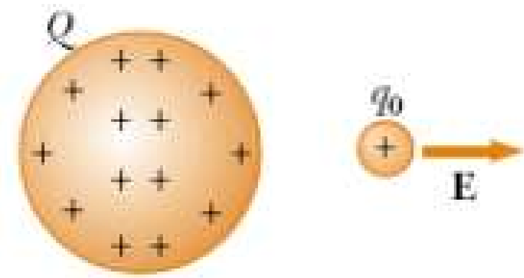
Physics 104

Ch 2: Electric Field

Part 2



Lecture Content

- Electric Field Concept.
- Electric field of a continuous charged object.

Electric Field

- Gravitational force is resulted because a gravity field (***g***) is present.
- Electric field exists in a region in space around a charged object (**source charge**).
- When another charged object (**test charge**) enters this electric field, an electric force acts on it.

Electric Field Definition

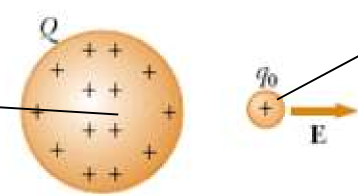
- The electric field due to the source charge at the location of the test charge is defined as the electric force on the test charge *per unit charge*, or to be more specific:
- The electric field vector ***E*** at a point in space is defined as the electric force $\boldsymbol{F_e}$ acting on a positive test charge q_0 placed at that point divided by the test charge.

$$E \equiv \frac{F_e}{q_0}$$

Only valid for a charged *particle*—an object of zero size. For a charged object of finite size in an electric field, the field may vary in magnitude and direction over the size of the object, so the corresponding force equation may be more complicated.

Test Charge

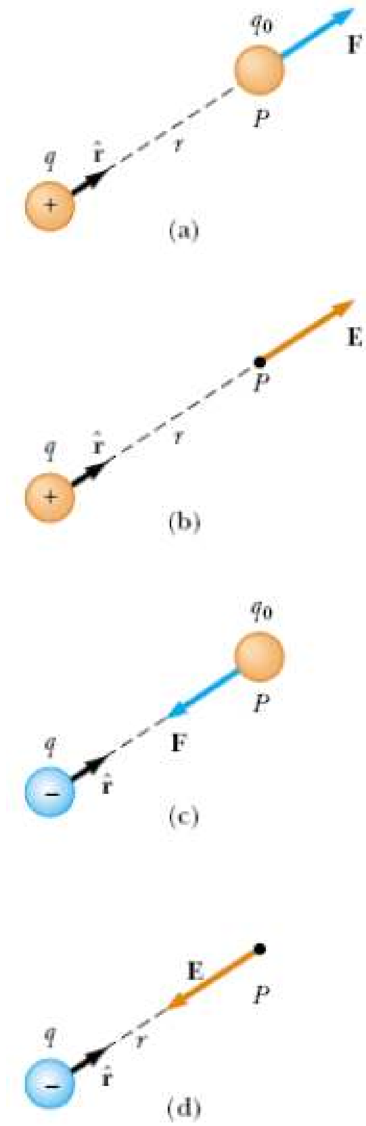
Source Charge



Presence of Electric Fields

- The electric field is present around the source charge whether the test charge is exist or not.
- The test charge is used as a detector to illustrate the principle.
- *E* has a unit (N / C).

Electric Force and Field on charged particle



- The electric field exists at a point if a test charge at that point experiences an electric force. (Better to say it is present around any charged object).
- The direction as shown in the adjacent figure.
- For positive source charge, the electric field points outward away from the charge. And for a negative source charge, the electric field point inward toward the charge.
- Using Coulomb's Law, *E* can be determined as:

$$E = k_e \frac{q}{r^2}$$

Electric Field for multi charged particle

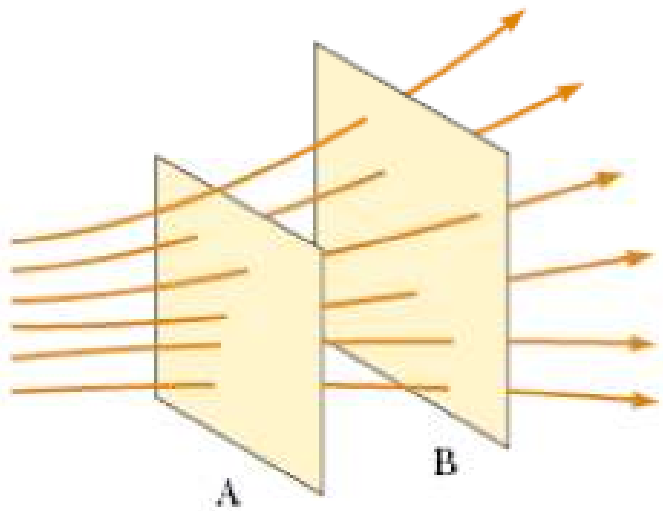
- If more than one charge is present, then the electric field on a point *P* is calculated for each field resulted from the source charges. And the net (resultant, total) electric field is the vectorial addition of each individual field.

$$E = k_e \sum_i \frac{q_i}{r_i^2}$$

Electric Field Lines

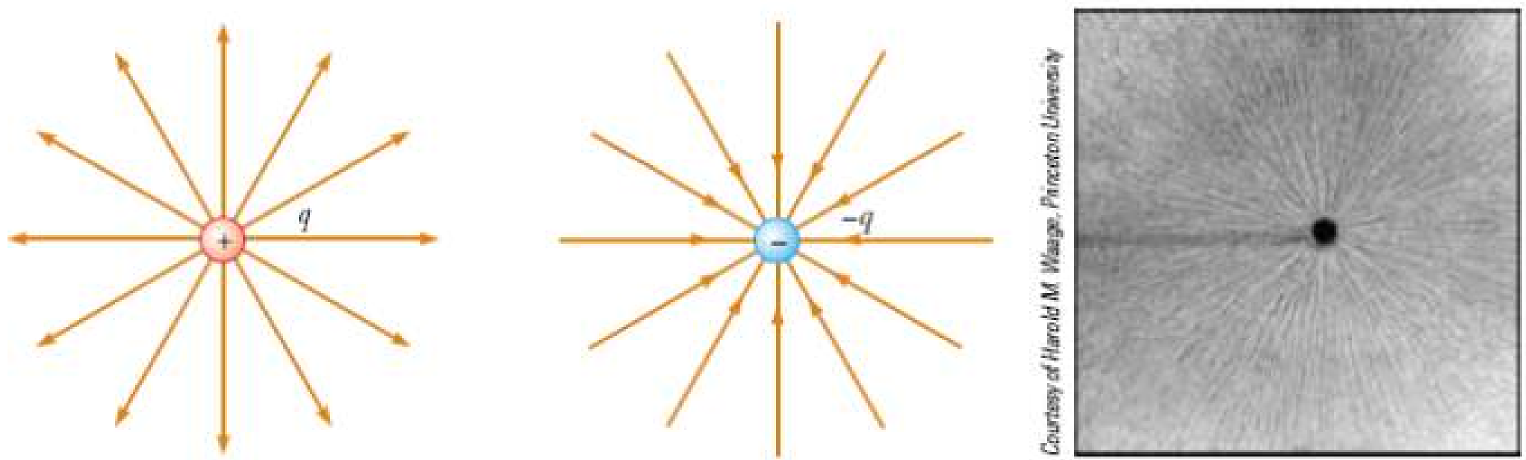
- •A convenient way of visualizing electric field patterns
- •By drawing curved lines that are parallel to the electric field vector at any point in space.
- •First introduced by Faraday.
- • The electric field vector E is tangent to the electric field line at each point. The line has a direction, indicated by an arrowhead, that is the same as that of the electric field vector.
- • The number of lines per unit area through a surface perpendicular to the lines is proportional to the magnitude of the electric field in that region. Thus, the field lines are close together where the electric field is strong and far apart where the field is weak.

Electric Field Lines



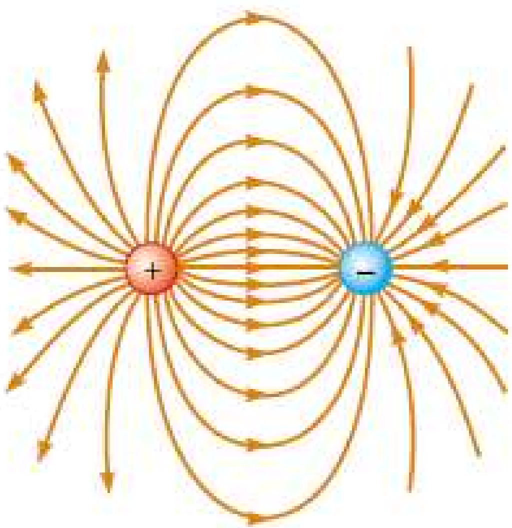
- The lines must begin on a positive charge and terminate on a negative charge. In the case of an excess of one type of charge, some lines will begin or end infinitely far away.
- The number of lines drawn leaving a positive charge or approaching a negative charge is proportional to the magnitude of the charge.
- No two field lines can cross.

Electric Field Lines

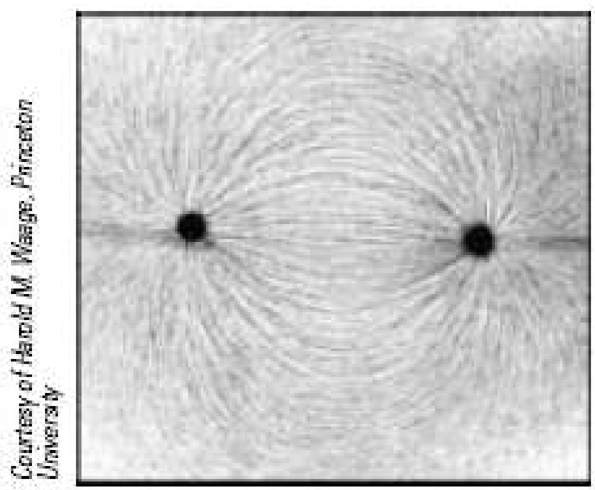


(a) (b) (c)

Electric Field Lines

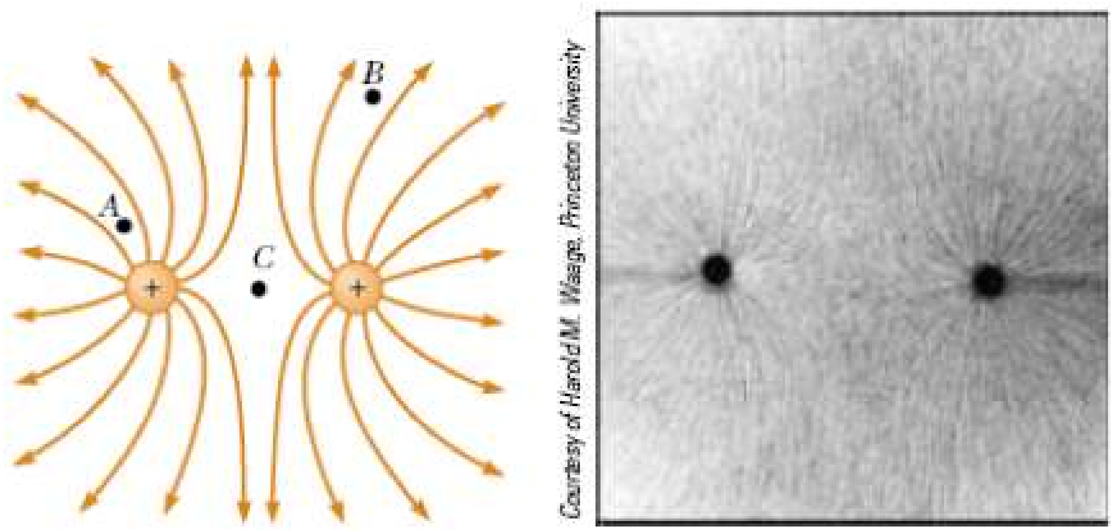


(a)



(b)

Electric Field Lines



(a) (b)