Physics 110A
Electricity and Magnetism

MWF 8-9 AM, Cory 241

Instructor: Paul Duffell
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Homework: Due Thursdays by 7pm, homework box on the 2nd floor of LeConte

Course Text:
Griffiths, David J. *Introduction to Electrodynamics.* 4th ed. (but any edition is fine)

Office Hours: Thursdays from 2-3pm, 355 Campbell Hall

GSI: [redacted]
Discussion Sessions:
Tuesday 1-2pm, Haviland 12
Thursday 4-5pm, Moffitt Library 150D

Grades: 20% Homework / 30% Midterm / 50% Final Exam

Tentative Midterm Date: Friday, March 2 (in class, testing material from chapters 1-3).

Proposed Schedule

- Week 1: Review of Vector Calculus: Jan 17, 19 — Griffiths, Chapter 1
- Week 2: Electrostatics and Conductors: Jan 22, 24, 26 — Griffiths, Chapter 2
- Week 3: The Laplace Equation, Method of Images: Jan 29, 31, Feb 2 — Griffiths, Chapter 3
- Week 4: Separation of Variables: Feb 5, 7, 9
- Week 5: Dipoles, Multipole Expansion: Feb 12, 14, 16

Presidents' Day: Monday, Feb 19

- Week 6: Polarization: Feb 21, 22 — Griffiths, Chapter 4
- Week 7: Dielectrics: Feb 26, 28, March 2

Midterm: Electrostatics (March 2)

- Week 8: Magnetostatics: March 5, 7, 9 — Griffiths, Chapter 5
- Week 9: Vector Potential: March 12, 14, 16
- Week 10: Magnetization, Magnetic Fields in Matter: March 19, 21, 23 — Griffiths, Chapter 6

Spring Break: March 26-30

- Week 11: EMF and Induction: April 2, 4, 6 — Griffiths, Chapter 7
- Week 12: Maxwell's Equations: April 9, 10, 11
- Week 13: Catch-Up or Special Topics: April 16, 18, 20
- Week 14: Catch-Up or Review: April 23, 25, 27

Final Exam

Disabled Students Program: http://www.dsp.berkeley.edu/

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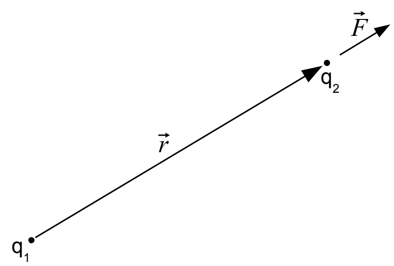
Student Code of Conduct: http://sa.berkeley.edu/code-of-conduct

The instructor and students are expected to behave with the utmost of integrity, responsibility, and civility towards all members of the classroom as well as Extension staff. Additionally, all members of the Extension community are expected to comply with all laws, University policies, and campus regulations, conducting themselves in ways that support a thriving learning environment. For more information, see the linked document. Violation of the code of conduct can result in disciplinary steps as outlined in the code.

Philosophy of Physics 110A

Presumably everyone in this course has already learned about E & M in a previous physics course. So why do we need to do it again? Well, in most introductory courses, the electromagnetic force is described by the following picture. Particles with charge q_1 and q_2 exert a force on one another, given by the following magnitude and direction:



$$\vec{F} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}\hat{r}, \tag{1}$$

where $\vec{r}$ is the displacement vector between the two charges (By the way, in this course we will be following Griffiths' conventions by using SI units, hence the appearance of the quantity ϵ_0).

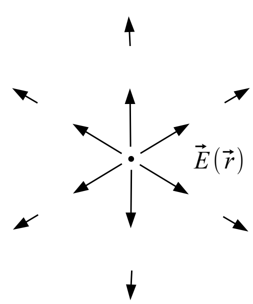
Sorry, where was I? Oh right. Philosophically, the picture above really can't be right. It suggests that every particle has to query every other particle in the universe to determine its charge and position relative to it, in order to determine the force it feels. Either that, or each charge queries every other charge in the universe to determine the force it exerts. Either way, this seems wrong on a philosophical level. Moreover, it suggests action at a distance. If I move one of the particles, the information that the particle has moved appears to be communicated instantaneously to the other particle in this picture.

The solution: Introduce some kind of intermediary.

Charges do not push each other directly; they are pushed by an electromagnetic field. The charges also affect the EM field around them, in such a way as to produce the observed force law. Specifically, define the electric field, $\vec{E}$. Each charge in the universe generates an electric field given by the following:

$$\vec{E} = \frac{q}{4\pi\epsilon_0 r^2}\hat{r} \tag{2}$$

where q is its charge and $\vec{r}$ is the distance from the charge.



The $\vec{E}$ field then exerts a force on charges given by $\vec{F} = q\vec{E}$. This reproduces the observed force law, and it means the particles don't have to talk directly to one another. What's important to understand about this is that the electric field is not just a handy tool for calculation, but a physical entity. It is as real as the charges. In Physics 110A, the charges are not the protagonist; the fields are.