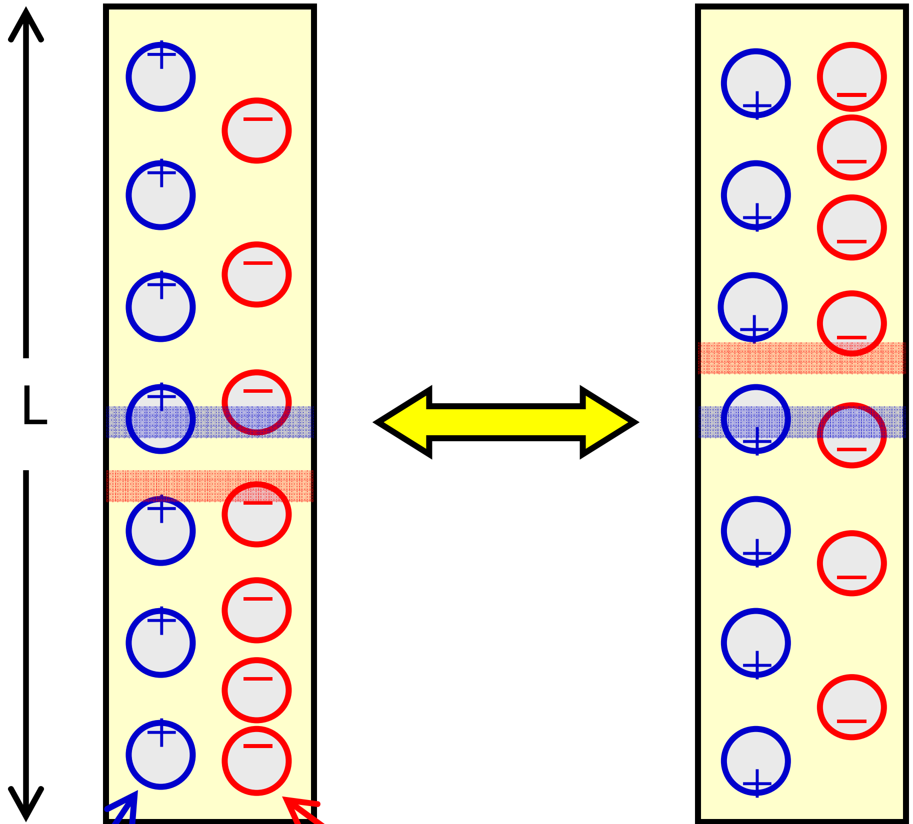
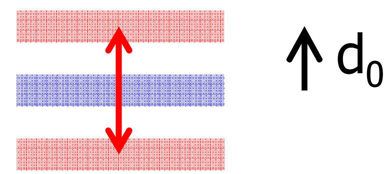
Modell für den Hertzschen Dipol



Dipolnäherung ⇔ Bewegung der Ladungsschwerpunkte

$$p(t) = Q d_0 e^{i\omega t}$$



d_0 ist <u>sehr</u> viel kleiner als L

feste Ionenrümpfe (Gesamtladung Q)

frei bewegliche Elektronen (Gesamtladung –Q)

Abstrahlung der Felder

$$\mathrm{rot}\,\vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

wechselseitige

Anregung

$$\mathrm{rot}\,\vec{B} = \mu_0\,\vec{j} + \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t}$$

$\mu_0\,\vec{j}$ $\Rightarrow$ Dynamik des Stromflusses (Quasistatik) $\Rightarrow$ Nahfelder: $\vec{E}, \vec{B} \propto \frac{1}{r^3}$

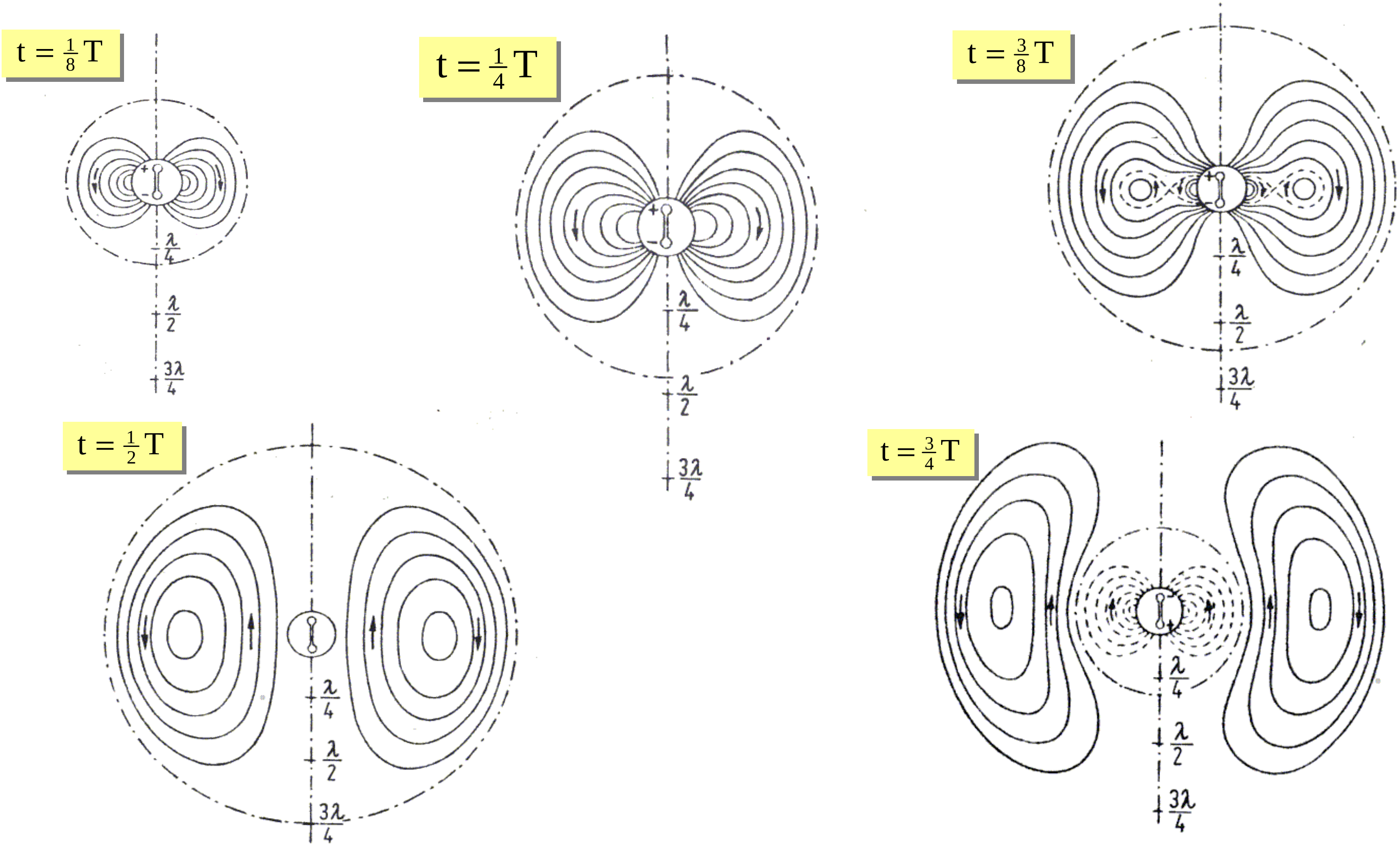
E- und B-Feld 90° phasenverschoben

$\frac{1}{c^2}\frac{\partial \vec{E}}{\partial t}$ $\Rightarrow$ Eigendynamik der Felder $\Rightarrow$ Fernfelder: $\vec{E}, \vec{B} \propto \frac{1}{r}$

E- und B-Feld phasengleich

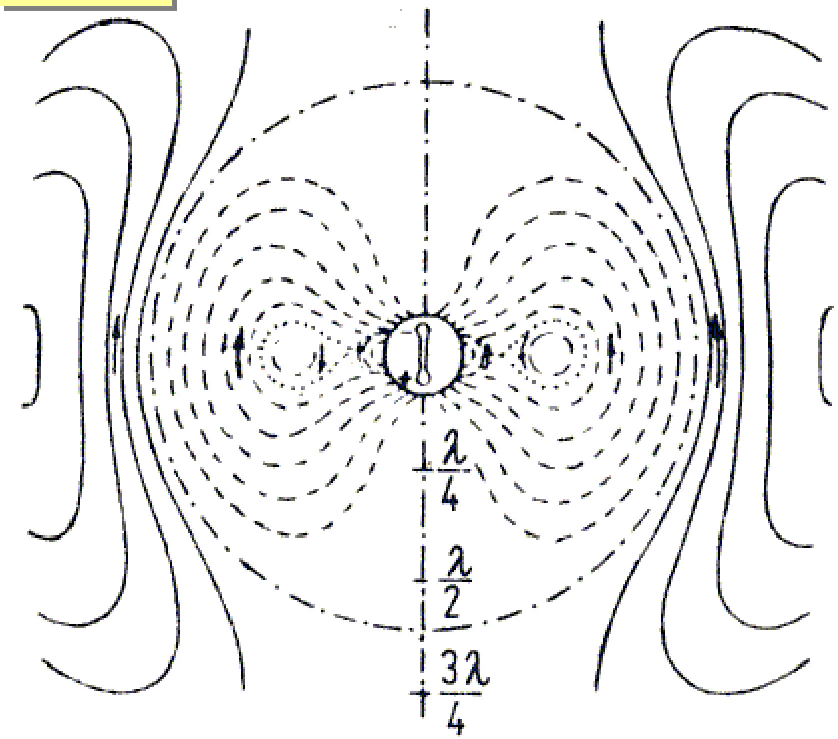
dominant für r » d_0

Zeitentwicklung des E-Feldes

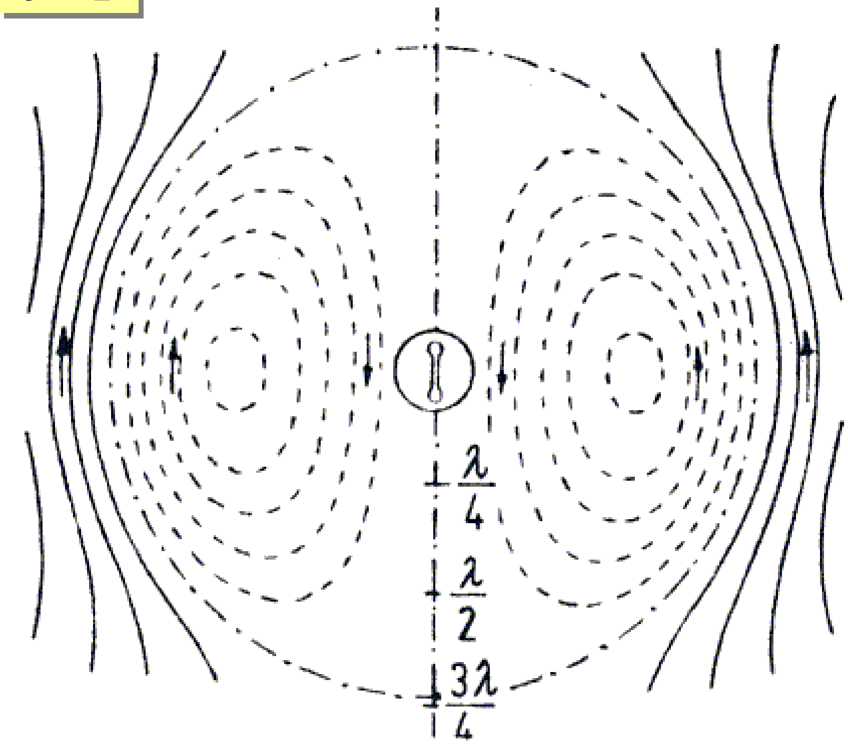


Zeitentwicklung des E-Feldes

$t = \frac{7}{8}T$



$t = T$



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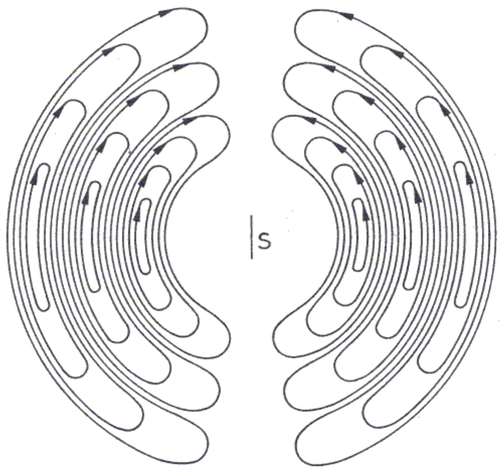
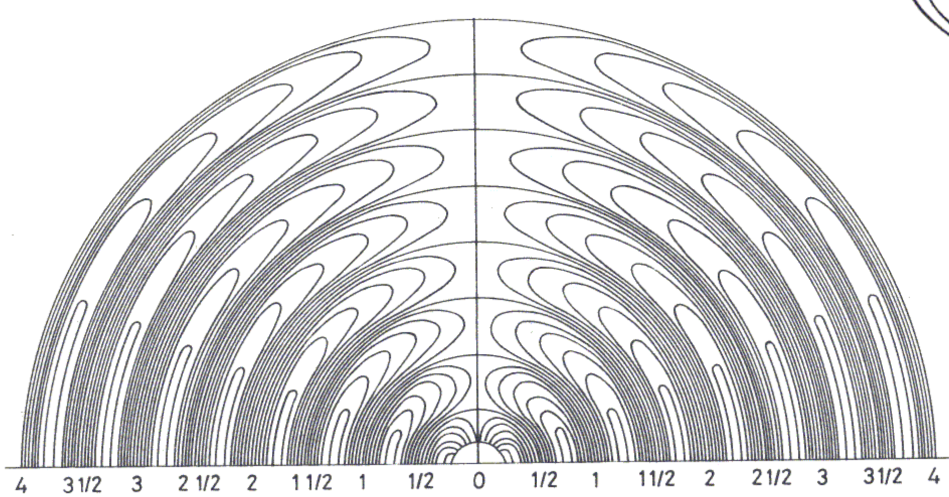
E- und B-Fernfelder

$\vec{E}$

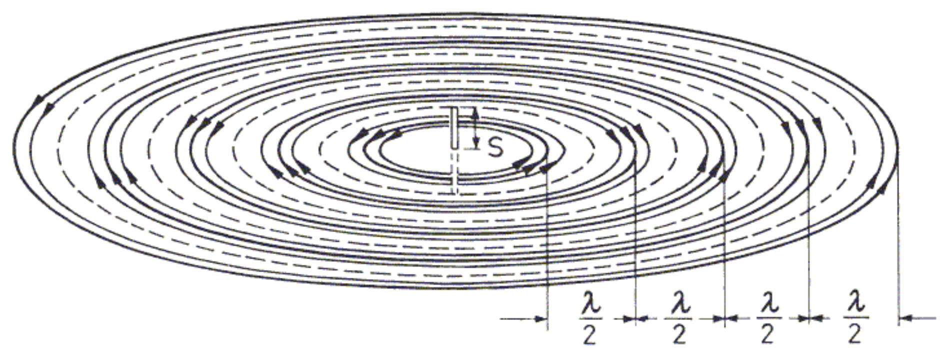


(a)



(b)

$\vec{B}$

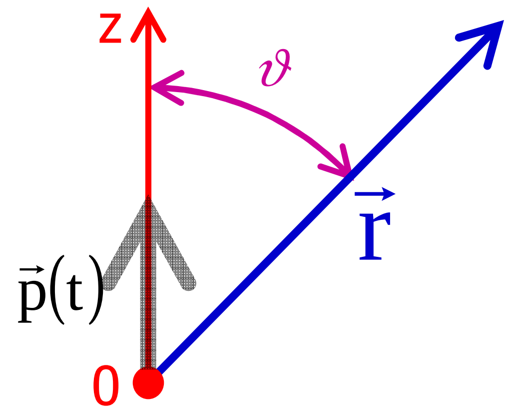


Quantitative Eigenschaften der Fenfelder

- $\vec{B}$ -Feld konzentrisch um Dipolachse

  $|\vec{B}| \propto \sin\vartheta$ (max. in Äquatorialebene)

- $\vec{E} \perp \vec{B}, \quad \vec{E} \perp \vec{r}, \quad |\vec{E}| \propto \sin\vartheta$ (max. in Äquatorialebene)



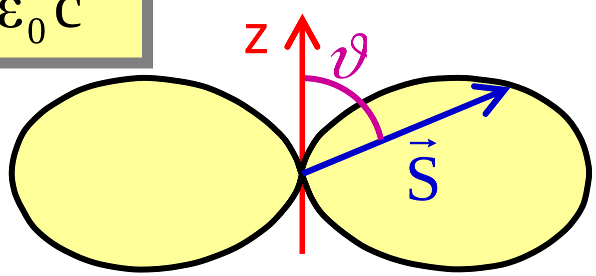
- mittlere Energiestromdichte

$$\overline{S}(\vartheta,\varphi) = \overline{S}(\vartheta) = \frac{p_0^2\,\omega^4}{16\pi^2\varepsilon_0 c^3} \cdot \frac{\sin^2\vartheta}{r^2}$$

- mittlere abgestrahlte Leistung

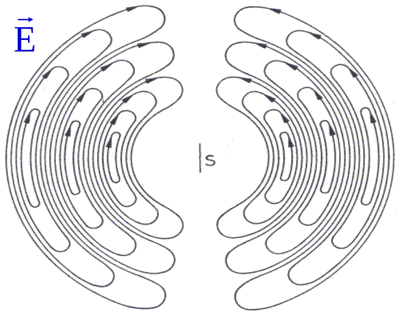
$$\overline{P} = \frac{p_0^2\,\omega^4}{6\pi\varepsilon_0 c^3}$$

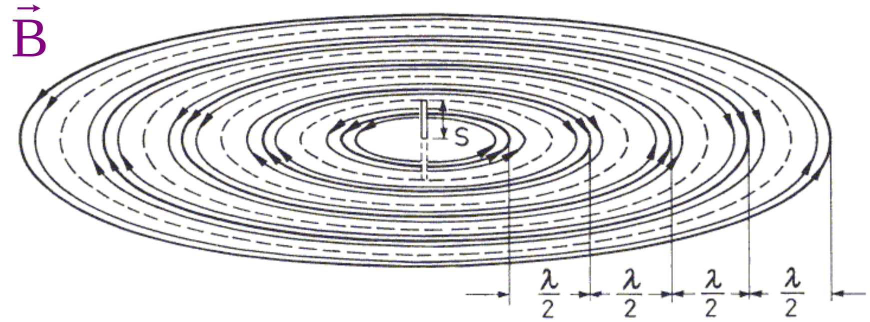
- Abstrahlcharakteristik



Abstrahlung $\propto \omega^4$
senkrecht zur Dipolachse

Strahlung in großem Abstand (r>>d)



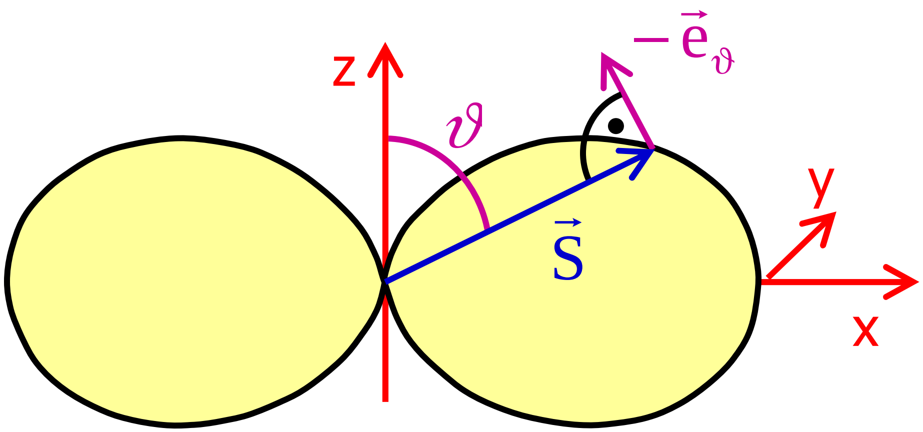


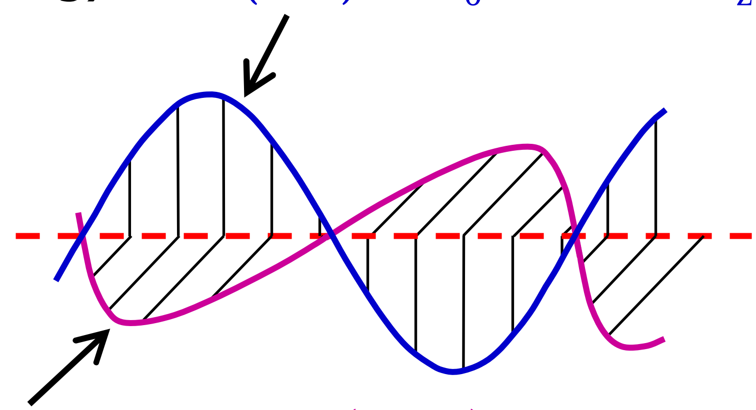
Krümmung der Phasenflächen zu vernachlässigen

$\Rightarrow$ Ebene Wellen, Polarisation ∥ $\vec{e}_\vartheta$

Strahlung senkrecht zur Antenne (x-Richtung):

$$\vec{E}(x,t) = E_0 e^{i(\omega t - kx)} \cdot \vec{e}_z$$





$$\vec{B}(x,t) = -\frac{E_0}{c} e^{i(\omega t - kx)} \cdot \vec{e}_y$$