PH5840 Homework 2

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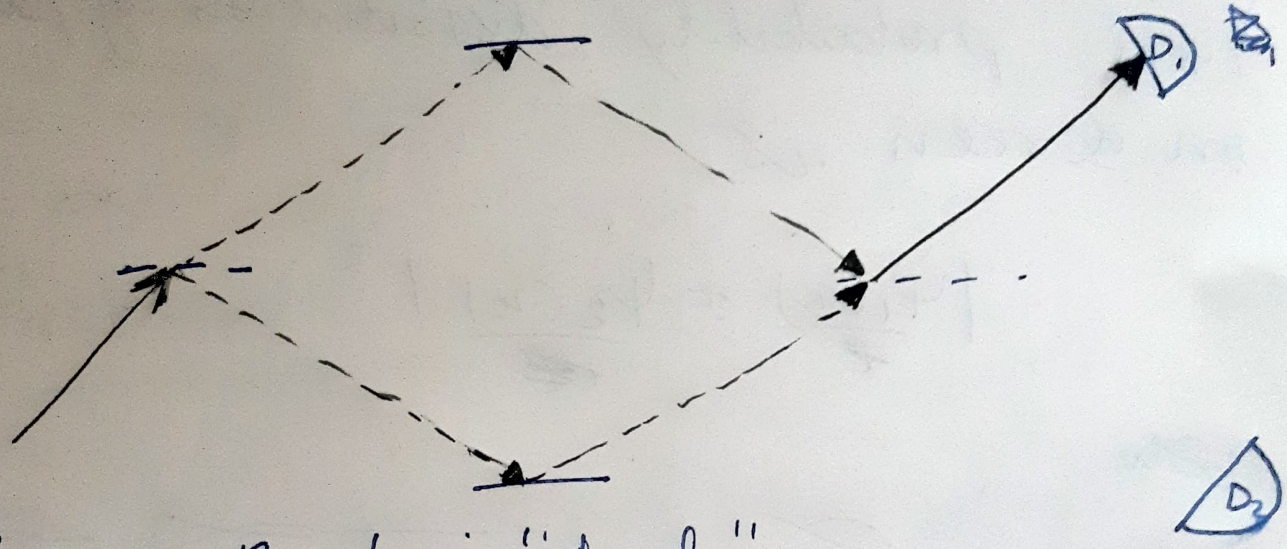
Problem 1 : "Interaction-free" measurements.

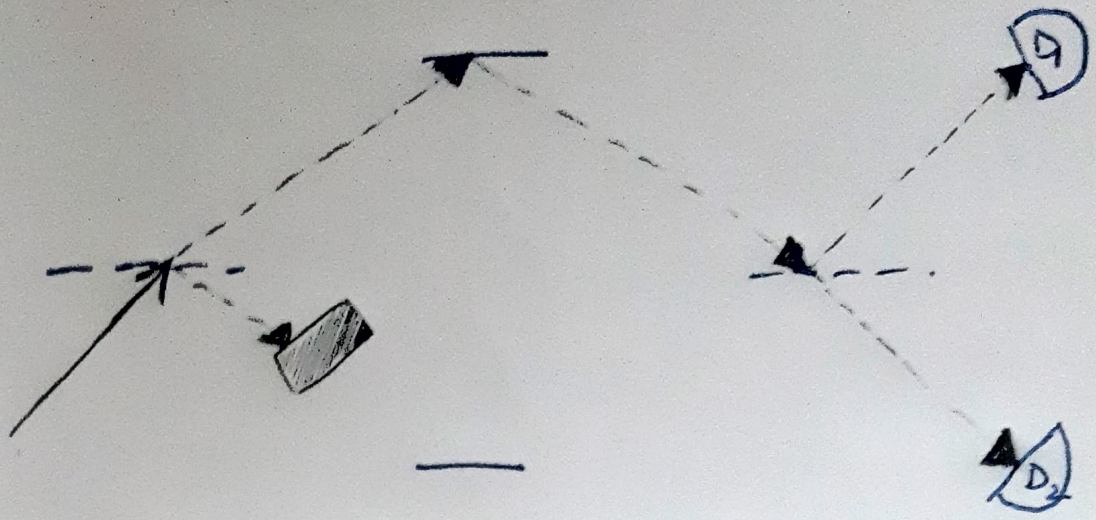
In case bomb is "dud"; i.e. it is transparent
Then the setup will look like.



Given Bomb is "dud"

	Event	Probability
	Bomb exploding	0
D1	Detector detecting	1
D2	detector detecting	0

Now if bomb is working; the equivalent setup will be.



Given that Bomb works.

Event	Probability
Bomb exploding	1/2
D_1 detector detecting	$1/2 \times 1/2 = 1/4$
D_2 detector detecting	$1/2 \times 1/2 = 1/4$.

We know, if D_2 is being clicked, it is for sure a real bomb because for a dud bomb, probability of ~~the~~ D_2 detecting is 0.

Hence, with 25% probability we can detect a real bomb using interferometer.

PH5100 Quiz 1 Problem 1

1) Amplitude emerging from top hole
$= \psi_1(x)$
Amplitude emerging from bottom hole
$= \psi_2(x)$

Probability density for detecting a particle at a point where amplitude overlap is

$$|\psi_1(x) + \psi_2(x)|^2 = |\psi_1(x)|^2 + |\psi_2(x)|^2 + [\psi_1(x)]^* \psi_2(x) + \psi_1(x)[\psi_2(x)]^*$$

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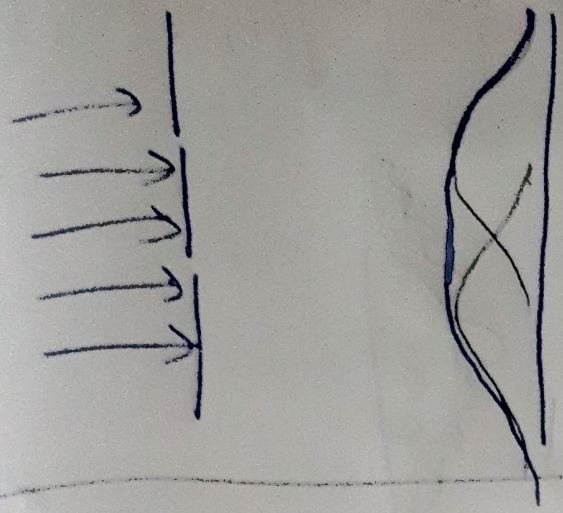
1) When our device gives complete information about which hole particle passed through.

i.e. probability through which hole particle passes through is definitive.

$$P_{12} = P_1 + P_2$$
$$= |\psi_1|^2 + |\psi_2|^2$$

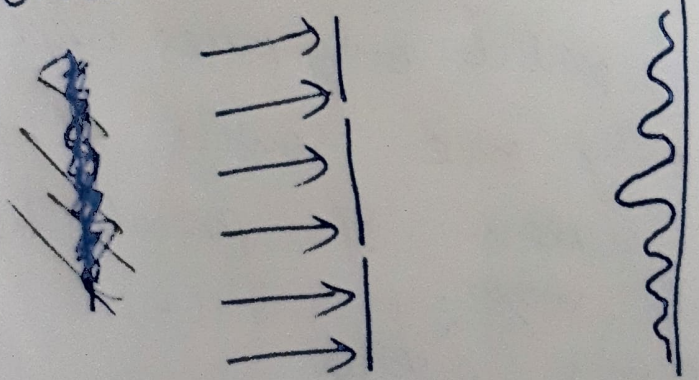
Assuming,

Then for case 1; Prob = $|\psi_1|^2 + |\psi_2|^2$



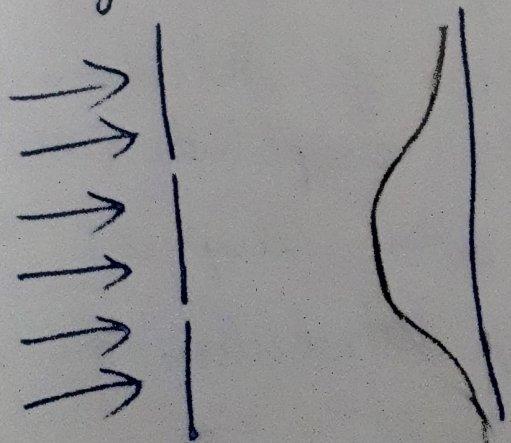
2) When device works only 50% of times.

→ 50% of times when particle is not detected; interference will occure.



$\text{Prob}(x) = |\psi_1(x) + \psi_2(x)|^2 = |\psi_1(x)|^2 + |\psi_2(x)|^2 + [\psi_1(x)]^* \psi_2(x) + \psi_1(x)[\psi_2(x)]^*$

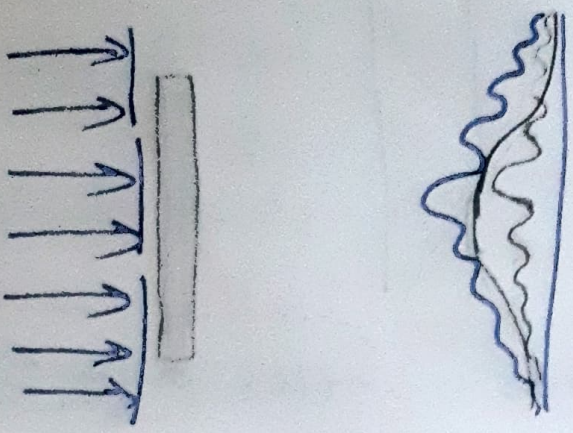
→ 50% of times when particle IS DETECTED



$\text{Prob}(x) = |\psi_1(x)|^2 + |\psi_2(x)|^2$

Net Probability distribution:

$$\frac{1}{2}\cdot\left[\left[\psi_1(x)+\psi_2(x)\right]^2\right] + \frac{1}{2}\cdot\left[\left(\psi_1(x)\right)^2 + \left|\psi_2(x)\right|^2\right]$$



Problem 2

1) If the particle only takes upper part, there is only one source of detected particle on screen. If probability amplitude associated with ~~source~~ upper arm setup is $\psi_1(x)$.

The probability is $|\psi_1(x)|^2$.

2) If particle only takes lower path, again only one source of detection of particle & if probability amplitude associated with ~~it~~ lower arm setup is $\psi_2(x)$

The probability distribution on screen is $|\psi_2(x)|^2$

3) Assuming we are not using the Stern-Gerlach magnet to determine states.

Then it is unknown which path particle is coming from to the screen.

Then probability distribution of particle on screen is

$$|\psi_1(x) + \psi_2(x)|^2$$