

Title: Lecture - Quantum Foundations, PHYS 639

Speakers: Lucien Hardy

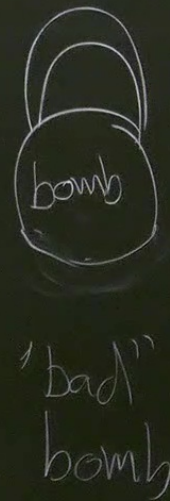
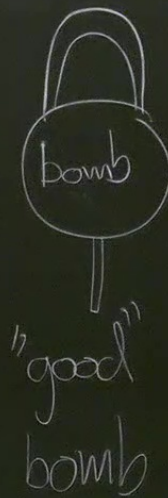
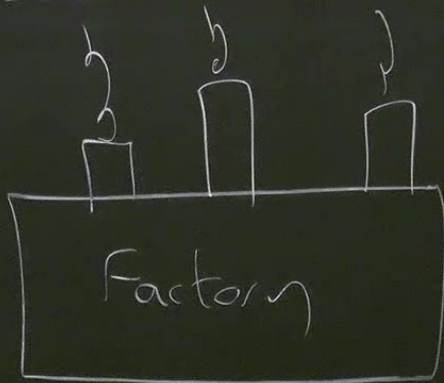
Collection/Series: Quantum Foundations (Elective), PHYS 639, January 6 - February 5, 2025

Subject: Quantum Foundations

Date: January 06, 2025 - 11:30 AM

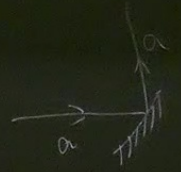
URL: <https://pirsa.org/25010037>

The Elitzur-Vaidman bomb problem.

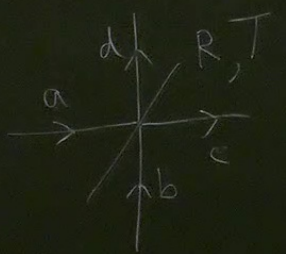


bomb

bomb



$$|a\rangle \rightarrow i|a\rangle$$



$$|a\rangle \rightarrow \sqrt{T}|c\rangle + i\sqrt{R}|d\rangle$$

$$|b\rangle \rightarrow i\sqrt{R}|c\rangle + \sqrt{T}|d\rangle$$

2π

|a>

$$R+T=1 \quad \langle a|b\rangle=0 \quad \langle c|d\rangle=1$$

$$\langle c|d\rangle=0 \quad \langle a|b\rangle = \sqrt{T}i-1$$

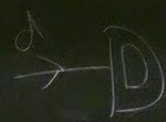
$$\rightarrow i|a\rangle$$

$$|a\rangle \rightarrow \sqrt{T}|c\rangle + i\sqrt{R}|d\rangle$$

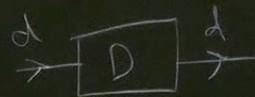
$$|b\rangle \rightarrow i\sqrt{R}|c\rangle + \sqrt{T}|d\rangle$$

$$\circ \langle c|c\rangle = 1$$

$$\circ \langle a|b\rangle = \sqrt{T} - i$$



$$|d\rangle|D_0\rangle \rightarrow |D\rangle$$

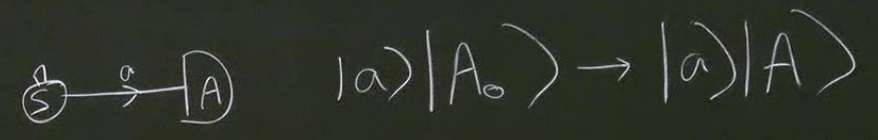


$$|d\rangle|D_0\rangle \rightarrow |d\rangle|D\rangle$$

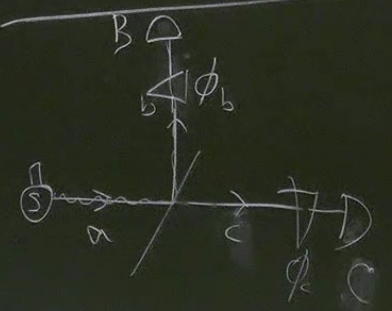
$$\langle cd \rangle = 0$$

$$\langle a/b \rangle$$

Zeroth example

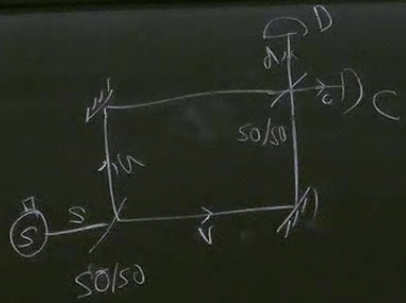


First example



$$|a\rangle |B_0\rangle |C_0\rangle \rightarrow \left(\sqrt{f} e^{i\phi_c} |c\rangle + \sqrt{r} e^{i\phi_b} |b\rangle \right) |B_0\rangle |C_0\rangle$$

$$\rightarrow \sqrt{f} e^{i\phi_c} |B_0\rangle |C\rangle + \sqrt{r} e^{i\phi_b} |B\rangle |C_0\rangle$$



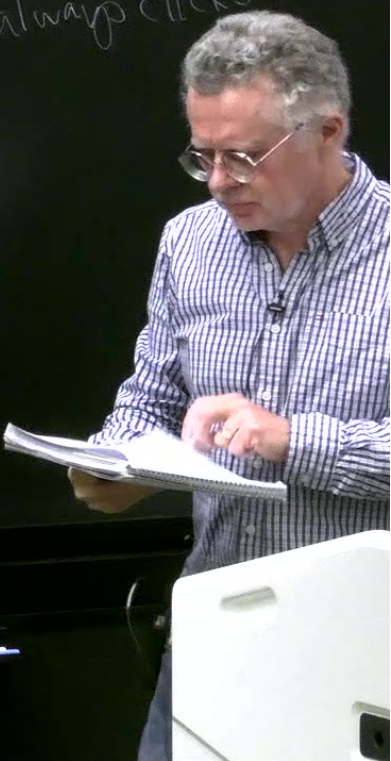
$$|s\rangle \rightarrow \frac{i}{\sqrt{2}} |a\rangle + \frac{1}{\sqrt{2}} |b\rangle \rightarrow \frac{i}{\sqrt{2}} \left(\frac{i}{\sqrt{2}} |a\rangle + \frac{1}{\sqrt{2}} |c\rangle \right) + \frac{1}{\sqrt{2}} \left(\frac{1}{\sqrt{2}} |a\rangle + \frac{1}{\sqrt{2}} |c\rangle \right)$$

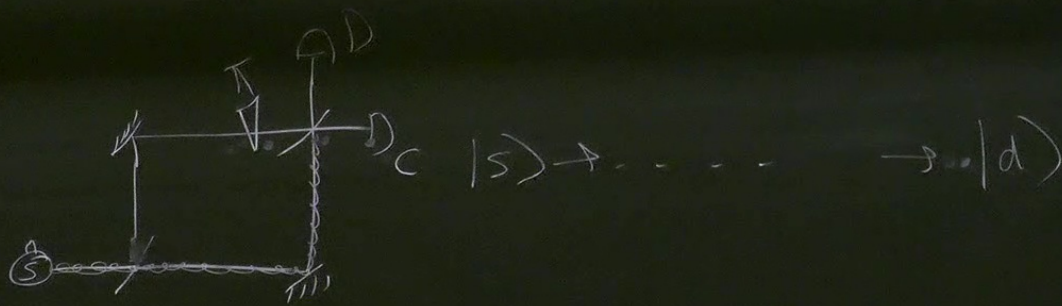
$$\frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

$$P + P = 2P$$

$$\left(\sqrt{P} + \sqrt{P} \right)^2 = \left(2\sqrt{P} \right)^2 = 4P$$

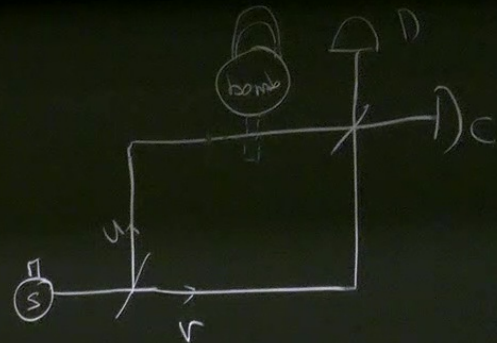
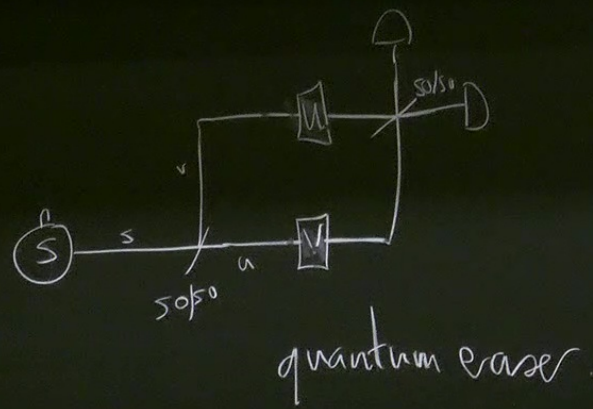
This man (always clicks)



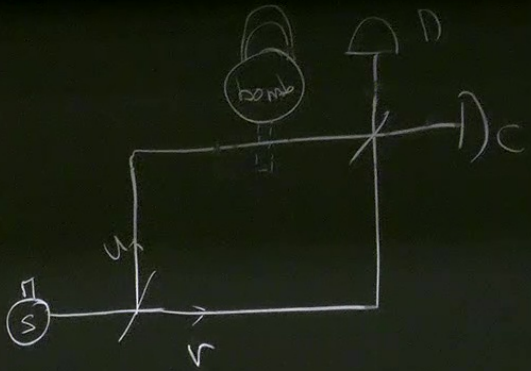


Detector D always clicks.

Argument that "something" goes along both paths.



Three possibilities
 1) Bomb explodes



Three possibilities

- 1) Bomb explodes — had a "good" bomb
- 2) C fires. Don't know if "good" or "bad".
- 3) D fires. Have a good bomb.