$3\frac{1}{2}$ hours; 1:00 pm CT or 1:30?

Using qiskit pulse for Grover's

- Measure qubit energy w/ freq./energy pulses
- Classification into 3 states
- Learn how to manipulate qubits (gates?)
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$$Z(+2) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} b \\ c \\ a \end{bmatrix} = Z(+1)^2 \text{ or } Z(01)\cdot Z(02)$$

$\boxed{\text{4 pulses}}$

$$Z(+1) = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} c \\ a \\ b \end{bmatrix} = Z(01)Z(12)$$

$\boxed{\text{2 pulses}}$

$$Z(01) = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} b \\ a \\ c \end{bmatrix} \quad 0 \rightarrow 1 \quad \text{1 pulse}$$

$$Z(02) = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} c \\ b \\ a \end{bmatrix} \quad 0 \rightarrow 2 = Z(01)Z(12)Z(01)$$

$\boxed{\text{3 pulses}}$

$$Z(12) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} a \\ c \\ b \end{bmatrix} \quad 1 \rightarrow 2 \quad \text{1 pulse}$$

$$Z(01)Z(12) = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

$$Z(01)Z(12)Z(01) = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

$$Z(01)Z(12) = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} = Z(+1)$$

$Z(+2) = Z(01)\cdot Z(02)$ (4 pulses)

or $Z(+1)\cdot Z(+1)$ (4 pulses)

$$S = \begin{pmatrix} \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{6}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{3}} & \frac{-2}{\sqrt{6}} & 0 \\ \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{6}} & \frac{-1}{\sqrt{2}} \end{pmatrix}$$

$$M\text{-}S_Z(a_1, a_2, \ldots, a_n) = \begin{cases} c \text{ shift by } Z \text{ if } a_i = 2 \text{ for } i = 1, \ldots, n \\ c \quad \text{otherwise} \end{cases}$$

$\hookrightarrow$ Only applies $Z(x)$ on c if all $a_i = 2$

$$P = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix} \qquad 2 \to -2$$

$$\gamma(t) = I(t) + iQ(t) = R(t)e^{i\phi(t)}$$

$$I = R\cos\phi \quad Q = R\sin\phi \Rightarrow \phi = \pi$$