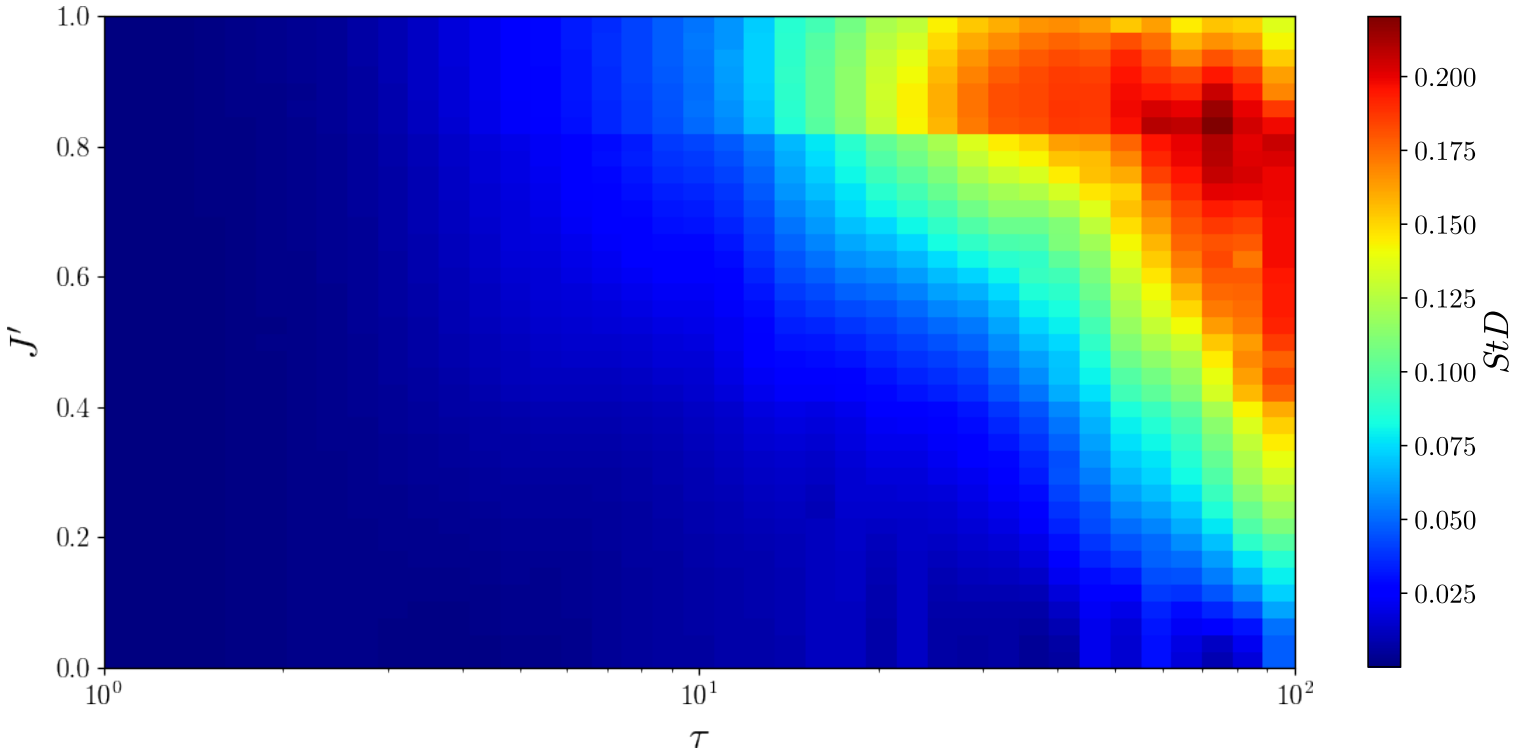
Entanglement Fluctuation at Echo



$N = 8, J = 1, h = 1, \delta h = 0.1$

random classical i.c. $(h_v = 0)$

Entanglement Fluctuation at Echo



$N = 8, J = 1, h = 1, \delta h = 0.1$

random classical i.c. $(h_v = 0)$

Overview