Problem Set 7

Physics 110A, UC Berkeley, Spring 2021

Due Monday, 3/15, at 11:59PM

Problem 1

Show that the quadrupole term in the multipole expansion can be written as

$$V_{\text{quad}}(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\frac{1}{r^3}\sum_{i,j=1}^{3}\hat{r}_i\hat{r}_j Q_{ij},$$

where

$$Q_{ij} = \int\left[\frac{3}{2}r'_i r'_j - \frac{1}{2}\left(r'\right)^2\delta_{ij}\right]\rho\left(\mathbf{r}'\right)d\tau'.$$

Note that Q_{ij} is a rank-two tensor, so it is possible to express it as a matrix. Also show that Q_{ij} is traceless.

Problem 2

Show that the quadupole and moment Q_{ij} is independent of origin if the monopole and dipole moments both vanish.

Problem 3

A circular disk has a radius R and a uniform surface charge density σ. The disk is lying on the $x-y$ plane, with its center fixed at the origin. Find the potential $V(\mathbf{r})$ of the disk for large r, up to the $1/r^3$ term.

Below are selected optional problems from Griffiths. We do not collect your work, but you are encouraged to do as many practice problems as you can.

- Problem 3.47
- Problem 3.48
- Problem 3.49
- Problem 4.2
- Problem 4.4
- Problem 4.8
- Problem 4.10
- Problem 4.12