Droplet Electro-Bouncing in μ-Gravity

Erin S. Schmidt, Mark M. Weislogel

Abstract

Notes on electric fields 'n stuff.

1 The Electric Field

We are faced with the need to compute the total electric field arising from the presence of free charge on the surface of a polarizable dielectric. In the electrostatic case we have

$$\nabla \times \mathbf{E}(\mathbf{r}) = 0 \tag{1}$$

$$\nabla \cdot \mathbf{D}(\mathbf{r}) = \rho(\mathbf{r}). \tag{2}$$

If the dielectric is linear and isotropic then the displacement field is

$$\mathbf{D}(\mathbf{r}) = \epsilon(\mathbf{r})\mathbf{E}(\mathbf{r}). \tag{3}$$

Given that the electric field is defined as the gradient of the scalar potential, $\mathbf{E} = -\nabla\varphi$, we can write equation **??** as

$$\nabla \cdot [\epsilon(\mathbf{r})\nabla\varphi(\mathbf{r})] = -\rho(\mathbf{r}). \tag{4}$$

This is a form of *Poisson's equation*. Our general method for finding the electric field, will solve $\varphi(\mathbf{r})$ on a half-space domain with permittivities ϵ_1, ϵ_2 for a point source using the free-space *Green's function*. We can then find the total electric field by superposition of the individual Green's functions by direct integration.

The non-homogoneous part of the Poisson's equation for the electrostatic potential is a Green's function, denoted by $\mathbf{G}(\mathbf{r}|\mathbf{r}')$, where $\mathbf{G}$ satisfies Poisson's equation at $\mathbf{r}$ when the point source is located at $\mathbf{r}'$ such that

$$\nabla^2 \mathbf{G}(\mathbf{r}|\mathbf{r}') = -\delta(\mathbf{r} - \mathbf{r}'). \tag{5}$$

Using the identity for the position vector ∇