

QUANTUM

CI

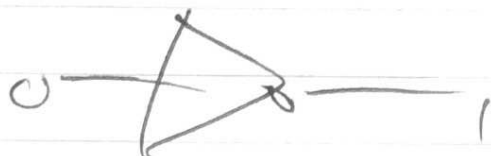
जिज्ञासु

BITS

0, 1

PI

GATES



⊗ CAN'T RUN MOST GATES  
BACKWARD

QBITS: QBIT IS A LINEAR  
COMBO OF 2 BASIS STATES

$|0\rangle$  ,  $|1\rangle$

$$q = a|0\rangle + b|1\rangle$$

$$a, b \in \mathbb{C} \quad a^2 + b^2 = 1$$

$$q = |0\rangle$$

$$|1\rangle$$

$$.6|0\rangle + .8|1\rangle$$

Q IS IN BOTH STATES  $\curvearrowright$

$|0\rangle, |1\rangle$

SIMULTANEOUSLY. IT'S A

SUPERPOSITION OF THEM

IF YOU OBSERVE Q, THAT WILL

COLLAPSE IT INTO EITHER

$|0\rangle$  OR  $|1\rangle$

WITH PROB  $a^2, b^2$ .

CANNOT OBSERVE  $a, b$

OBSERVING CHANGES Q.

CANNOT CLONE Q.

SHORTHAND  $Q = \begin{pmatrix} a \\ b \end{pmatrix}$

$Q = \begin{pmatrix} a \\ b \end{pmatrix}$

$a, b \in \mathbb{C}$   
 $a^2 + b^2 = 1$

OPERATE ON  $\varphi$  WITH  
2x2 MATRIX  
UNITARY

$$X = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

$$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} b \\ a \end{pmatrix}$$

LIKE A NOT  
IT CHANGES  $\varphi$ .

IT'S INVERTIBLE  $X^2 = I$

$$Y = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} -1b \\ 1a \end{pmatrix}$$

$$Z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

HADAMARD  $H = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} \frac{a+b}{\sqrt{2}} \\ \frac{a-b}{\sqrt{2}} \end{pmatrix}$

2 QUBITS

$\varphi_1, \varphi_2$

4

$$\varphi_1 = \begin{pmatrix} a_1 \\ b_1 \end{pmatrix}$$

$$\varphi_2 = \begin{pmatrix} a_2 \\ b_2 \end{pmatrix}$$

NOW COMBINING THEM

$$\varphi = \begin{pmatrix} \varphi_1 \\ \varphi_2 \end{pmatrix} = \begin{pmatrix} a_1 a_1 | 00 \rangle \\ a_1 b_2 | 01 \rangle \\ a_2 b_1 | 10 \rangle \\ a_2 b_2 | 11 \rangle \end{pmatrix}$$

$$\sum_{i,j} a_i b_j^2 = 1$$

OPERATE WITH A KEY MATRIX

$$Q = \begin{pmatrix} a \\ b \\ c \\ d \end{pmatrix}$$

3 QBIT SYSTEM:

5

8 WEIGHTS

$$\varphi = \begin{pmatrix} i \\ j \end{pmatrix} = \begin{pmatrix} a_0 b_0 c_0 |000\rangle \\ a_1 b_1 c_1 |001\rangle \\ \vdots \\ \vdots \end{pmatrix}$$

8 QBIT SYSTEM:

256 ELEMENT VECTOR

OPERATOR IS A 256x256 MATRIX

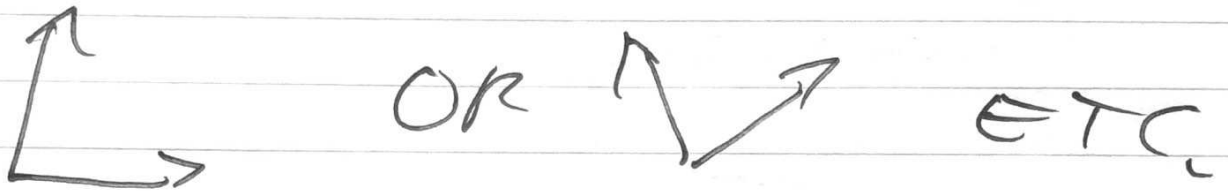
SYSTEM IS SUPERPOSITION

OF 256 STATES.

OPERATOR TRANSFORMS ALL 256.

OBSERVE  $\psi$  BY APPLYING A <sup>6</sup>  
MEASUREMENT OPERATOR.

IT HAS A BASIS.



IT PROJECTS  $\psi$  ONTO EITHER OR

ITS BASIS VECTORS WITH

PROBABILITY  $|\langle \psi | \phi \rangle|^2$

---

ALL THIS ~~SO~~ SOUNDS CRAZY.

PHYSICS EXPERIMENTS

CONFIRM IT.