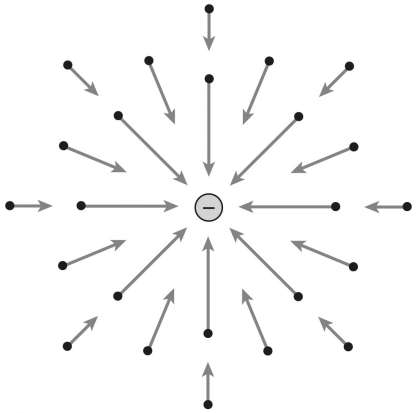

University Physics 227N/232N
Old Dominion University

More Electrostatics
20:3-4 Electric Field, Dipoles, Quiz

Dr. Todd Satogata (ODU/Jefferson Lab)
satogata@jlab.org
http://www.toddsatogata.net/2014-ODU

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Happy Birthday to Zooey Deschanel, Kid Rock, Jim Carrey,
Andy Kaufman, Muhammad Ali, and Michelle Obama!

Review: The Electric Field

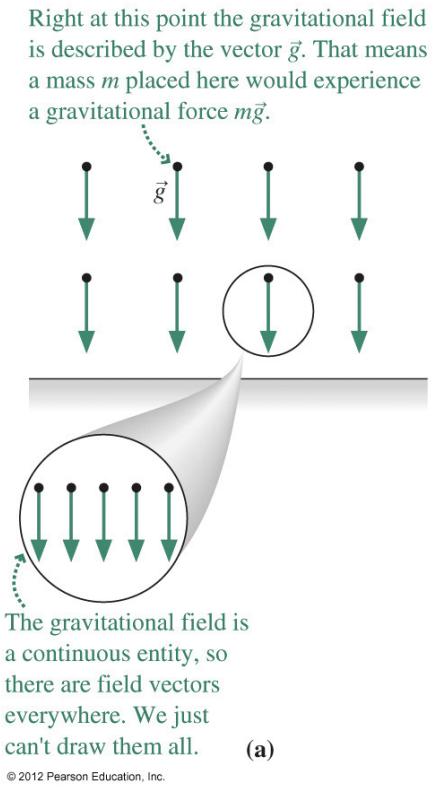
- The electric field at a point in space is the force per unit charge that a charge q placed at that point **would** experience:

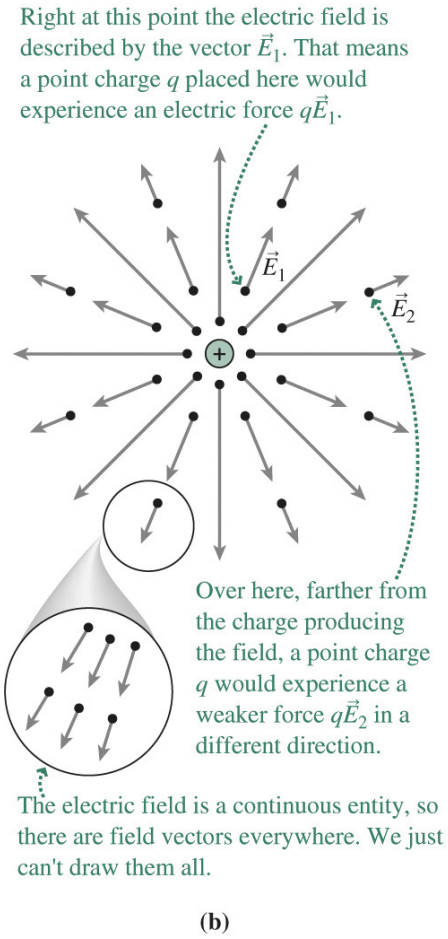
$$\vec{E} = \frac{\vec{F}}{q} \qquad \frac{\mathrm{N}}{\mathrm{C}} = \frac{\mathrm{V}}{\mathrm{m}}$$

- The force on a charge q in an electric field $\vec{E}$ is

$$\vec{F} = q\vec{E}$$

  - Electric field is analogous to the gravitational field, which gives force per **unit** mass.

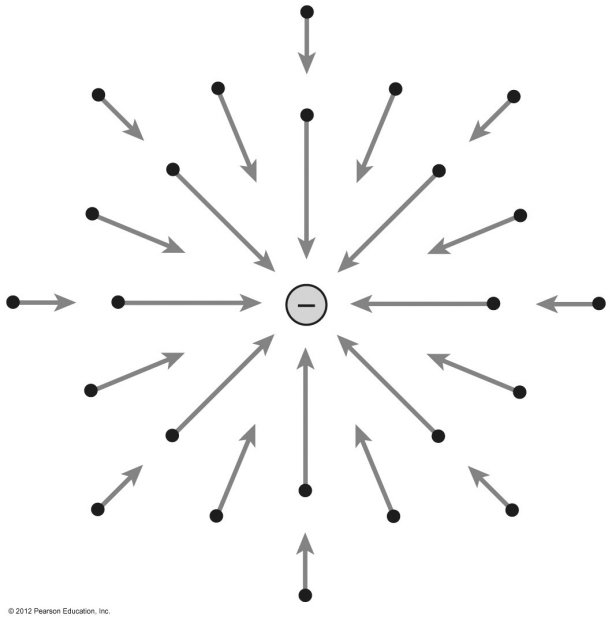




Fields of Point Charges and Charge Distributions

- The field of a point charge is radial, **outward** for a positive charge and **inward** for a negative charge.

$$\vec{E}_{\text{point charge}} = \frac{kq}{r^2}\,\hat{r}$$

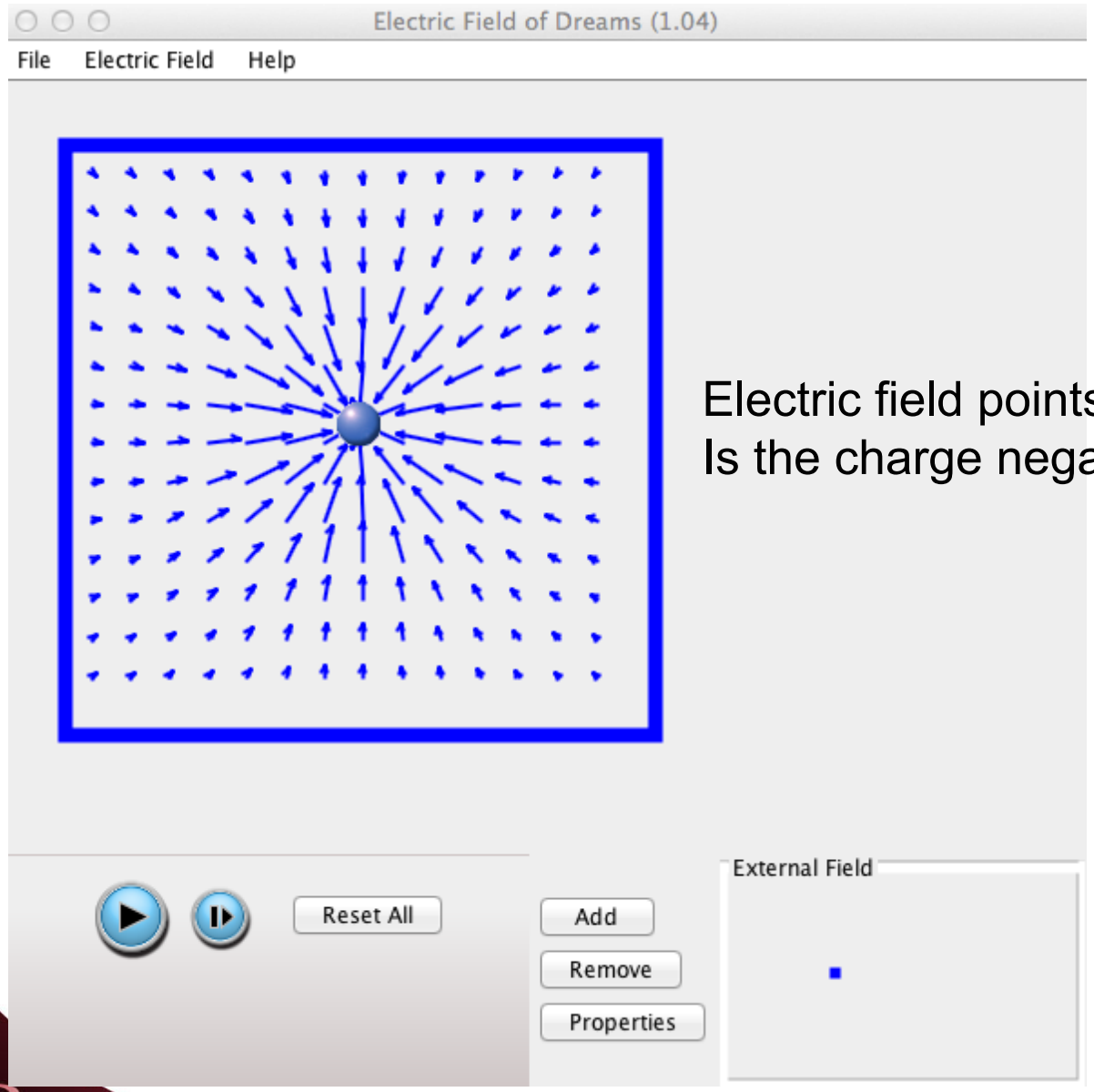


- The superposition principle shows that the field due to a charge distribution is the vector sum of the fields of the individual charges.

$$\vec{E}_{\text{total}} = \sum_i \vec{E}_i = \sum_i \frac{kq_i}{r_i^2}\,\hat{r}_i$$

Review: Electric Field (of Dreams)

http://phet.colorado.edu/en/simulation/efield

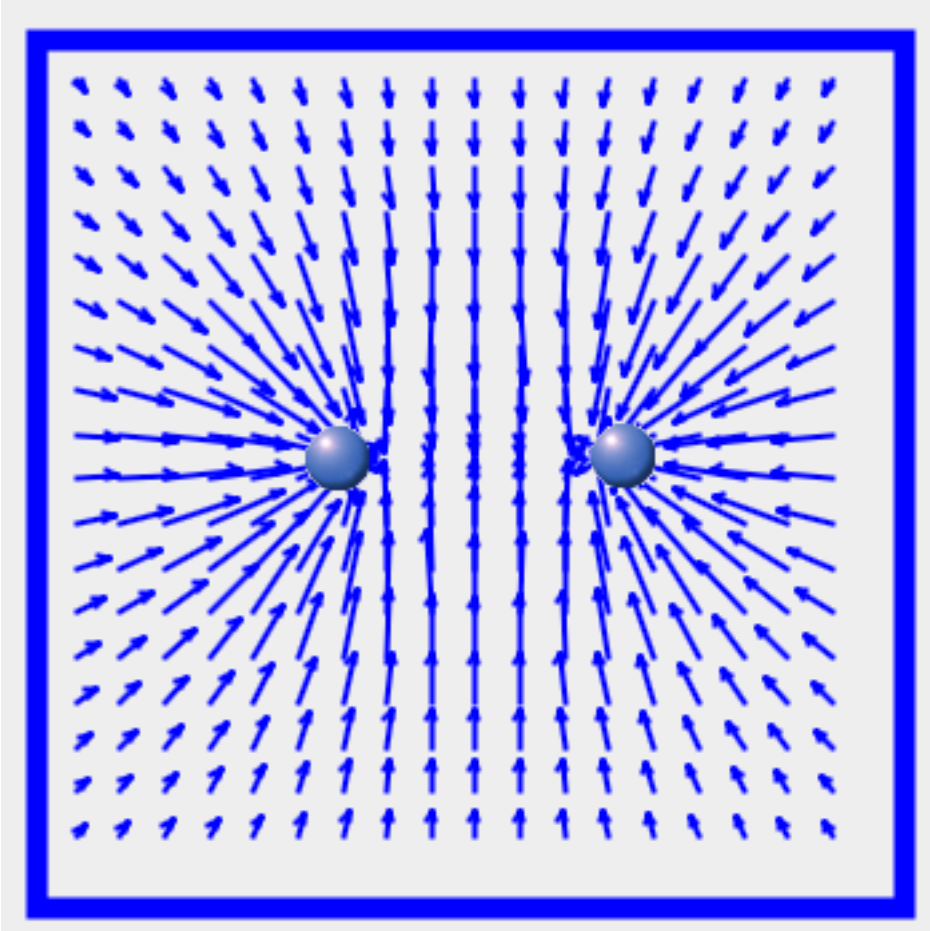


Electric field points **towards** charge

Is the charge negative or positive?

Review: Electric Field (of Dreams)

http://phet.colorado.edu/en/simulation/efield



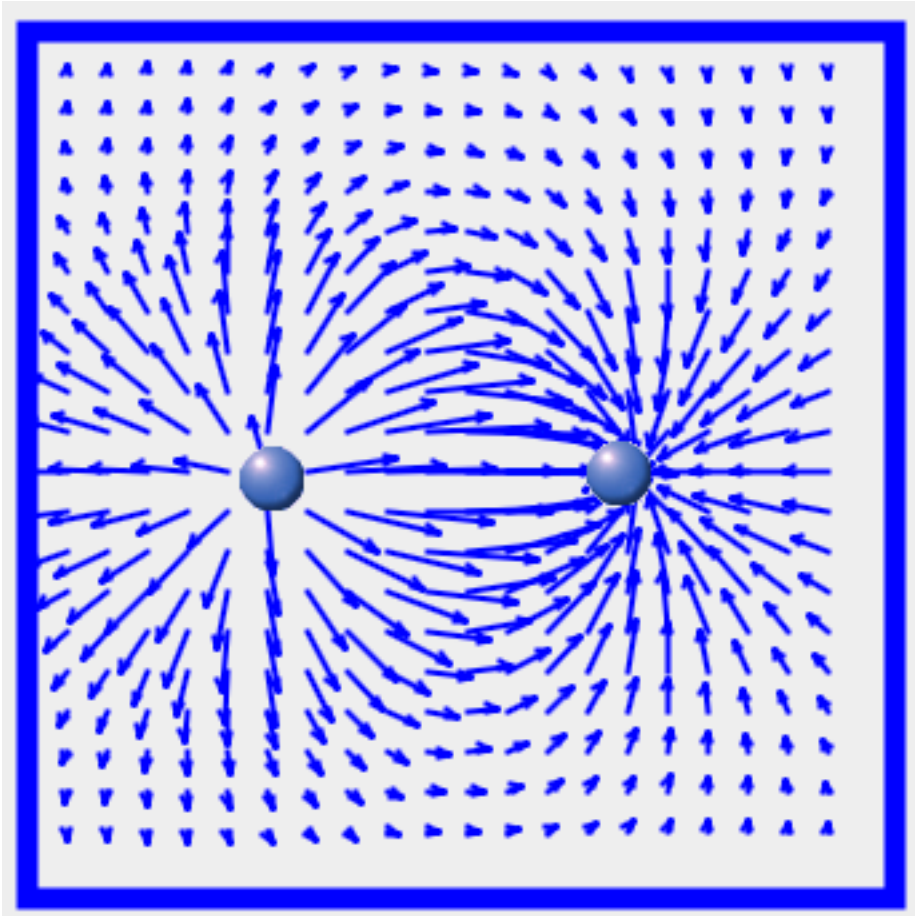
Two equal negative charges

$$\vec{E}_{\text{total}} = \sum_i \vec{E}_i = \sum_i \frac{kq_i}{r_i^2}\,\hat{r}_i$$

Note the absence of horizontal electric field in the middle

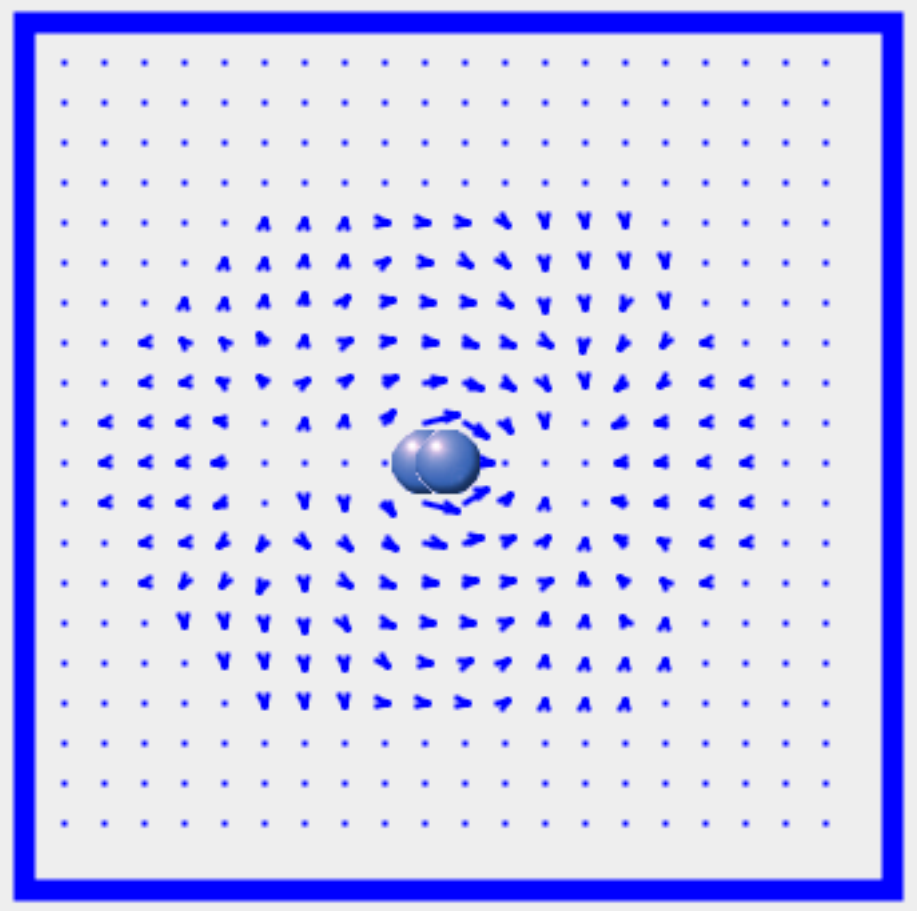
(But there is vertical magnetic field)

Electric Dipole



- Here is the field created by two equal and opposite charges
  - Like my H “atom” in the Wednesday lecture
- Electric field lines point away from positive charge, towards negative charge
- But far away (compared to the distance between them), the electric fields cancel
  - (r is very nearly the same for + and – charges)
  - This is an **electric dipole**

Electric Dipole



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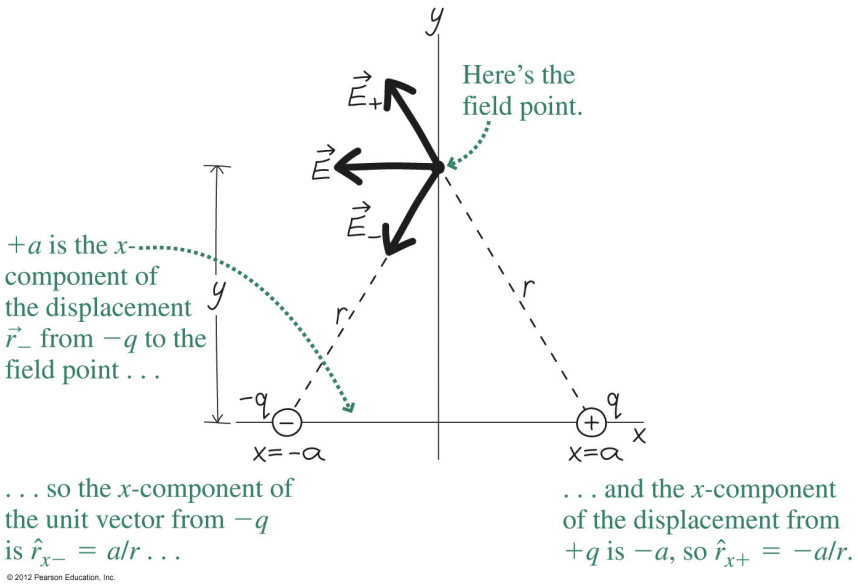
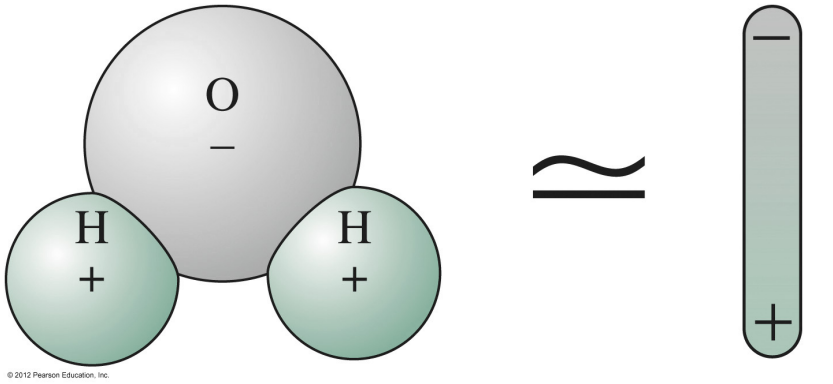
  - (r is very nearly the same for + and – charges)
  - This is an **electric dipole**

The Dipole: an Important Charge Distribution

- An **electric dipole** consists of two point charges of equal magnitude but opposite signs, held a short distance apart.
  - The dipole is electrically neutral, but the separation of its charges results in an electric field.
  - Many charge distributions, especially molecules, behave like electric dipoles.
  - The product of the charge and separation is the dipole moment: $p = qd$.
  - Far from the dipole, its electric field falls off as the inverse cube of the distance.





Quiz #1 Equation/Concept Sheet

Charge Units

$$\text{elementary charge } e = 1.6 \times 10^{-19}\ \text{C}$$

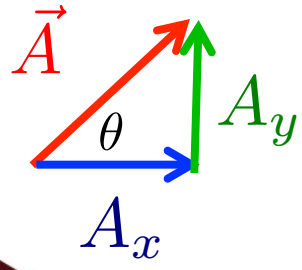
Coulomb's Law

$$\vec{F}_{12} = \frac{kq_1q_2}{r^2}\hat{r} \qquad k = 9.0 \times 10^9\ \text{N m}^2/\text{C}^2$$

Electric Field

$$\vec{E} = \frac{kq}{r^2}\hat{r} \qquad k = 9.0 \times 10^9\ \text{N m}^2/\text{C}^2$$

Vector Decomposition



$$A_x = A\cos\theta$$

$$A_y = A\sin\theta$$

$$A^2 = A_x^2 + A_y^2$$