

Electromagnetic Field Theory

Week 8

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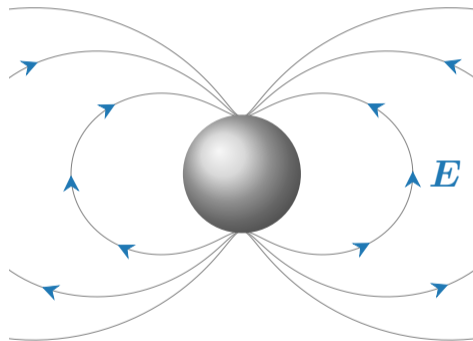
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1. Clausius-Mossotti Relation
2. Dielectrophoresis





Field in a Cavity

Field in a cavity:

$$\mathbf{E}_{\text{cav}} = \mathbf{E} - \mathbf{E}_{\text{sph}}$$

with the field of a homogeneously polarized sphere is

$$\mathbf{E}_{\text{sph}} = -\frac{\mathbf{P}}{3\epsilon_0}.$$



Clausius-Mossotti Relation

$$\frac{N\alpha}{3\epsilon_0} = \frac{\epsilon_{r,\text{in}} - 1}{\epsilon_{r,\text{in}} + 2}$$



Dielectrophoresis (DEP)

The force exerted on a polarizable particle:

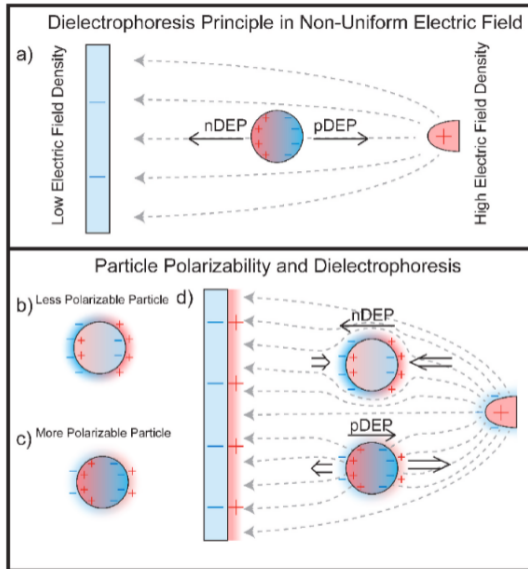
$$\mathbf{F} = (\mathbf{p} \cdot \nabla) \mathbf{E} = \alpha \mathbf{E} \cdot \nabla \mathbf{E} = \frac{1}{2} \alpha \nabla E^2.$$

$$\mathbf{F} = 2\pi \varepsilon_{\text{out}} a^3 \left(\frac{\varepsilon_{\text{in}} - \varepsilon_{\text{out}}}{\varepsilon_{\text{in}} + 2\varepsilon_{\text{out}}} \right) \nabla |\mathbf{E}|^2 = 2\pi \varepsilon_{\text{out}} a^3 f \nabla |\mathbf{E}|^2,$$

f ... the Clausius-Mossotti factor.

Considering AC field and the time-harmonic quantities, the dielectrophoretic force is

$$\langle \mathbf{F} \rangle = 2\pi \varepsilon_{\text{out}} a^3 \text{Re} \left\{ \frac{\varepsilon_{\text{in}} - \varepsilon_{\text{out}}}{\varepsilon_{\text{in}} + 2\varepsilon_{\text{out}}} \right\} \nabla E_{\text{rms}}^2.$$



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Questions?

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