1 Quantum Annealing

- The energy landscape of a random Ising model like an Ising spin glass has a complex multimordal structure. It is difficult to find out its ground state.
- Because of the exponential increase in the number of states (exceeds 10^2) we can't examine the energy of all the state.
- We can use the thermal fluctuation in simulated annealing. It helps the state of a system hop from one energy miminum to another. The ground state can be obtained by decreasing the temperature slowly.

1.1 Combinatorial Optimization Problems

$$H_{TSP} = \sum_{\text{all links}} d_{\langle i,j \rangle} \frac{S_{\langle i,j \rangle} + 1}{2} \ . \tag{1}$$

under the conditions

$$\sum_j d_{\langle j,i \rangle} \frac{S_{\langle i,j \rangle} + 1}{2} = 1 \tag{2}$$

and

$$\sum_j d_{\langle i,j \rangle} \frac{S_{\langle i,j \rangle} + 1}{2} = 1 \ . \tag{3}$$

1.2 Non-crossing Rule

Let H be an Hermite matrix of dimenstion d. If H has f different engenvalues and each of them has m_i $(i = 1, 2, ..., f)$ multiplicity.

A unitary matrix is generally composed of $2d^2$ real parameters. However, due to the unitarity,