Notes on Electrodynamics

Pugazharasu A D

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1.5.1 The Divergence of $\frac{\hat{r}}{r^2}$

$$\nabla . \frac{\hat{r}}{r^2} = 0 \tag{1.1}$$

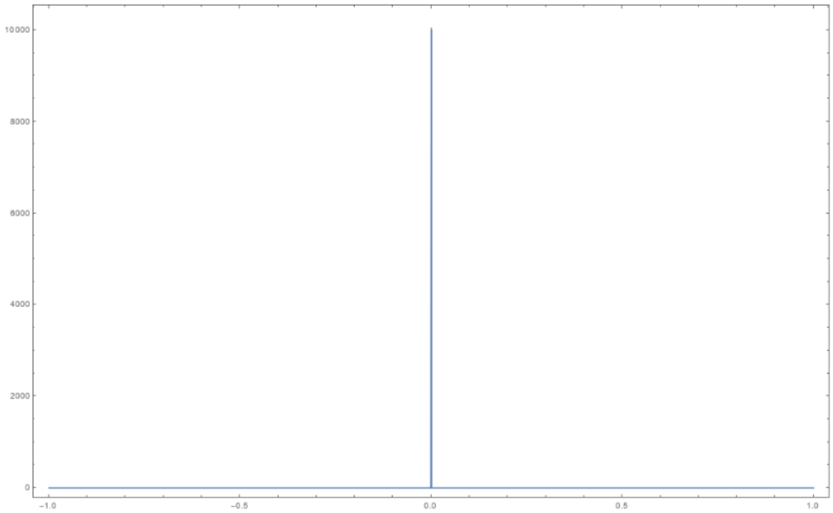

Figure 1.1: A Plot of $\delta(x)$

1.5.2 The One-Dimensional Dirac Delta Function

The Dirac Delta is a functional [1] which we define as,

$$\delta(x-a) = \begin{cases} 0, & \text{if } x \neq a \\ \infty, & \text{if } x = a \end{cases} \tag{1.2}$$

$$\int_{-\infty}^{+\infty} \delta(x-a)dx = 1 \tag{1.3}$$

$\forall\ a \in \mathbb{R}$ We can visualize it as a sharp peak at a, We can interpret 1.3 as saying "the area of the delta distribution is always 1".

$$f(x)\delta(x-a) = f(a) \tag{1.4}$$

We can combine these to get,

$$\int_{-\infty}^{+\infty} \delta(x-a)f(x)dx = f(a) \tag{1.5}$$

A few interesting properties

$$\delta(kx) = \frac{1}{|k|}\delta(x) \tag{1.6}$$

$$\frac{d}{dx}(\delta(x)) = -\delta(x) \tag{1.7}$$

[1] An object that is a map between functions

where k is a constant

$$\frac{d\theta}{dx} = \delta(x) \tag{1.8}$$

Where θ is the step function defined as,

$$\theta(x) = \begin{cases} 1, & \text{if } x > 0 \\ o, & \text{if } x \leq 0 \end{cases} \tag{1.9}$$

1.5.3 The Three-Dimensional Dirac Delta Function

We generalize () to three dimensions,

$$\delta^3(\vec{r} - \vec{a}) = \delta(x - a_x)\delta(y - a_y)\delta(z - a_z) \tag{1.10}$$

$$\int_{-\infty}^{+\infty} \delta^3(\vec{r} - \vec{a})dV = 1 \tag{1.11}$$

We can also define the three-dimensional delta function as

$$\mathfrak{r} \tag{1.12}$$

$$\mathfrak{r} =$$

1.6 The Theory of Vector Fields

1.6.1 The Helmoltz Theorem

This does cause an issue with ”Ontology” [2]

1.6.2 Potentials

[2] What's real and what isn't?

Chapter 2

Potentials And Fields

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Chapter 5

Tensors and Lagrangians

We can write the Faraday tensor as,

$$\frac{\partial J^{\mu}}{\partial x^{\mu}} = 0 \tag{5.1}$$

$$\frac{\partial F^{\mu\nu}}{\partial x^{\nu}} = \mu_0 J^{\mu} \tag{5.2}$$

$$\frac{\partial G^{\mu\nu}}{\partial x^{\nu}} = 0 \tag{5.3}$$

Chapter 6

Helmholtz Theorem