Electromagnetc Theory: PHYS330

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Summary

Week 2 Summary

1. Homework discussions
    - Proofs! Glorious proofs.
    - Exercises with *checking* fundamental theorems
2. Electrostatics and Coulomb forces
    - Charge distributions, superposition, and the Coulomb force
    - A note about the *far-field*
    - Setting up integrals, taking limits, checking units
    - The divergence of electric fields
    - The curl of electric fields
3. Electric Potential
    - Definitions, fundamental theorem for gradients
    - Reference points
    - Laplace equation ...
4. Work, energy, and conductors

Homework

Homework, Week 2

Unlike last week, these exercises come from *within* the chapter. Ideally, you should look at all of the problems within the chapter as you study.

- Exercise 2.5
- Exercise 2.6
- Exercise 2.9
- Exercise 2.12
- Exercsie 2.16
- Exercise 2.18
- Exercise 2.25
- Exercise 2.29

Charge distributions, Superposition, and the Coulomb Force

Charge distributions, Superposition, and the Coulomb Force

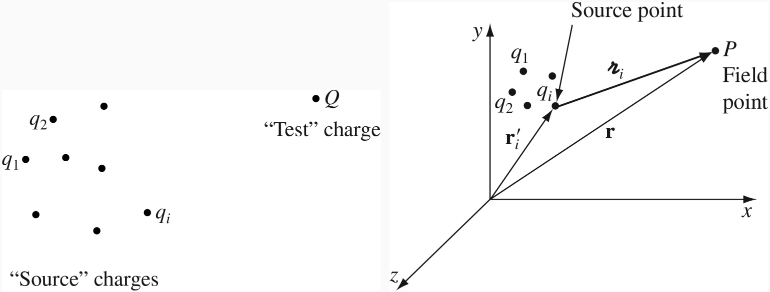

Figure 1: The basic problem of electrostatics. Note the definition of the separation vector, and the vectors to the field point and to all the source charges.

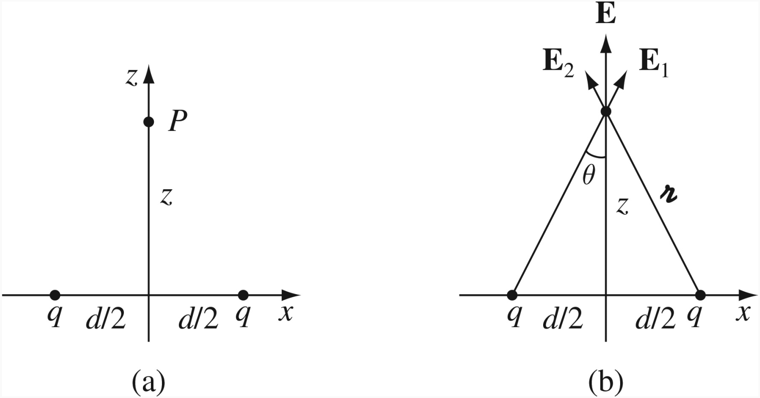

Figure 2: Begin with a dipole, and then a *physical* dipole.

Charge distributions, Superposition, and the Coulomb Force

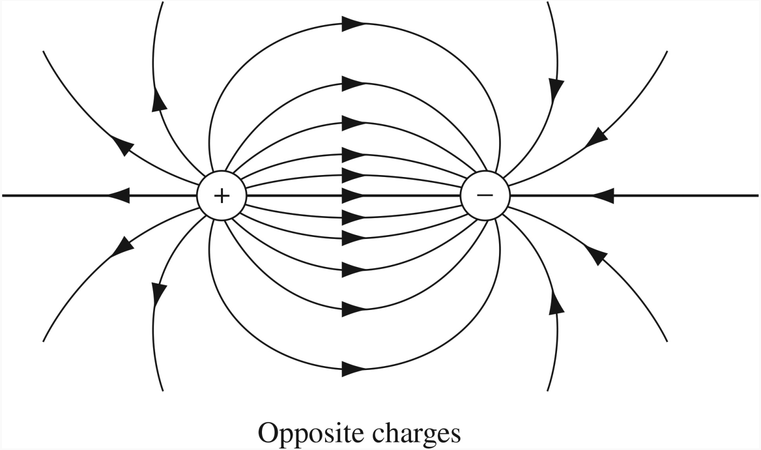

Figure 3: Field of a *physical* dipole.

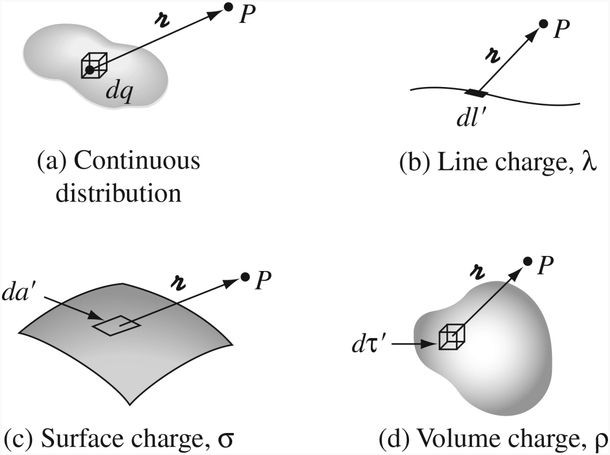

Figure 4: The continuous limit implies a variety of symmetries and geometries over which we integrate, rather than sum.

Charge distributions, Superposition, and the Coulomb Force

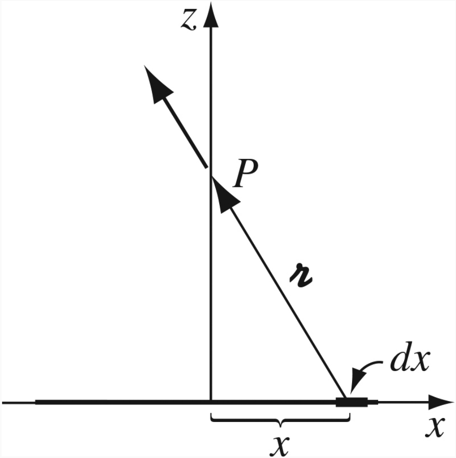

Figure 5: A coninuous line density of charge. Integration yields the electric field.

Charge distributions, Superposition, and the Coulomb Force

Useful calculations:

1. Continuous line charge, length L.
2. Continuous plane of charge, radius R.
3. Loop of charge, radius R, a distance z above the center.

Why are these interesting? One example is that these shapes are used as *antennas*. Give some alternating current at the right voltage and impedance to a shape of metal, then you've got your antenna that radiates a certain way.

Professor do these examples.[1]

[1] Remember from PHYS180? Remember? Yeah...good times.

A Note about the Far-Field

The Far-Field

One way to express the **far-field** approximation (compare to Fraunhofer and Fresnel limits in diffraction):

$$\vec{r} = \vec{r'} + \vec{\mathscr{r}} \tag{1}$$

$$\vec{\mathscr{r}} = \vec{r} - \vec{r'} \tag{2}$$

$$\mathscr{r} = \sqrt{r^2 - 2\vec{r} \cdot \vec{r'} + r'^2} \tag{3}$$

$$\mathscr{r} = r\sqrt{1 - 2\vec{r} \cdot \vec{r'} r^{-2} + r'^2 r^{-2}} \tag{4}$$

$$\mathscr{r} \approx r\sqrt{1 - 2\vec{r} \cdot \vec{r'} r^{-2}} \tag{5}$$

$$\mathscr{r} \approx r\left(1 - \vec{r} \cdot \vec{r'} r^{-2}\right) \tag{6}$$

$$\mathscr{r} \approx r\left(1 - \hat{r} \cdot \vec{r'} r^{-1}\right) \tag{7}$$

$$\mathscr{r} \approx r - \hat{r} \cdot \vec{r'} \tag{8}$$

The Divergence of $\vec{E}$-fields