Random_grain_thermalization

October 15, 2021

1 Quantum bath coupled to a localized chain - an introduction

1.1 Contents of this notebook

This notebook is intended as a test of the implementation of the random ergodic grain included in the larger Hamiltonian. The theory is given in the paper by David Luitz et. al. on "How a small quantum bath can thermalize a long localized chain."

1.1.1 Some preliminary calculations, instantiation of the Hamiltonian etc.

1.1.2 Define the model constants

For now, we resort to those used in the paper. With L_{b}, we denote the bath length, while L_{loc} denotes the length of the localized portion of the system. Disorder strength parameter is denoted, as usually, by W and g_0 and α specify the couplings of LIOMs to the bath, respectively. Bath parameters are controlled by setting the value of β. We also provide a brief explanation in the comments.

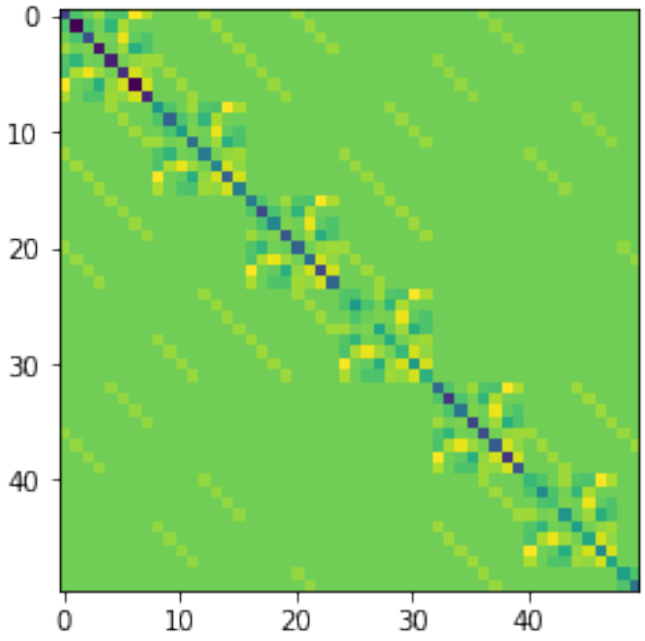
1.1.3 Set up the Hamiltonian

```
Please wait, building the Hamiltonian …
Building the Hamiltonian finished!
Calculating nnz, o_nnz, d_nnz!
Calculating nnz, o_nnz, d_nnz finished!
```

1.1.4 Display the matrix properties, perform diagonalization etc.

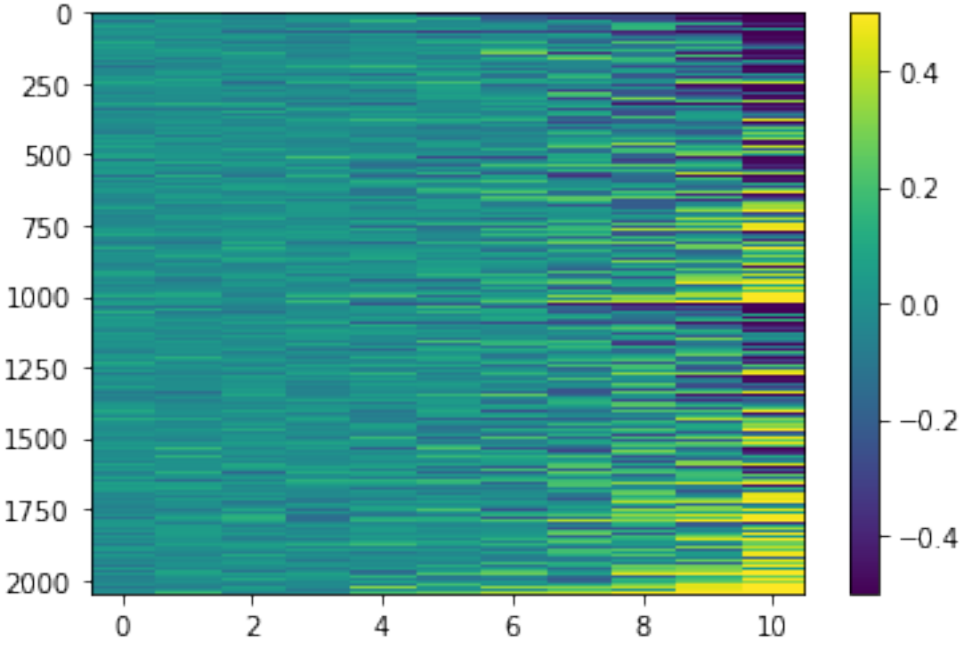
Only a portion of the matrix of size $2^L \times 2^L$ is shown.

```
<matplotlib.image.AxesImage at 0x7fd0526566d0>
```

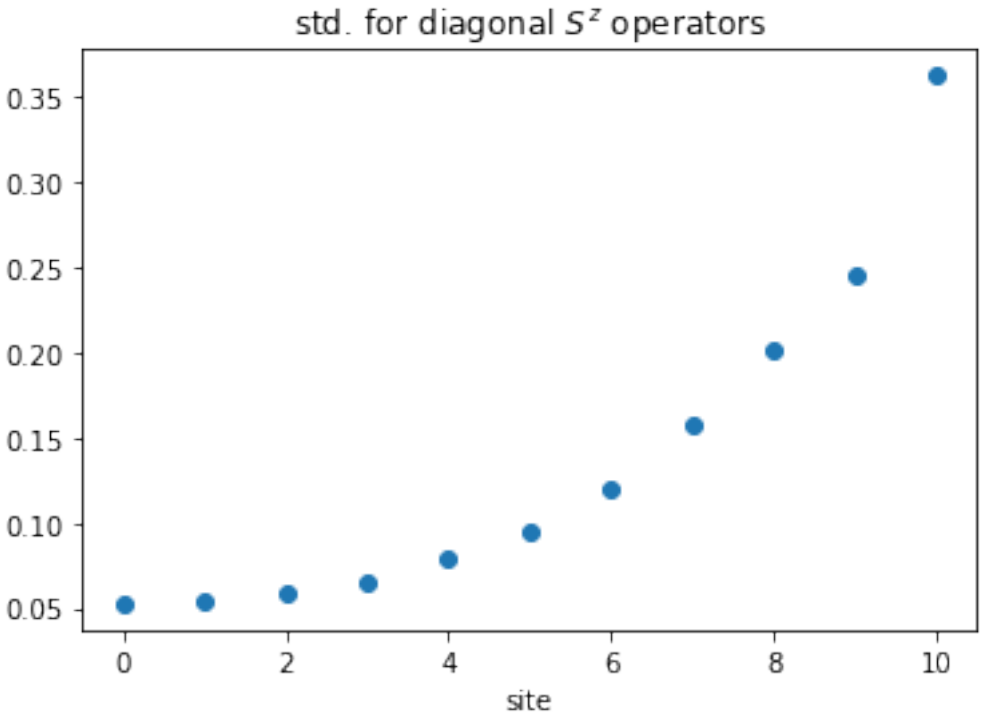


1.1.5 S^z operator on different sites

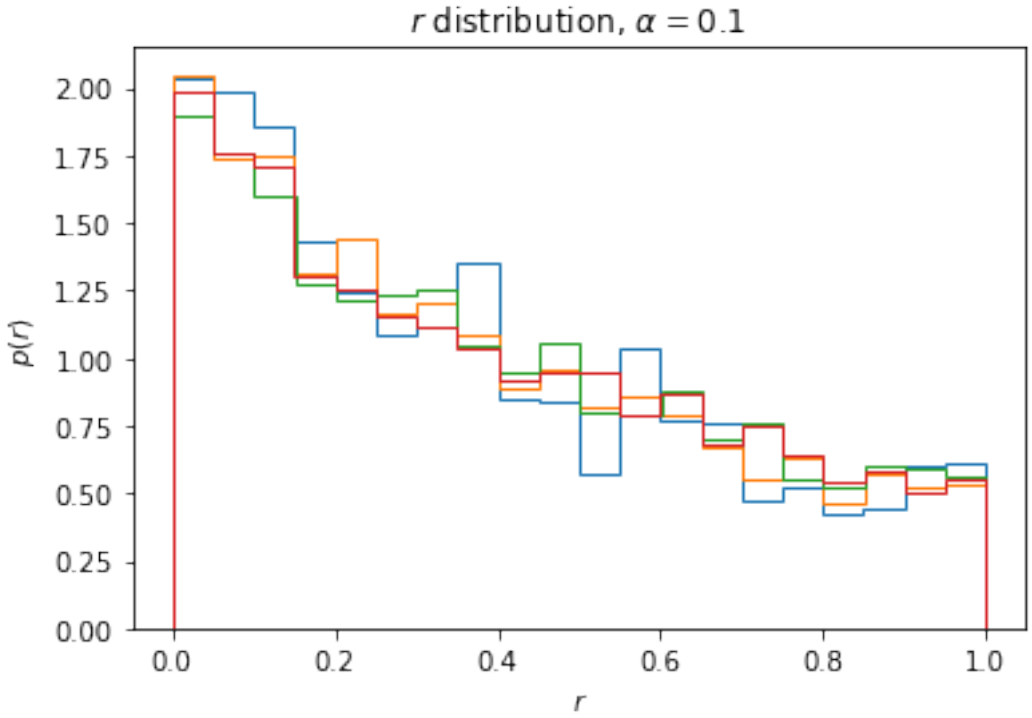
```
/home/jan/.local/lib/python3.7/site-packages/ipykernel_launcher.py:5:
ComplexWarning: Casting complex values to real discards the imaginary part
  """
```

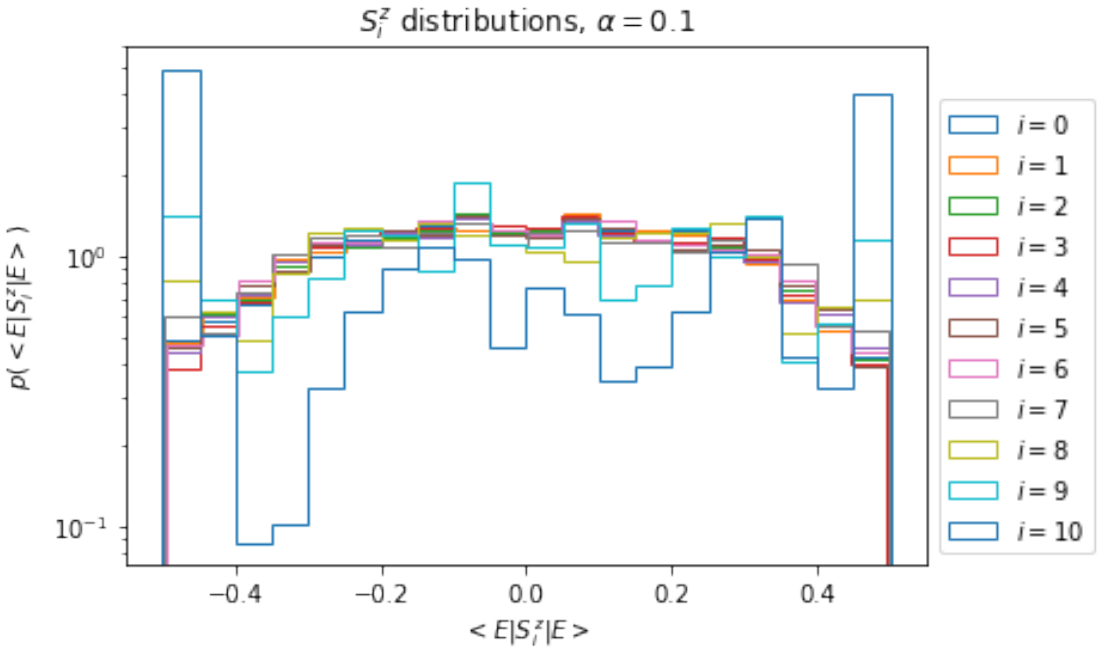


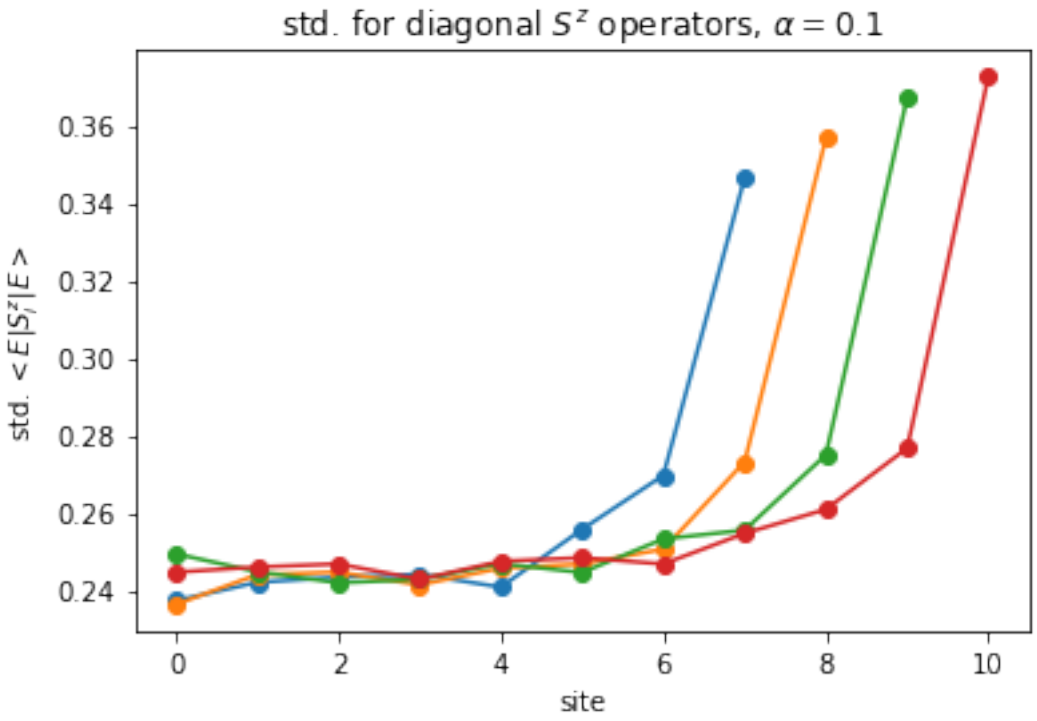
```
Text(0.5, 1.0, 'std. for diagonal $S^z$ operators')
```



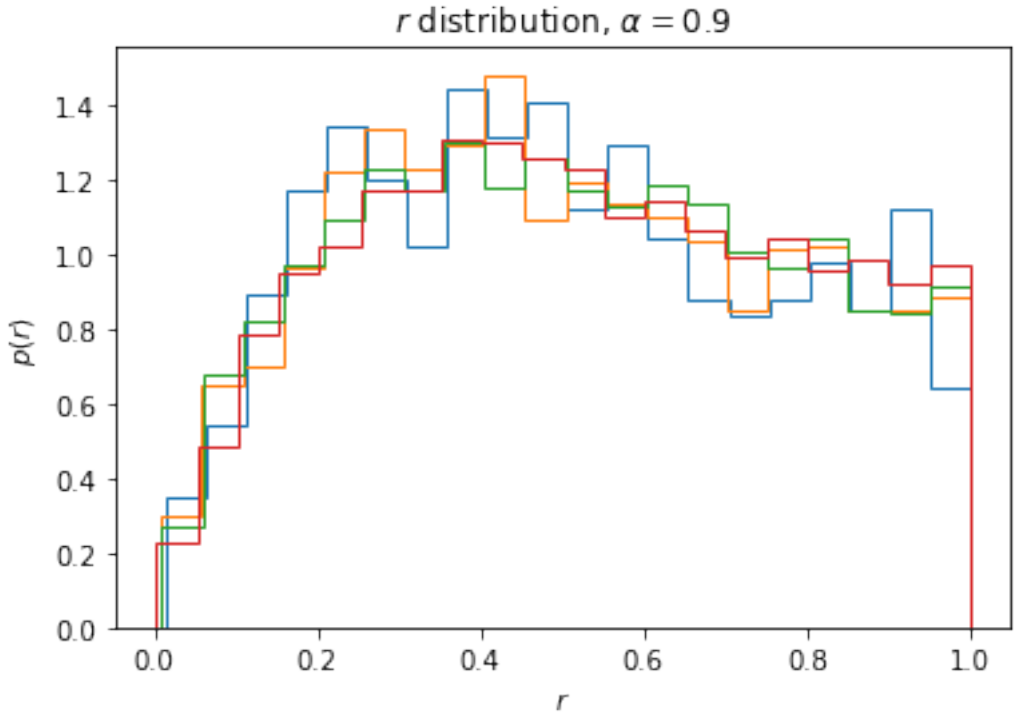
1.2 Below the critical point

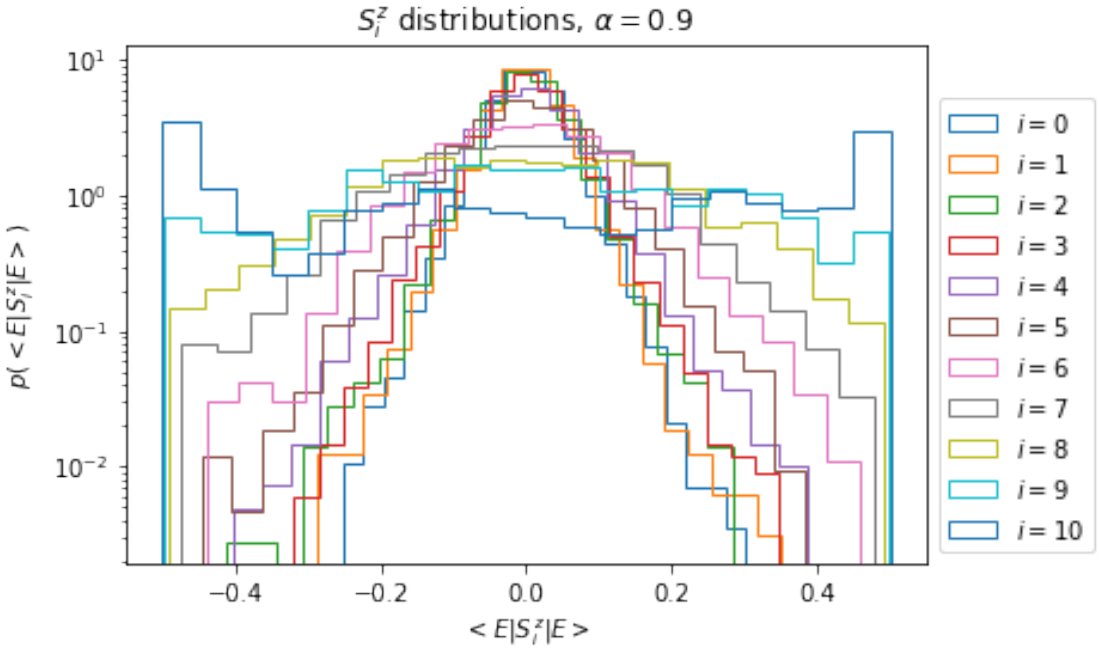


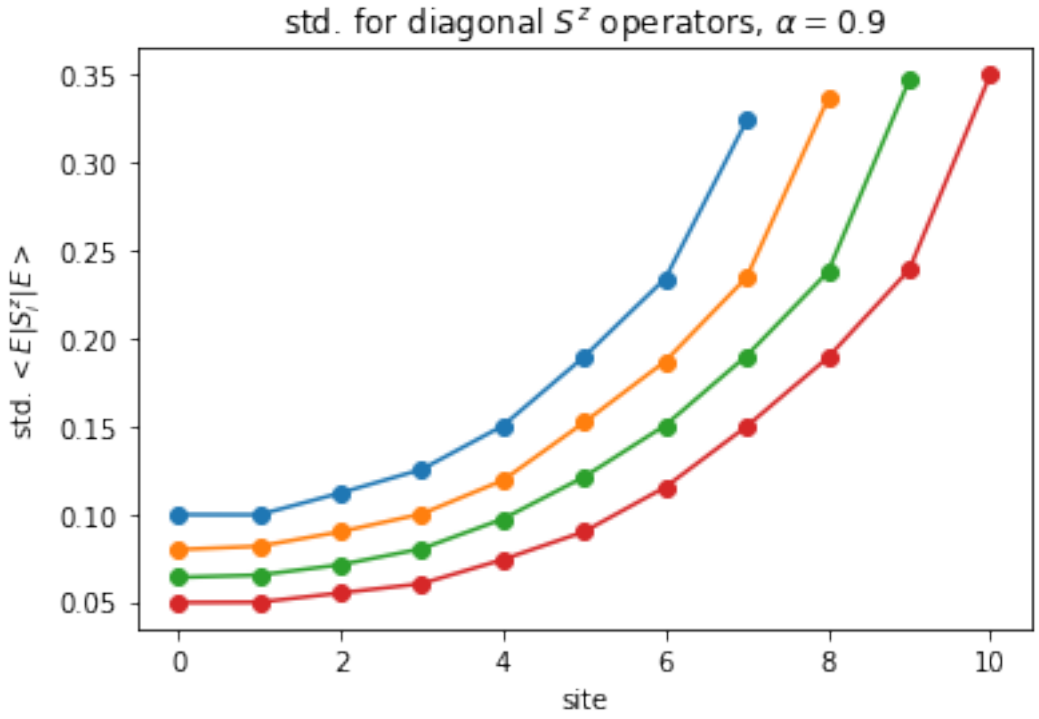




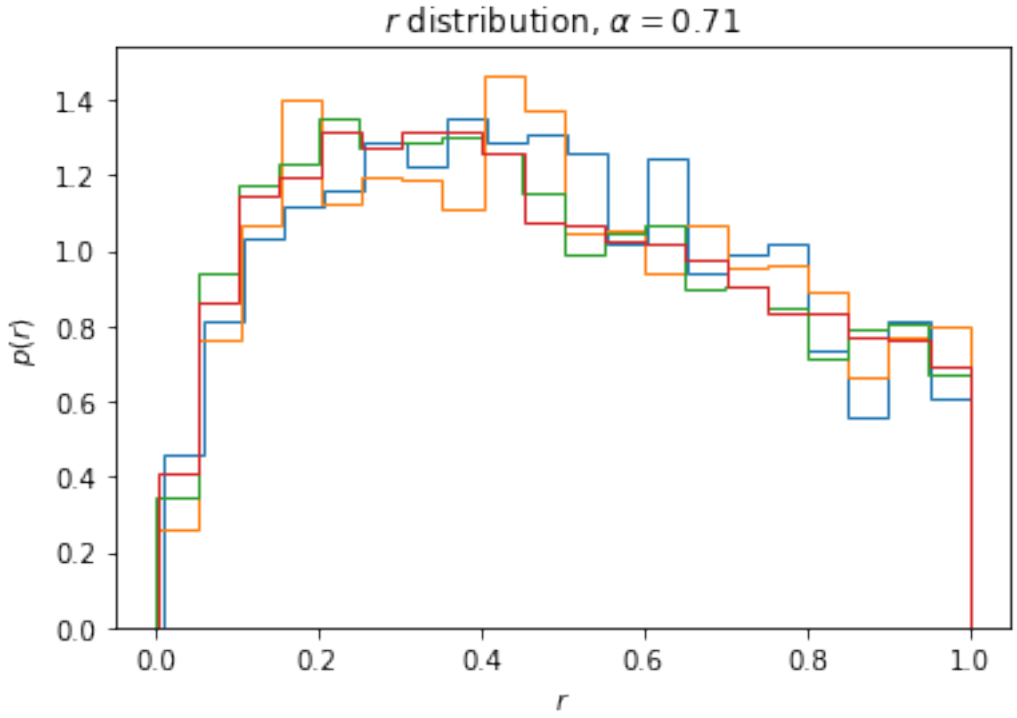
1.2.1 Above the critical point

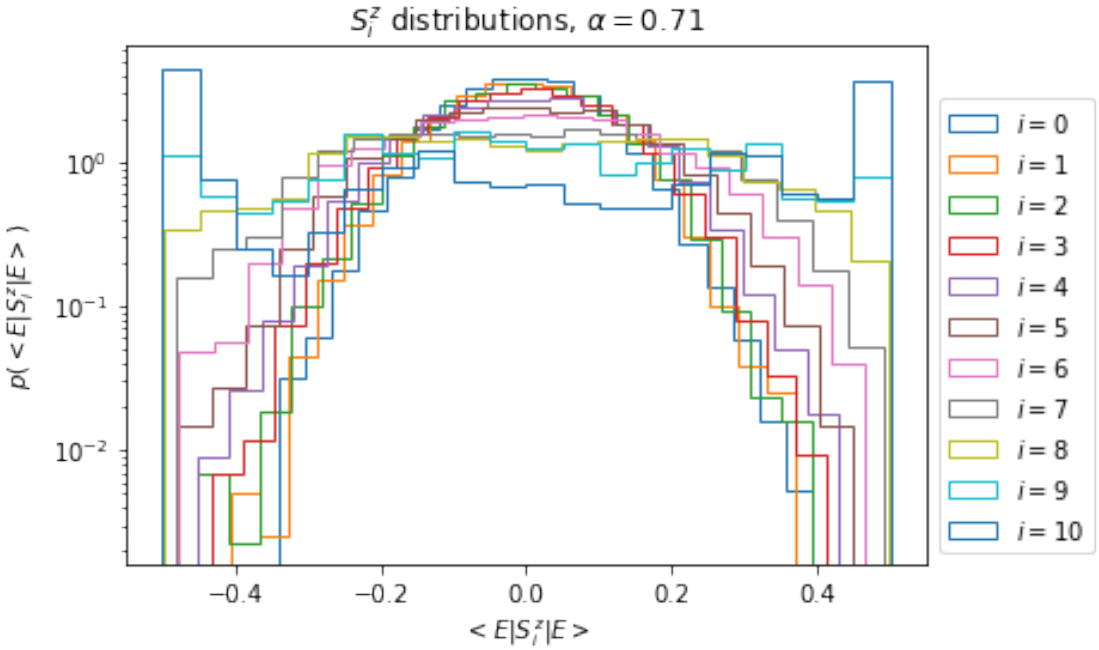


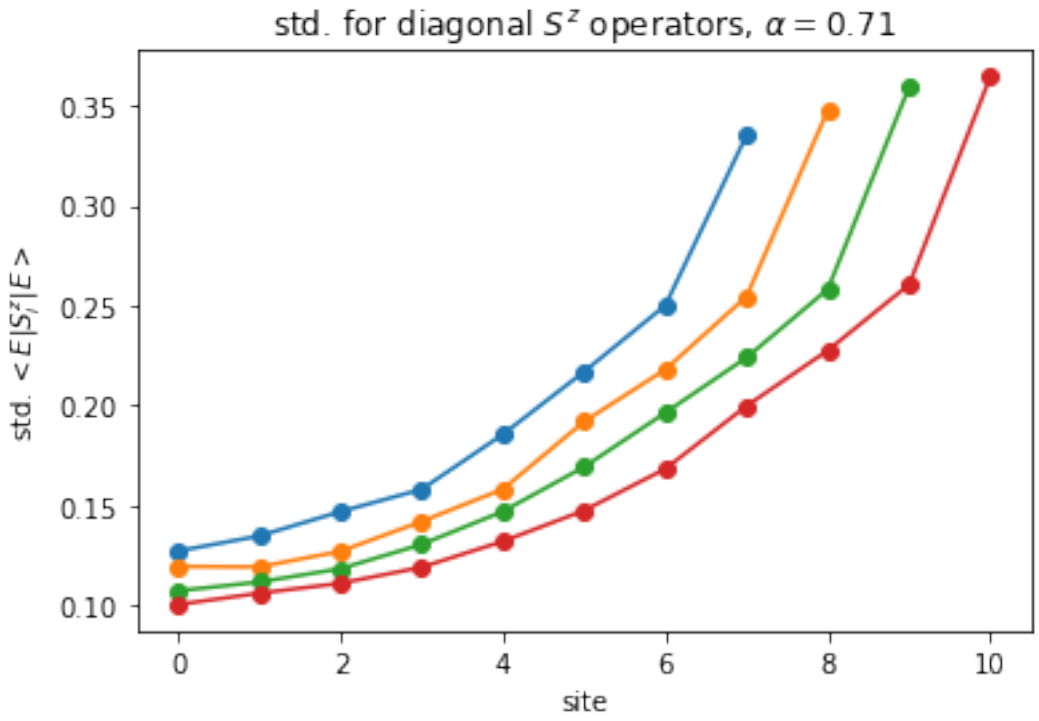

S_i^z distributions, $\alpha = 0.9$
$p(< E|S_i^z|E >)$
$< E|S_i^z|E >$
10^1
10^0
10^{-1}
10^{-2}
−0.4
−0.2
0.0
0.2
0.4
$i = 0$
$i = 1$
$i = 2$
$i = 3$
$i = 4$
$i = 5$
$i = 6$
$i = 7$
$i = 8$
$i = 9$
$i = 10$


std. for diagonal S^z operators, $\alpha = 0.9$
std. $< E|S_i^z|E >$
site
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
2
4
6
8
10

1.2.2 At the critical point






std. for diagonal S^z operators, $\alpha = 0.71$
std. $< E|S_j^z|E >$
0.35
0.30
0.25
0.20
0.15
0.10
0
2
4
6
8
10
site