AS 3520

Lecture 6

Lectures 1 – 5 strain guaging.

Lecture 6 – photoelasticity.

Photoelasticity: Stress measurements in certain solids using light.

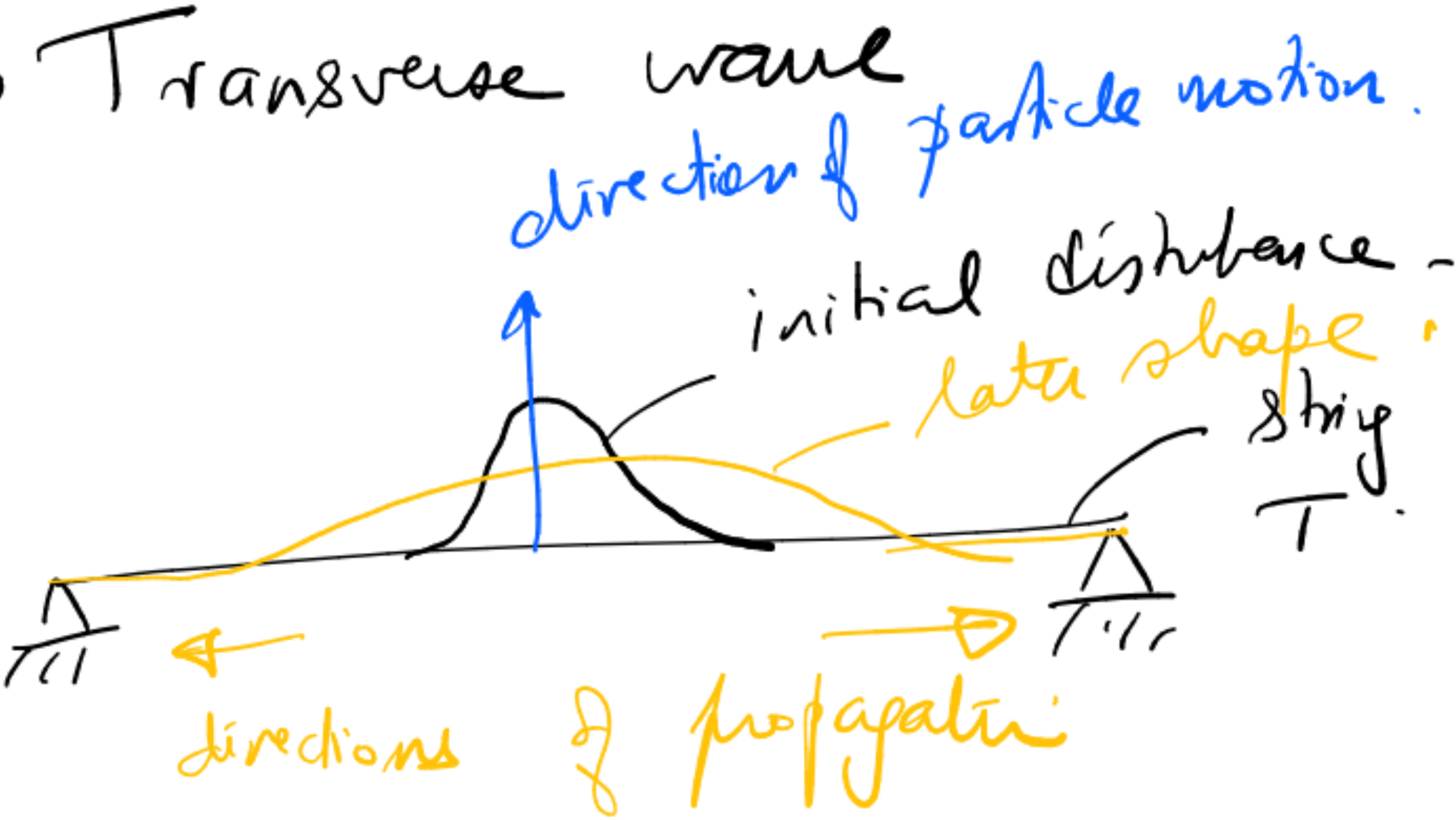
Chap – 3 Freddi et al.

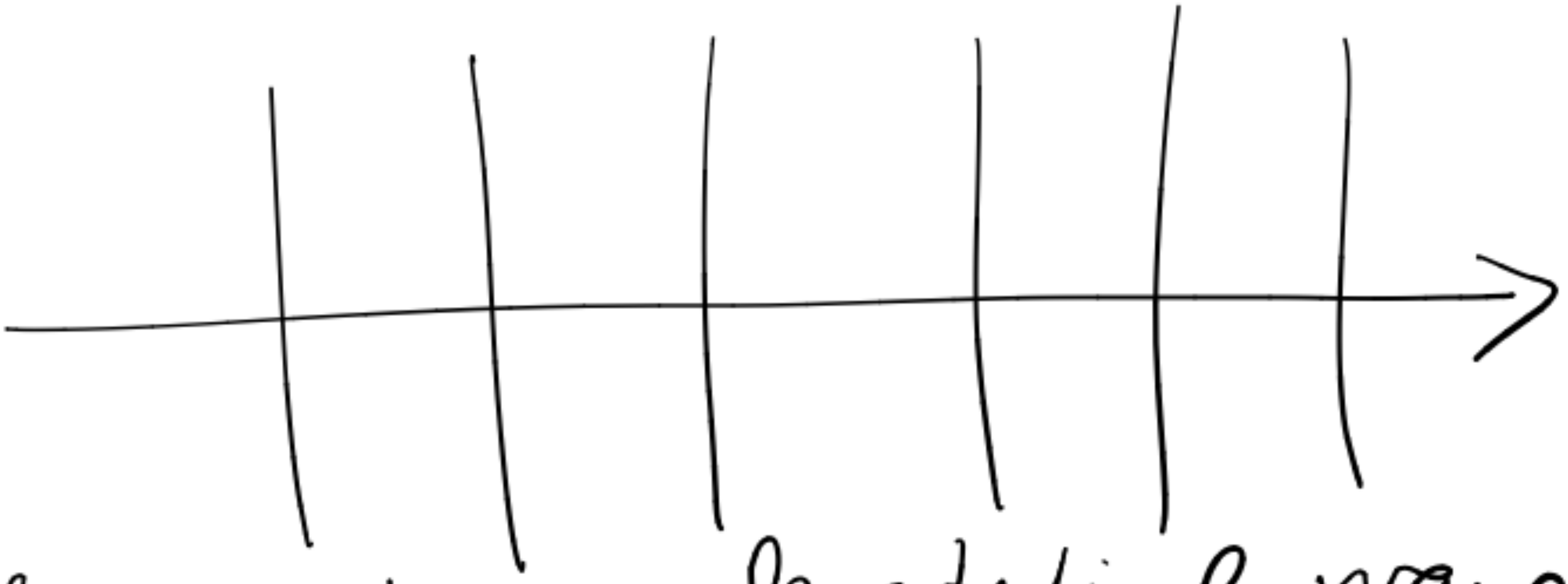
Nature of light:

Electromagnetic wave.

$\underset{\sim}{E}$ & $\underset{\sim}{B}$ planes are mutually ⊥ & they are both ⊥ to the direction of light propagation

↳ Transverse wave

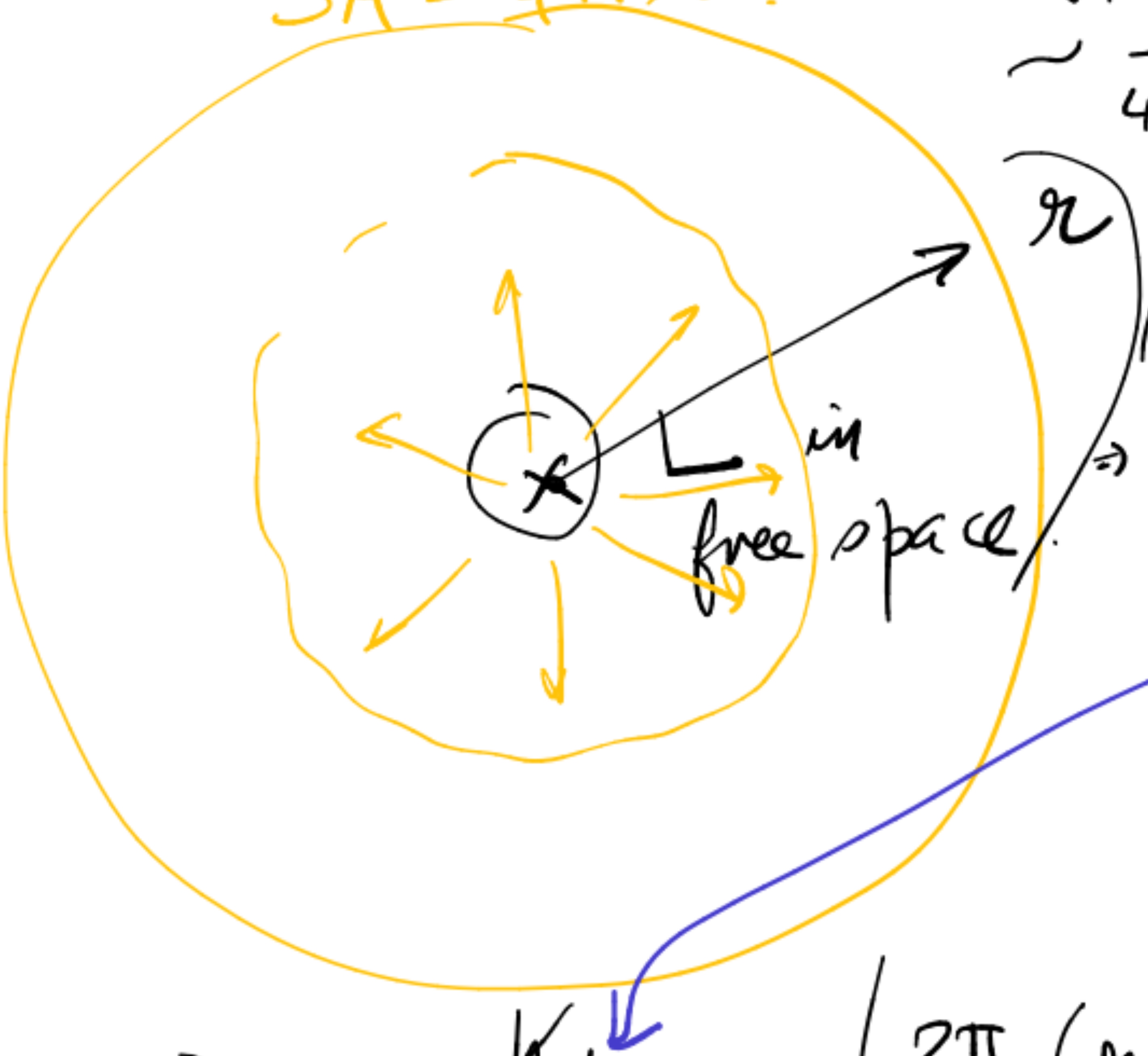




Sound is a longitudinal wave.

Because $\underset{\sim}{E}$ & propagation direction & propagation speed determine $\underset{\sim}{B}$, it is redundant to specify $\underset{\sim}{B}$ also

$SA = 4\pi r^2 \Rightarrow$ Flux = Enrg / unit area $\sim \frac{1}{4\pi r^2}$

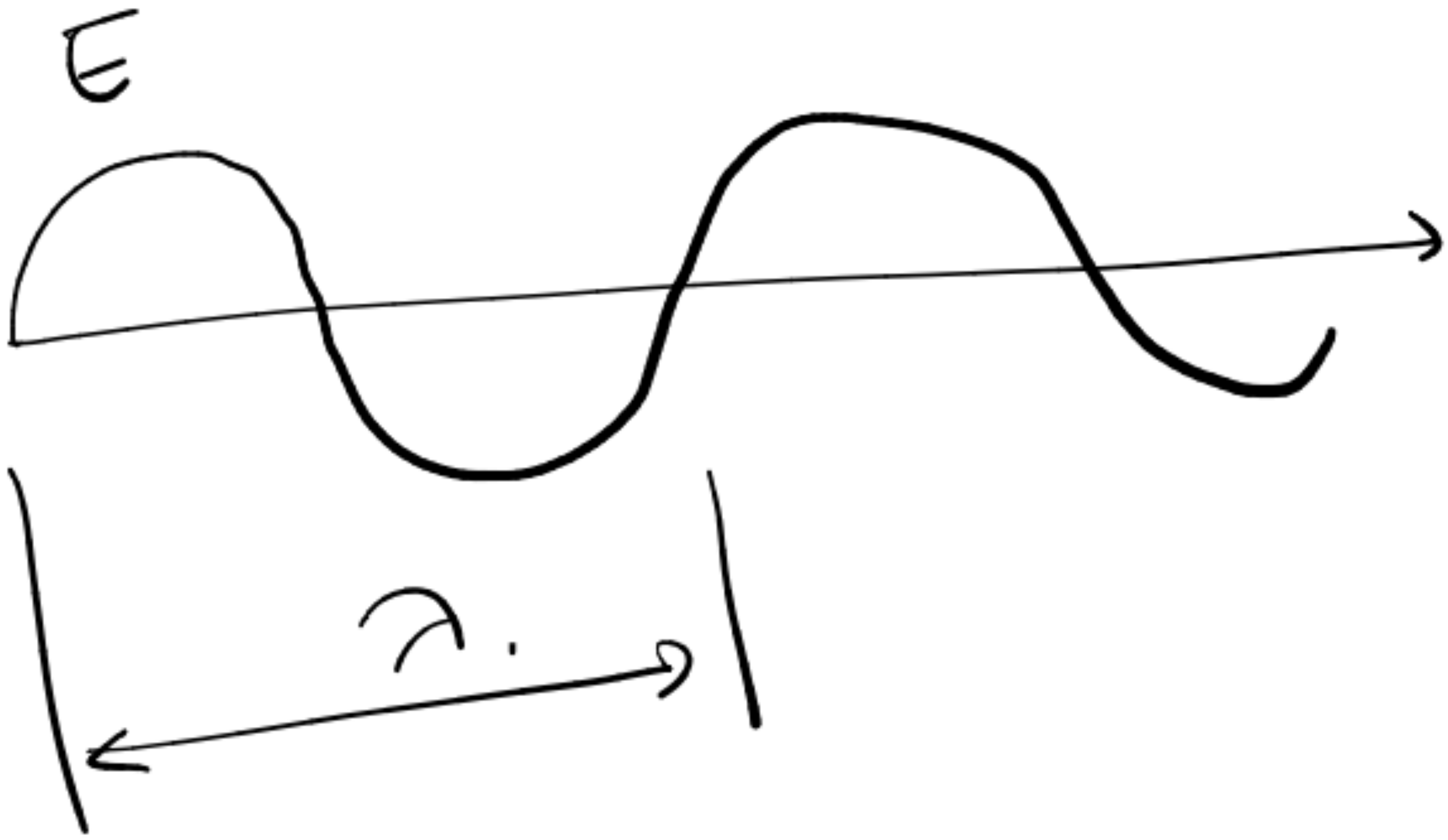


But $\text{Ampl}^2 \propto$ flux. $\Rightarrow \text{Ampl} \sim \frac{1}{r}$

$$E(r,t) = \frac{K}{r} \cos\left(\frac{2\pi}{\lambda}(r - ct) + \varphi\right)$$

$\frac{K}{r}$ = amplitude of the electric vector @ distance r.

λ = wave length of light



r = radial distance

t = time

c = speed of light in vacuum.

φ = phase angle.

It is better to write

$$E(r,t) = \mathrm{Re}\left\{ \frac{K}{r} \exp\left(i \frac{2\pi}{\lambda}(r-ct) + \varphi \right) \right\}$$

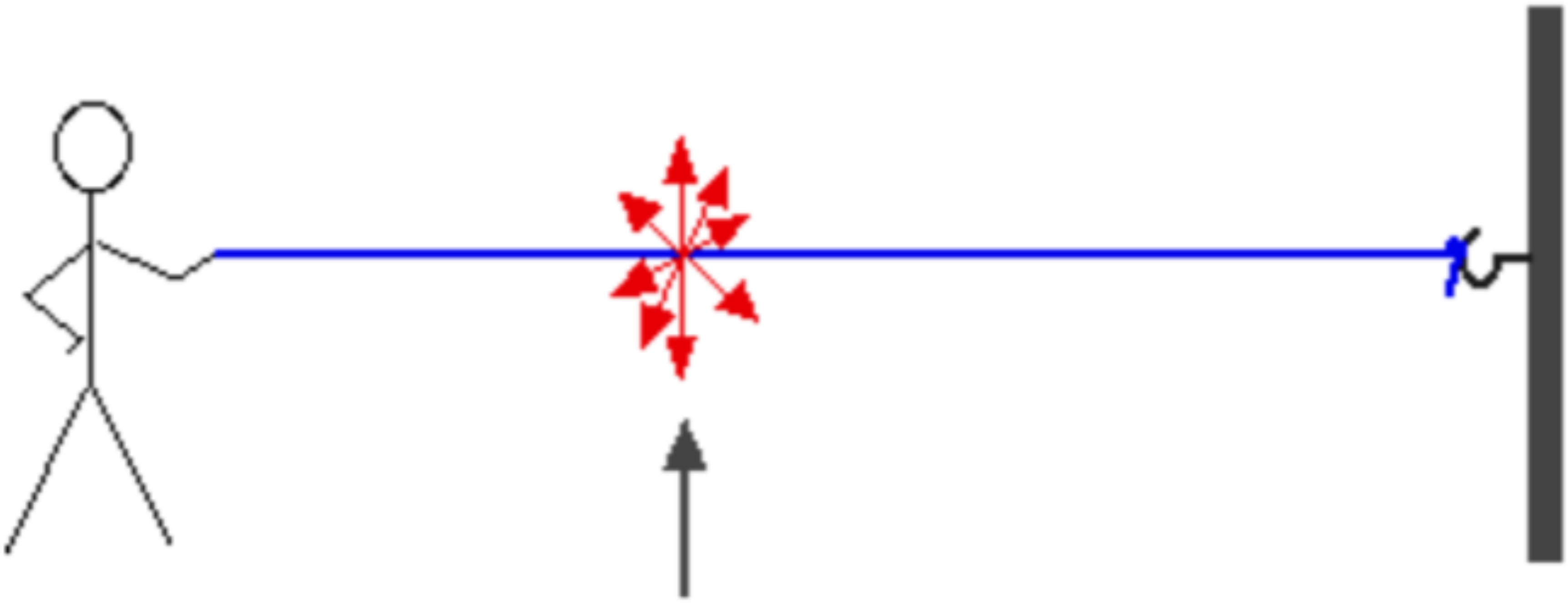
$$= \frac{K}{r} \mathrm{Re}\left\{ \exp\left(i \frac{2\pi}{\lambda}(r-ct) \right) \exp(i\varphi) \right\}$$

$\underline{A}$ ← complex amplitude of the $\underset{\sim}{E}(r,t)$

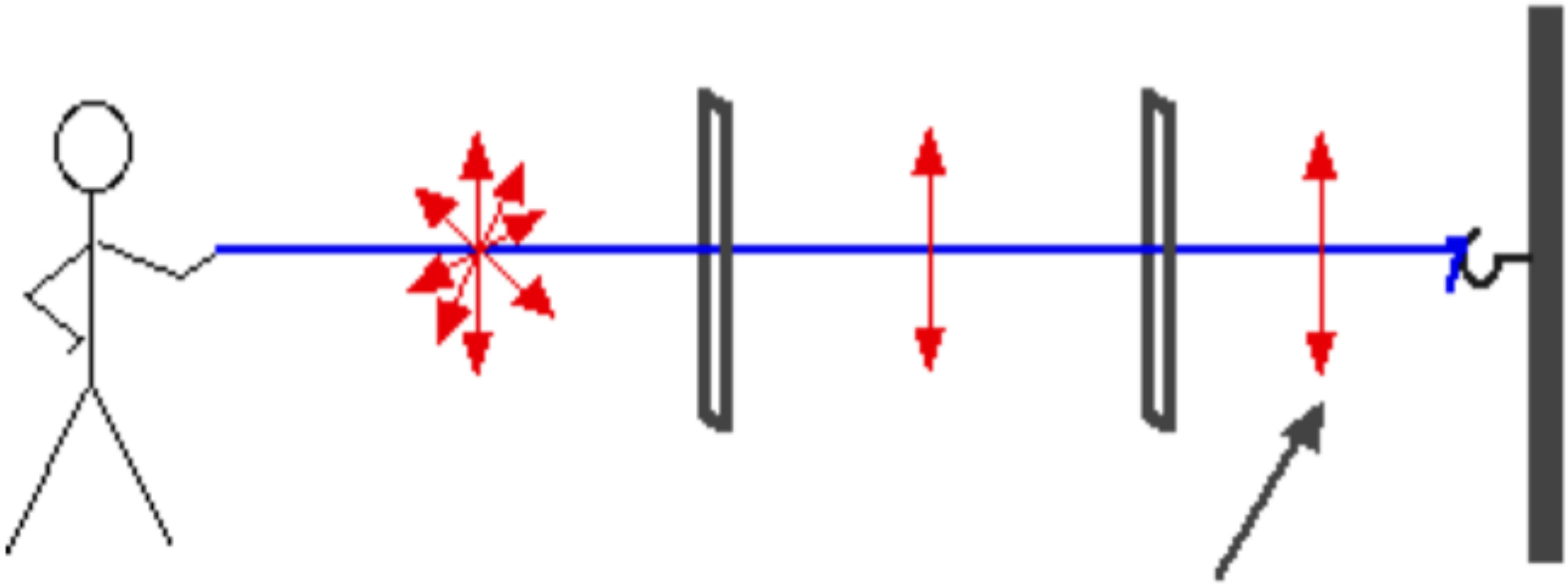
$$= \frac{K}{r} e^{i\phi}.$$

$$\Rightarrow E(r,t) = \mathrm{Re}\left\{ \underline{A} e^{i\left(\frac{2\pi}{\lambda} r - \omega t\right)} \right\}$$

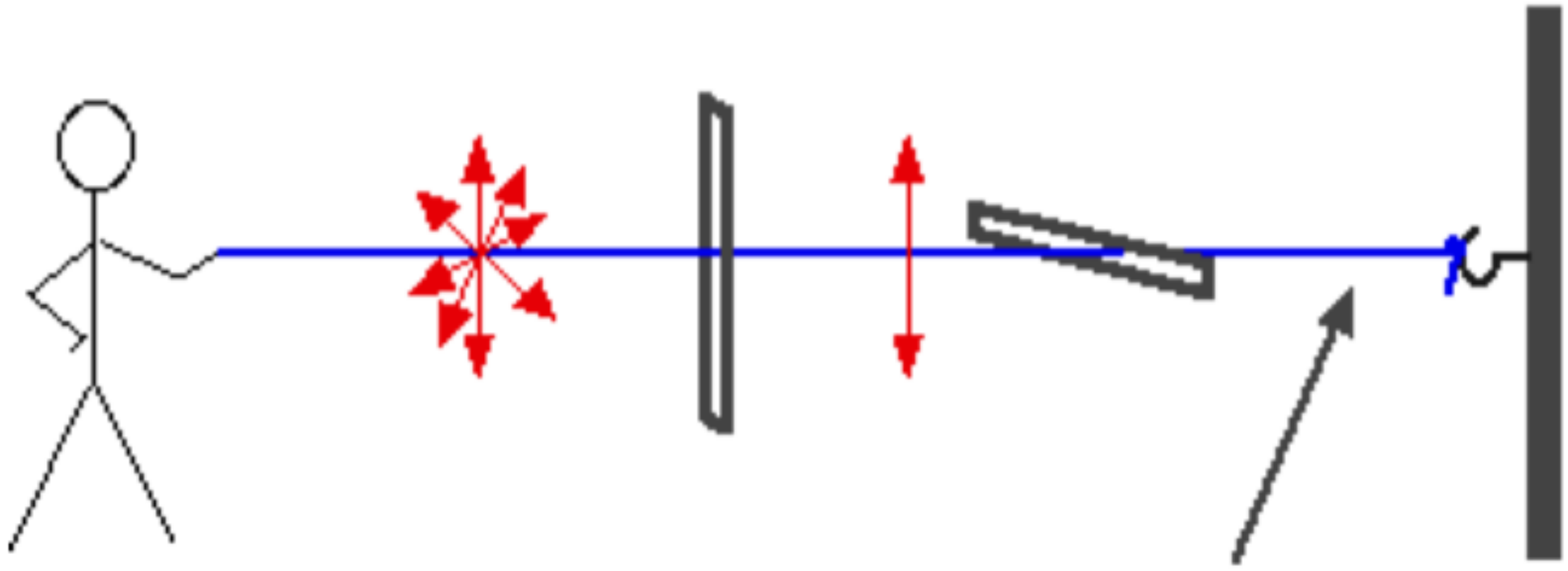
Polarized light.



string vibrates in all directions - up-and-down, side-to-side, and every direction in-between



vibrations still get through second slit



string is now completely still

Vertical slit transmits vertical
vibrations of the string.
Horizontal " absorbs "
" . of the string.

Optical polarizer does the same thing to light waves.

AmazonBasics Circular Polarizer Filter- 55 mm

Brand: AmazonBasics

★★★★☆ 1,311 ratings

| 98 answered questions

M.R.P.: ~~₹ 1,045.00~~

Price: ₹ 539.00 ✓prime

You Save: ₹ 506.00 (48%)

Inclusive of all taxes

FREE delivery: **Tuesday, May 4** Details

Save Extra with 4 offers

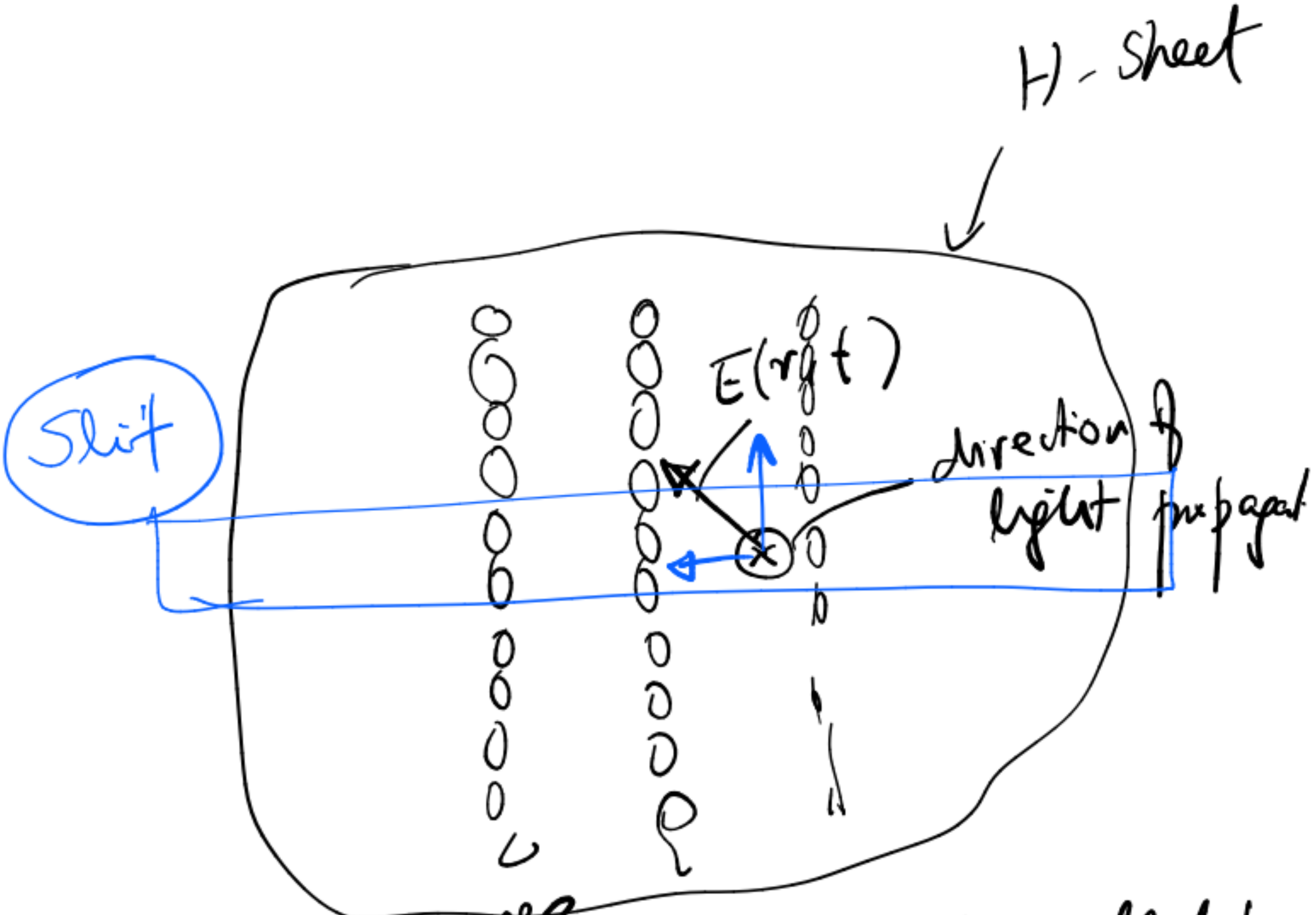
Bank Offer (2): Get 7.5% up to Rs. 1250 Instant Discount on Yes Bank Credit Card EMI... | See All

Cashback (3): Get up to ₹500 back on Amazon Pay ICICI credit card approval. And get... | See All

See 2 more

Long PVA molecules aligned in 1 direction doped with I.

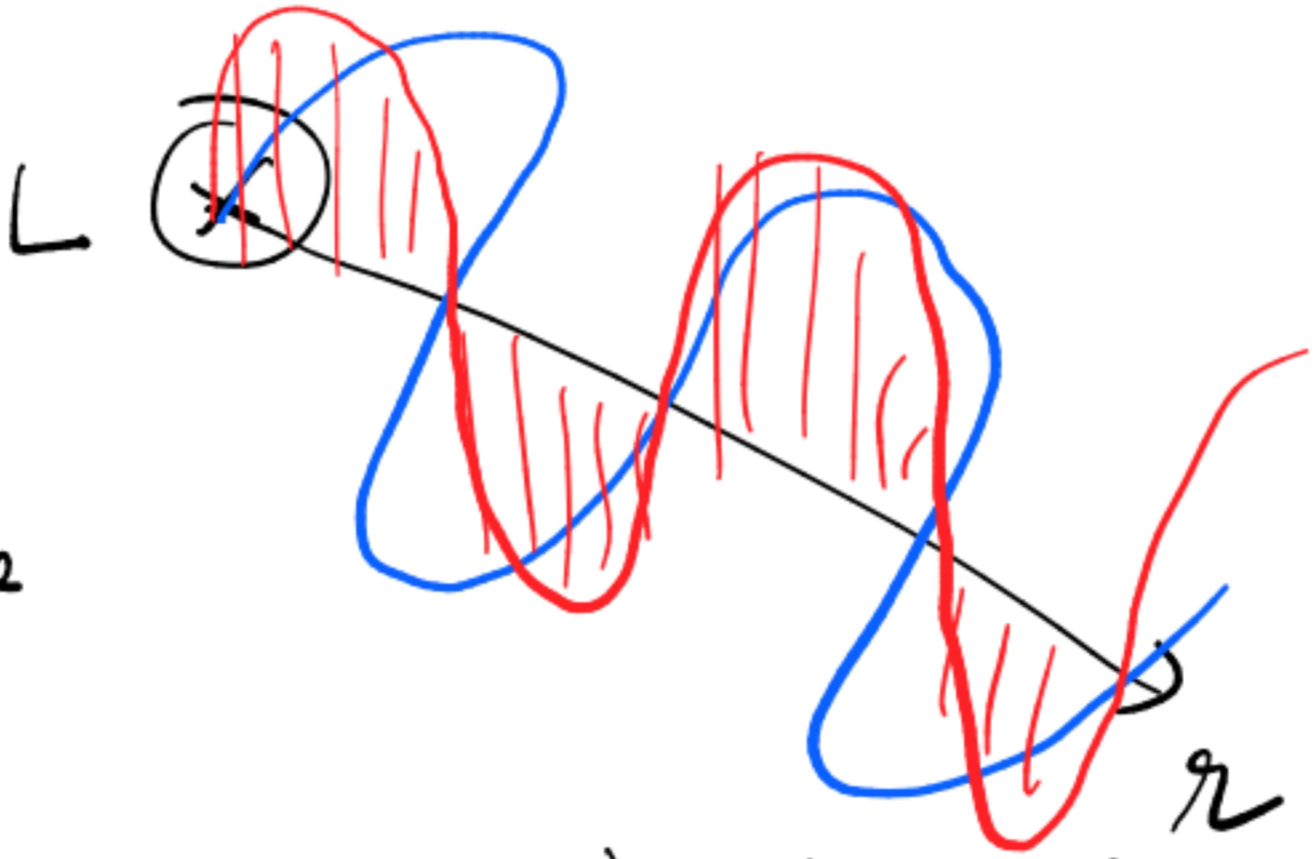
During manufacture the sheet is stretched in 1 dirn. & this aligns the long PVA molecules.



Light waves w/ ∥ polarization parallel to the chain is absorbed &

light waves ⊥ to the chains is transmitted (horizontal)

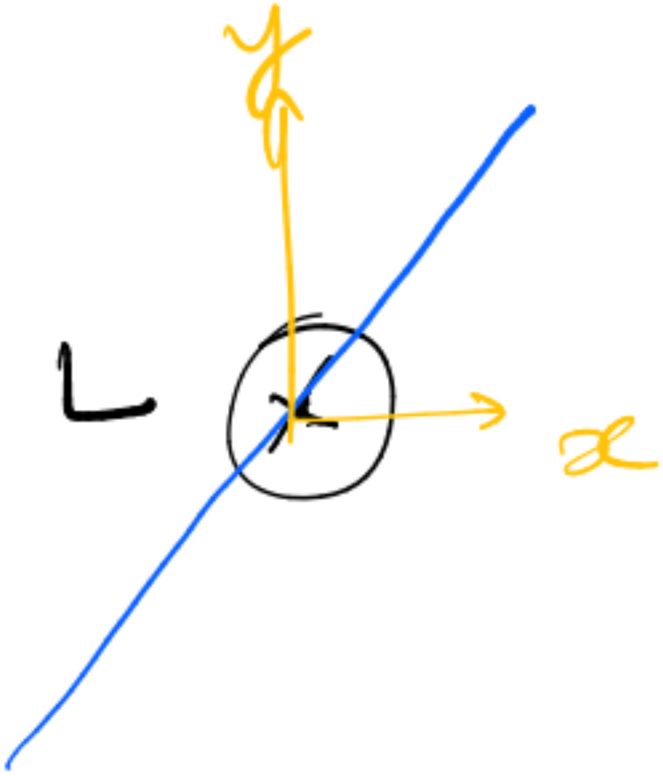
$E(r,t)$ = "light vector."



L =
line source
of light.

L will in general produce light of all possible polarizations. Two polarizations, red & blue, are shown in the figure.

Consider a light beam of a single polarization. Eg. Blue wave



An arbitrarily inclined light vector can be described by 2 complex amplitudes.

$$\begin{pmatrix} A_x e^{i\phi_x} \\ A_y e^{i\phi_y} \end{pmatrix}_{2\times 1}$$

Instead of ϕ_x, & ϕ_y, it is better to use $\beta = \phi_x + \phi_y$ & $\Delta = \phi_y - \phi_x$.

$$\begin{pmatrix} A_x e^{i\phi_x} \\ A_y e^{i\phi_y} \end{pmatrix} = \begin{pmatrix} A_x \\ A_y e^{i\Delta} \end{pmatrix} e^{i\beta/2} e^{-\frac{i\Delta}{2}}$$

A_y Comp. of the light vector is $e^{i\Delta}$ ahead of the A_x Component.