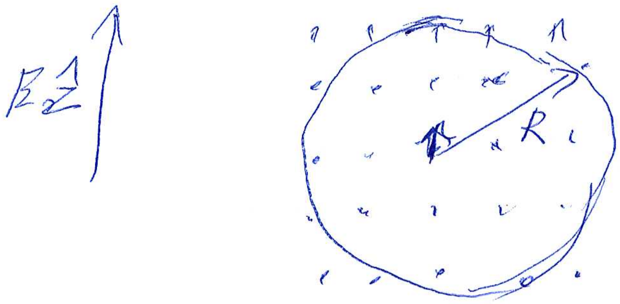
# Dielectrics – Acting field – Pôsobiace pole

for dielectrics with no permanent dipoles (or too high frequency)

derivation – cubic lattice for simplicity

concept – sphere around studied dipole
inside point-like dipoles, outside continuum




$\vec{E}_s$ field on central dipole from dipoles inside sphere

$\vec{E}_v$ field from outside

$\vec{E}$ Maxwell's macroscopic field

$\vec{E}_a$ acting field

$\vec{E}_s = \vec{0}$ !

$\vec{E}_v = \vec{E} - \vec{E}_d$

$E_a = \vec{E}_s + \vec{E}_v = \vec{E}_v$

$\Phi_d = \dfrac{\vec{p}_s \vec{r}}{4\pi\varepsilon_0 R^3} \quad \Big| \ r \geq R$

$\Phi_d = \dfrac{p_s z}{4\pi\varepsilon_0 R^3} \quad \Big| \ r \leq R$

$p_s = \frac{4}{3}\pi R^3 P$

$E_d = -\dfrac{p_s}{4\pi\varepsilon_0 R^3} = -\dfrac{P}{3\varepsilon_0}$ $\quad E_d$ – dipole sphere field

$E_a = E_v = E - E_d = E + \dfrac{P}{3\varepsilon_0} \Rightarrow \vec{E}_a \neq \vec{E}$

$P = N\alpha E_a = N\alpha\left(E + \dfrac{P}{3\varepsilon_0}\right)$ $\quad \alpha$ – polarizability

$P = \varepsilon_0(\varepsilon_r - 1)\vec{E} = N\alpha E\left(1 + \dfrac{\varepsilon_r - 1}{3}\right)$ $\quad N$ – density of ~~dipoles~~ dipoles

$\dfrac{\varepsilon_r - 1}{\varepsilon_r + 2} = \dfrac{N\alpha}{3\varepsilon_0}$ $\quad$ Clausius-Mossotti relation

n – index of refraction – high frequency

$\varepsilon_r = n^2$ $\qquad \dfrac{n^2 - 1}{n^2 + 2} = \dfrac{N\alpha}{3\varepsilon_0}$ $\quad$ Lorentz-Lorenz relation (valid – most dielectrics)