위상 연산자

상대적인 위상차 만들기

최만수 (고려대 물리학과)

Pauli Operators

and their Eigenbasis

Computational Basis

The Eigenbasis of Pauli Z

- $\{|0\rangle, |1\rangle\}$
- $\hat{Z} = |0\rangle\langle 0| - |1\rangle\langle 1|$

Eigenbasis of Pauli X

- $\{|+\rangle, |-\rangle\}$
- $\hat{X} = |+\rangle\langle +| - |-\rangle\langle -|$

$$|\pm\rangle := \frac{|0\rangle \pm |1\rangle}{\sqrt{2}}$$

$$|+\rangle = \hat{H}|0\rangle$$
$$|-\rangle = \hat{H}|1\rangle$$

Eigenbasis of Pauli Y

- $\{|L\rangle, |R\rangle\}$
- $\hat{Y} = |L\rangle\langle L| - |R\rangle\langle R|$

$$|L/R\rangle := \frac{|0\rangle \pm i\,|1\rangle}{\sqrt{2}}$$

$$|L\rangle = \hat{H}\hat{S}\,|0\rangle$$
$$|r\rangle = \hat{H}\hat{S}\,|1\rangle$$

Phase Operators

Relative Phase Shifts

Phase Shift

in the Computational Basis

- $|0\rangle + |1\rangle \mapsto |0\rangle + |1\rangle e^{i\phi}$

$$\hat{Z}^{\phi} \doteq \begin{bmatrix} 1 & 0 \\ 0 & e^{i\phi} \end{bmatrix}$$

Phase Shift in the X Basis

$$\hat{X}^{\phi} := |+\rangle\langle +| + |-\rangle\, e^{i\phi}\,\langle -|$$

- $|+\rangle + |-\rangle \mapsto |+\rangle + |-\rangle e^{i\phi}$

Phase Shift in the X Basis

$$\hat{Y}^{\phi} := |L\rangle \langle L| + |R\rangle e^{i\phi} \langle R|$$

- $|L\rangle + |R\rangle \mapsto |L\rangle + |R\rangle e^{i\phi}$

감사합니다!