ADVANCED DYNAMICS — PHY 4241/5227

HOME AND CLASS WORK – SET 10

(March 2, 2009)

(33) One of the Apollo missions left a mirror on the moon. The McDonald Observatory in Texas flashes a laser wave at this mirror, which is received back after an elapsed time $\triangle t$. At what distance was the mirror, when it reflected the signal? Due March 5 in class (1 point).

(34) Let (in arbitrary units)

$$\begin{aligned}
&(a) \quad ct = 5,\ x^1 = 1,\ x^2 = 2,\ x^3 = 3\,,\\
&(b) \quad ct = 5,\ x_1 = 1,\ x^2 = 2,\ x^3 = 3\,,\\
&(c) \quad ct = 5,\ x^1 = 1,\ x^2 = 2,\ x^3 = -3\,,\\
&(d) \quad ct = 5,\ x^1 = 0,\ x^2 = 3,\ x^3 = 4\,,\\
&(e) \quad ct = 5,\ x_1 = 0,\ x_2 = 3,\ x_3 = 4\,,\\
&(f) \quad ct = 5,\ x^1 = 2,\ x^2 = 3,\ x^3 = 4\,,\\
&(g) \quad ct = 5,\ x^1 = 0,\ x^2 = 3,\ x^3 = -4\,.
\end{aligned}$$

Write down the row and column vector for each case and calculate $x^\alpha\, x_\alpha$. Due March 5 in class (7 points).

(35) 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 15 before class (10 points).

(36) 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 March 24 in class (8 points).

Read the **Notes on Relativity** up to section 1.1.3 (due March 15).