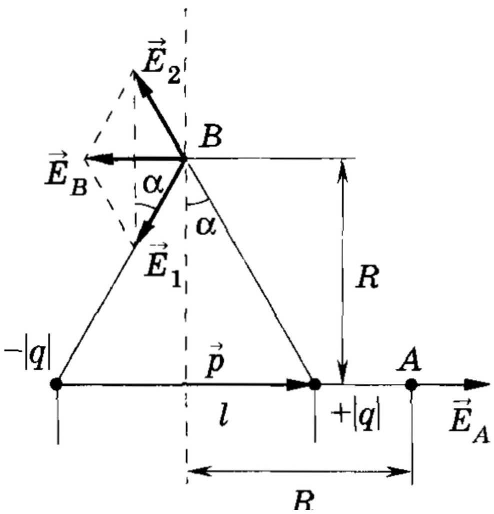
Earnshaw's Theorem.

Theorem. Any closed stationary system of electric charges is not stable.

Dipole



$$E_A = E_{+q} - E_{-q} = k|q|\left(\frac{1}{\left(R-\frac{l}{2}\right)^2} - \frac{1}{\left(R+\frac{l}{2}\right)^2}\right)$$

$$\frac{1}{\left(R-\frac{l}{2}\right)^2} - \frac{1}{\left(R+\frac{l}{2}\right)^2} \approx \frac{2l}{R^3}$$

$$E_A \approx k\frac{2|q|l}{R^3} = k\frac{2p}{R^3}$$

$$E_1 = E_2 = k\frac{|q|}{R^2 + \frac{l^2}{4}}$$

$$E_B = 2E_1 \sin\alpha = k\frac{|q|l}{\left(R^2 + \frac{l^2}{4}\right)^{3/2}} \approx k\frac{p}{R^3}$$

Note how both results give you same dependence on R ! If we have time we will try to use these results in class to derive the general formula

$$\vec{E} = \frac{3(\vec{p}\vec{r})}{r^5}\vec{r} - \frac{\vec{p}}{r}$$

Homework problem. *Four equal charges q are in the vertices of square with side equal to b. Find the electric field*

(a) at a distance d = 2b from the square along the continuation of the diagonal

(b) at a distance d = 2b from the square along the line running through the center of the square and parallel to two of the sides.