Due date: Wednesday, Nov. 8

Reading: Griffiths 3.4, Handout #3, and Griffiths 4.1-2.
Note that the second hour exam will be on Wed. Nov. 15. No new homework will be handed out next week. This homework is a little bit long to compensate.

The first three problems refer to the multipole expansion for systems with axial symmetry (the charge density is independent of $\phi$ in radial coordinates). See Handout #3 for reference in solving these three problems. (We don’t quite follow Griffiths here.) The idea in these problems is to think about which of the constants $I_0$, $I_1$, and $I_2$ is the first to be non-zero; that will determine the “leading behavior” at large $r$. Then calculate the relevant constant $I_n$ to answer the question. Note that the integrals appearing in the last column of the handout might need to turn into sums, or line integrals, or surface integrals depending on what kind of charge distribution is specified.

1. [4 points] Three charges are arranged on the $z$ axis as follows.
   a) Charges $-q_0$, $3q_0$, and $-2q_0$ are located at $z = 2$, $z = 1$, and $z = -1$, respectively.
   What is the leading behavior of $V(r, \theta)$ at large $r$?
   b) Now the $3q_0$ charge is moved to the origin while the others are left in place. What is now the leading behavior at large $r$?

2. [4 points] A disk of radius $a$ lies in the $x$-$y$ plane and carries a variable surface charge density $\sigma(r) = \sigma_0 \left(1 - \frac{3r}{2a}\right)$.

3. [3 points] A ring of radius $a$ lies in the $x$-$z$ plane (read carefully: not the $x$-$y$ plane) and carries a variable linear charge density $\lambda = \lambda_0 \cos \theta$, where $\theta$ is the usual polar angle measured from the $+\hat{z}$ axis.

The remaining problems are independent of the above.

