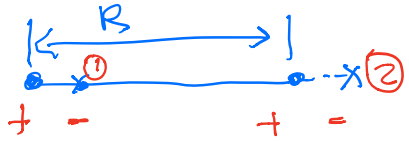
Dipole-dipole coupling



$$E = \frac{1}{R} - \frac{1}{R-x_1} - \frac{1}{R+x_2} + \frac{1}{R+x_2-x_1}$$

$$++ \quad +- \quad -+ \quad --$$

$$E = \frac{1}{R} - \frac{1}{R\left(1-\frac{x_1}{R}\right)} - \frac{1}{R\left(1+\frac{x_2}{R}\right)} + \frac{1}{R+x_2-x_1}$$

$$E = \frac{1}{R} - \left[\frac{1}{R} + \frac{x_1}{R^2} + \frac{x_1^2}{R^2}\right] - \left[\frac{1}{R} - \frac{x_2}{R^2} + \frac{x_2^2}{R^2}\right]$$

$$+ \left[\frac{1}{R} - \frac{(x_2-x_1)}{R^2} + \frac{(x_2-x_1)^2}{R^2}\right] + \cdots$$

$$E = -\frac{2x_1x_2}{R^3}$$

Note: I set the charges equal to +1 and -1. More generally, there will be q^2 factors in the numerator.

Recall $\mu_1 = q_1 x_1$, $\mu_2 = q_2 x_2$

So this corresponds to $-\frac{2\mu_1\mu_2}{R^3}$