Assignment 2

Griffiths, David J. (2013). *Introduction to electrodynamics* (4th ed.) Portland, OR: Pearson.

The relevant material in this book is chapter 10, Potentials and Fields. In particular, section 1, The Potential Formulation, provides some insight into gauge transformations. The first subsection deals mainly with deriving a potential formulation of Maxwell’s equations. The second introduces the idea of gauges, and the third discusses two particularly popular gauges – the Coulomb gauge, which the book uses up to this point and is particularly useful for statics; and the Lorenz gauge, which the rest of the book uses and is particularly nice for making the potentials V and **A** equally easy to solve. The d’Alembertian operator is introduced to make this point clear. The fourth subsection uses the Lorenz gauge to discuss the Lorentz force law. The remaining two sections of this chapter discuss continuous distributions and point charges; their main relevance to the discussion of gauges is as an application of the Lorenz gauge, in finding a general solution to Maxwell’s equations.

This chapter is useful in providing an introduction to gauges and highlighting the main uses of the Coulomb and Lorenz gauges. There is also substantial applicative material in terms of how a gauge choice might aid in the study of electromagnetism. In particular, the material on solving the inhomogeneous wave equation will provide general forms of the electric and magnetic fields which could be used to compare with the same results derived from other gauges. However, it does not go much further than that. The direct study of gauges as objects will have to be left to other sources.

Jackson, J. D. (2002) From Lorenz to Coulomb and other explicit gauge transformations. *American Journal of Physics, 70*, 917. Retrieved from <http://aapt.scitation.org.proxy1.cl.msu.edu/doi/10.1119/1.1491265>

The primary purpose of this paper is to provide the reader with examples of gauges and show explicitly how they interact, both my means of gauge transformations and by means of showing that they result in the same electric and magnetic field equations. The first few sections deal primarily with the Lorenz and Coulomb gauge; section II covers the potential solutions to Maxwell’s equations, while sections III and IV discuss these gauges from the perspective of the theory (as described above). Section V derives the electric and magnetic fields from the Coulomb gauge. The later sections provide examples of several other common gauges, discussing them in ways similar to the discussion of the Lorenz and Coulomb gauges, albeit in a truncated manner. The results are summarized at the end.

This source provides a wealth of intuition to the discussion of gauges. By bringing to light several common examples of gauges and types of gauges, Jackson gives the reader a toolbox of gauges to use as well as a feel for the kind of things looked for in creating new gauges. This makes the field of gauge theory applicable, as opposed to a theoretical construct without attachment to electrodynamics. Thus, intuition will be the primary use for this paper.