Prof. D. K. Ghosh
Lec. 4 10/5/2016
Lec. No. 4

Cbit : **Qubit**

2 d - Hilbert Space

0, 1

$|0\rangle$

$|1\rangle$

$\langle 0|0\rangle = 1$

$\langle 0|1\rangle = \langle 1|0\rangle = 0$

$\langle 1|1\rangle = 1$

$$|\psi\rangle = 0.2\,|0\rangle + 0.5i\,|1\rangle$$

Any Linear combination of $|0\rangle, |1\rangle$

$$|0\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$|1\rangle = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

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

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

a, b complex.

$\{|0\rangle, |1\rangle\}$

Computational basis.

$$|0\rangle : \frac{a}{\sqrt{|a|^2+|b|^2}}.$$

$$|1\rangle : \frac{b}{\sqrt{|a|^2+|b|^2}}.$$

Measurement yields $|0\rangle$ or $|1\rangle$ with a probability

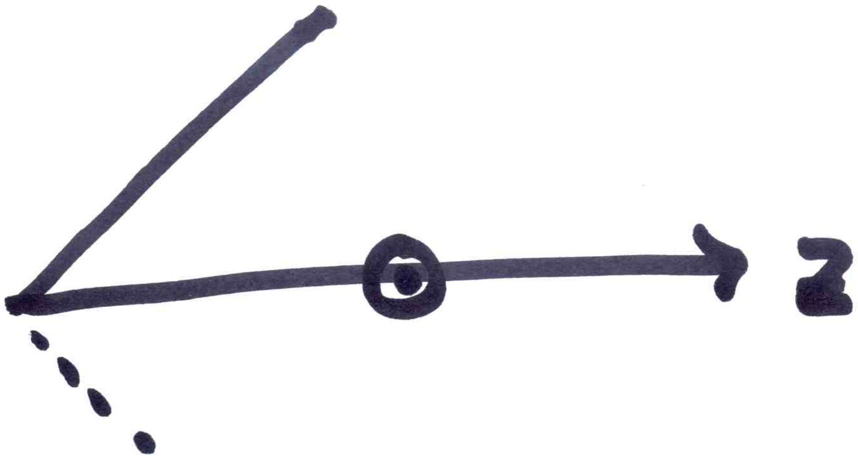
Spin of electron, proton, neutron

$$S_z = +\frac{1}{2} \quad \text{or} \quad -\frac{1}{2}$$

Polarization state of a photon

Horizontal Polarization

Vertical



Diagonal Basis.

45° with computational basis

135°

$$|+\rangle = \frac{1}{\sqrt{2}}\left[|\leftrightarrow\rangle + |\updownarrow\rangle\right]$$

$$|-\rangle = \frac{1}{\sqrt{2}}\left[|\leftrightarrow\rangle - |\updownarrow\rangle\right].$$

$$|\pm\rangle = \frac{1}{\sqrt{2}}\left[|0\rangle \pm |1\rangle\right]$$

<u>Qutrit</u> : 3 state system

d- dimensional.

<u>Qudit</u>.

$$S_x = \frac{\hbar}{2}\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = \frac{\hbar}{2}\sigma_x \qquad \begin{pmatrix} \alpha \\ \beta \end{pmatrix}$$

$$S_y = \frac{\hbar}{2}\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} = \frac{\hbar}{2}\sigma_y$$

$$S_z = \frac{\hbar}{2}\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} = \frac{\hbar}{2}\sigma_z$$

$\underline{\sigma_x, \sigma_y, \sigma_z}$: Pauli Matrices.

Along with $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$