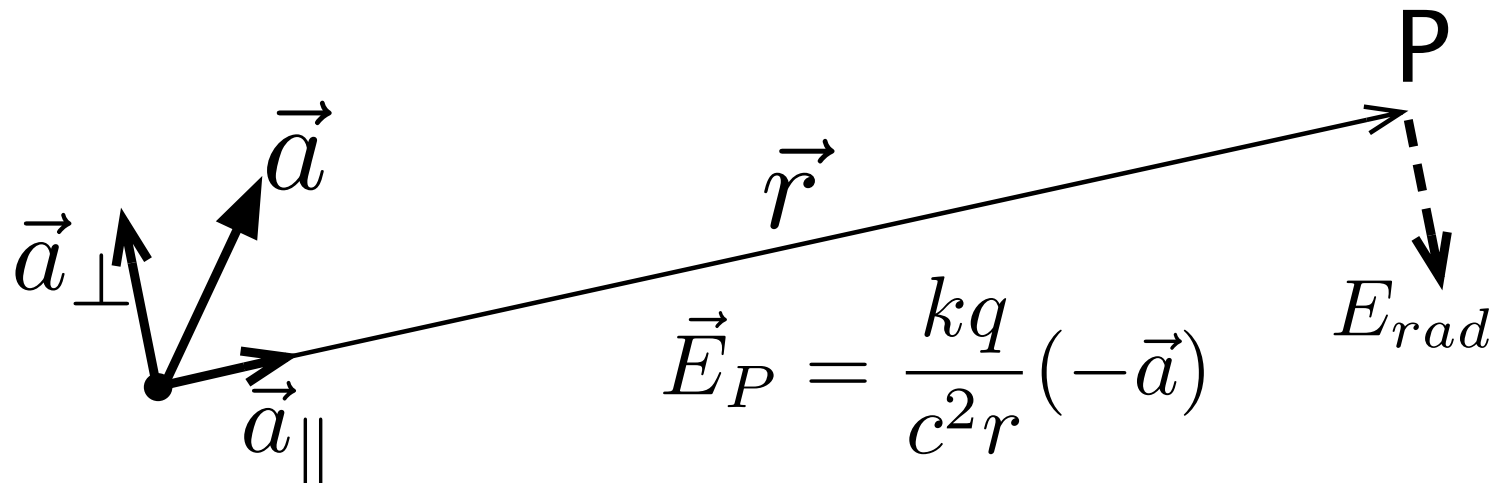
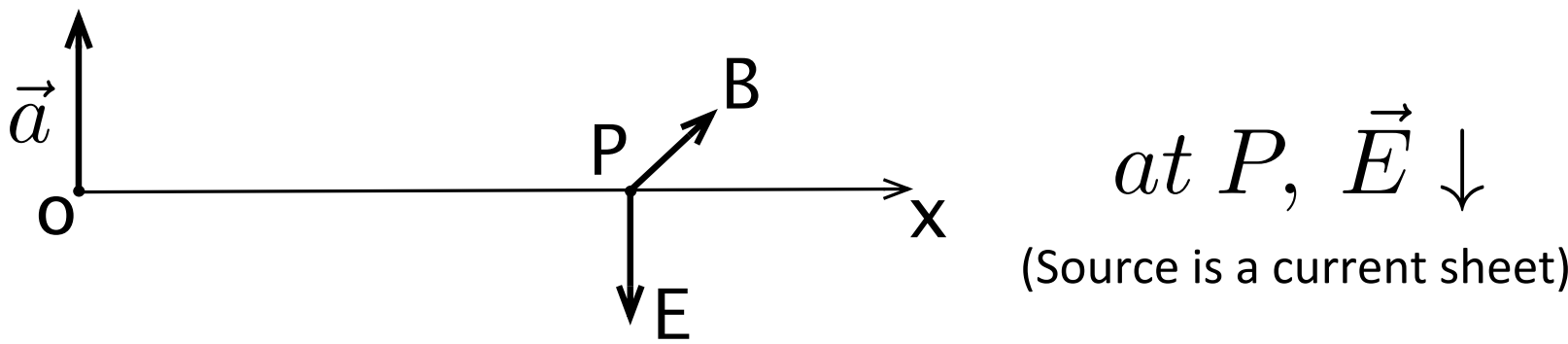


Lecture 37

Application of E-radiation formula due to acceleration of a point charge:



For 1D-plane wave case – simple case: (Assume $q > 0$)



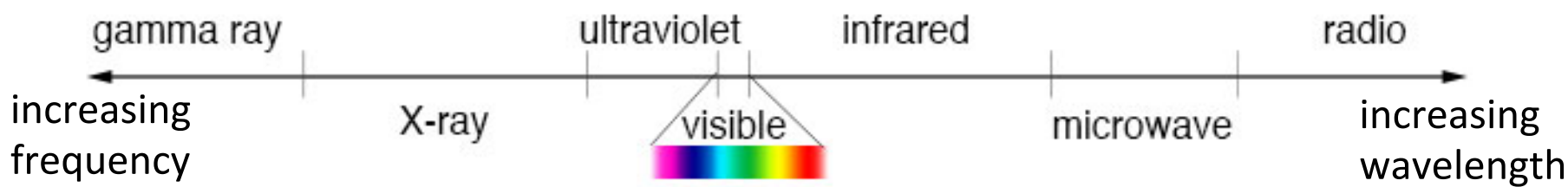
For point charge case, notice only a-perp contributes.
As is convenient, do the vector decompositions as indicated.
At P the direction of E-rad detected is indicated by the dashed vector.

EM Waves

EM waves in a vacuum are specified by one thing:

λ or f

EM wave spectrum:



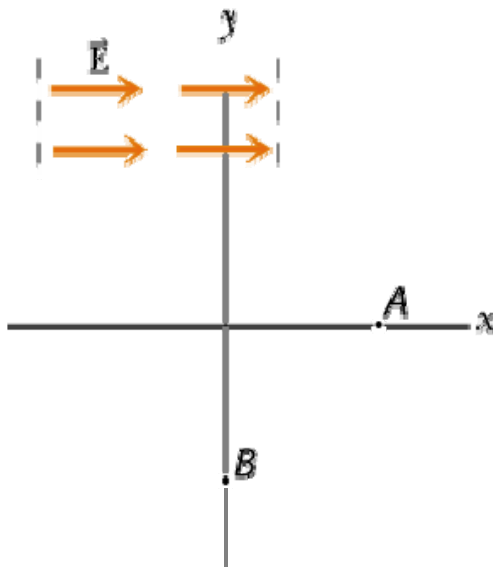
Radio Station KLBJ

$$590\text{ kHz} \approx 600 \times 10^3 \frac{1}{\text{sec}} \longrightarrow \lambda = \frac{c}{f} = \frac{3 \times 10^8}{6 \times 10^5} \approx 500\text{ m}$$

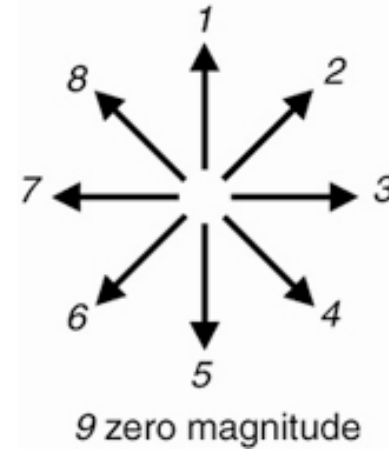
Example of EM waves:

Radio AM	stadium	10^3 m
Microwaves	Bean size	10^2 m
Visible Light	Micrometer	600 nm
X-Ray	Atomi size	10^{-10} m

Q23.5a

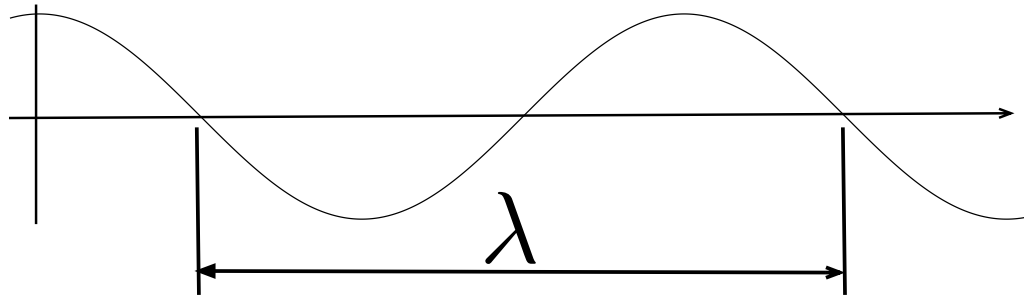


A narrow collimated pulse of radiation propagates in the $-y$ direction. There is a proton at location B . What is the direction of the radiative electric field detected at location A ?



$$E_y \approx \sin(\omega t_0 - kx + \phi)$$

Sinusoidal in x:



$$k\lambda = 2\pi, \quad k = \frac{2\pi}{\lambda}$$

λ is a conversion factor from
x-scale to angle-scale

$$\text{Period: } \omega T = 2\pi, \quad \omega = \frac{2\pi}{T} = 2\pi f$$

Fix phase: Defines the speed the fixed shape travels

$$v = \left. \frac{dx}{dt} \right|_{\text{fixed phase}} ; \quad \omega t - kx + \phi = \text{const.}$$

$$kx = \omega t + \phi - \text{const.}$$

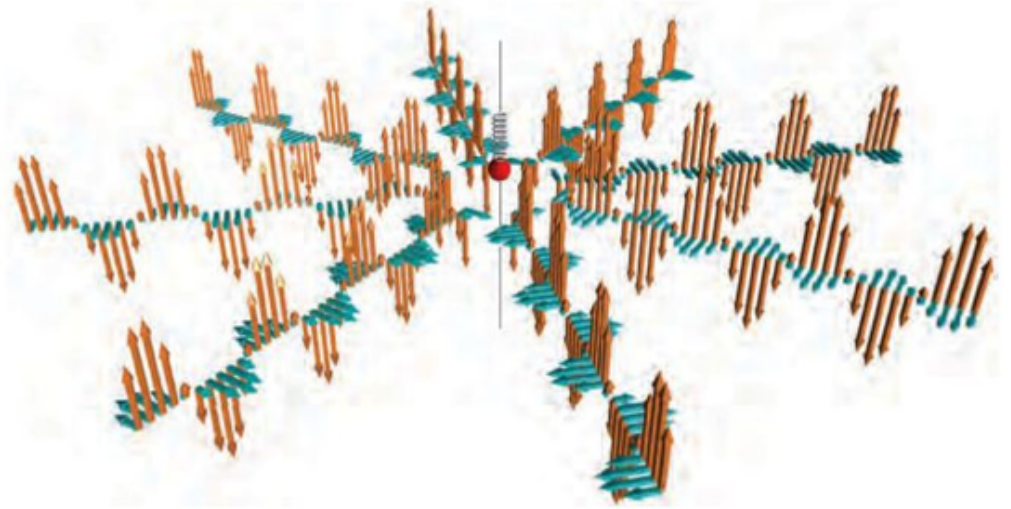
$$\therefore \frac{dx}{dt} = \frac{\omega}{k} = \left(\frac{2\pi}{T} \right) / \left(\frac{2\pi}{\lambda} \right) = \frac{\lambda}{T} = \lambda f = c$$

Radiation Field Due to Sinusoidal Oscillation of a Point Charge

$$y = y_{max} \sin \omega t$$

$$\frac{dy}{dt} = y_{max} \omega \cos \omega t$$

$$\begin{aligned} \frac{d^2 y}{dt^2} &= y_{max} \omega^2 (-\sin \omega t) \\ &= -\omega^2 y \end{aligned}$$



$$E_y = \frac{kq}{c^2 r} (-a_{\perp}) = \frac{kq}{c^2 r} y_{max} \omega^2 \sin \omega t = E_{y,max} \sin \omega t$$

Along x (or more generally, along r):

$$E_y = E_{y,max} \sin(\omega t - kx + \phi)$$

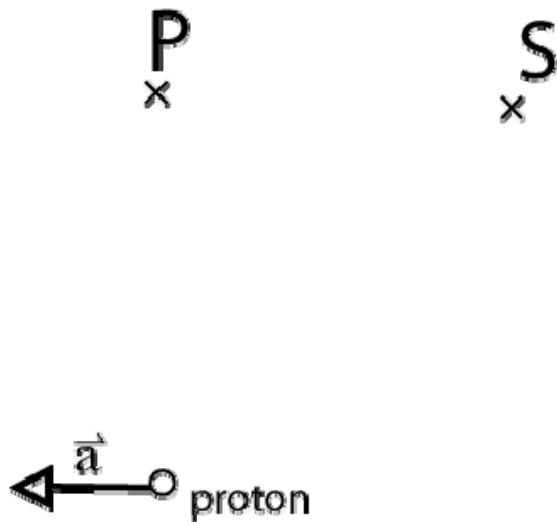
Φ is the initial phase angle of the oscillation

Fix $t = t_0$:

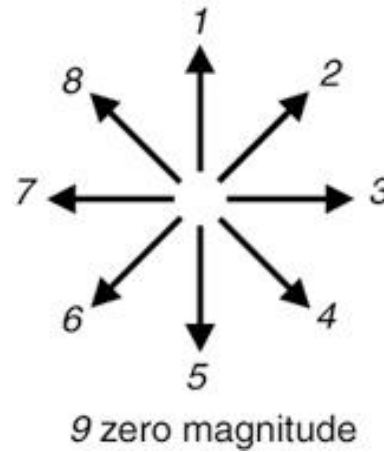
$$E_y \approx \sin(\omega t_0 - kx + \phi)$$

Q23.3d

A proton is accelerated in the direction shown.

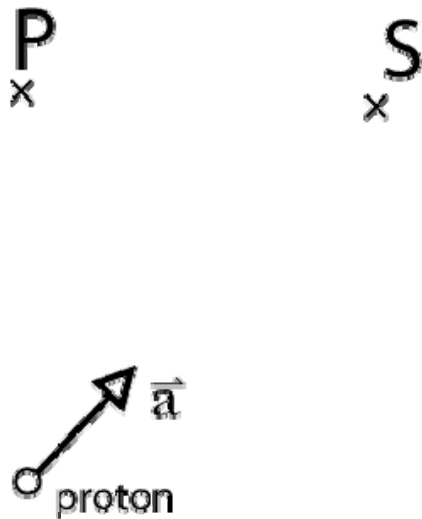


What is the direction of propagation of radiation reaching location S?



Q23.3a

A proton is accelerated in the direction shown.



What is the direction of propagation of radiation reaching observation location P?

