Unit 2

Introduction to quantum computing

→ Qubit

States 0, 1
Classical bit

symbols for states in QC

$|0\rangle$, $|1\rangle$ → pure state

→ Qubits / quntam bits

- Superimpostion (combition of both)

$\alpha|0\rangle + \beta|1\rangle$

real   complex

ex:- Tommor there will be lec or not of QC

Tommor lec - Yes , No
0.8   0.1

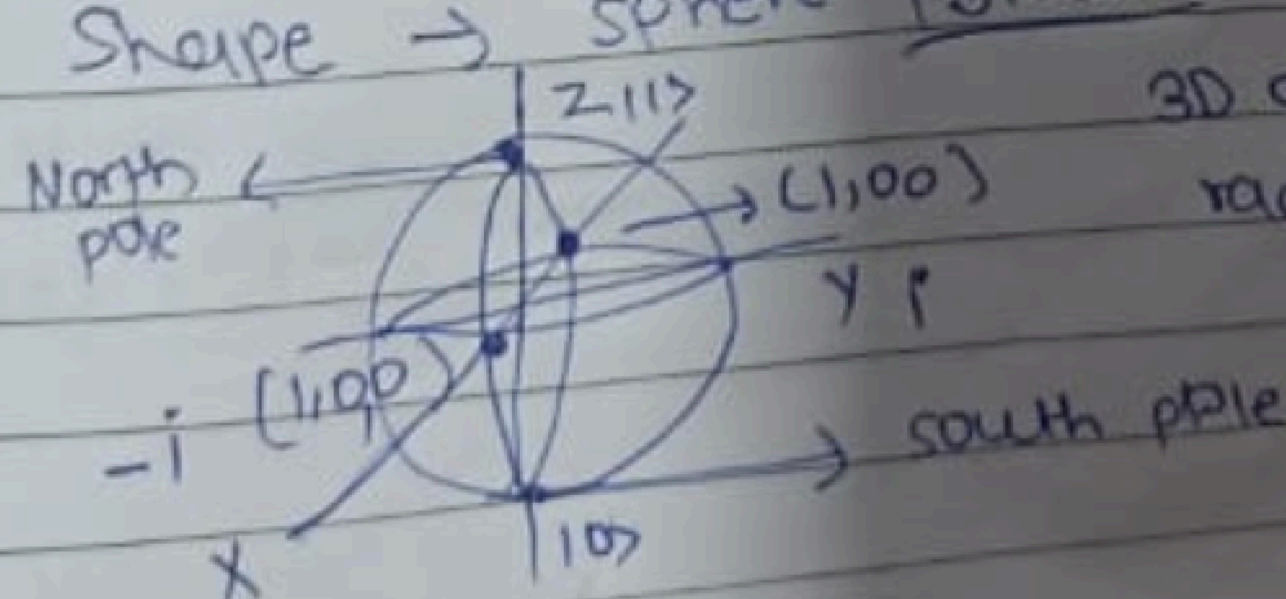
$0.8|0\rangle$ → yes $0.2|1\rangle$ → No

yestarday lec - yes

ket → 0   ket → 1

* geametrical interperatition / visualising quit

Shape → sphere [Bloch]



3D object radius | r = mm/cm/km 1unit

$|0\rangle = \frac{1}{\sqrt{2}}(|+\rangle + |-\rangle)$

$|1\rangle = \frac{1}{\sqrt{2}}(|+\rangle - |-\rangle)$

$\frac{\sqrt{3}}{2}|0\rangle + \frac{1}{2}|1\rangle$

$\frac{\sqrt{3}}{2}\cdot\frac{1}{\sqrt{2}}|+\rangle + \frac{\sqrt{3}}{2}\cdot\frac{1}{\sqrt{2}}|-\rangle +$

$\frac{1}{2}\cdot\frac{1}{\sqrt{2}}|+\rangle + \frac{1}{2}\cdot\frac{1}{\sqrt{2}}\cdot|-\rangle$

$= \frac{\sqrt{3}+1}{2\sqrt{2}}|+\rangle + \frac{\sqrt{3}-1}{2\sqrt{2}}|-\rangle$

$|\alpha|^2 = \left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)^2$ $\quad |\beta|^2 = \frac{(\sqrt{3}-1)^2}{2\sqrt{2}}$

$= 0.93$ $\quad = 0.207$

$|0\rangle = \frac{1}{\sqrt{2}}(|i\rangle + |-i\rangle)$

$|1\rangle = \frac{1}{\sqrt{2}}(|i\rangle - |-i\rangle)$

$\alpha = \frac{\sqrt{3}}{2}|0\rangle + \frac{1}{2}|1\rangle$

$\frac{\sqrt{3}}{2}\cdot\frac{1}{\sqrt{2}}|i\rangle + \frac{\sqrt{3}}{2\sqrt{2}}|-i\rangle$, $\frac{-i}{2\sqrt{2}}|i\rangle + \frac{1}{2\sqrt{2}}|-i\rangle$

$\frac{\sqrt{3}-i}{2}|i\rangle + \frac{\sqrt{3}+i}{2\sqrt{2}}|-i\rangle$

$\alpha = \frac{\sqrt{3}-i}{2\sqrt{2}}$ $\quad |\alpha|^2 = \frac{(\sqrt{3}-i)(\sqrt{3}+i)}{8} = \frac{1}{2}$

$\beta = \frac{\sqrt{3}+i}{2\sqrt{2}}$ $\quad |\beta|^2 = \frac{(\sqrt{3}+i)(\sqrt{2}-i)}{8\cdot 2} = \frac{1}{2}$

- Normalization

$\alpha^2 + \beta^2 = 1$ → Normalized quantum state

$\alpha \ \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$

$\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2 = \frac{1}{2} + \frac{1}{2} \ 1$ ✓

- Normalization constant $= \frac{1}{\sqrt{3}}$

$\underline{\frac{1}{\sqrt{3}}}(\sqrt{2}|0\rangle + i|1\rangle)$

- $|A\rangle = \frac{1}{\sqrt{2}}(|0\rangle + e^{-i\pi/6}|1\rangle)$

$\frac{1}{\sqrt{2}}|0\rangle + \frac{e^{i\pi/6}}{\sqrt{2}}|1\rangle$

$a = \frac{1}{\sqrt{2}}$ $\quad |B|^2 = \frac{e^{-i\pi/6}}{\sqrt{2}}$

$|\alpha|^2 = \frac{1}{2}$ $\quad = \frac{e^{-i\pi/6}}{\sqrt{2}} \times \frac{e^{i\pi/6}}{\sqrt{2}} = \frac{1}{2}$

$\frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1$.

$\alpha = \frac{2}{3}$ $\quad \beta = \frac{1-2i}{3}$

$|\alpha|^2 = \frac{4}{9}$ $\quad |\beta|^2 = \frac{(1-2i)(1+2i)}{3 \cdot 3}$

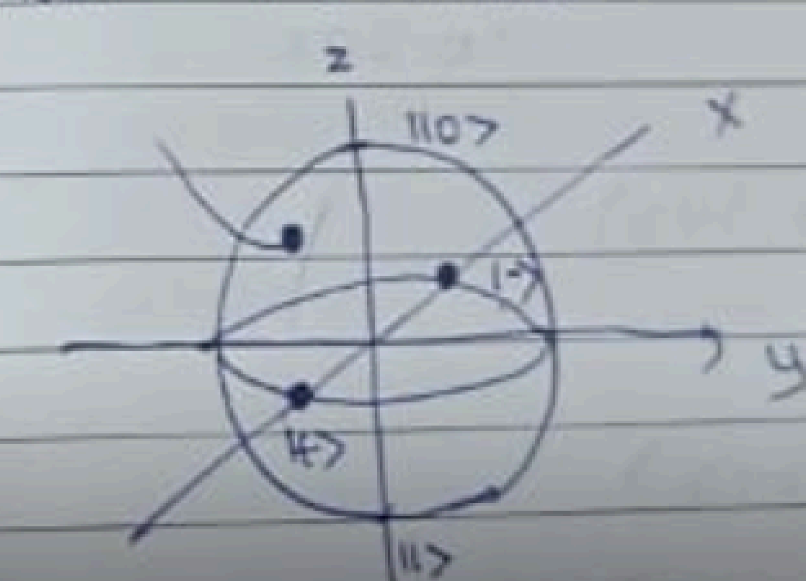
$\frac{4}{9}$ $\quad = \frac{1-2i+2i+4}{9}$

$= \frac{5}{9}$ greater.

$\boxed{\frac{4}{9} < \frac{5}{9}}$

- Measurment collapses to a qubit.

Measurment w.r.t x-axis.



Complex Num calculation

superposition

$|1\rangle \to (0,0,1)$ | $|+\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle) \to (1,0,0) = \frac{|0\rangle}{\sqrt{2}} + \frac{|1\rangle}{\sqrt{2}}$

$|0\rangle \to (0,0,-1)$ | $|-\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle \to (-1,0,0) = \frac{|0\rangle}{\sqrt{2}} - \frac{|1\rangle}{\sqrt{2}}$

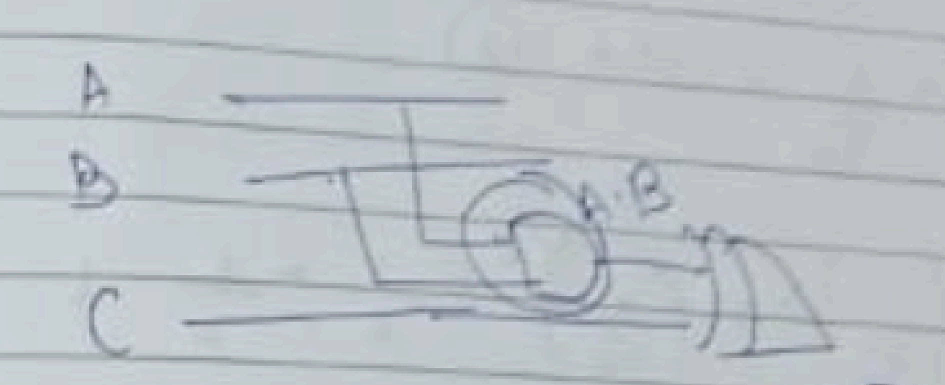
If we cut the sphere there will be two part southern & northern part

$|i\rangle = \frac{1}{\sqrt{2}}(|0\rangle + i|1\rangle)$

$|-i\rangle = \frac{1}{\sqrt{2}}(|0\rangle - i|1\rangle)$

$\boxed{\alpha^2 + \beta^2 = 1}$ $\quad$ ex $- \frac{3}{4} + \quad = 1$

Tsot



ABDC

complex num

$z = x + iy$ $\quad$ $i = \sqrt{-1}$

real $\quad$ img

Real → Imaginary

$z = 3 + i4$

function

1) Real : complex → float

2) Img : complex → float

Complex Number

complex conjugate

Cartisian	Polar
$z = x + iy$	$z = re^{i\theta}$
$\bar{z} = x - iy$	$\bar{z} = re^{-i\theta}$

Num squ

$|z|^2 = r^2 = z^* \times z$