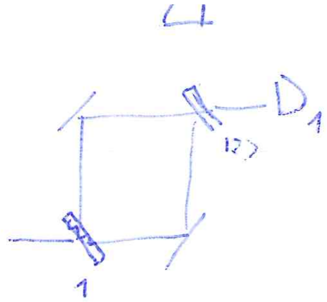
Bomb/2



How many bombs can we save?

In the old set-up we achieve $1/4$, but another $1/4$ is "unloaded", $\frac{1}{2}$ is lost

$$|x\rangle \mapsto \sqrt{\tfrac{1}{2}}\,(|x\rangle + |y\rangle)$$

$$|y\rangle \mapsto \sqrt{\tfrac{1}{2}}\,(|x\rangle - |y\rangle)$$

By repeating the experiment with the "unloaded" $1/4$ we can save $1/4 \cdot 1/4$ and so on.

In total:

$$\frac{1}{4} + \frac{1}{4}\cdot\frac{1}{4} + \frac{1}{4}\cdot\frac{1}{4}\cdot\frac{1}{4} + \dots$$

$$= \frac{1}{4}\sum_{n=0}^{\infty}\left(\frac{1}{4}\right)^n = \frac{1}{4}\cdot\frac{1}{1-\frac{1}{4}} = \frac{1}{4}\,\frac{1}{\frac{3}{4}} = \frac{1}{3} \quad \checkmark$$

But now let us refine the experiment. To this end, let us consider the first one as:

$\boxed{1}$ $$|x\rangle \to c|x\rangle + s|y\rangle \xmapsto{\text{reflect}} c|y\rangle + s|x\rangle \to c\,(c|x\rangle - s|y\rangle) + s\,(s|x\rangle + c|y\rangle) = |x\rangle \quad \checkmark$$

$\boxed{2}$ $$\begin{cases} |x\rangle \mapsto s|x\rangle + c|y\rangle \\ |y\rangle \mapsto c|x\rangle - s|y\rangle \end{cases}$$

We make a measurement after the "reflection". Then:

$|s\rangle = c|y\rangle + s|x\rangle$

with probability c^2 it explodes... lost, gone...

with probability s^2 it does not, but then $|x\rangle \mapsto s|x\rangle + c|y\rangle$

Then:

probability $s^4 \to$ click in "$|1\rangle$". We shall do not care. Undecided...

probability: $s^2c^2 \to$ click in "$|2\rangle$" $\to$ good bombe.

θ must be close to $\pi/2$ small... the number of save bombes is then

$$\underbrace{s^2c^2}_{1^\circ \text{ round}} + s^4(s^2c^2) + s^8(s^2c^2) + \dots =$$

$$= s^2c^2 \sum_{n=0}^{\infty} (s^4)^n = s^2c^2 \frac{1}{1-s^4} = \frac{s^2c^2}{1-s^4} = \frac{s^2c^2}{(1-s^2)(1+s^2)} = \frac{s^2c^2}{c^2(1+s^2)} = \frac{s^2}{1+s^2}$$

Now for $\theta \simeq \pi/2 \to 1/2$

But you have to wait very very long, but in the end you can save the half of the bombs.