PHYSICS 200C, SPRING 2017
ELECTRICITY AND MAGNETISM

Assignment Six (aka Take-Home Final), Due Tuesday, June 13, noon.

[1.] Two Frames S and S′ have axes which are parallel and origins which coincide at $t = t' = 0$. If S′ moves with velocity $\vec{\mathbf{v}} = v\,(\cos\phi\,\hat{\mathbf{x}} + \sin\phi\,\hat{\mathbf{y}})$ with respect to S, write down the Lorentz transformation matrix Λ.

[2.] Find the magnetic field of a point charge q moving with velocity $\vec{\mathbf{v}}$ and show that it reduces to the Biot-Savart result in the limit $v/c \ll 1$.

[3.] Show that

$$\left(F^{\mu\,\nu}\right)' = \Lambda^{\mu}_{\rho}\Lambda^{\nu}_{\sigma}\left(F^{\rho\,\sigma}\right)$$

gives the correct rules for the transformation of the electric and magnetic fields.

[4.] Show that

$$\frac{F^{\mu\,\nu}}{\partial x^{\nu}} = \mu_0 J^{\mu} \qquad\qquad \frac{G^{\mu\,\nu}}{\partial x^{\nu}} = 0$$

are an alternative re-writing of the Maxwell equations.

[5.] Express

$$F^{\mu\,\nu}F_{\mu\,\nu}$$

in terms of the electric and magnetic fields.