

Spatial search by quantum walks

- N elements distributed in space, described by **N -vertex graph**
- Quantum walk dynamics determined by the **Laplacian** L of the graph
- Marked state is **identified** by an **oracle** $H_w = -|w\rangle\langle w|$

$$H = -\gamma L - |w\rangle\langle w|$$

- **Complete graph:** $O(\sqrt{N})$

Search procedure

- Start in state $|s\rangle = \frac{1}{\sqrt{N}} \sum_j |j\rangle$
- Schrodinger evolve for time T using the Hamiltonian H
- Measure the state
- Goal: choose γ , T so that the probability $|\langle w|e^{-iHT}|s\rangle|^2$ is as close to 1 for the smallest T .

A. Child and J. Goldstone, Spatial search by quantum walk. *Physical Review A* (2004)