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

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

Home work, due March 2 before class (8 points).

Read the Notes on Relativity up to section 1.1.3 (due February 27).

(38) 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 $\Delta t$. At what distance was the mirror, when it reflected the signal? Due February 25 in class (1 point).

(39) Let (in arbitrary units)

(a) $ct = 5$, $x^1 = 1$, $x^2 = 2$, $x^3 = 3$,
(b) $ct = 5$, $x_1 = 1$, $x^2 = 2$, $x^3 = 3$,
(c) $ct = 5$, $x^1 = 1$, $x^2 = 2$, $x^3 = -3$,
(d) $ct = 5$, $x^1 = 0$, $x^2 = 3$, $x^3 = 4$,
(e) $ct = 5$, $x_1 = 0$, $x_2 = 3$, $x_3 = 4$,
(f) $ct = 5$, $x^1 = 2$, $x^2 = 3$, $x^3 = 4$,
(g) $ct = 5$, $x^1 = 0$, $x^2 = 3$, $x^3 = -4$.

Write down the row and column vector for each case and calculate $x^\alpha x_\alpha$. Due February 25 in class (7 points).

(40) 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 February 27 in class (8 points).