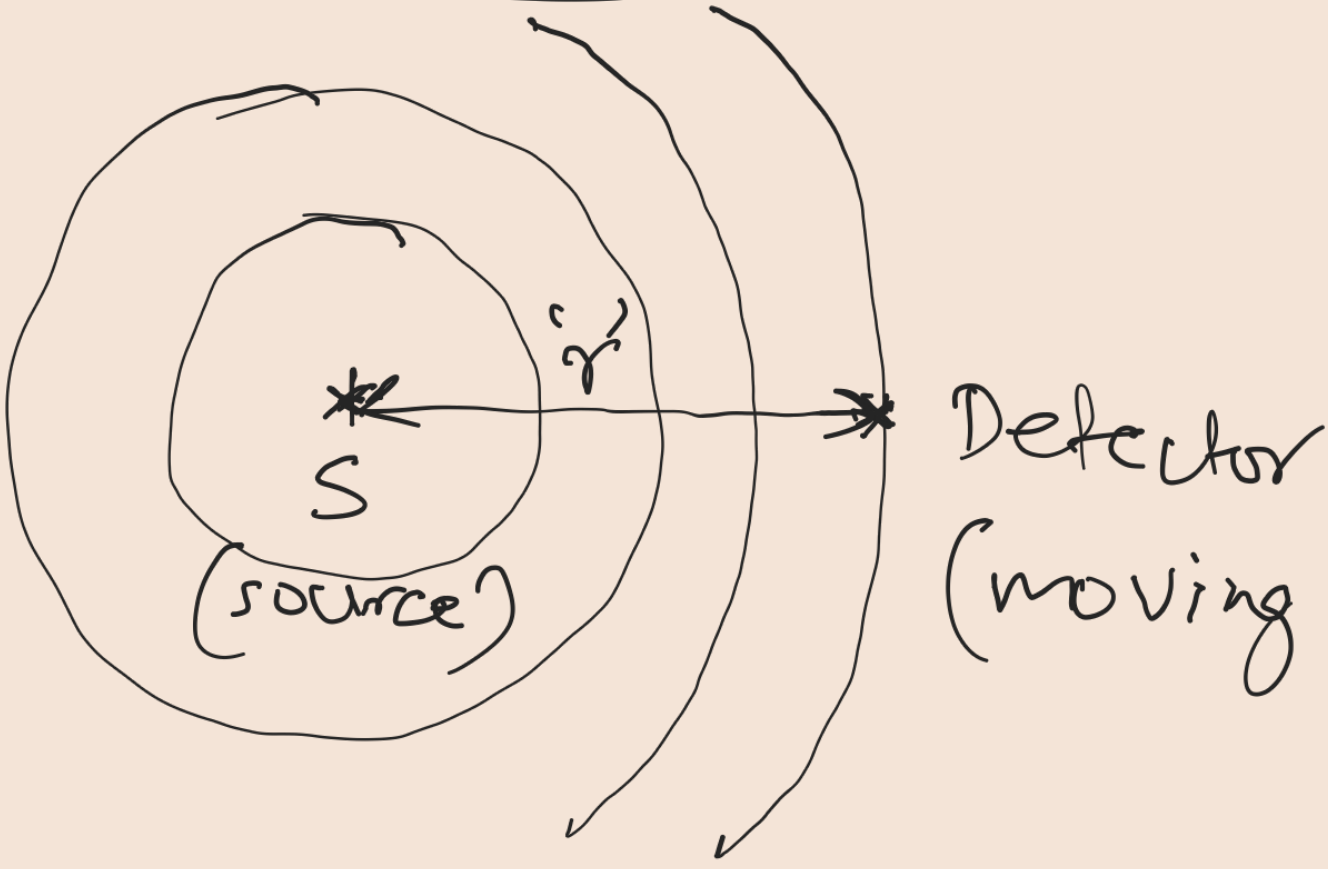
First Part :-



When source is stationary, all the wavefronts created by it are equally spaced. Hence, the wavefront received by detector at any instant will have radius equal to 'r', distance b/w source

& detector. Now, some basic info :→ Power is rate of energy flow, hence, $P = (E)(f_0)$,

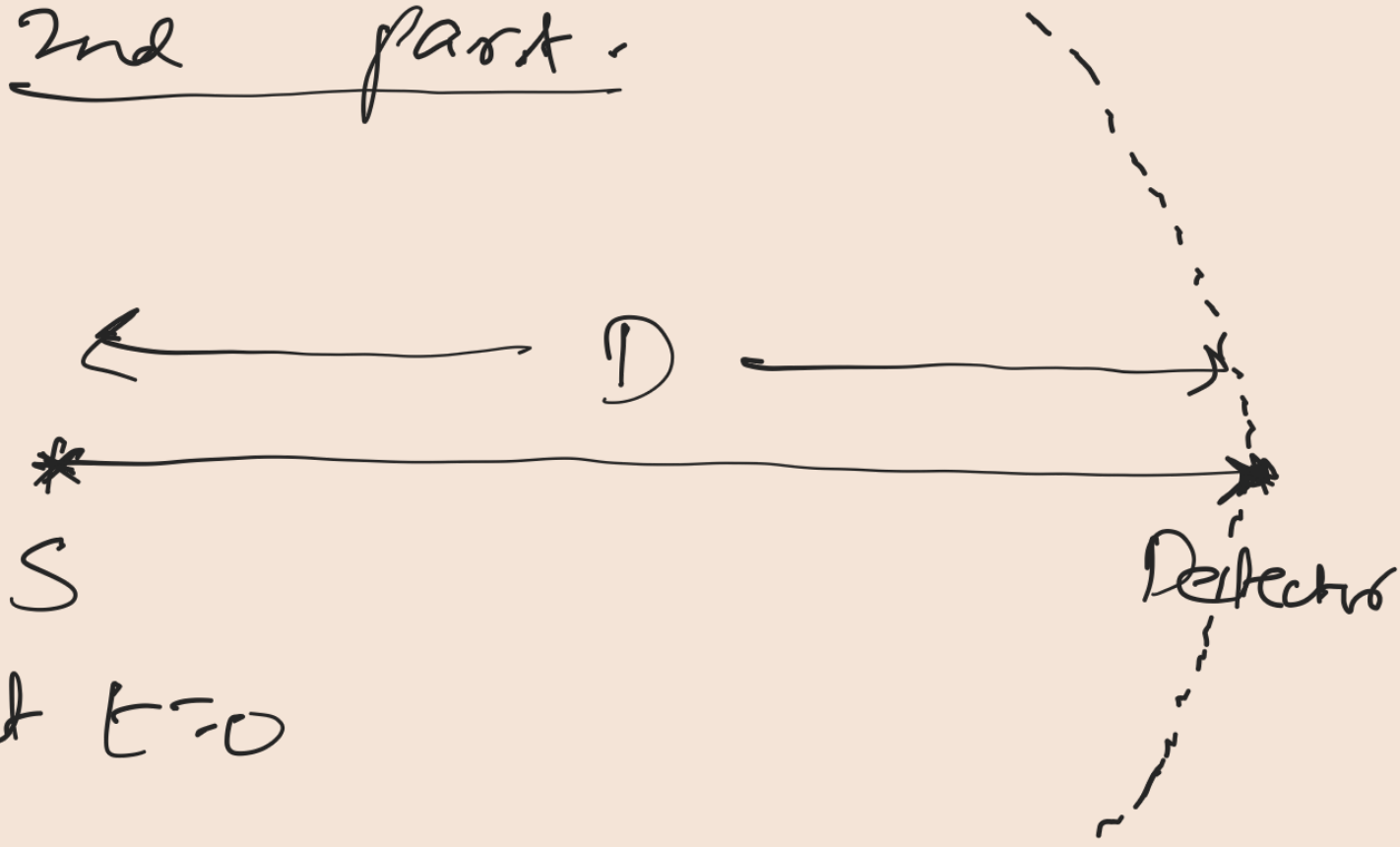
'E' → energy possesed by one wave pulse & f_0 is actual frequency. So,

$P_{app} = (E) f_{app}$. So,

$$I_{app} = \frac{P_{app}}{4\pi r^2}$$

$$= \frac{P}{4\pi r^2}\left(1 + \frac{v_d}{c}\right),$$

2nd part:



at t=0

Let source create a sound pulse at t=0. Let distance between source & detector at that instant be 'D'. Now, when this pulse reaches detector, its radius will be obviously 'D'.

Time taken for pulse to reach detector $= \frac{D}{C}$.

Distance moved by source during this interval is $(V_s) \times \left(\frac{D}{C}\right)$. So, the distance 'r' between source & detector at that instant is

$$D - \frac{D V_s}{C} = D\left(1 - \frac{V_s}{C}\right).$$

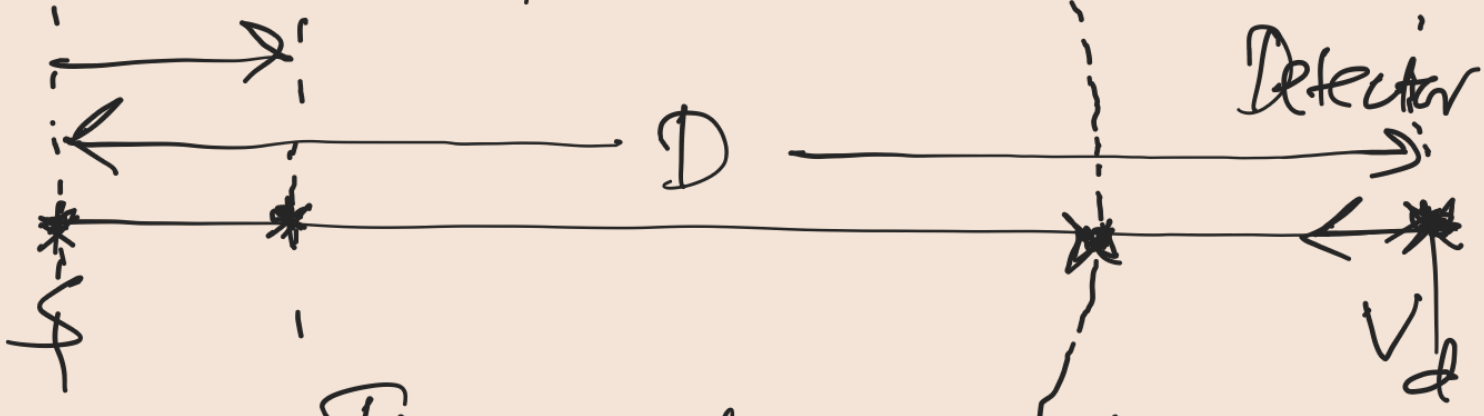
So, $D = \frac{(r)\,C}{(C - V_s)}$

Now, $I_{app} = \frac{P_{app}}{4\pi D^2}$

$$= \frac{(E)\, f_0\, (c)}{(c - v_s)} \times \frac{1 \times (c - v_s)}{4\pi r^2 c}$$

$$= \left[\frac{P}{4\pi r^2} \left(1 - \frac{v_s}{c} \right) \right] * \sim$$

3rd part.



at $t \to 0$ Time taken by wave to reach detector is $\frac{D}{c + v_d}$. So,

distance travelled by wave

$= \left[\frac{D}{c+v_d}\right] \times (c) =$ radius of wavefront.

Distance moved by source during this interval is

$(v_s) \times \frac{D}{(c+v_d)}$. So, dist btw source

& detector at this instant is $\left(\frac{D}{c+v_d}\right)[c-v_s]$

$= r$. So, $\frac{Dc}{(c+v_d)}$

$= \frac{rc}{(c-v_s)}$. Now again,

$$I_{app} = \frac{(E) f_{app} (c - v_s)^2}{4\pi (r^2 c^2)}$$

$$= \frac{E f_0 \left(\frac{c + v_d}{c - v_s}\right) \left(\frac{c - v_s}{c}\right)^2}{4\pi r^2}$$

$$= \boxed{\frac{P}{4\pi r^2} \left(1 + \frac{v_d}{c}\right) \left(1 - \frac{v_s}{c}\right)}$$