**Week 8**

Alongside investigating further, the dynamics of the local quench, this week I had a look at some applications of single addressing lasers on our atoms. One notable application I came across was the generation of GHZ states on even number Rydberg atom chains. This was outlined in the following paper: https://arxiv.org/abs/1905.05721.

The state we are after is the GHZ state which takes on different forms. In this case the state the paper was referring to is:

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Description automatically generated

The paper reached this target state by perform a linear detuning sweep on an even number of neutral Rb atoms at a distance such that nearest neighbour blockade took effect. This put the system into a superposition of alternate Z2 crystals states alongside some ‘edge states’ with Rydberg excitations on the end atoms.

In order to attain the GHZ state we would like to have the system in solely a superposition of the alternating Z2 even states. To do this the paper single addresses atoms such that the two Z2 states become the most energetically favourable. This is done by single addressing the edge atoms to have lasers detuned less such that two Rydberg excitations on the edge atoms (‘edge states’) are less likely and more energetically costly. As the process is down adiabatically, they stay in their desired ground state.

Following the process outlined by the paper, I decided to try generating these states for a 4 and 6 atom system. I did this by sweeping the edge atoms to lower detuning values then the rest as outlined by the figures below.

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Description automatically generated with medium confidence

The result we get is the generation of the of the GHZ state to 96% fidelity in the 4-atom case and 90% in the 6-atom case. As expected, the fidelity of the GHZ decreases with an increase in the number of atoms as new ‘edge states’ with third site excitations start to creep in. To address this, we can as before single address these third sites with less detuned lasers to keep the two Z2 states most energetically favourable.