

Entanglement

сцепленность
перепутанность

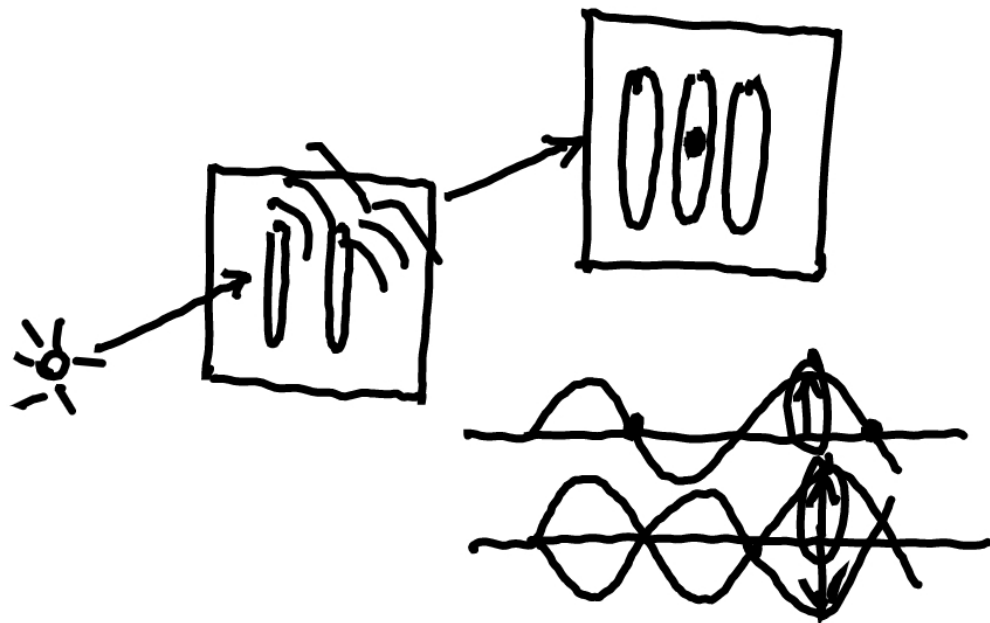
$$\alpha |\text{лев}\rangle + \beta |\text{прав}\rangle$$

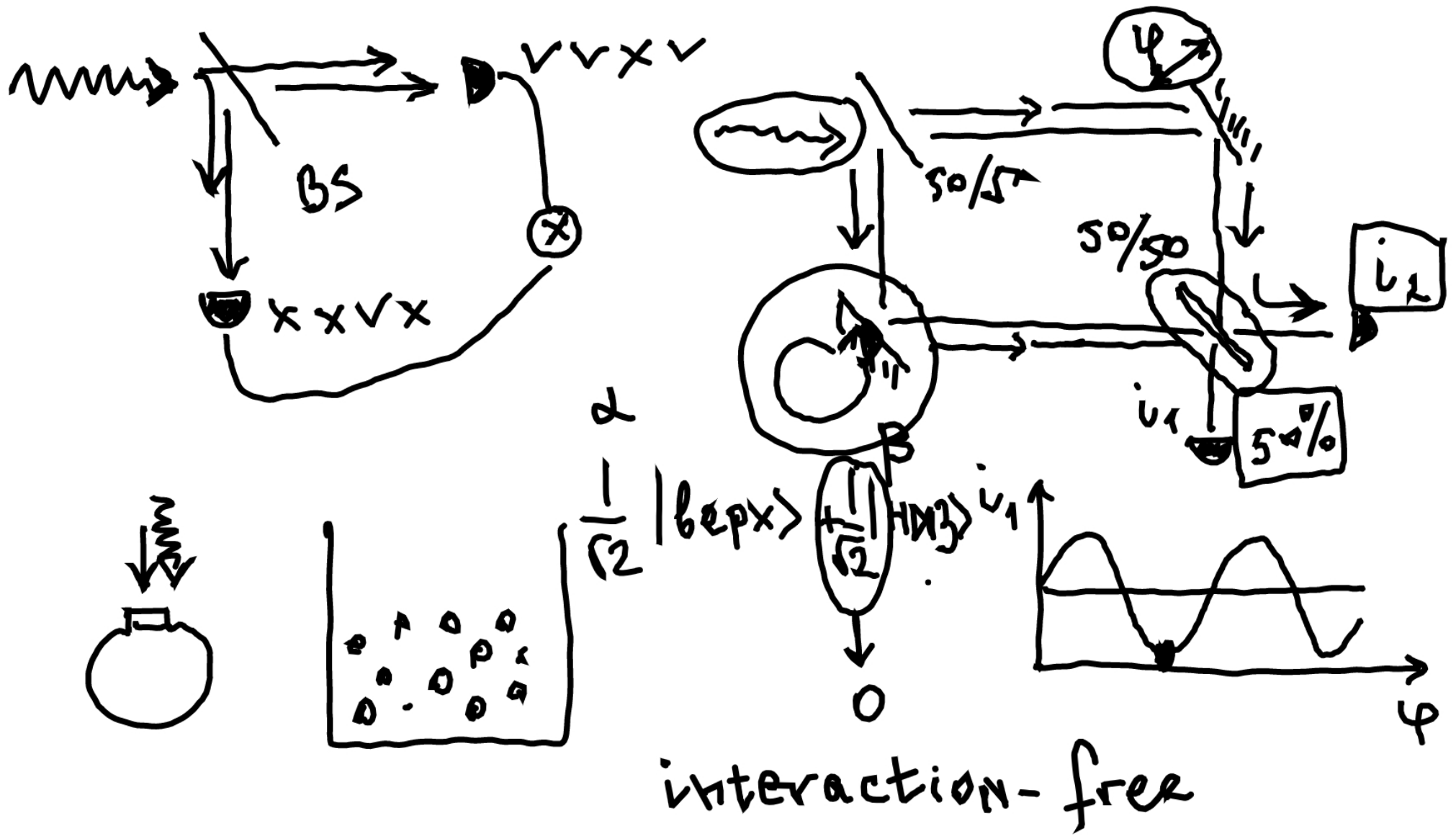
$$\alpha |\text{орел}\rangle + \beta |\text{решка}\rangle$$

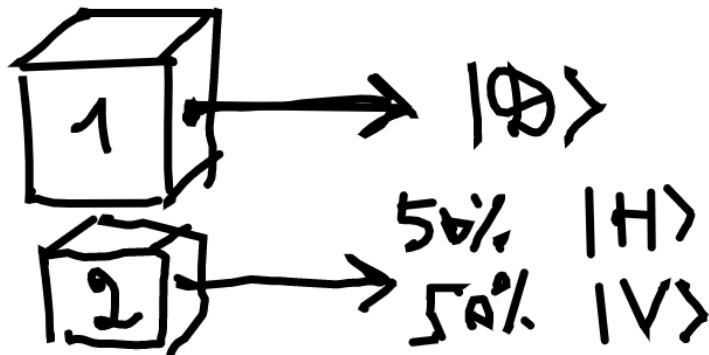
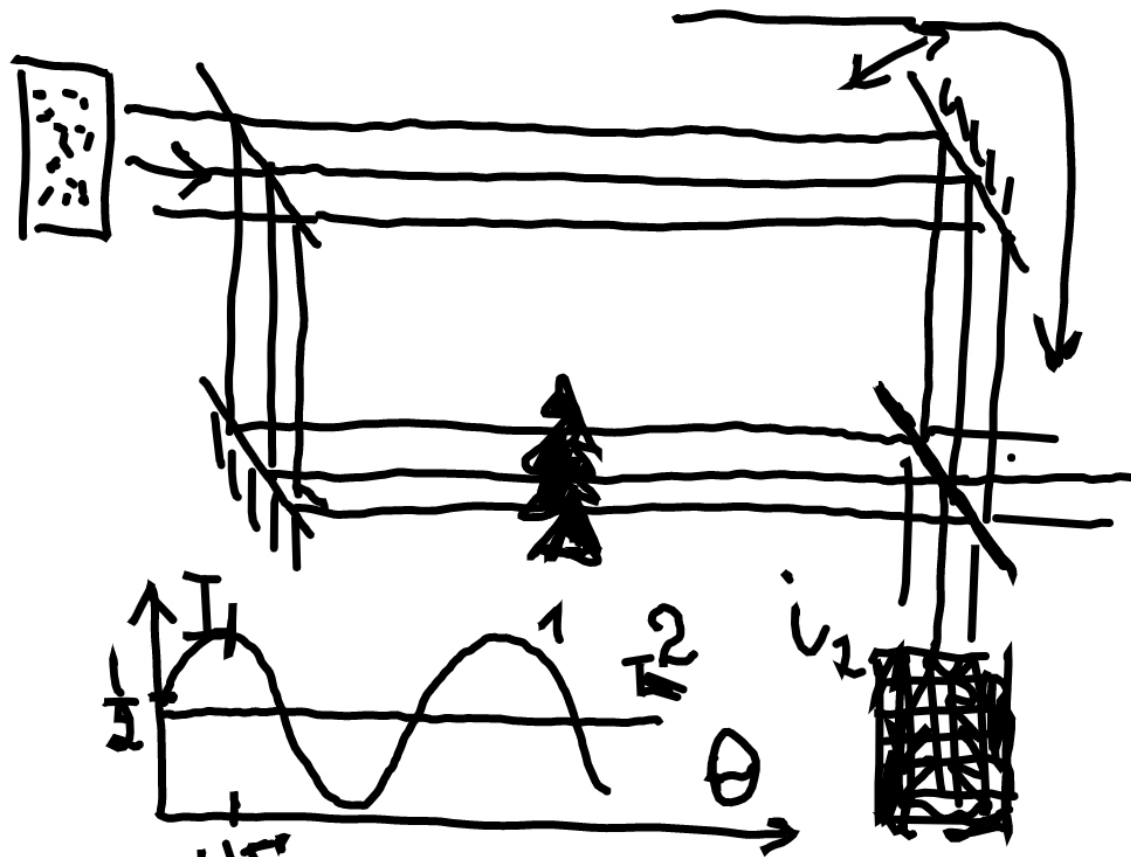
$$\alpha, \beta \in \mathbb{C}$$

$|\alpha|^2$ - вер-ть "орел"
 $|\beta|^2$ - вер-ть "решка"

$$|\alpha|^2 + |\beta|^2 = 1$$







$$|\alpha| e^{i\varphi} |H\rangle + |\beta| e^{i\varphi} |V\rangle$$

i_1 - ТЕМНОТА

A diagram showing a quantum state in phase space. The horizontal axis is labeled x . Two states are represented by red ellipses: $|V\rangle$ (vertical) and $|H\rangle$ (horizontal). The state $|H\rangle$ is highlighted in red.

$$\alpha |H\rangle + \beta |V\rangle$$

$$|\Phi\rangle = \frac{1}{\sqrt{2}} |H\rangle + \frac{1}{\sqrt{2}} |V\rangle$$

$$|A\rangle = \dots$$

$e^{i\varphi}$

1 монета:

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

2 монеты:

$$\alpha |0,0\rangle + \beta |0,1\rangle + \gamma |1,0\rangle + \delta |1,1\rangle$$

$$\alpha, \beta, \gamma, \delta \in \mathbb{C} \quad |\alpha|^2 + |\beta|^2 + |\gamma|^2 + |\delta|^2 = 1$$

$$|H, H\rangle_{AB}$$

$$|H\rangle_A \otimes |H\rangle_B$$

$$|HH\rangle$$

Cos-Hu-Bell

Bell states

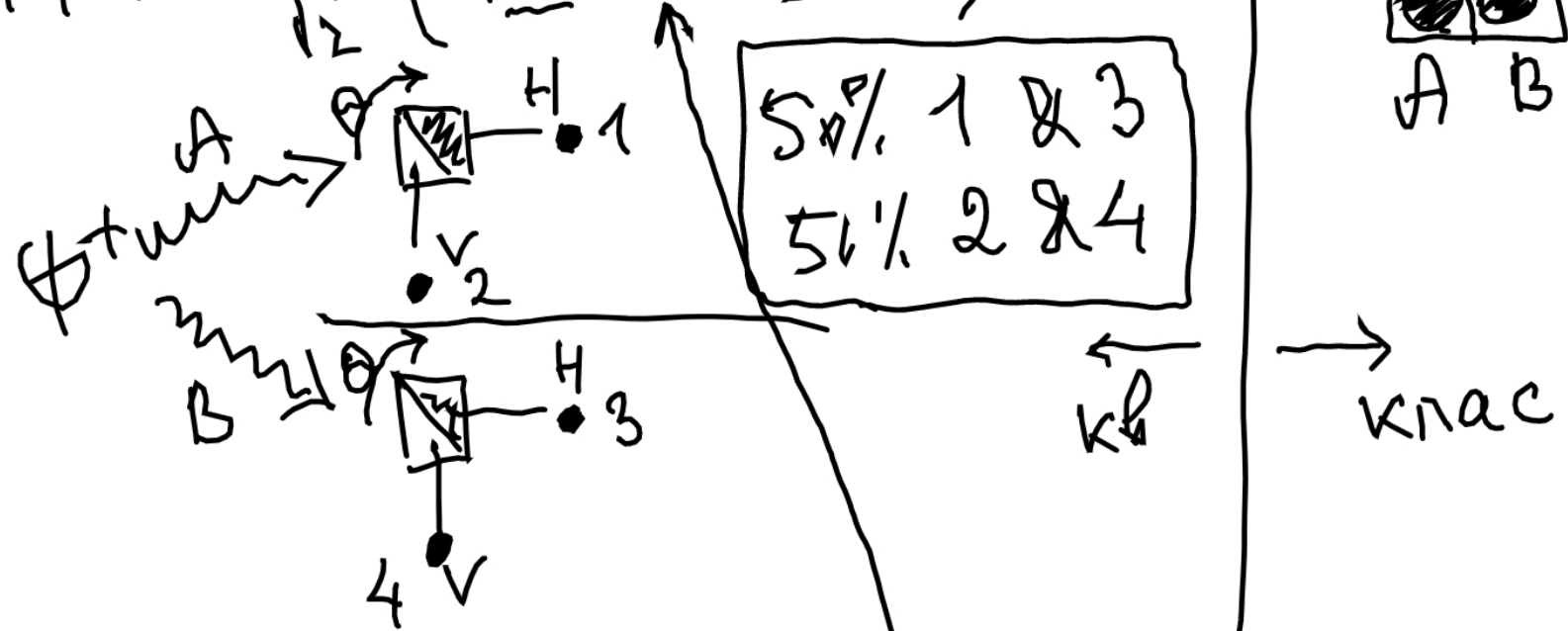
$$|\Phi^\pm\rangle = \frac{1}{\sqrt{2}} (|HH\rangle \pm |VV\rangle)$$

$$|\Psi^\pm\rangle = \frac{1}{\sqrt{2}} (|HV\rangle \pm |VH\rangle)$$

$$\langle \Phi^+ | \Phi^- \rangle = 0$$

$$\langle \Phi^+ | \Psi^+ \rangle = 0$$

$$|\Phi^+\rangle = \frac{1}{\sqrt{2}} (|\underline{H}\underline{H}\rangle + |\underline{V}\underline{V}\rangle)$$



$$|\Phi\rangle = \frac{1}{\sqrt{2}} (|H\rangle + |V\rangle)$$

$$|A\rangle = \frac{1}{\sqrt{2}} (|H\rangle - |V\rangle)$$

$$|H\rangle = \frac{1}{\sqrt{2}} (|\Phi\rangle + |A\rangle)$$

$$|V\rangle = \frac{1}{\sqrt{2}} (|\Phi\rangle - |A\rangle)$$

$$|\Phi^+\rangle = (\Phi + A)(\Phi + A) + (\Phi - A)(\Phi - A) = \Phi\Phi + AA$$

$$|\psi^-\rangle = \frac{1}{\sqrt{2}} (|HV\rangle - |VH\rangle) = \frac{1}{\sqrt{2}} (|\alpha\rangle|\tilde{\alpha}\rangle - |\tilde{\alpha}\rangle|\alpha\rangle)$$

$$|\theta\rangle|\theta + \frac{\pi}{2}\rangle$$

$$|\theta + \frac{\pi}{2}\rangle|\theta\rangle$$

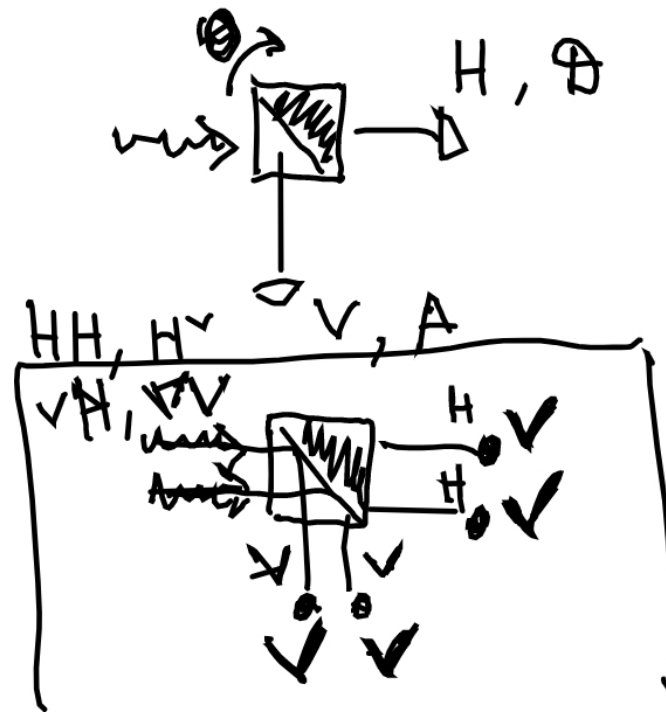
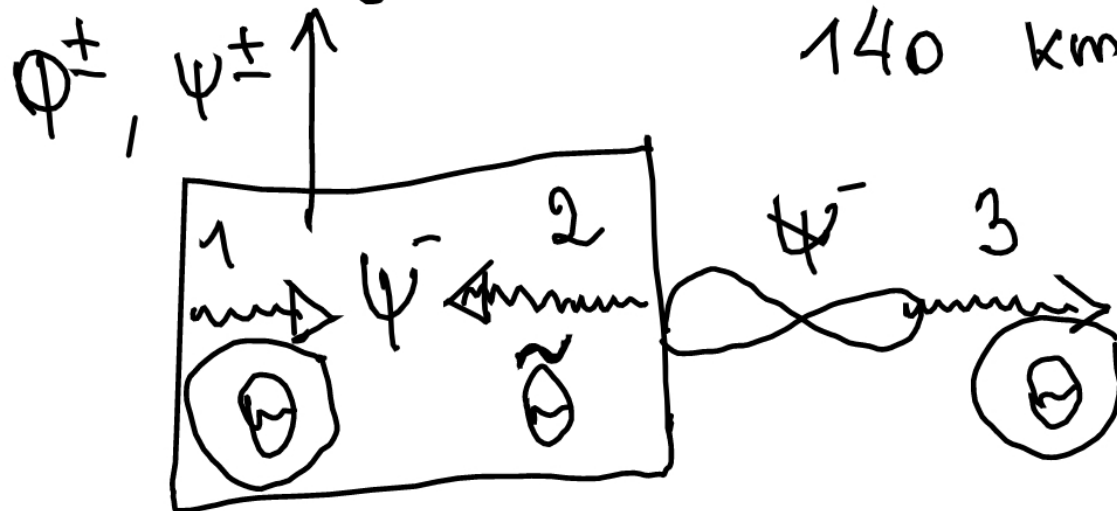
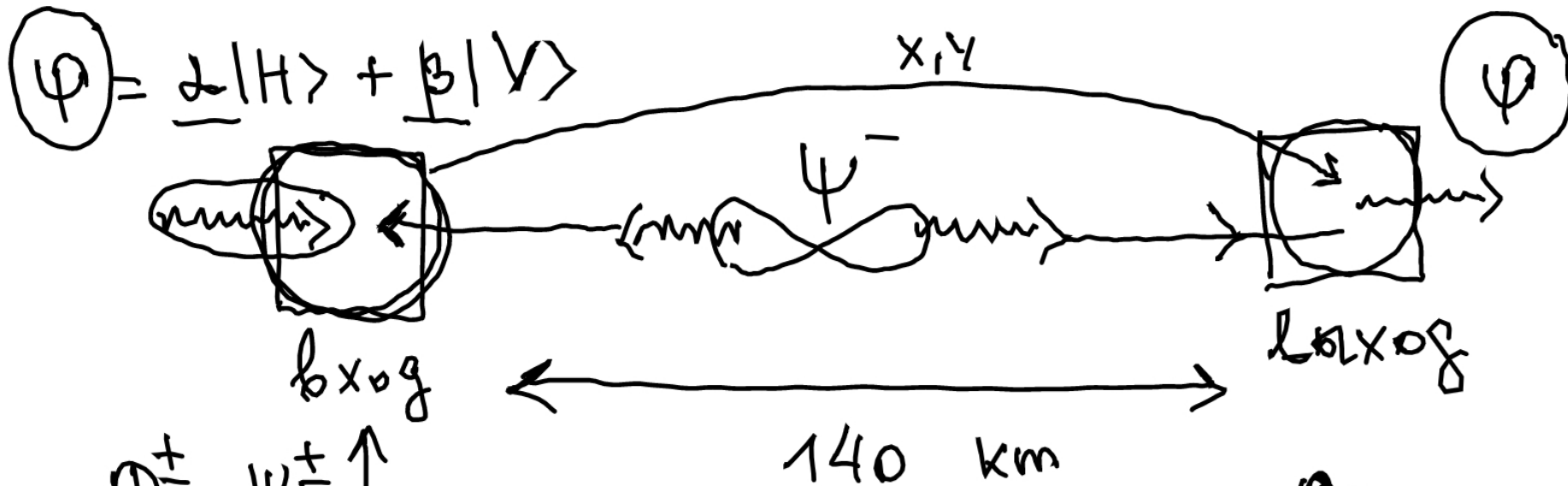
$\Phi/3$

	H/V	Φ/A	R/L
Φ^+	+	+	.
Φ^-	.	.	.
Ψ^+	.	.	.
Ψ^-	-	-	-

$$|R\rangle = \frac{1}{\sqrt{2}} (|H\rangle + e^{i\frac{\pi}{L}} |V\rangle)$$

L

$\pm i$



1, 2, 3 :

$$\psi = \alpha |H\rangle + \beta |V\rangle$$

$$\begin{cases} \psi^{\pm} = \frac{1}{\sqrt{2}} (|HV\rangle \pm |VH\rangle) \\ \phi^{\pm} = \frac{1}{\sqrt{2}} (|HH\rangle \pm |VV\rangle) \end{cases} \rightarrow$$

$$\psi_1 \otimes \psi_{2,3} \rightarrow \frac{1}{\sqrt{2}} (\alpha |H\rangle + \beta |V\rangle) (|HV\rangle - |VH\rangle)$$

$$\begin{matrix} HH \\ HV \\ VH \\ VV \end{matrix} = \frac{1}{\sqrt{2}} (\psi_{1,2}^{+} + \psi_{1,2}^{-}) \underbrace{\alpha |H\rangle_1 |H\rangle_2 |V\rangle_3}_{\text{J/3}}$$

$$\begin{matrix} \psi_{1,2}^{-} \\ \psi_{1,2}^{+} \\ \psi_{1,2}^{-} \\ \psi_{1,2}^{+} \end{matrix} + \begin{pmatrix} \dots \\ \dots \\ \dots \end{pmatrix} \cdot \begin{pmatrix} \dots \\ \dots \\ \dots \end{pmatrix}$$

$$\alpha |H\rangle + \beta |V\rangle$$