Electromagnetism (PHYS 295): Week 8

Spring 2024 v1.0

Intro:

We're in the middle of exploring the properties of a more-local form of Amperé's law and he new quantity "curl", or $\nabla\times$. This week we will uncover Stoke's theorem and derive the transformation properties of the both electric and magnetic fields. We may also return to the Lorentz force law to find the force on current carrying wires.

Reading:

- PM Chapter 5 Sections 5.3 - 5.6
- PM Chapter 2 Sections 2.14 - 2.17 on the curl
- PM Chapter 6 Sections 6.1 - 6.2

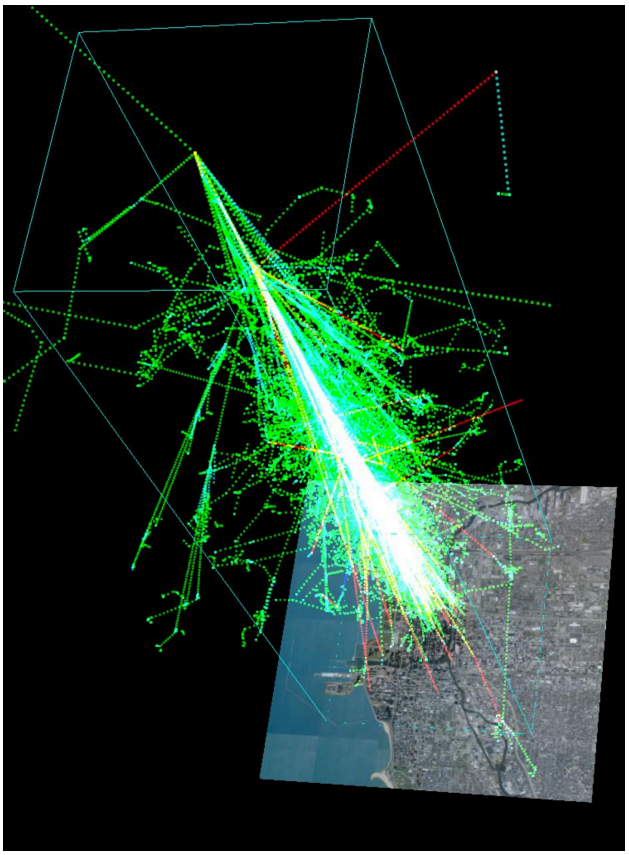
Problems: Due in class, 10 AM Friday, April 5

(1) Antiprotons are negatively charged twins of protons. They have charge $-e$ and mass m_p, same as a proton. In a particle collider an antiproton travels east and a proton travels west. At the closest approach they are 1.2×10^{-10} m apart. The energy of each particle in the lab frame is 6.5 TeV.
   (a) What is γ for each of the particles in the lab frame?
   (b) In the rest frame of the proton, what is the maximum intensity of the electric field due to the antiproton?
   (c) For approximately how long is the electric field magnitude larger than half the maximum?
   (d) What is the maximum force and acceleration of the proton?
   (Some of this was inspired by an analysis of the ship's acceleration and force in the Baltimore bridge disaster.)

(2) 5.10

(3) 5.15

(4) 5.16 Cosmic rays! Here's a picture of the shower from one 1 TeV event:



https://commons.wikimedia.org/w/index.php?curid=3954715

(5) 5.28

(6) 2.28 Computing a curl

(7) 2.75 Computing curls and diveregences

(8) 2.78 A theorem on $\nabla \cdot \nabla \times \mathbf{v}$