

Title: Lecture - Quantum Foundations, PHYS 639

Speakers: Lucien Hardy

Collection/Series: Quantum Foundations (Elective), PHYS 639, January 6 - February 5, 2025

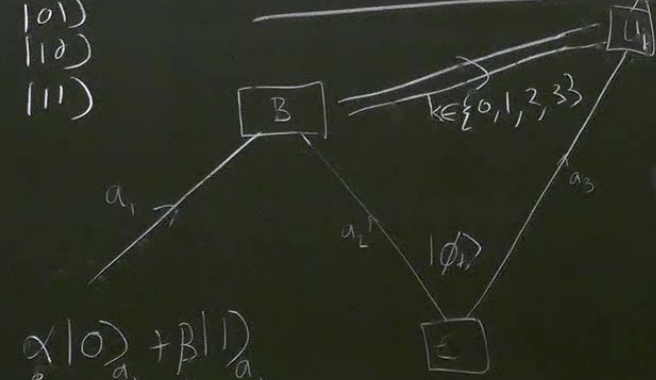
Subject: Quantum Foundations

Date: January 13, 2025 - 11:30 AM

URL: <https://pirsa.org/25010040>

- $|00\rangle$
- $|01\rangle$
- $|10\rangle$
- $|11\rangle$

Quantum Teleportation



$$\alpha|0\rangle_{a_1} + \beta|1\rangle_{a_1}$$

0.327...

$$|\eta\rangle = \alpha|00\rangle + \beta|11\rangle$$

$$|\Phi_{\pm}\rangle = \frac{1}{\sqrt{2}}(|00\rangle \pm |11\rangle)$$

$$|\Psi_{\pm}\rangle = \frac{1}{\sqrt{2}}(|01\rangle \pm |10\rangle)$$

$$(\alpha|0\rangle_{a_1} + \beta|1\rangle_{a_1}) |\Phi_{+}\rangle_{a_2 a_3}$$

$$= \frac{1}{2} |\Phi_{+}\rangle_{a_1 a_2} (\alpha|0\rangle_{a_3} + \beta|1\rangle_{a_3}) + \frac{1}{2} |\Phi_{-}\rangle_{a_1 a_2} (\alpha|0\rangle_{a_3} - \beta|1\rangle_{a_3})$$

$$+ \frac{1}{2} |\Psi_{+}\rangle_{a_1 a_2} (\beta|0\rangle_{a_3} + \alpha|1\rangle_{a_3}) + \frac{1}{2} |\Psi_{-}\rangle_{a_1 a_2} (\beta|0\rangle_{a_3} - \alpha|1\rangle_{a_3})$$

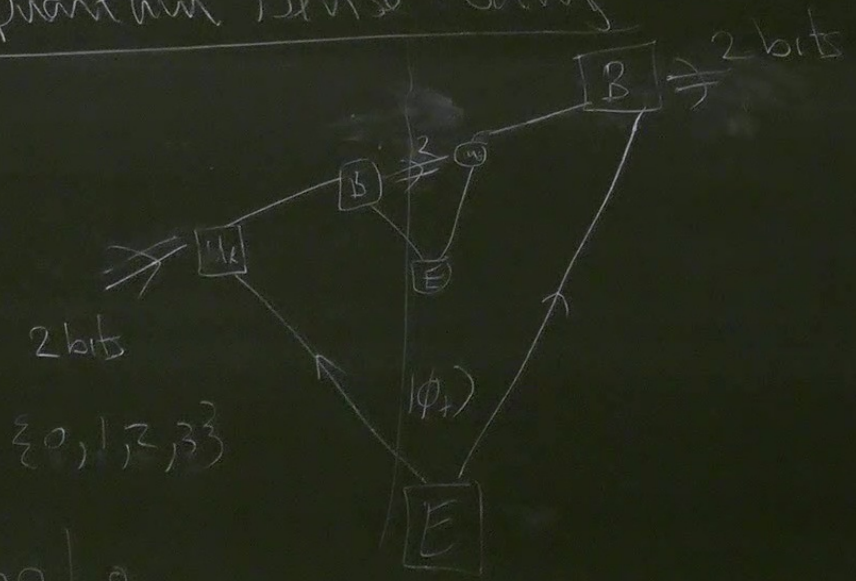
0.527...

$$|1\rangle = a|00\rangle + b|11\rangle$$

$$\rightarrow b|00\rangle + b|11\rangle$$

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

Quantum Dense Coding



2 bits
 $\{0, 1, 2, 3\}$

$|00\rangle, |11\rangle$

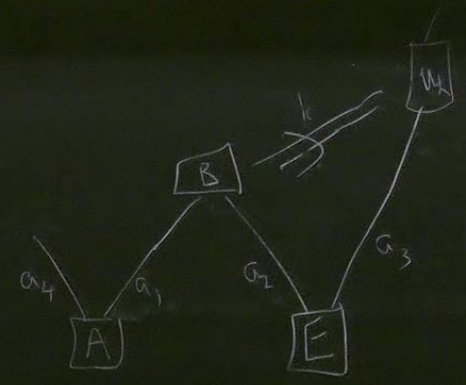
00	0
01	1
10	2
11	3

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

$$\begin{pmatrix} 1 & 0 \\ 1 & 0 \end{pmatrix} \quad \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

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

$$a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle$$



The Quantum Zero Effect

Sudarshan & Misra (1977)

$|0\rangle_{a_1}$ at time $t=0$

$$|\psi(\delta t)\rangle_{a_1} = e^{-i\hat{H}\delta t/\hbar} |0\rangle_{a_1}$$

$$= \left(1 - \frac{i\hat{H}\delta t}{\hbar} + \dots\right) |0\rangle = |0\rangle - \frac{i\hat{H}\delta t}{\hbar} |0\rangle + \dots$$