Problems

1. Prove the following vector identity

$$(\nabla \times \vec{B}) \times \vec{B} = (\vec{B} \cdot \nabla)\vec{B} - \nabla \left(\frac{B^2}{2} \right).$$

2. Derive equations to calculate the relative abundance of hydrogen and helium in the solar wind given that you have measured the number density of protons, n_p, the number density of α particles (i.e, doubly ionized helium, He^{++}), n_α, and the number density of electrons, n_e.

3. Comment on Hughes footnote 39. That is, elaborate on the notion that magnetic field lines can't be uniquely identified, and expand on the example of particles bounding and drifting in a stationary dipole magnetic field. Even though the magnetic flux through the cyclotron orbit is approximately constant (this is the magnetic moment that we've discussed in class), are the same field lines threading through the orbit as the particle drifts? Why or why not?

4. Using Matlab, plot the Parker spiral from $10R_\odot$ out to 1AU. Choose approximately 27 field lines, as we did in class. In a second figure, plot these field lines out to Neptune's orbit. Comment on the differences between these two plots.

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