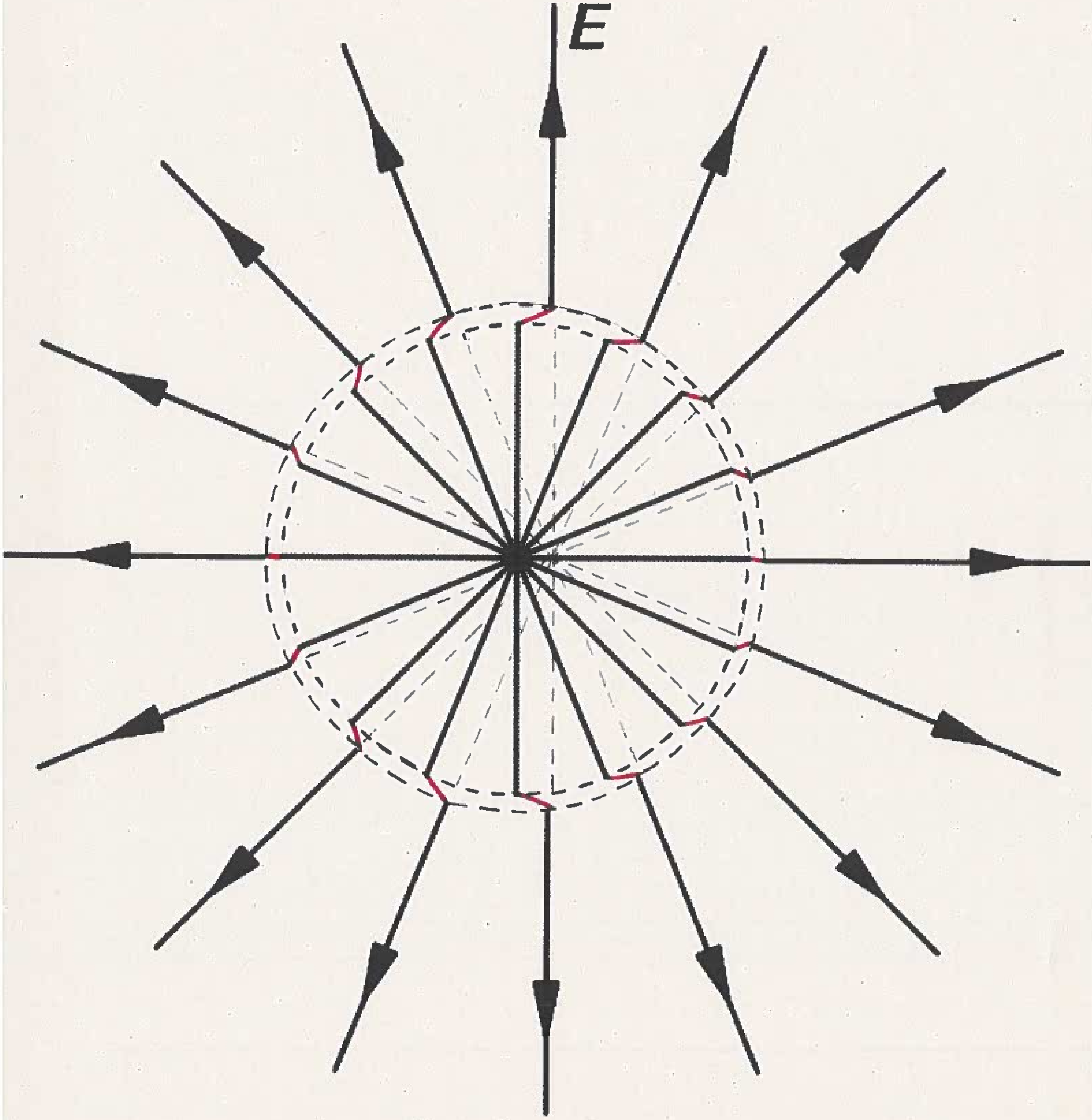
Lecture 18) Accelerating point charge - intuitive approach

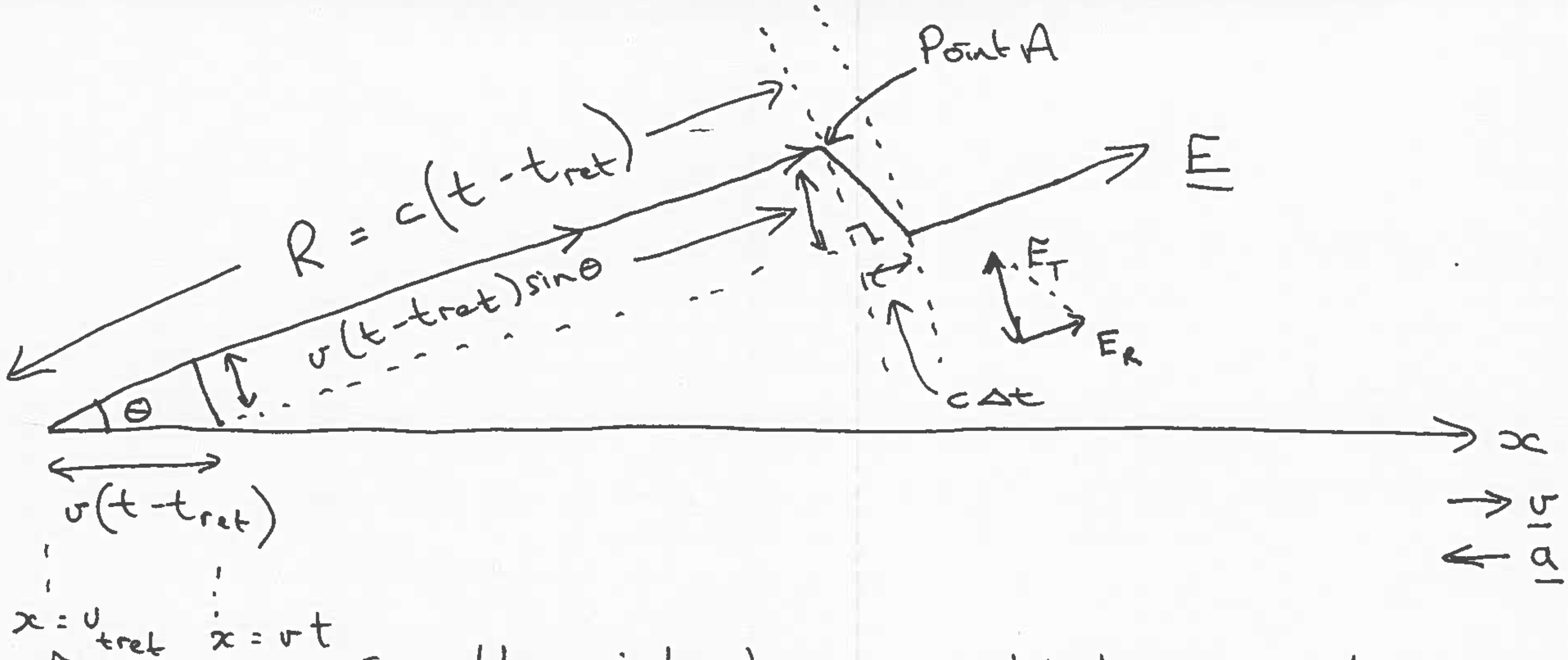
- ~~Poin~~ Point charge q travelling with constant velocity $\underline{v} \ll c$
- At t_{ret}: q decelerates rapidly to rest over time interval

Δt

$$\Rightarrow \quad \text{Acceleration} \quad \dot{\beta} = \frac{v}{c\Delta t}$$

- At some later time t (assuming $t - t_{ret} \gg \Delta t$):
  - Region within $R = c(t - t_{ret})$ sees the field produced by stationary charged particle
  - Region outside $R + c\Delta t$ still sees the field of the charge centred at $x = vt$, the position q would have reached if it had carried on moving!


E



← the point charge would have reached.

↑ where the particle came to rest.

Consider right-angled ~~band~~ triangle containing point A

Radial component at point A : $E_R = \frac{1}{4\pi\varepsilon_0} \frac{q}{R^2}$

Tangential component E_T at point A by geometry

$$\frac{E_T}{E_R} = \frac{v\,(t - t_{ret})\sin\theta}{c\,\Delta t}$$

$$\therefore\quad E_T = \frac{q}{4\pi\varepsilon_0}\,\frac{\overbrace{c\,(t - t_{ret})}^{R}\,v}{c\,R^2\,c\,\Delta t}\,\sin\theta$$

$$\frac{v}{c\,\Delta t} = \dot{\beta}$$

$$\boxed{\therefore\quad E_T = \frac{q}{4\pi\varepsilon_0 c}\,\frac{\dot{\beta}}{R}\,\sin\theta}$$

(all evaluated at t_{ret})

Notes

- Acceleration has produced a tangential field E_T which falls off as $\frac{1}{R}$ and not $\frac{1}{R^2}$!!
- $E_T \propto \sin\theta$ makes intuitive sense given the diagram.
- Associated with E_T there is also a B_T.
- Spherical shell of E_T and B_T expands at the speed of light from retarded position $x = v\, t_{ret}$.

What is this!? Electromagnetic radiation!