PHYSICS 200B, WINTER 2017
ELECTRICITY AND MAGNETISM

Assignment Six, Due Monday, March 20, 5:00 pm.

[1.] The following three vector potentials describe the same magnetic field:

$$B_0 x\hat{\mathbf{y}}, \quad -B_0 y\hat{\mathbf{x}}, \quad \frac{1}{2}B_0(x\hat{\mathbf{y}} - y\hat{\mathbf{x}}).$$

Find the magnetic field, and the gauge transformations relating the different choices of $\mathbf{A}$.

[2.] Consider the vector potential $\mathbf{A}(\mathbf{r}) = A_0 e^{-(x^2+y^2+z^2)/a^2}\hat{\mathbf{z}}$, where A_0 and a are constants.
(a) Find and sketch the corresponding magnetic field.
(b) Can this be a magneto*static* field? If yes, find the current distribution that would give rise to it, and if not, explain why not.
(c) Is the vector potential given in the Coulomb gauge? If not, transform it to the Coulomb gauge to the best of your ability.

[3.] There is an interstellar magnetic field throughout the Milky Way with a strength between 1 and 10 μG. Taking an intermediate value of 3×10^{-6} G, and modelling the galaxy as a disk of diameter $\sim 10^{23}$ cm, and thickness 10^{21} cm, find the magnetic energy stored in the galaxy in order of magnitude. To get a sense of whether this is big or small, consider that all the stars in the galaxy put together are radiating 10^{44} ergs/sec. How many years of starlight is the magnetic energy worth?