PHY 411 Winter 2021

Class Summary—Week 9, Day 2—Thursday, Mar 4

Method of Images

In principle, all boundary value problems in electrostatics for which either the potential or surface charge density is specified can be solved using Green functions. In practice, however, it may not always be possible to find a Green function by simple means. This has led to the development of a number of special techniques to the solution of boundary value problems. One of these, the expansion in orthogonal functions, we have already learned in great detail when we wrote the solution to the Laplace equation in Cartesian coordinates and then in spherical coordinates; we will do the solution in cylindrical coordinates next quarter. Another special technique is the **method of images**, which we will learn today.

The method of images can be applied when we have one or more point charges in the presence of boundary surfaces, e.g., conductors that are grounded or held at fixed potentials. If the geometry is favorable, we can place charges of appropriate magnitudes in suitable locations external to the region of interest to simulate the required boundary conditions. These charges are known as **image charges**, and the substitution of the actual problem with boundaries by a larger region with image charges but no boundaries is known as the **method of images**.

A simple example of the method of images is that of a point charge located in front of an infinite plane conductor at zero potential. We can replace this with the equivalent problem in which we have an equal and opposite charge located at the mirror image point behind the plane defined by the conductor. *On Question 1 of today's worksheet, you discussed why this choice is justified*; I won't repeat it here since I've discussed it in the posted video. You will see this problem again on the homework.

Point Charge Outside a Grounded Conducting Sphere

In Question 2 and Question 3 on today's worksheet, you solved for the potential when a point charge is placed outside a grounded conducting sphere. I won't repeat the details here since they are described in the posted video. Note also that in Tuesday's class next week, I will review a number of cases for a conducting sphere on the PowerPoint slides (to be posted in the video for that day).

Conducting Sphere in a Uniform Electric Field

On Question 4 and Question 5 of today's worksheet, you worked on the problem of a conducting sphere in a uniform electric field. Again, I won't repeat the details here since they are described in the posted video.