ADVANCED DYNAMICS — PHY 4241/5227

HOME AND CLASS WORK – SET 8

Download the Special Relativity and Maxwell Equations script and read up to section 1.1.4 (included). Due March 25.

(23) A particle of mass m and electric charge q moves under the influence of a constant magnetic field of the form $\mathbf{B}(\mathbf{r}) = B_0\hat{\mathbf{z}}$. Obtain the most general solution for the velocity $\mathbf{v}(t)$ using Newton's second law of motion in combination with the Lorentz force

$$\mathbf{F} = m\dot{\mathbf{v}} = \frac{q}{c}\mathbf{v}\times\mathbf{B}\ .$$

Homework, due March 28 before class (10 points).

(24) SI units (due March 28 before class, 4 points).

1. How is one second [s] defined?
2. How is one meter [m] defined?
3. How is one kilogram [kg] defined?
4. How is one Newton [N] defined?
5. How is one Ampere [A] defined?
6. How is one Coulomb [C] defined?
7. From the Biot-Savart law it follows that the force exerted by one (infinitely long) wrire on a section of length l of a parallel wire is given by

$$F = \frac{\mu_0}{2\pi}\,\frac{I_1\,I_2}{d}\,l\ ,$$

where μ_0 is the *permeability of vacuum*. What is the (exact) value of μ_0?

8. Using the above units, Coulomb's law read

$$F(r) = \frac{\kappa_0\,Q_1\,Q_2}{r^2}\,,\quad \kappa_0 = \frac{1}{4\pi\,\epsilon_0}$$

where κ_0 is called *Coulomb constant* and ϵ_0 *permittivity of vacuum*. They can, for instance, be estimated by force measurements. In SI units $\epsilon_0 = 8.85418782\times10^{-12}$. What are the physical dimensions of ϵ_0?

(25) Consider the 2D rotation

$$\begin{pmatrix} x'^1 \\ x'^4 \end{pmatrix} = \begin{pmatrix} \cos(\phi) & \sin(\phi) \\ -\sin(\phi) & \cos(\phi) \end{pmatrix}\begin{pmatrix} x^1 \\ x^4 \end{pmatrix}$$

and substitute $\phi = i\,\zeta$, $x^4 = i\,x^0$, $x'^4 = i\,x'^0$. Write out the equations for x'^1 and x'^0. Due in class (4 points).