PHY 272: FIELDS
PROBLEM SET 8
due April 3rd, **before class**

I. CURLY THINGS

1) Show that

$$\nabla \times \nabla f = 0 \quad and \quad \nabla.\nabla \times \mathbb{A} = 0, \tag{1}$$

for any scalar (f) and vector ($\mathbb{A}$) fields by computing them in cartesian coordinates. The geometrical interpretation of this fact, which makes it obvious, will be discussed in class.

II. TOROIDAL SOLENOID

I lied in class.

The magnetic field generated by a toroidal solenoid (like the ones in the figure below) can be calculated exactly, regardless of the shape of the "cross-section", as long as it is constant all around the torus. The difficult part is to argue that the $\mathbb{B}$ field does not have a B_z ro B_r components, only a B_θ one (r, z and θ are the usual spherical coordinates). After that, a simple use of Ampere's law determines the field. Make your arguments very carefully and explicit.

III. CYCLOTRON MOTION

A non-relativistic electron with mass m and charge $-e$ moves around a circle in a constant magnetic field. Find the relation between the frequency of motion (called "cyclotron frequency") and the radius of the orbit.

If you want to understand the origin of the name "cyclotron" click here.