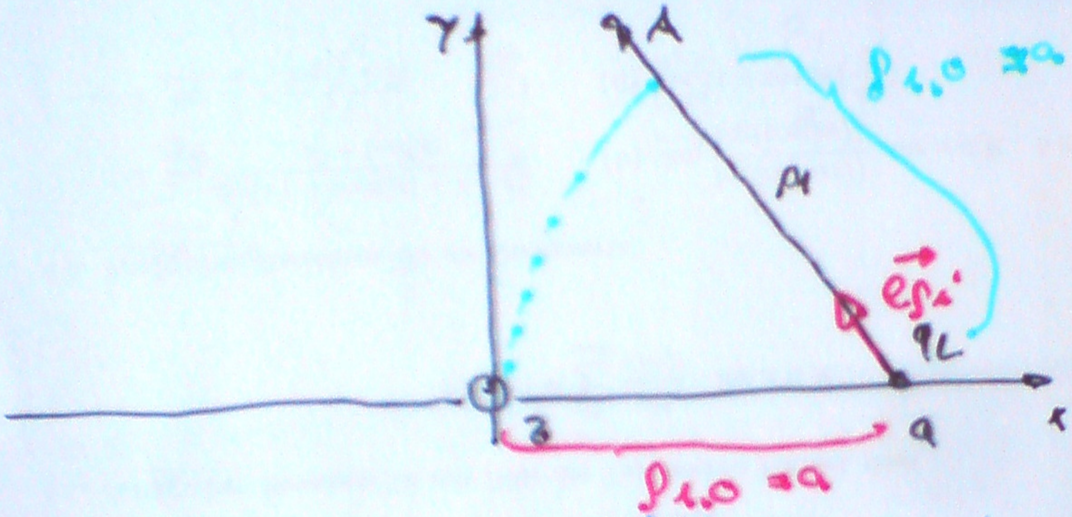
Lösung – Aufgabe 8

(a) Betrachte zunächst das Feld <u>einer</u> Linienladung in der z-Achse.

$$\vec{E} = \frac{q_L}{2\pi\varepsilon_0}\,\frac{\vec{e}_\rho}{\rho}$$

bei $x = a$: $\vec{E} = \frac{q_L}{2\pi\varepsilon_0}\,\frac{\vec{e}_{\rho_1'}}{\rho_1'}$



$$\Rightarrow \varphi_1(\rho_1) = \varphi_1(\rho_{1,0}) - \int_{\rho_1'=a}^{\rho_1'=\rho_1} \frac{q_L}{2\pi\varepsilon_0}\,\frac{1}{\rho_1'}\,d\rho_1'$$

$$= \frac{q_L}{2\pi\varepsilon_0}\cdot\ln\left(\frac{a}{\rho_1}\right)$$

(b) $\varphi_2(\rho_2)$ analog wie in (a)

$$\Rightarrow \varphi_{ges}(\rho_1, \rho_2) = \varphi_1(\rho_1) + \varphi_2(\rho_2)$$

$$= \frac{q_L}{2\pi\varepsilon_0}\left[\ln\left(\frac{a}{\rho_1}\right) - \ln\left(\frac{a}{\rho_2}\right)\right] = \frac{q_L}{2\pi\varepsilon_0}\ln\left(\frac{\rho_2}{\rho_1}\right)$$

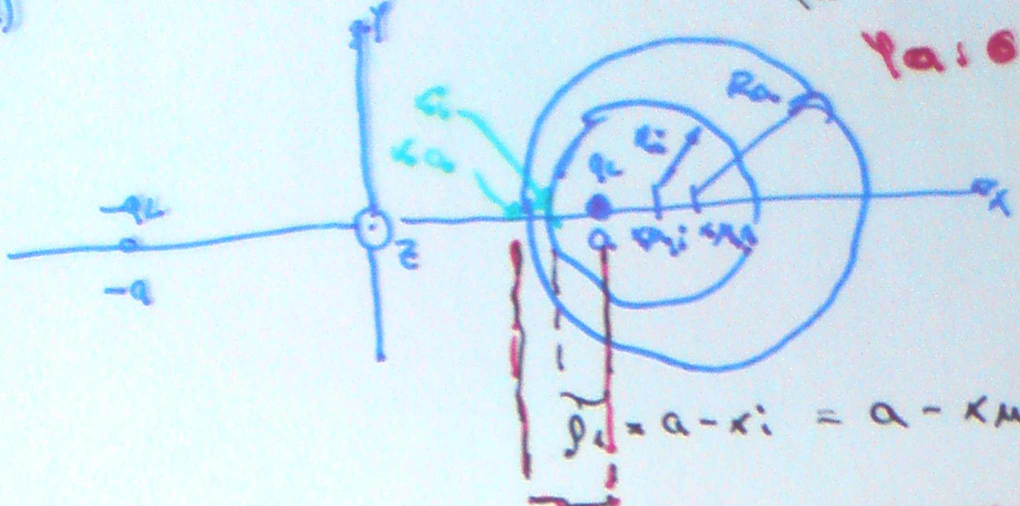
(c) $a^2 + R_a^2 = x_{M,a}^2$

$$\Rightarrow a = \sqrt{x_{M,a}^2 - R_a^2} = \sqrt{144}\,\rho_0 = 12\,\rho_0$$

Abstand $\hat{=}\ 2a = 24\,\rho_0$

(d) $\varphi_i = 0$

$\varphi_a = 0$



$\rho_1 = a - x_i = a - x_{M,i} + R_i = 4\rho_0$

$\rho_1 = a - x_a = a - x_{M,a} + R_a = 6\rho_0$

$\rho_2 = a + x_{M,i} - R_i = 20\rho_0$

$\rho_2 = a + x_{M,a} - R_a = 18\rho_0$

$\rightarrow$ damit $\varphi_i = \varphi_{ges}(\rho_1 = 4\rho_0,\ \rho_2 = 20\rho_0)$

$= \frac{q_L}{2\pi\varepsilon_0} \ln(5)$

und $\varphi_a = \varphi_{ges}(\rho_1 = 6\rho_0,\ \rho_2 = 18\rho_0)$

$= \frac{q_L}{2\pi\varepsilon_0} \ln(3)$

also $U = \varphi_i - \varphi_a = \frac{q_L}{2\pi\varepsilon_0} \ln\left(\frac{5}{3}\right)$

$$C_E = \frac{Q_i}{U} = \frac{2\pi\varepsilon_0 \cdot l}{\ln\left(\frac{5}{3}\right)} \cdot \frac{q_L}{q_L}$$

(e) bei konzentrischen Kreisen nur das Feld einer Linienladung.

also: $U_K = \int_{R_i}^{R_a} E(\rho)\, d\rho) = \frac{q_L}{2\pi\varepsilon_0} \ln\left(\frac{R_a}{R_i}\right)$

$$C_K = \frac{Q_i}{U_K} = \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{9}{5}\right)}$$