Quantum channel criticality

Hao-Xin Wang

Model

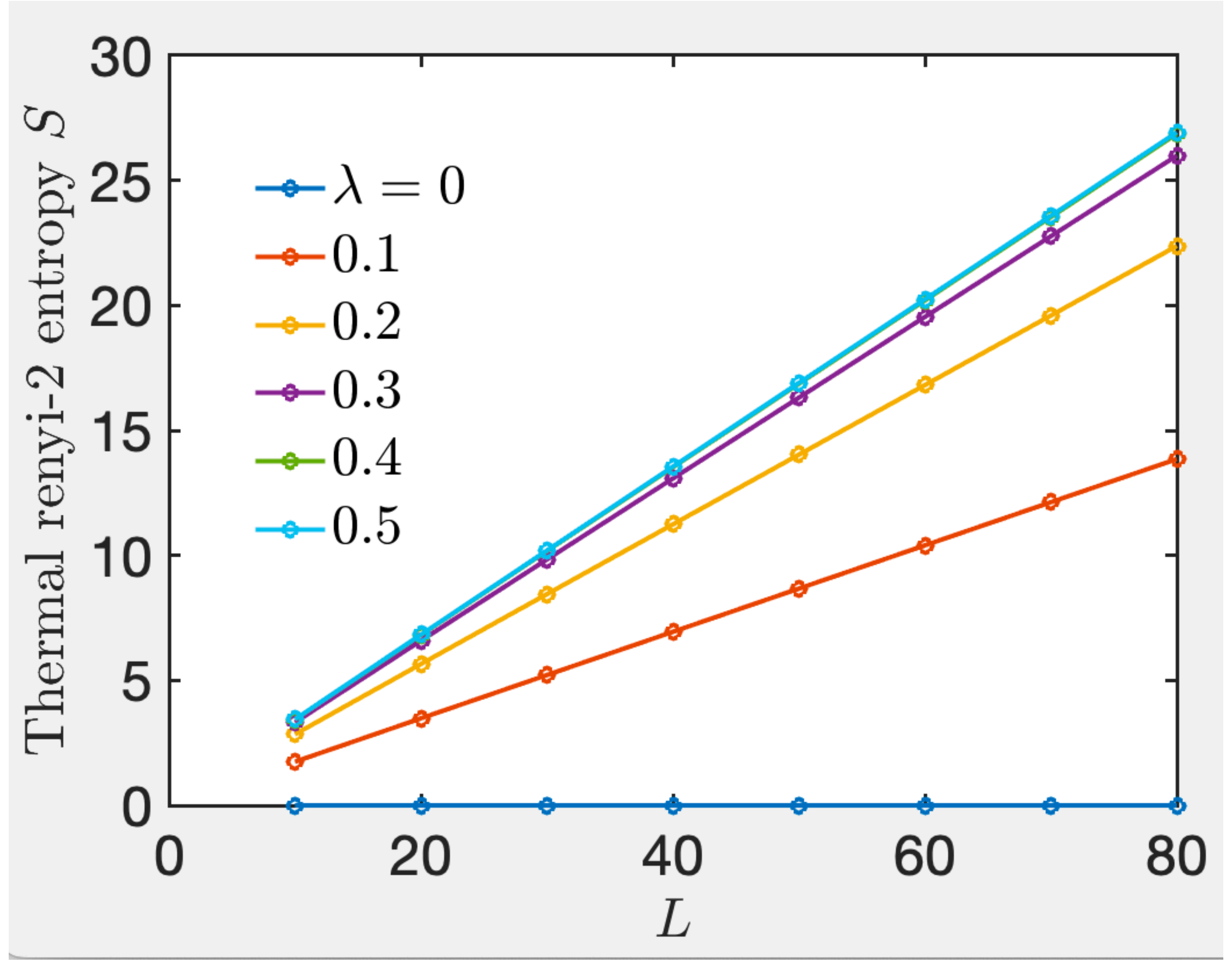
$$H = \sum_i \mathbf{S}_i \cdot \mathbf{S}_{i+1}$$

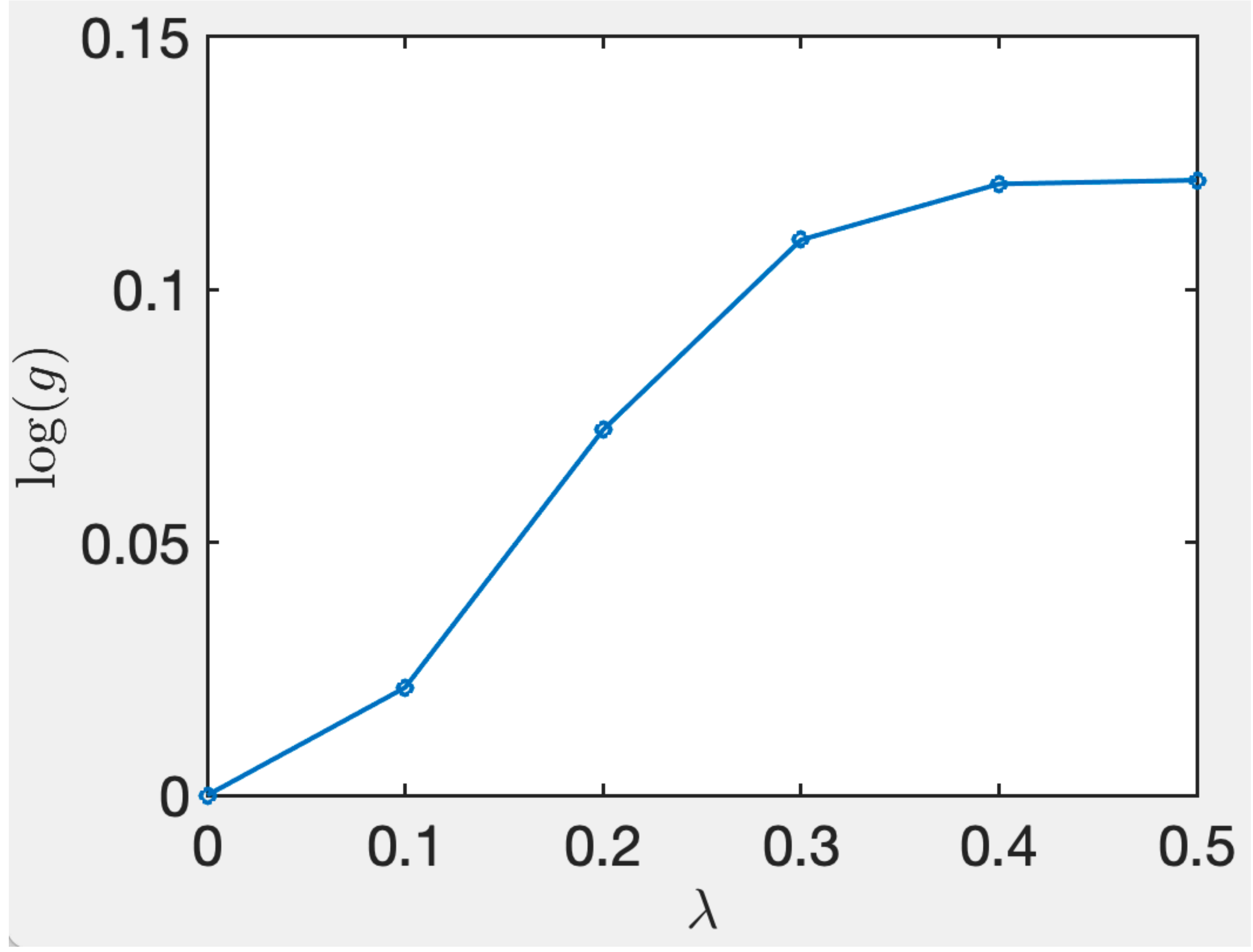
$$\mathscr{D}(\rho) = (1-\lambda)\rho + \lambda\sigma_i^z\rho\sigma_i^z$$

$$\mathscr{D}(\rho) = (1-\lambda)\rho + \frac{\lambda}{3}(\sigma_i^z\rho\sigma_i^z + \sigma_i^x\rho\sigma_i^x + \sigma_i^y\rho\sigma_i^y)$$

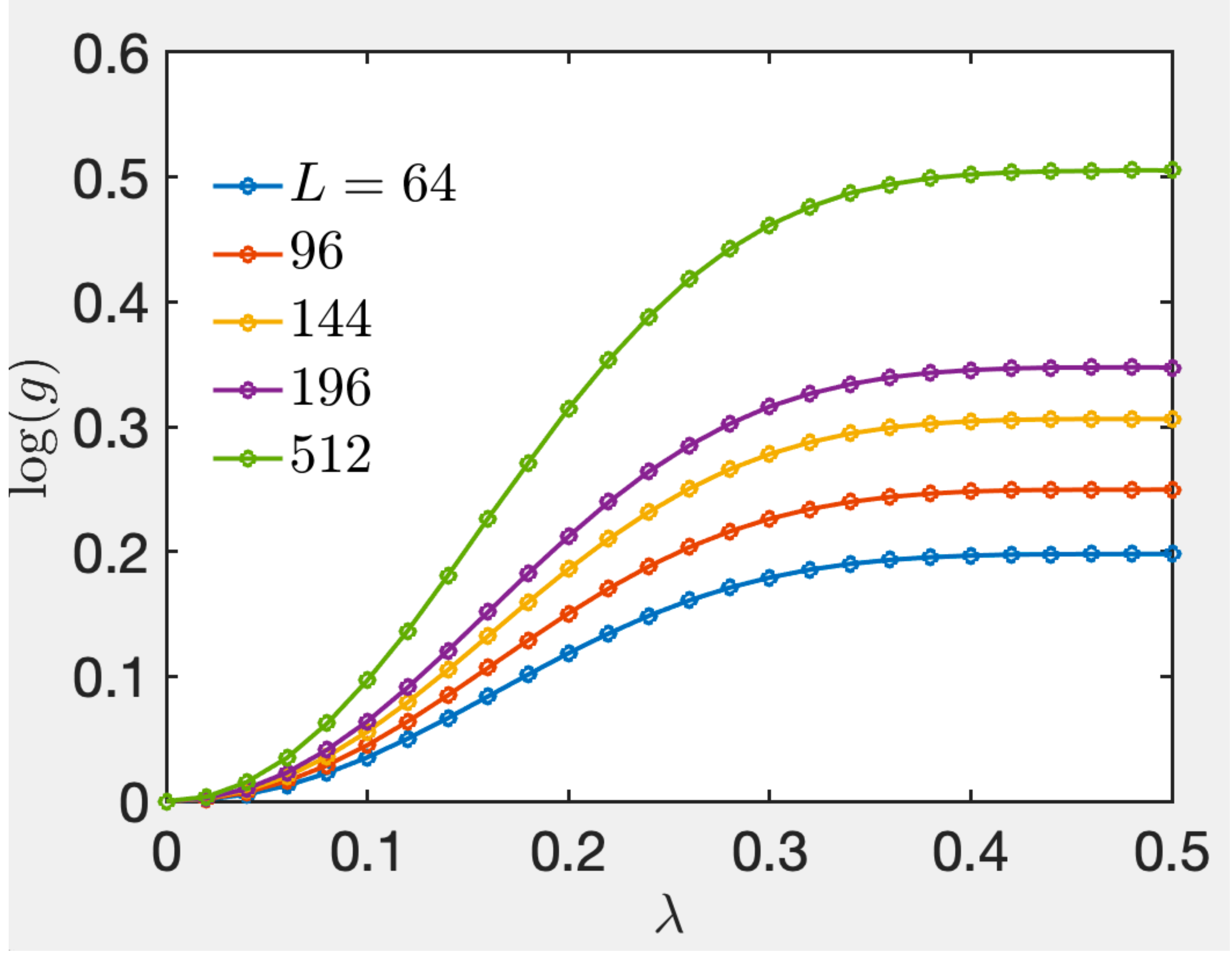
Boundary entropy, z channel

$$\mathcal{D}(\rho) = (1-\lambda)\rho + \lambda\sigma_i^z\rho\sigma_i^z$$





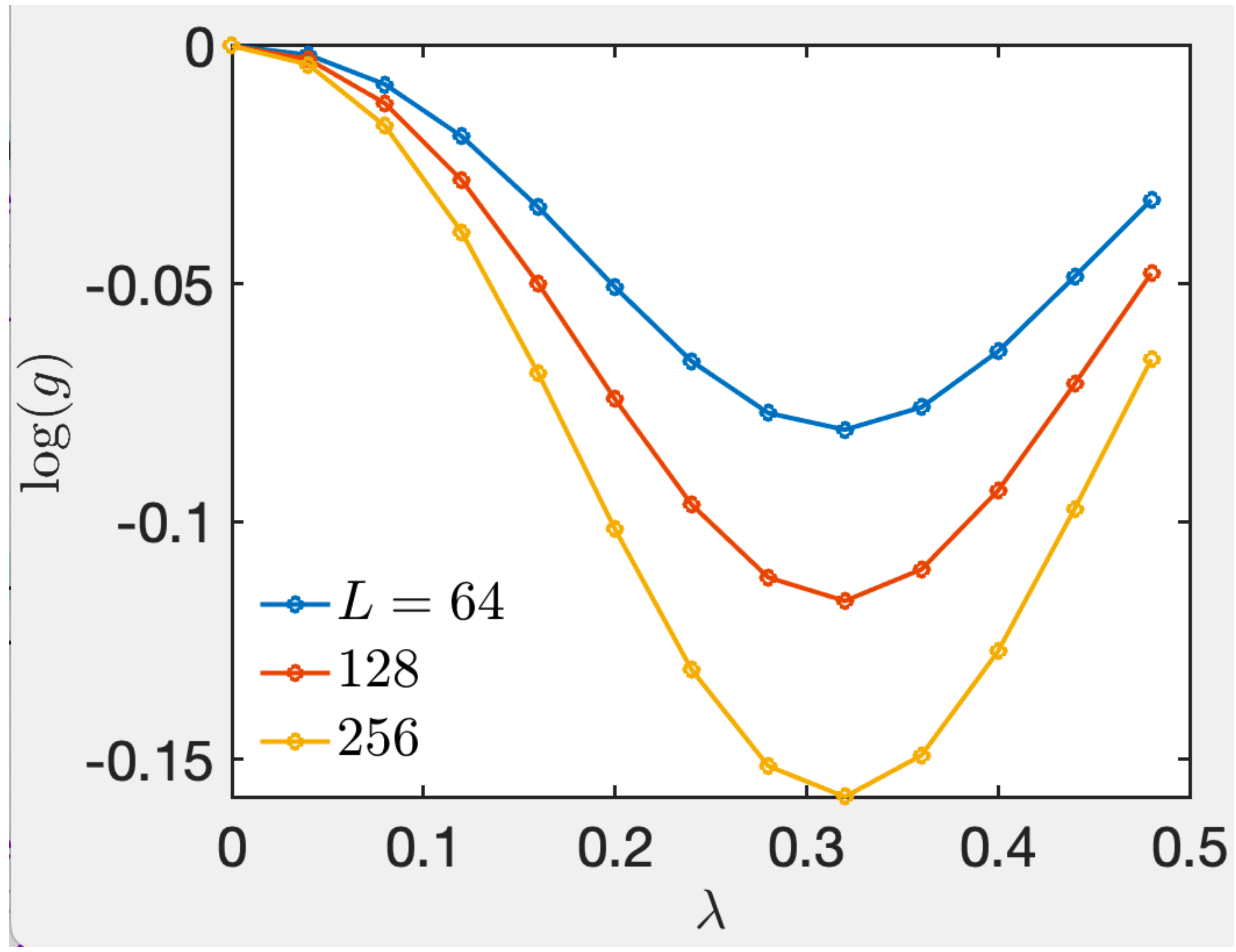
这里log(g)应该是负数。差了个负号。



$$\log g^{(n)}(L) = \left(1 - L\frac{d}{dL}\right)\log Z^{(n)}(L).$$

$$\log g^{(n)}(L) = -\left(\frac{S^{(n)}(L+4) + S^{(n)}(L-4)}{2} - L\frac{S^{(n)}(L+4) - S^{(n)}(L-4)}{8}\right)$$

Boundary entropy, xyz channel



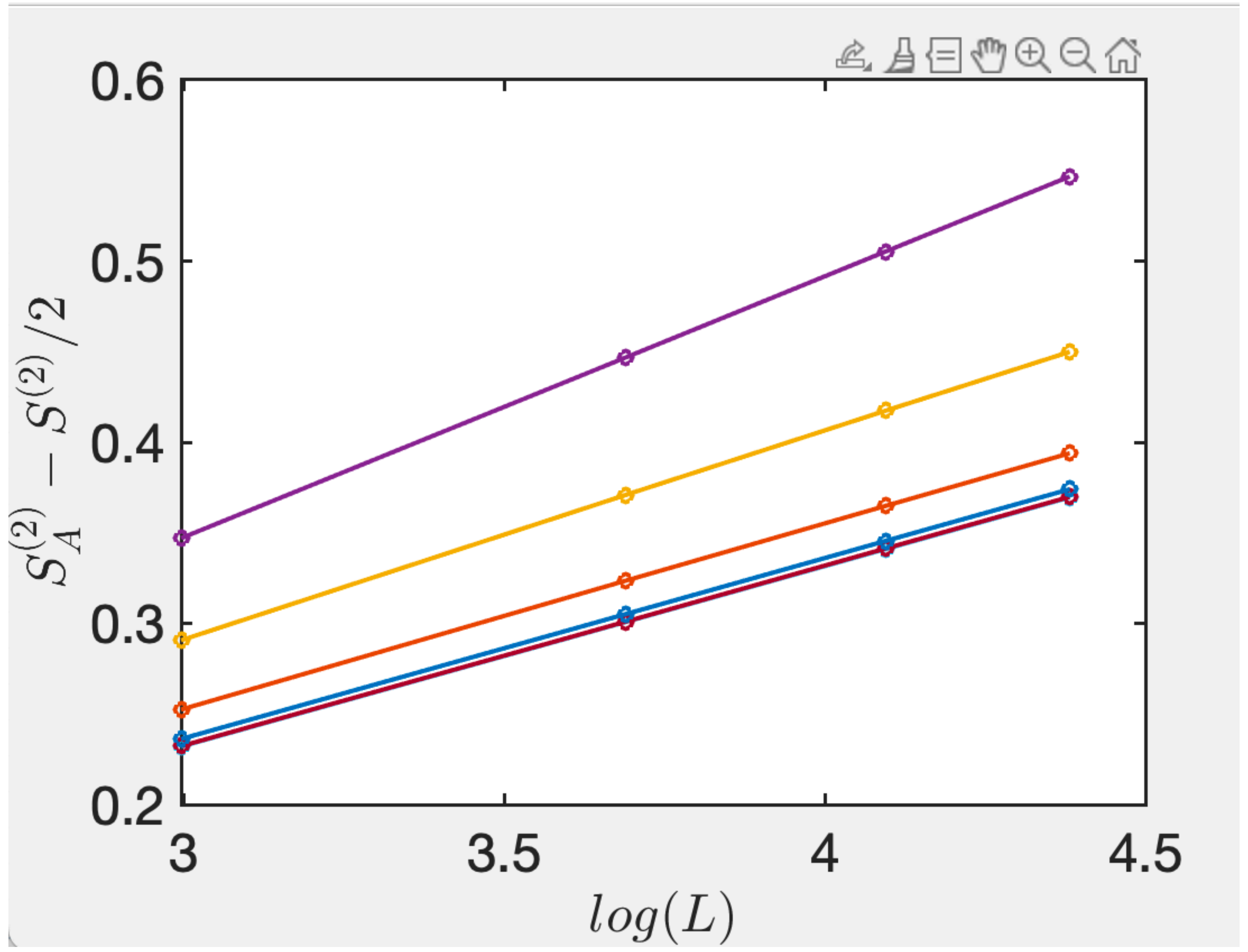
$$\mathscr{D}(\rho) = (1-\lambda)\rho + \frac{\lambda}{3}(\sigma_i^z \rho \sigma_i^z + \sigma_i^x \rho \sigma_i^x + \sigma_i^y \rho \sigma_i^y)$$

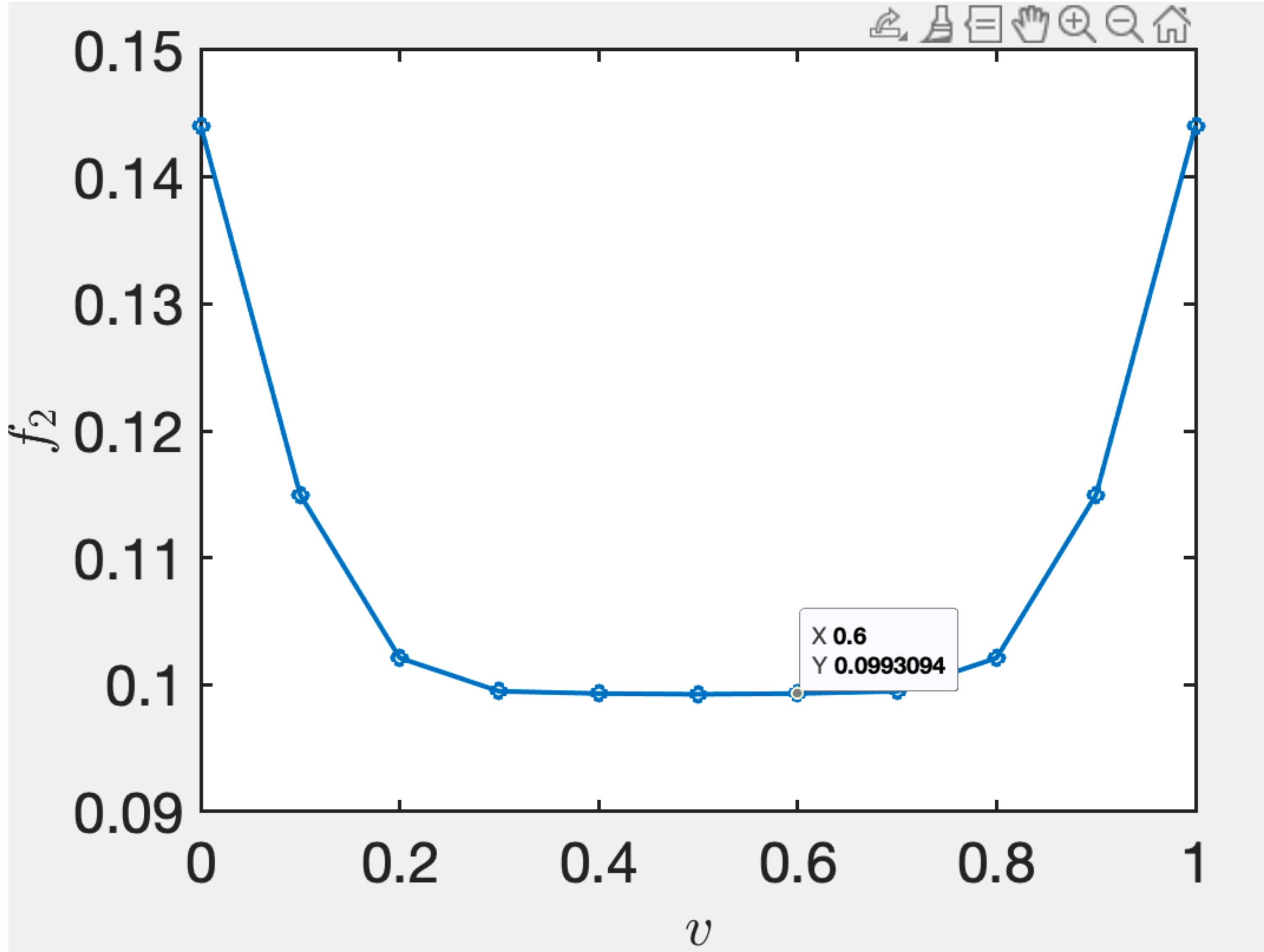
$$\log g^{(n)}(L) = -\left(S^{(n)}(L) - L\frac{S^{(n)}(L+4) - S^{(n)}(L-4)}{8} \right)$$

Mutual information, z channel

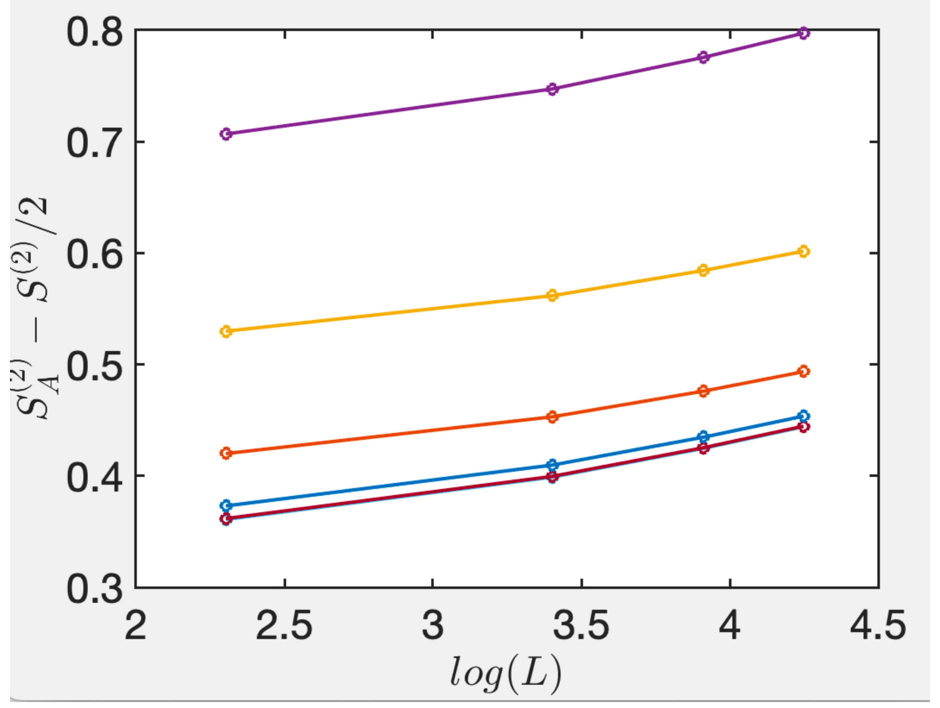
$L = 20,40,60,80$

For different size of systems, cut along the middle bond, and get the mutual information.





$L = 10,30,50,70$



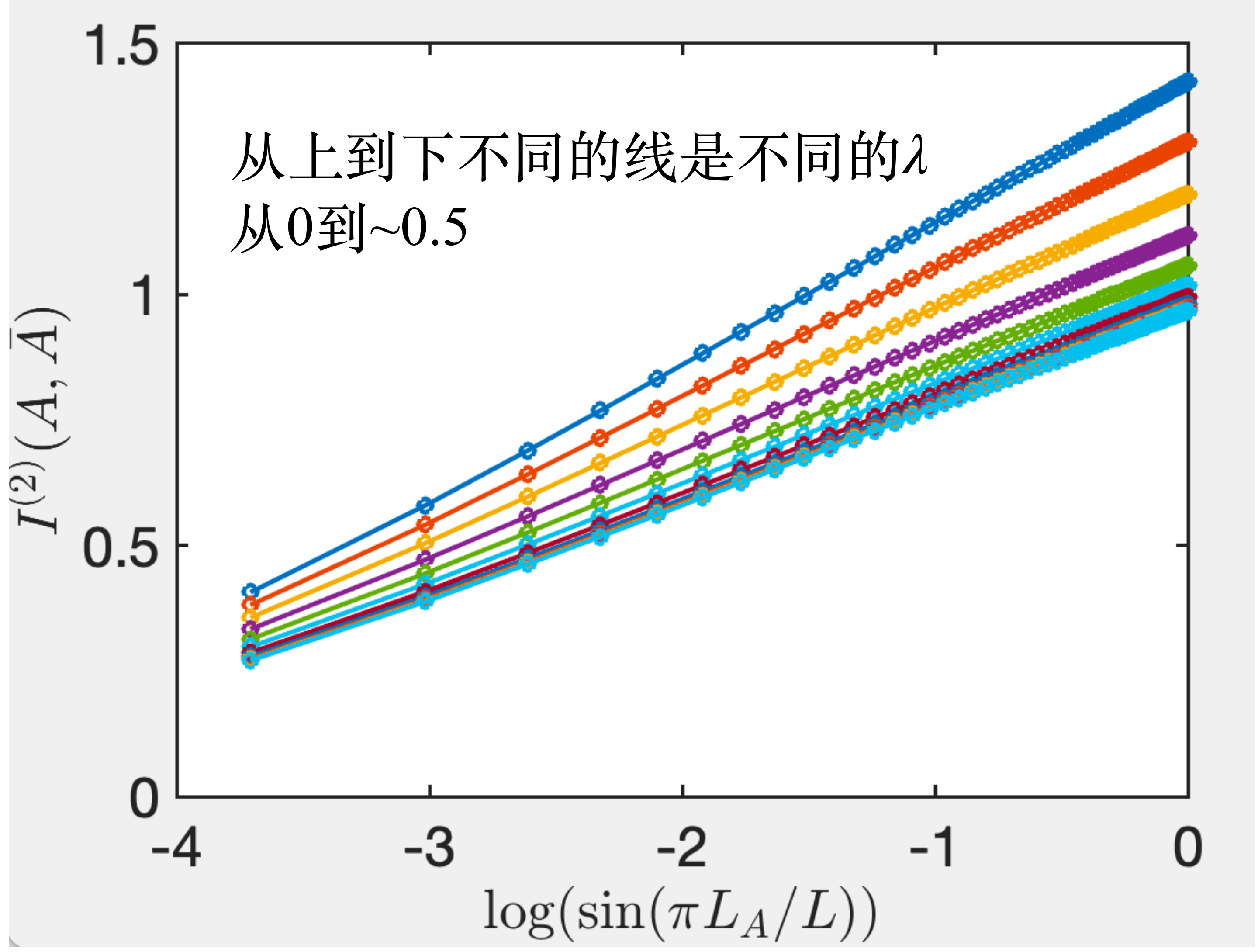
Mutual information, z channel

$$I^{(n)}(A,B) = S^{(n)}\left(\rho_A\right) + S^{(n)}\left(\rho_B\right) - S^{(n)}\left(\rho_{AB}\right)$$

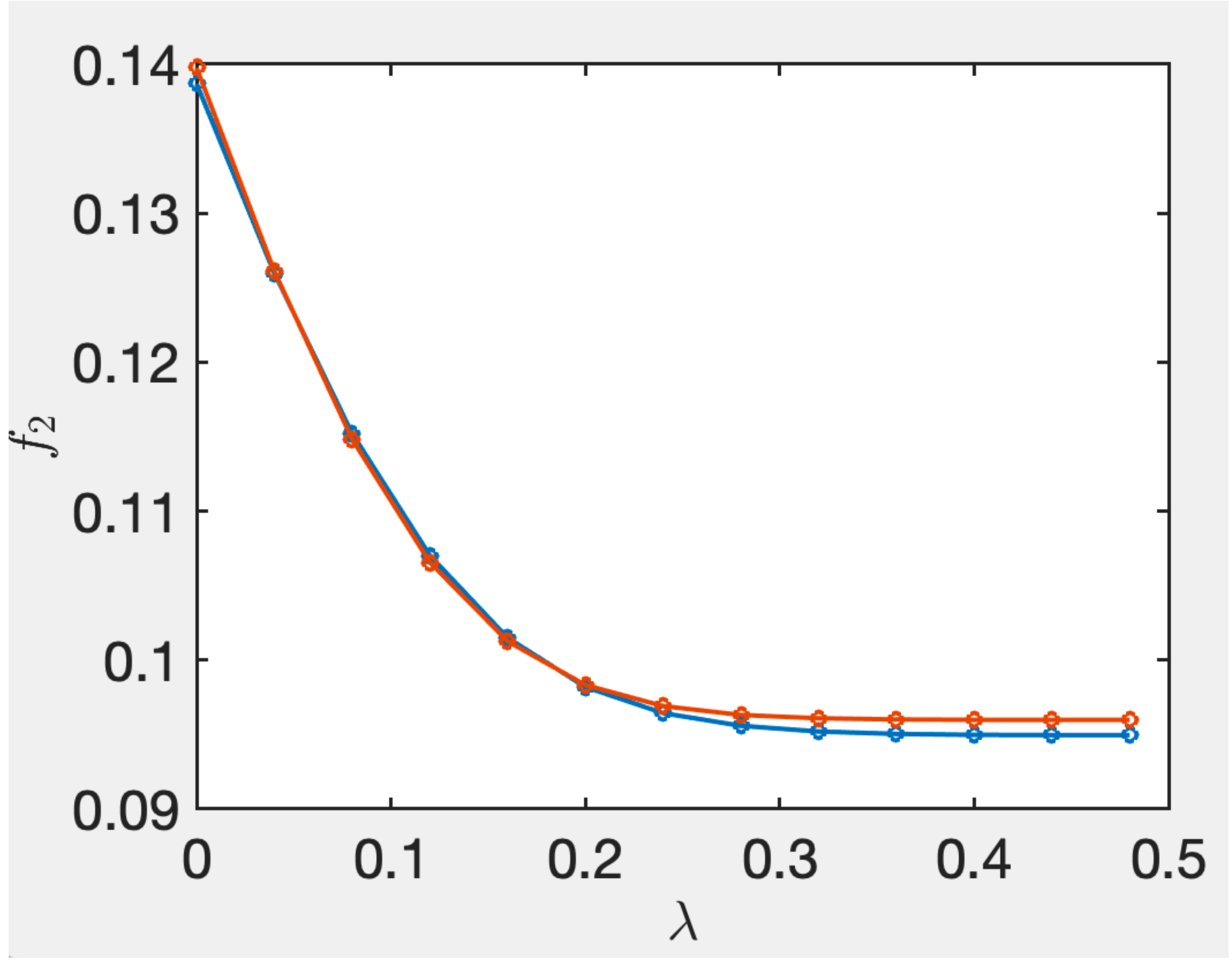
$$S_A^{(2)}\left(\rho_f\right) = \alpha L_A + f_2(\Delta)\log(\sin(\pi L_A/L))$$

We fix L = e.g. 256, partite the system on different bond with different size of subsystem A.

Below the left figure only retains the A length even data to avoid the oscillation.



Finite size effect:
Red: L = 256;
Blue: L=128;
Lambda = 0, we expect f2 = 0.125?



Mutual Information, depolarizing noise

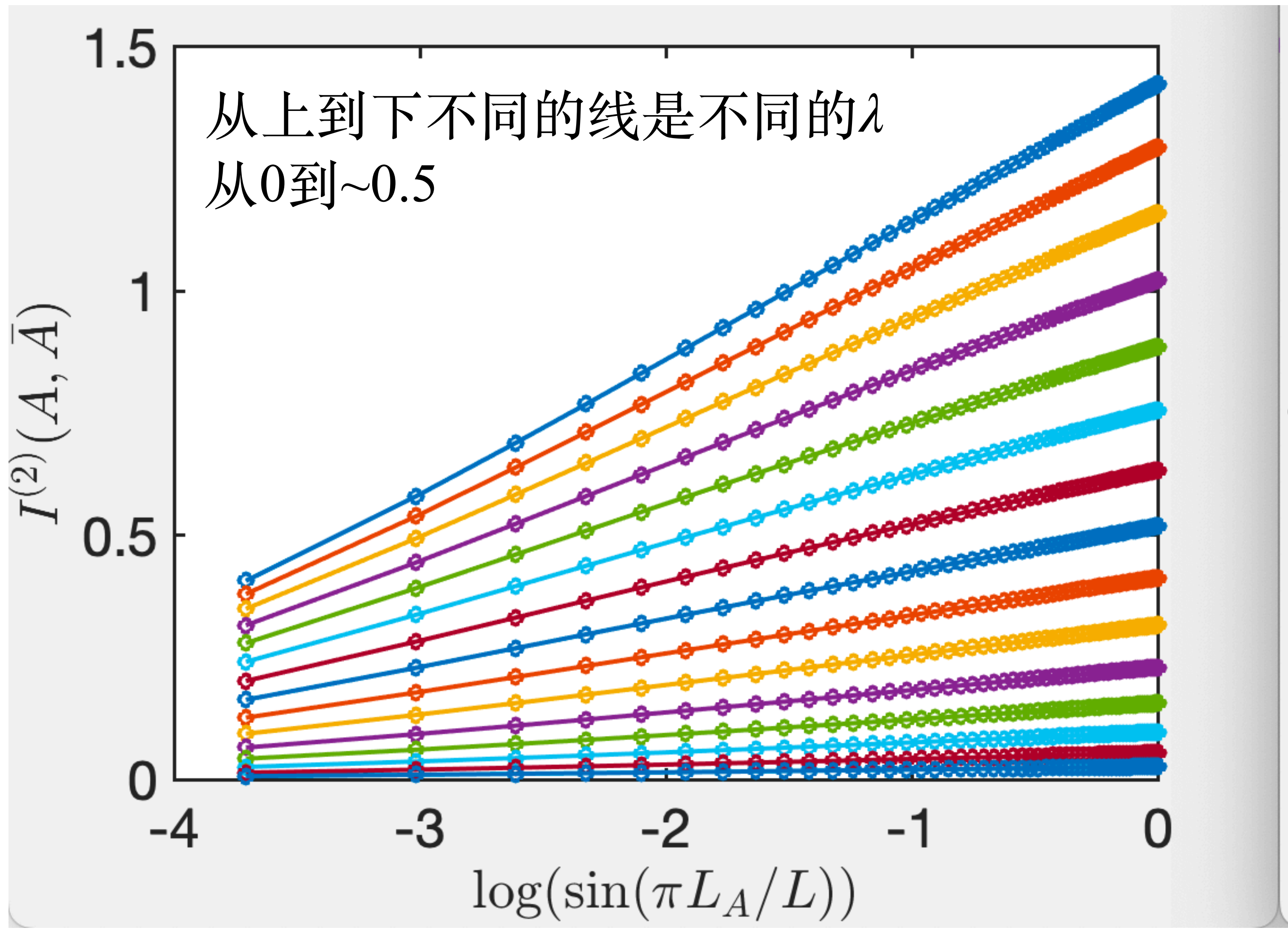
$$I^{(n)}(A,B) = S^{(n)}\left(\rho_A\right) + S^{(n)}\left(\rho_B\right) - S^{(n)}\left(\rho_{AB}\right)$$

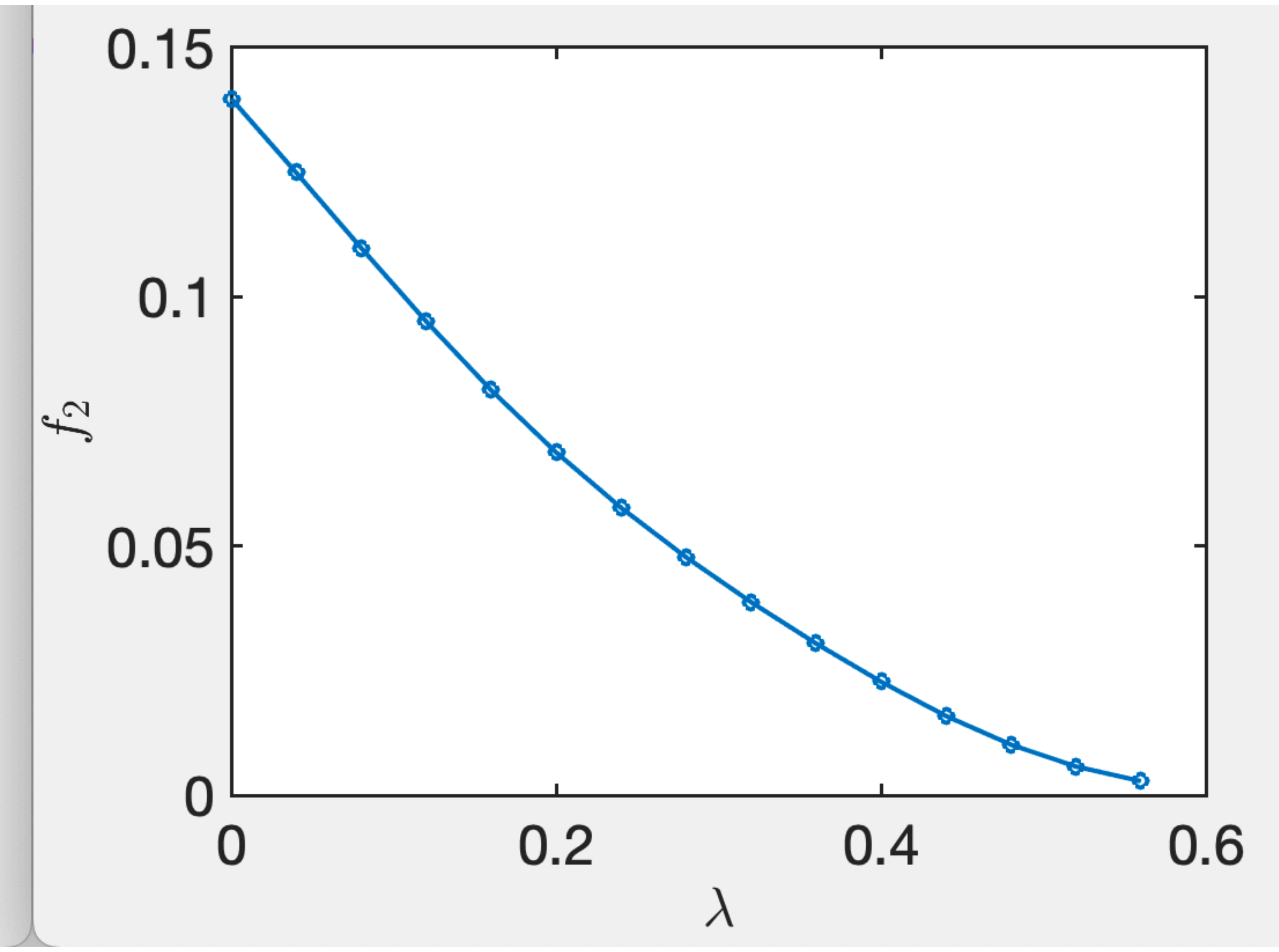
$$S_A^{(2)}\left(\rho_f\right) = \alpha L_A + f_2(\Delta)\log L_A$$

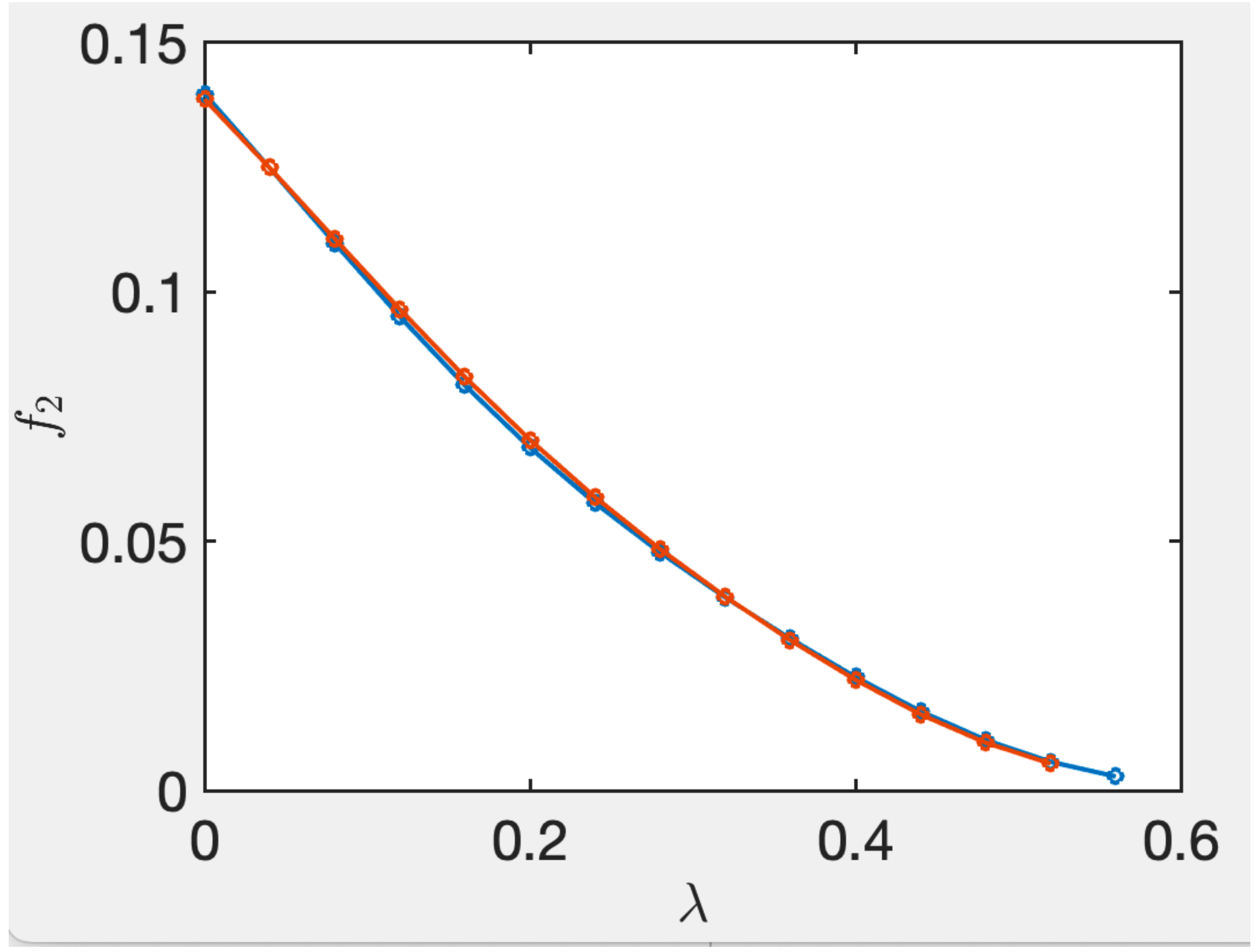
We fix L = e.g. 256, partite the system on different bond with different size of subsystem A.

Below the left figure only retains the A length even data to avoid the oscillation.

Finite size effect:
Red: L = 128;
Blue: L=256.
Lambda = 0, we expect f2 = 0.125?







Negativity

$L = 20{,}40{,}60{,}80$